



2020 TRANSPORTATION BOND PROJECT IMMANUEL ROAD IMPROVEMENTS

Prepared By



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IMMANUEL ROAD IMPROVEMENTS

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GEOTECHNICAL REPORT

Geotechnical Engineering Report by Corsair Consulting LLC dated October 8, 2024.

CITY OF PFLUGERVILLE REQUEST FOR PROPOSALS

City of Pflugerville, Texas
County of Travis

Competitive Sealed Proposals will be accepted online via CivCast at www.civcastusa.com, Project ID – “Immanuel Road Improvements” Project consisting of approximately 6845 feet of roadway from Bumblebee Drive to E. Pecan Street which includes retaining walls, drainage, bridges, signing & pavement markings, traffic signals, illumination, and pedestrian facilities.

Online services will open for submission of Competitive Sealed Proposals on **Wednesday, November 5, 2025**, and close on **Thursday, January 22, 2026** at 2:00 P.M. Offerors must follow submittal instructions on www.civcastusa.com. Hard copy proposals will not be accepted for this solicitation. Results will be read in a Virtual Bid Opening beginning at 2:00 P.M. on **Thursday, January 22, 2026**. Access instructions for the Virtual Bid Opening will be posted on the procurement website.

Proposals must be submitted on the Proposal forms provided and must be accompanied by a Bid Bond in a penal sum of not less than five percent (5%) of the total Contract Price proposed. The security may be in the form of a Bid Bond furnished by a reliable surety company having authority under the laws of Texas to write surety bonds in the amount required, with such security made payable without recourse to the City.

The final Notice of Award of Contract will be issued to the successful bidder by the City within sixty (60) days following the opening of bids and no bidder may withdraw a bid within sixty (60) days after opening thereof. The successful Offeror must furnish a Performance Bond and Payment Bond on the forms provided, each in the amount of one hundred percent (100%) of the contract amount, from a surety company authorized by the State of Texas to act as surety.

State statutes, including Prevailing wage and hour provisions and contract regulations must be adhered to as they relate to this Project. Contractors will be required to comply with all applicable Equal Employment Opportunity laws and regulations.

Copies of the Proposal Documents are on file and may be examined at the following location:

- www.civcastusa.com, Project ID – “Immanuel Road Improvements”

Proposal Documents must be obtained electronically by the prospective bidders or suppliers at www.civcastusa.com at no charge.

A Non-Mandatory Pre-Proposal Video Conference will be held at 2:00 P.M. on **Thursday, November 6, 2025**. Access instructions for the video conference will be posted as an addendum on www.civcastusa.com under Project ID – “Immanuel Road Improvements”.

Questions must be submitted using the Question-and-Answer process through www.civcastusa.com. Responses to questions posted on www.civcastusa.com will also be posted on the City of Pflugerville website for the benefit of all Offerors. A response will be posted for all questions until but no later than 12:00 P.M. on **Friday, January 16, 2026**.

The City of Pflugerville reserves the rights to reject any and all offers and to waive any informalities in proposals received; to eliminate a portion of the work or add additional work as required to keep the total contract amount within the funds budgeted; the right to award any parts or combination of parts of the Project it deems necessary; and any other rights established under the laws of the State of Texas.

Honorable Victor Gonzales, Mayor
City of Pflugerville

**CITY OF PFLUGERVILLE
INSTRUCTIONS TO OFFERORS**

1. **PROPOSAL FORMS:** All Offerors shall use only the proposal forms furnished, which will state the description of the proposed work, approximate quantities of the various items of work to be performed and materials to be furnished for which unit bid prices are asked. Terms not defined herein shall have the same meanings assigned thereto in the City's General Conditions.
2. **ESTIMATES OF QUANTITIES:** The quantities listed in the proposal forms shall be considered as approximate and will be used for comparison of proposals. Payment to the contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the contract, and it is understood that the quantities may be increased or decreased as provided in the General Conditions without invalidating the unit bid prices.
3. **PLAN SPECIFICATIONS AND SITE OF WORK:** Before submitting a Proposal, the Offeror shall examine the Project's Contract Documents carefully, including without limitation, the proposal, plans, specifications, special conditions of agreement, special provisions, and site of the proposed work. Offeror shall satisfy itself as to the character, quality, and quantities of work to be performed and materials to be furnished. The submission of a Proposal by an Offeror shall be conclusive evidence that Offeror has complied with these requirements.
4. **PREPARATION OF PROPOSAL AND BID PACKAGE:** Offeror shall submit their Proposal on the forms furnished. All blank spaces for each bid item in the proposal forms shall be correctly filled in by writing in words and numerals. The Offeror shall submit a price for each item in the Proposal. In case of conflict between words and numerals, the words shall govern unless otherwise addressed in the General Conditions. The Proposal shall be executed in the complete and correct name of the individual, firm or corporation making the proposal and signed by the person or persons authorized to bind the individual, firm, or corporation. The Offeror shall properly acknowledge all addenda in the spaces provided therefore on the proposal forms.

The following forms shall be completed in their entirety and included with the Offeror's Proposal:

1. City of Pflugerville Proposal and Bid Schedule
2. Proposal Form Exhibit A
3. Qualifications Statement
4. City of Pflugerville State of Texas Tax Code, Chapter 151 Compliance Certificate
5. City of Pflugerville Compliance to Texas State Law Regarding Nonresident Bidders Statement
6. Texas Ethics Commission Conflict of Interest Questionnaire
7. City of Pflugerville Non-Collusion Certificate
8. City of Pflugerville Bid Bond

Questions about the meaning or intent of the Contract Documents, Addenda, and the related supplemental data must be submitted via www.civcastusa.com under Project ID "Immanuel Road Improvements" prior to 12:00 P.M. **Friday, January 16, 2026**. A response may not be forthcoming if the inquiry or request is not submitted in time. Any interpretation of the Plans, Specifications and Contract Documents will be made by addendum only and a copy of each addendum will be posted on www.civcastusa.com. If no response is provided to a submitted question, the Offeror is advised to prepare their Proposal based on the Contract Documents as modified by any issued Addenda.

Responses to questions are not part of the Contract Documents and cannot modify the Contract Documents. An Addendum may be issued to clarify, correct, or change the Contract Documents, Addenda, or the related supplemental data as deemed advisable by City and the Project Design Consultant. Modifications to the Contract Documents can only be made by an Addendum.

5. **REJECTION OF PROPOSALS:** Proposals containing any omission, alteration of form, additions or conditions not called for, incomplete proposals, or proposals otherwise regular, but that are not accompanied by acceptable

proposal security will be considered irregular and may be rejected. In any case of ambiguity or lack of clearness in stating the prices in the proposal, the Owner reserves the right to consider the most advantageous construction thereof, or to reject the proposal. Unreasonable or unbalanced unit bid prices will be cause to reject any proposal.

6. BID SECURITY: Each proposal must be accompanied by a cashier's or certified check, payable to the City of Pflugerville or an acceptable bid bond in the amount of not less than five percent (5%) of the total amount bid, as a guarantee that bidder will enter into a contract and furnish bonds, if required, on the forms provided within ten (10) days after Notice of Award of the contract.
7. DELIVERY OF PROPOSAL: Each completed proposal shall be submitted, together with the bid security, online via www.civcastusa.com under Project ID – "Immanuel Road Improvements". Acknowledgement of all issued Addenda shall be made on the Proposal. Proposals will not be considered unless submitted on or before the time designated in the "Request for Proposals." Late proposals will not be considered.
8. WITHDRAWAL OF PROPOSALS: Any Offeror, upon written request, will be permitted to withdraw the Offeror's Proposal not later than the time set for the opening thereof. No Offeror may withdraw a Proposal within sixty (60) days after the date of the opening of proposals.
9. DISQUALIFICATION OF OFFERORS: The following causes may be considered as sufficient for the disqualification of an Offeror and the rejection of the Offeror's Proposal:
 - a. Submittal of more than one proposal for the same work from an individual, firm, partnership or corporation, or affiliate or subsidiary thereof.
 - b. Evidence of collusion among Offerors or evidence of impermissible ex parte communications initiated by the Offeror to City officials or employees not in accordance with the terms of the City's proposal processes.
 - c. Poor performance in the execution of work under previous contracts.
 - d. For being in arrears on existing contracts, in litigation with Owner, or having defaulted on a previous contract.
 - e. An Offeror, proposer, or other person interested in receiving the award of a contract from the City or entering into any other transaction with the City shall be deemed non-responsible and shall be denied any contract or other transaction with the City if that Offeror, proposer, or other person is indebted to the City or is delinquent in any payment owed to the City under a contract or other legal obligation, or otherwise is not eligible to contract with the City under Chapter 38 of the City's adopted Code of Ordinances.
10. EVALUATION OF PROPOSALS:
 - a. The selection of the Contractor will be made using a competitive sealed proposal process in accordance with Texas Government Code Chapter 2269. The City will evaluate and rank each proposal with respect to the selection criteria within forty-five (45) days after the date proposals are received. In evaluating proposals, the City will consider whether or not the proposals comply with the prescribed requirements, and such alternatives, prices, and other data, as may be requested in the proposal forms or may be requested from Offerors prior to a Notice of Award.
 - b. The City will consider the proposed Contract Price, proposed Contract Times, the experience Past Performance of the Offer, and the experience and qualifications of the proposed Key Personnel and Subcontractors, as described in this Article to determine which proposal offers the best value to the Owner. The proposals will be evaluated for each rating category with the maximum point value for each category as indicated in the following table:

Rating Category	Evaluation Criteria	Weighting Value in Points
A	Proposed Contract Price	60
B	Proposed Contract Times	15
C	Experience/Past Performance of Offeror	10
D	Experience and Qualifications of Proposed Key Personnel	10
E	Experience and Qualifications of Proposed Subcontractors	5
Total		100

- c. Proposals will be evaluated based on the evaluation criteria as indicated in this Article. In evaluating proposals, City will consider whether or not the proposals comply with the prescribed requirements, and such alternatives, prices, and other data, as may be requested in the Proposal and Bid Schedule or may be requested from Offerors prior to a Notice of Award.
- d. City will consider the proposed Contract Price and Contract Times and the qualifications of the Offerors to determine which Proposal offers the best value to Owner. Proposals will be evaluated using the information submitted in the Proposal and the information submitted as required by the Qualifications Statement.
- e. City may conduct such investigations as it deems necessary to establish the responsibility, qualifications, and financial ability of contractors, individuals, or entities proposed to furnish parts of the Work in accordance with the Contract Documents.
- f. City, at its discretion, may also choose to conduct interviews with the top-ranking Offerors to provide the Offerors a better opportunity to demonstrate they can provide the best value to the City for this Project.
 - 1. Should the City choose to conduct interviews with the top-ranking Offerors, they will be notified of:
 - a. The time and place for the interview;
 - b. Interview format and agenda;
 - c. Questions to answer at the interview; and
 - d. Individuals that are expected to participate in the interview as a minimum.
 - 2. Failure to participate in the interview may result in disqualification from consideration for the Project.
- g. Submission of a Proposal indicates the Offeror's acceptance of the evaluation technique and methodology as well as the Offeror's recognition that some subjective judgments must be made by the City during the evaluation.
- h. Evaluation for Rating Categories:
 - 1. Rating Category A – Proposed Contract Price:
 - a. The City will consider the Offeror's proposed Contract Price for completion of the project in determining best value to the Owner.
 - b. The City will consider the Contract Price offered and demonstrated ability to complete projects for the Contract Price.
 - c. The Contract Price will be used in the best value determination and will be the Contract Price awarded unless this amount is changed during negotiations between the Contractor and City. Negotiations, if any, will be conducted in accordance with Government Code 2269.155 and will only be for changes in scope and associated changes in Contract Time or Contract Price
 - d. The evaluation of proposed Contract Price will consider percentages of change orders for past projects as an indicator of ability to complete the Project within the Contract Price.

2. Rating Category B – Proposed Contract Time:
 - a. The City will consider the Offeror’s proposed Contract Times for completion of the project as well as any specific intermediate milestones in determining best value to the Owner.
 - b. The City will consider the proposed Contract Times and the demonstrated ability to complete projects on time, resources available for this project, and Offeror’s capacity.
 - c. The City will use the number of days proposed by Offeror to calculate the Substantial Completion and Final Completion dates from the date of the Notice to Proceed. These dates will define the Contract Times. Liquidated Damages as defined in Section 11 “Standard CIP Construction Agreement” will start to accrue after these dates.
 - d. The City will give consideration to earlier completion dates in the best value determination for the Project. The value of this early completion will be determined using the Offerors’ proposed completion dates, and approach for construction.
3. Rating Category C – Experience/Past Performance of Offeror:
 - a. The City will give consideration to the experience and past performance of the Offeror as a company, including, but not limited to:
 - i. Offeror’s recent experience and performance on similar projects;
 - ii. Organization’s operating philosophy and approach to deliver quality projects and satisfy the City;
 - iii. Financial stability and approach to financial management of projects;
 - iv. Safety programs and past safety performance;
 - v. Past experience on claims and litigation; and
 - vi. Past experience with the City.
4. Rating Category D - Experience and Qualifications of Proposed Key Personnel:
 - a. The City will give consideration to the experience and qualifications of the proposed Project Manager, Project Superintendent, Safety Manager, and Quality Control Manager for this Project, including, but not limited to:
 - i. Education, training, and personal experience in delivering similar projects while serving in the capacity for which they are being proposed;
 - ii. Demonstrated ability to complete quality projects on time and within budget as demonstrated by proposal information and reference checks for offered individuals;
 - iii. Demonstrated leadership, character, and capability of proposed individuals; and
 - iv. Availability and commitments to other projects.
5. Rating Category E – Proposed Subcontractors:
 - a. The City will give consideration to the experience and qualifications of proposed Subcontractors that will perform five percent (5%) or more of the Project either by dollar value or work quantity.
 - b. The City will consider the proposed Subcontractor’s past experience and performance with the City.
 - c. The City will consider the proposed subcontractor’s work history with the Offeror.

11. AWARD OF CONTRACT: The Offeror selected for award of the Contract will be the Offeror whose offer provides the best value to the City based on the selection criteria and the ranking. The City is not bound to accept the lowest priced proposal if that proposal is not in the best interest of the City as determined by the City. If the City determines that it is unable to reach a contract satisfactory to the City with the selected Offeror, then the City will terminate discussions with the selected Offeror and proceed to the next Offeror in order of selection ranking until an agreement is reached or the Owner has rejected all proposals.
- a. The City reserves the right to reject any and all proposals, including non-conforming, non-responsive, or conditional proposals. The Owner may also reject the Proposal of any Offeror if the Owner believes that it would not be in the best interest of the Owner to make an award to that Offeror. The Owner reserves the right to waive all formalities.
 - b. More than one proposal for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Offeror has an interest in more than one Proposal for the Work will be cause for disqualification of that Offeror and the rejection of all Proposals in which that Offeror has an interest.
 - c. Evaluation scoring will be made public no later than 7 days after the contract is awarded.
12. EXECUTION OF CONTRACT AND BONDS: The contract will include the Request for Proposals, Instructions to Offerors, Offeror's Proposal, any Bid Addenda issued, and all other Contract Documents specified within the City of Pflugerville Standard Capital Improvement Project (CIP) Construction Agreement between City and Contractor. Within ten (10) days after issuance of a Notice of Award of the contract, the successful Offeror shall execute the contract and furnish City of Pflugerville with a Performance Bond and labor and materials Payment Bond, each in the full amount of the Contract Price. The bonds are to be furnished as a guarantee of the faithful performance of the Work for the protection of the Owner against defective workmanship or materials, and as a guarantee that Offeror shall pay all sums for labor and materials incorporated therein.
13. APPROVAL OF CONTRACT: Upon receipt of the Contractor's executed contract and required security bonds, the contract will be executed by the Owner and delivered to the Contractor. The contract will not be binding to the Owner until it has been executed by the Owner and delivered to the Contractor.
14. FAILURE TO EXECUTE CONTRACT AND BONDS: Should the Offeror to whom the contract is awarded refuse or neglect to execute the contract and furnish the required bonds within ten (10) days after issuance of the Notice of Award of the contract, the bid security shall become the property of the Owner, not as a penalty but as liquidated damages.
15. PURSUING THE WORK: The Contractor shall commence work on or before, if agreed to by the City, a date to be specified in a written Notice to Proceed issued by the Owner and shall substantially complete the work within the number of days set forth in the Proposal, in accordance with the Contract Documents.
16. AGREEMENT: The terms and conditions described in the contract agreement included in 01-11.0 "Standard CIP Procurement Agreements" and supporting contractual conditions including 01-15.0 "Pflugerville CIP General Conditions for Procurement Contracts" and 01-16.0 "Pflugerville CIP Special Conditions" are non-negotiable.

End of Instructions to Offerors.

CITY OF PFLUGERVILLE PROPOSAL

Proposal of _____ (hereinafter called "Offeror"), doing business as a corporation / a partnership / an individual (strike out inapplicable terms), to the CITY OF PFLUGERVILLE (hereinafter called "Owner").

City of Pflugerville:

The Offeror, in compliance with your invitation for bids for the construction of Immanuel Road Improvements, having examined the Plans and Specifications and related documents, the site of the proposed Work, and being familiar with all of the conditions surrounding the construction of the proposed project, including materials and supplies, and to construct the project in accordance with the Plans, Specifications and Contract Documents, within the time set forth therein, and in performing the Work required under the Contract Documents, of which this proposal is part.

Offeror hereby agrees to commence work under this Contract on or before a date to be specified in written "Notice to Proceed" issued by the Owner and to Substantially and Finally Complete the Work within _____ and _____ consecutive calendar days thereafter. Offeror further agrees to pay as liquidated damages the sum set forth in the City of Pflugerville Standard Capital Improvement Project (CIP) Construction Agreement between City and Contractor for each consecutive calendar day thereafter.

Offeror acknowledges receipt of the following ADDENDA:

Addendum No. 1 dated _____	Received _____
Addendum No. 2 dated _____	Received _____
Addendum No. 3 dated _____	Received _____
Addendum No. 4 dated _____	Received _____

Offeror hereby acknowledges and agrees that the description of Work to be done at unit prices is intended principally to serve as a guide in evaluating bids and is not intended to fully describe all Work required.

Offeror further agrees that the Work to be done and material to be furnished at unit prices may be increased or diminished as may be considered necessary in the opinion of the Design Consultant and approved by the Owner to complete the Work fully as planned and contemplated, and that estimated quantities may be increased to cover additional work ordered by the Design Consultant and approved by the Owner, but not shown on the Plans or required by the Specifications, in accordance with the provisions of the General Conditions. Similarly, they may be decreased to cover deletion of the work so ordered.

Offeror hereby represents that the foregoing prices shall include all labor, materials, removal, overhead, profit, insurance, and any other costs from whatever source derived necessary to cover the finished work called for to complete the project. Changes shall be processed in accordance with applicable provisions of the General Conditions.

Offeror understands that the Owner reserves the right to reject any or all bids and to waive any informalities in the bidding, and also reserves all other rights afforded under applicable law whether stated in the Owner's proposal or not.

The Offeror agrees that this bid shall be good and may not be withdrawn for a period of sixty (60) calendar days after the scheduled closing and opening time for receiving bids.

Upon receipt of written Notice of Award of contract based on this bid, Offeror will execute the formal contract attached and deliver performance and payment bonds as required by the Contract Documents within ten (10) days.

The bid security attached in the sum of _____ (five percent (5%) of the bid amount) shall become the property of the Owner in the event the contract and performance and payment bonds are not executed and delivered within the time above set forth, as liquidated damages for the delay and additional expense to the Owner caused thereby.

Offeror represents that the following Architects, Engineers, Consultants, Sub-Consultants, job-site superintendents, Subcontractors and suppliers, as applicable, shall be involved in Project construction.

(Attach additional sheet if necessary)

Respectfully submitted:

Offeror: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(typed or printed)

Business Address: _____

Email: _____

Phone: _____

(Attach evidence of authority to sign if Offeror is a corporation, partnership, or a joint venture.)

(Seal – if bid by a corporation)

**CITY OF PFLUGERVILLE
IMMANUEL ROAD IMPROVEMENTS**

BID SCHEDULE

ITEM NO.	SECTION TITLE	SPECIFICATION BID ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
1	REMOVAL	C.O.P. 101S-B	PREPARING RIGHT OF WAY - DEVELOPMENT	STA	68.5	\$ -	\$ -
2	REMOVAL	TxDOT 104-7001	REMOVING CONC (PAV)	SY	464.0	\$ -	\$ -
3	REMOVAL	TxDOT 104-7007	REMOVING CONC (RIPRAP)	SY	38.0	\$ -	\$ -
4	REMOVAL	TxDOT 104-7011	REMOVING CONC (DRIVEWAYS)	SY	342.0	\$ -	\$ -
5	REMOVAL	TxDOT 104-7013	REMOVING CONC (SIDEWALK OR RAMP)	SY	2,808.0	\$ -	\$ -
6	REMOVAL	TxDOT 104-7018	REMOVING CONC (CURB OR CURB & GUTTER)	LF	2,615.0	\$ -	\$ -
7	REMOVAL	TxDOT 104-7037	REMOVE CONC RAIL (PARAPET & METAL EL)	LF	220.0	\$ -	\$ -
8	ROADWAY	TxDOT 110-7001	EXCAV (ROADWAY)	CY	26,013.0	\$ -	\$ -
9	ROADWAY	TxDOT 132-7004	EMBANK (FNL)(DC)(TY B)	CY	10,432.0	\$ -	\$ -
10	ROADWAY	TxDOT 132-7006	EMBANK (FNL)(DC)(TY C)	CY	2,304.0	\$ -	\$ -
11	EROSION CONTROL	TxDOT 160-7002	FURNISH & PLACE TOPSOIL (4")	SY	22,954.0	\$ -	\$ -
12	EROSION CONTROL	TxDOT 162-7002	BLOCK SODDING	SY	2,614.0	\$ -	\$ -
13	EROSION CONTROL	TxDOT 164-7012	DRILL SEED (PERM) (URBAN) (CLAY)	SY	20,340.0	\$ -	\$ -
14	EROSION CONTROL	TxDOT 164-7013	DRILL SEED (TEMP) (WARM)	SY	10,171.0	\$ -	\$ -
15	EROSION CONTROL	TxDOT 164-7014	DRILL SEED (TEMP) (COOL)	SY	10,171.0	\$ -	\$ -
16	EROSION CONTROL	TxDOT 168-7001	VEGETATIVE WATERING	TGL	866.1	\$ -	\$ -
17	EROSION CONTROL	TxDOT 169-7010	SOIL RET BLKT (SL_MOD_CLAY_LONG_ROLL)	SY	6,644.0	\$ -	\$ -
18	EROSION CONTROL	TxDOT 169-7029	SOIL RET BLKT (CHAN_TEMP_2 PSF)	SY	2,297.0	\$ -	\$ -
19	ROADWAY	TxDOT 216-7001	PROOF ROLLING	HR	20.0	\$ -	\$ -
20	ROADWAY	TxDOT 247-7176	FL BS (CMP IN PLC)(TYA GR1-2)(FNAL POS)	CY	8,159.0	\$ -	\$ -
21	ROADWAY	TxDOT 260-7005	LIME (COM OR QK)(SLURRY)	TON	858.0	\$ -	\$ -
22	ROADWAY	TxDOT 260-7020	LIME TRT (SUBGRADE)(8")	SY	18,927.0	\$ -	\$ -
23	ROADWAY	TxDOT 260-7026	LIME TRT (SUBGRADE)(12")	SY	18,915.0	\$ -	\$ -
24	ROADWAY	TxDOT 310-7015	PRIME COAT (MULTI OPTION)	GAL	7,323.0	\$ -	\$ -
25	ROADWAY	TxDOT 341-7015	D-GR HMA TY-C PG64-22	TON	10,265.0	\$ -	\$ -
26	WORK ZONE TRAFFIC CONTROL / ROADWAY	TxDOT 341-7046	D-GR HMA TY-C PG64-22 (LEVEL-UP)	TON	128.0	\$ -	\$ -
27	ROADWAY	TxDOT 341-7050	D-GR HMA TY-D SAC-B PG70-22	TON	3,041.0	\$ -	\$ -
28	ROADWAY	TxDOT 341-7082	TACK COAT	GAL	2,945.0	\$ -	\$ -
29	REMOVAL	TxDOT 354-7065	PLANE ASPH CONC PAV (0" TO 1.5")	SY	5,325.0	\$ -	\$ -
30	DRAINAGE / BRIDGE	TxDOT 400-7010	CEM STABIL BKFL	CY	405.0	\$ -	\$ -
31	DRAINAGE	TxDOT 402-7001	TRENCH EXCAVATION PROTECTION	LF	6,418.0	\$ -	\$ -
32	WORK ZONE TRAFFIC CONTROL	TxDOT 403-7001	TEMPORARY SPL SHORING	SF	2,671.0	\$ -	\$ -
33	BRIDGE	TxDOT 416-7002	DRILL SHAFT (18 IN)	LF	36.0	\$ -	\$ -
34	BRIDGE	TxDOT 416-7004	DRILL SHAFT (24 IN)	LF	656.0	\$ -	\$ -
35	BRIDGE	TxDOT 416-7006	DRILL SHAFT (36 IN)	LF	312.0	\$ -	\$ -
36	ILLUMINATION	TxDOT 416-7040	DRILL SHAFT (RDWY ILL POLE) (30 IN)	LF	304.0	\$ -	\$ -
37	TRAFFIC SIGNALS	TxDOT 416-7042	DRILL SHAFT (TRF SIG POLE)(24 IN)	LF	72.0	\$ -	\$ -
38	TRAFFIC SIGNALS	TxDOT 416-7043	DRILL SHAFT (TRF SIG POLE)(30 IN)	LF	24.0	\$ -	\$ -
39	TRAFFIC SIGNALS	TxDOT 416-7044	DRILL SHAFT (TRF SIG POLE)(36 IN)	LF	28.0	\$ -	\$ -
40	DRAINAGE	TxDOT 420-7002	CL A CONC (MISC)	CY	3.0	\$ -	\$ -
41	BRIDGE	TxDOT 420-7012	CL C CONC (ABUT)	CY	142.7	\$ -	\$ -
42	BRIDGE	TxDOT 420-7022	CL C CONC (CAP)	CY	71.3	\$ -	\$ -
43	BRIDGE	TxDOT 420-7038	CL C CONC (COLUMN)	CY	44.5	\$ -	\$ -
44	BRIDGE	TxDOT 422-7001	REINF CONC SLAB	SF	8,820.0	\$ -	\$ -
45	BRIDGE	TxDOT 422-7007	REINF CONC SLAB (SLAB BEAM)	SF	11,060.0	\$ -	\$ -
46	BRIDGE	TxDOT 422-7011	BRIDGE MEDIAN	SF	744.0	\$ -	\$ -
47	BRIDGE	TxDOT 422-7012	BRIDGE SIDEWALK	SF	7,280.0	\$ -	\$ -
48	RETAINING WALL	TxDOT 423-7001	RETAINING WALL (MSE)	SF	13,074.0	\$ -	\$ -
49	WORK ZONE TRAFFIC CONTROL / ROADWAY	TxDOT 423-7012	RETAINING WALL (TEMP WALL)	SF	3,556.0	\$ -	\$ -
50	BRIDGE	TxDOT 425-7001	PRESTR CONC GIRDER (TX28)	LF	1,290.33	\$ -	\$ -
51	BRIDGE	TxDOT 425-7018	PRESTR CONC SLAB BEAM (4SB15)	LF	1,108.78	\$ -	\$ -
52	BRIDGE	TxDOT 425-7019	PRESTR CONC SLAB BEAM (5SB15)	LF	1,247.38	\$ -	\$ -
53	ROADWAY	C.O.P. 430S-B	PC CONCRETE CURB AND GUTTER (FINE GRADING)	LF	14,195.0	\$ -	\$ -
54	ROADWAY	C.O.P. 432S-A	NEW PC CONCRETE SIDEWALKS, (THICKNESS 4")	SF	7,990.0	\$ -	\$ -
55	ROADWAY	C.O.P. 432S-A	NEW PC CONCRETE SIDEWALKS, (THICKNESS 5-1/2")	SF	111,904.0	\$ -	\$ -
56	ROADWAY	C.O.P. 433S-A	TYPE I PC CONCRETE DRIVEWAY	SF	900.0	\$ -	\$ -
57	ROADWAY	C.O.P. 433S-C	TYPE II PC CONCRETE DRIVEWAY	SF	11,072.0	\$ -	\$ -
58	WZ TCP / ROADWAY / ILLUMINATION	TxDOT 432-7001	RIPRAP (CONC)(4 IN)	CY	267.2	\$ -	\$ -
59	RETAINING WALL	TxDOT 432-7012	RIPRAP (CONC)(FLUME)	CY	5.6	\$ -	\$ -
60	RETAINING WALL	TxDOT 432-7013	RIPRAP (MOW STRIP)(4 IN)	CY	33.1	\$ -	\$ -
61	BRIDGE	TxDOT 432-7045	RIPRAP (STONE PROTECTION)(24 IN)	CY	942.0	\$ -	\$ -
62	BRIDGE	TxDOT 432-7047	RIPRAP (STONE PROTECTION)(30 IN)	CY	708.0	\$ -	\$ -

ITEM NO.	SECTION TITLE	SPECIFICATION BID ITEM		DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
63	BRIDGE	TxDOT	442-7008	STR STEEL (MISCELLANEOUS BRIDGE)	LB	1,316.0	\$ -	\$ -
64	RETAINING WALL / BRIDGE	TxDOT	450-7032	RAIL (TY C221)	LF	2,453.0	\$ -	\$ -
65	ROADWAY	TxDOT	450-7063	RAIL (HANDRAIL)(TY F)	LF	1,388.0	\$ -	\$ -
66	BRIDGE	TxDOT	454-7003	ARMOR JOINT (SEALED)	LF	287.0	\$ -	\$ -
67	DRAINAGE	TxDOT	462-7007	CONC BOX CULV (5 FT X 3 FT)	LF	244.0	\$ -	\$ -
68	DRAINAGE	TxDOT	464-7003	RC PIPE (CL III)(18 IN)	LF	2,339.0	\$ -	\$ -
69	DRAINAGE	TxDOT	464-7005	RC PIPE (CL III)(24 IN)	LF	446.0	\$ -	\$ -
70	DRAINAGE	TxDOT	464-7007	RC PIPE (CL III)(30 IN)	LF	1,959.0	\$ -	\$ -
71	DRAINAGE	TxDOT	464-7009	RC PIPE (CL III)(36 IN)	LF	1,530.0	\$ -	\$ -
72	DRAINAGE	TxDOT	464-7010	RC PIPE (CL III)(42 IN)	LF	499.0	\$ -	\$ -
73	DRAINAGE	TxDOT	464-7011	RC PIPE (CL III)(48 IN)	LF	621.0	\$ -	\$ -
74	DRAINAGE	TxDOT	464-7012	RC PIPE (CL III)(54 IN)	LF	178.0	\$ -	\$ -
75	DRAINAGE	TxDOT	464-7013	RC PIPE (CL III)(60 IN)	LF	91.0	\$ -	\$ -
76	DRAINAGE	TxDOT	464-7019	RC PIPE (CL IV) (18 IN)	LF	82.0	\$ -	\$ -
77	DRAINAGE	TxDOT	464-7027	RC PIPE (CL IV) (54 IN)	LF	84.0	\$ -	\$ -
78	DRAINAGE	TxDOT	465-7076	JCTBOX(COMPL)(PJB)(6FTX6FT)	EA	6.0	\$ -	\$ -
79	DRAINAGE	TxDOT	465-7077	JCTBOX(COMPL)(PJB)(8FTX8FT)	EA	1.0	\$ -	\$ -
80	WORK ZONE TRAFFIC CONTROL	TxDOT	465-7146	INLET(COMPL) (PSL)(SFG) (3FTX3FT-3FTX3FT)	EA	6.0	\$ -	\$ -
81	DRAINAGE	TxDOT	465-7152	INLET (COMPL)(PAZD)(RC)(3FTX3FT)	EA	18.0	\$ -	\$ -
82	DRAINAGE	TxDOT	465-7153	INLET (COMPL)(PAZD)(RC)(4FTX4FT)	EA	3.0	\$ -	\$ -
83	DRAINAGE	TxDOT	466-7174	WINGWALL (PW - 1) (HW=4 FT)	EA	1.0	\$ -	\$ -
84	DRAINAGE	TxDOT	467-7099	SET (TY I)(S= 5 FT)(HW= 4 FT)(3:1)(C)	EA	1.0	\$ -	\$ -
85	DRAINAGE	TxDOT	467-7305	SET (TY II)(18 IN)(RCP)(3: 1)(C)	EA	1.0	\$ -	\$ -
86	DRAINAGE	TxDOT	467-7325	SET (TY II)(24 IN)(RCP)(3: 1)(C)	EA	1.0	\$ -	\$ -
87	DRAINAGE	TxDOT	467-7389	SET (TY II)(48 IN)(RCP)(3: 1)(C)	EA	1.0	\$ -	\$ -
88	DRAINAGE	TxDOT	467-7397	SET (TY II)(54 IN)(RCP)(3: 1)(C)	EA	1.0	\$ -	\$ -
89	DRAINAGE	TxDOT	467-7405	SET (TY II)(60 IN)(RCP)(3: 1)(C)	EA	1.0	\$ -	\$ -
90	DRAINAGE	TxDOT	479-7002	ADJUSTING INLETS	EA	3.0	\$ -	\$ -
91	DRAINAGE	C.O.P.	506S	STORM DRAIN MANHOLE (4')	EA	6.0	\$ -	\$ -
92	DRAINAGE	C.O.P.	506S	STORM DRAIN MANHOLE (5')	EA	25.0	\$ -	\$ -
93	DRAINAGE	C.O.P.	506S	STORM DRAIN MANHOLE (6')	EA	15.0	\$ -	\$ -
94	DRAINAGE	C.O.P.	508S	CURB INLET (10')	EA	85.0	\$ -	\$ -
95	REMOVAL	TxDOT	496-7004	REMOV STR (SET)	EA	34.0	\$ -	\$ -
96	REMOVAL	TxDOT	496-7006	REMOV STR (HEADWALL)	EA	3.0	\$ -	\$ -
97	REMOVAL	TxDOT	496-7007	REMOV STR (PIPE)	LF	1,801.0	\$ -	\$ -
98	REMOVAL	TxDOT	496-7009	REMOV STR (BRIDGE 0 - 99 FT LENGTH)	EA	1.0	\$ -	\$ -
99	REMOVAL	TxDOT	496-7010	REMOV STR (BRIDGE 100 - 499 FT LENGTH)	EA	1.0	\$ -	\$ -
100	REMOVAL	TxDOT	496-7014	REMOV STR (ABUTMENT)	EA	2.0	\$ -	\$ -
101	UTILITY - PFLUGERVILLE & MANVILLE	C.O.P.	504	ADJUST WATER VALVE TO FG	EA	2.0	\$ -	\$ -
102	UTILITY - PFLUGERVILLE	C.O.P.	504	ADJUST WATER METER TO FG	EA	3.0	\$ -	\$ -
103	UTILITY - MANVILLE	C.O.P.	504	ADJUST AIR RELEASE VALVE AND AIR PIPING TO FG	EA	1.0	\$ -	\$ -
104	UTILITY - PFLUGERVILLE	C.O.P.	504	REMOVE WATER VALVE	EA	1.0	\$ -	\$ -
105	UTILITY - PFLUGERVILLE	C.O.P.	504	REMOVE EXISTING FIRE HYDRANT	EA	2.0	\$ -	\$ -
106	UTILITY - MANVILLE	C.O.P.	505	CONCRETE ENCASEMENT OF PIPE (24-IN DIA)	LF	20.0	\$ -	\$ -
107	UTILITY - MANVILLE	C.O.P.	505	ENC PIPE STL (1/4 IN THICK) 4-IN DIA (OPEN CUT)(ALL DEPTHS)	LF	39.0	\$ -	\$ -
108	UTILITY - MANVILLE	C.O.P.	505	ENC PIPE STL (5/16 IN THICK) 20-IN DIA (OPEN CUT)(ALL DEPTHS)	LF	478.0	\$ -	\$ -
109	UTILITY - PFLUGERVILLE	C.O.P.	505	ENC PIPE STL (3/8 IN THICK) 24-IN DIA (OPEN CUT)(ALL DEPTHS)	LF	40.0	\$ -	\$ -
110	UTILITY - PFLUGERVILLE	C.O.P.	506	MINOR MANHOLE ADJUSTMENT	EA	1.0	\$ -	\$ -
111	UTILITY - PFLUGERVILLE & MANVILLE	C.O.P.	509	TRENCH SAFETY SYSTEMS (ALL DEPTHS)	LF	1,963.0	\$ -	\$ -
112	UTILITY - MANVILLE	C.O.P.	510	PIPE (CL 150 RJ OR PVC C900) 1-IN DIA (ALL DEPTHS) INCL E&B	LF	62.0	\$ -	\$ -
113	UTILITY - MANVILLE	C.O.P.	510	PIPE (CL 150 RJ OR PVC C900) 10-IN DIA (ALL DEPTHS) INCL E&B	LF	1,121.0	\$ -	\$ -
114	UTILITY - PFLUGERVILLE	C.O.P.	510	PIPE (CL 350 RJ OR PVC C900) 6-IN DIA (ALL DEPTHS) INCL E&B	LF	42.0	\$ -	\$ -
115	UTILITY - PFLUGERVILLE	C.O.P.	510	PIPE (CL 350 RJ OR PVC C900) 8-IN DIA (ALL DEPTHS) INCL E&B	LF	294.0	\$ -	\$ -
116	UTILITY - PFLUGERVILLE	C.O.P.	510	PIPE (CL 250 RJ OR PVC C900) 12-IN DIA (ALL DEPTHS) INCL E&B	LF	345.0	\$ -	\$ -
117	UTILITY - PFLUGERVILLE	C.O.P.	510	PIPE (CL 250 RJ OR PVC C900) 16-IN DIA (ALL DEPTHS) INCL E&B	LF	99.0	\$ -	\$ -
118	UTILITY - MANVILLE	C.O.P.	510	PIPE REMOVAL, (1-IN DIA) (ALL DEPTHS), INCL EXC AND BACKFILL	LF	60.0	\$ -	\$ -
119	UTILITY - PFLUGERVILLE	C.O.P.	510	PIPE REMOVAL, (8-IN DIA) (ALL DEPTHS), INCL EXC AND BACKFILL	LF	303.0	\$ -	\$ -
120	UTILITY - MANVILLE	C.O.P.	510	PIPE REMOVAL, (10-IN DIA) (ALL DEPTHS), INCL EXC AND BACKFILL	LF	1,065.0	\$ -	\$ -
121	UTILITY - PFLUGERVILLE	C.O.P.	510	PIPE REMOVAL, (12-IN DIA) (ALL DEPTHS), INCL EXC AND BACKFILL	LF	346.0	\$ -	\$ -
122	UTILITY - PFLUGERVILLE	C.O.P.	510	PIPE REMOVAL, (16-IN DIA) (ALL DEPTHS), INCL EXC AND BACKFILL	LF	91.0	\$ -	\$ -
123	UTILITY - MANVILLE	C.O.P.	510	WET CONNECTION 1-IN DIA X 1-IN DIA	EA	1.0	\$ -	\$ -
124	UTILITY - PFLUGERVILLE	C.O.P.	510	WET CONNECTION 8-IN DIA X 6-IN DIA	EA	1.0	\$ -	\$ -
125	UTILITY - PFLUGERVILLE	C.O.P.	510	WET CONNECTION 8-IN DIA X 8-IN DIA	EA	4.0	\$ -	\$ -
126	UTILITY - MANVILLE	C.O.P.	510	WET CONNECTION 10-IN DIA X 10-IN DIA	EA	10.0	\$ -	\$ -

ITEM NO.	SECTION TITLE	SPECIFICATION BID ITEM		DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
127	UTILITY - PFLUGERVILLE	C.O.P.	510	WET CONNECTION 12-IN DIA X 12-IN DIA	EA	3.0	\$ -	\$ -
128	UTILITY - PFLUGERVILLE	C.O.P.	510	WET CONNECTION 16-IN DIA X 16-IN DIA	EA	3.0	\$ -	\$ -
129	UTILITY - PFLUGERVILLE & MANVILLE	C.O.P.	510	DUCTILE IRON FITTINGS	TON	7.7	\$ -	\$ -
130	UTILITY - MANVILLE	C.O.P.	511	AIR RELEASE VALVE (1-IN DIA)	EA	1.0	\$ -	\$ -
131	UTILITY - MANVILLE	C.O.P.	511	VALVES (GATE TYPE)(1-IN DIA)	EA	1.0	\$ -	\$ -
132	UTILITY - PFLUGERVILLE	C.O.P.	511	VALVES (GATE TYPE)(6-IN DIA)	EA	3.0	\$ -	\$ -
133	UTILITY - PFLUGERVILLE	C.O.P.	511	VALVES (GATE TYPE)(8-IN DIA)	EA	2.0	\$ -	\$ -
134	UTILITY - MANVILLE	C.O.P.	511	VALVES (GATE TYPE)(10-IN DIA)	EA	2.0	\$ -	\$ -
135	UTILITY - PFLUGERVILLE	C.O.P.	511	VALVES (GATE TYPE)(12-IN DIA)	EA	1.0	\$ -	\$ -
136	UTILITY - PFLUGERVILLE	C.O.P.	511	VALVES (GATE TYPE)(16-IN DIA)	EA	1.0	\$ -	\$ -
137	UTILITY - PFLUGERVILLE	C.O.P.	511	FIRE HYDRANT ASSEMBLY	EA	4.0	\$ -	\$ -
138	UTILITY - PFLUGERVILLE	C.O.P.	863	REFLECTORIZED PAVEMENT MARKERS (TY II-B-B)	EA	4.0	\$ -	\$ -
139	WORK ZONE TRAFFIC CONTROL	TxDOT	503-7002	PORTABLE CHANGEABLE MESSAGE SIGN	EA	4.0	\$ -	\$ -
140	WORK ZONE TRAFFIC CONTROL	TxDOT	505-7001	TMA (STATIONARY)	DAY	35.0	\$ -	\$ -
141	WORK ZONE TRAFFIC CONTROL	TxDOT	505-7002	TMA (MOBILE OPERATION)	HR	48.0	\$ -	\$ -
142	EROSION CONTROL	TxDOT	506-7043	BIODEG EROSN CONT LOGS (INSTL) (12")	LF	1,880.0	\$ -	\$ -
143	EROSION CONTROL	TxDOT	506-7046	BIODEG EROSN CONT LOGS (REMOVE)	LF	1,880.0	\$ -	\$ -
144	WORK ZONE TRAFFIC CONTROL	TxDOT	508-7003	CONSTRUCTING DETOURS (TY 1)	SY	4,744.0	\$ -	\$ -
145	WORK ZONE TRAFFIC CONTROL	TxDOT	508-7004	CONSTRUCTING DETOURS (TY 2)	SY	1,200.0	\$ -	\$ -
146	WORK ZONE TRAFFIC CONTROL	TxDOT	512-7009	PORT CTB (FUR & INST)(LOW PROF)(TY 1)	LF	3,660.0	\$ -	\$ -
147	WORK ZONE TRAFFIC CONTROL	TxDOT	512-7010	PORT CTB (FUR & INST)(LOW PROF)(TY 2)	LF	320.0	\$ -	\$ -
148	WORK ZONE TRAFFIC CONTROL	TxDOT	512-7033	PORT CTB (MOVE)(LOW PROF)(TY 1)	LF	2,820.0	\$ -	\$ -
149	WORK ZONE TRAFFIC CONTROL	TxDOT	512-7034	PORT CTB (MOVE)(LOW PROF)(TY 2)	LF	260.0	\$ -	\$ -
150	WORK ZONE TRAFFIC CONTROL	TxDOT	512-7057	PORT CTB (REMOVE)(LOW PROF)(TY 1)	LF	3,660.0	\$ -	\$ -
151	WORK ZONE TRAFFIC CONTROL	TxDOT	512-7058	PORT CTB (REMOVE)(LOW PROF)(TY 2)	LF	320.0	\$ -	\$ -
152	ROADWAY	TxDOT	531-7006	CURB RAMPS (TY 2)	EA	6.0	\$ -	\$ -
153	ROADWAY	TxDOT	531-7007	CURB RAMPS (TY 3)	EA	2.0	\$ -	\$ -
154	ROADWAY	TxDOT	531-7008	CURB RAMPS (TY 5)	EA	16.0	\$ -	\$ -
155	ROADWAY	TxDOT	531-7010	CURB RAMPS (TY 7)	EA	6.0	\$ -	\$ -
156	ROADWAY	TxDOT	531-7011	CURB RAMPS (TY 10)	EA	7.0	\$ -	\$ -
157	ROADWAY	TxDOT	531-7013	CURB RAMPS (TY 21)	EA	2.0	\$ -	\$ -
158	REMOVAL	TxDOT	542-7001	REMOVE METAL BEAM GUARD FENCE	LF	375.0	\$ -	\$ -
159	REMOVAL	TxDOT	542-7002	REMOVE TERMINAL ANCHOR SECTION	EA	2.0	\$ -	\$ -
160	REMOVAL	TxDOT	544-7003	GUARDRAIL END TREATMENT (REMOVE)	EA	6.0	\$ -	\$ -
161	RETAINING WALL	TxDOT	550-7001	CHAIN LINK FENCE (INSTALL) (6')	LF	86.0	\$ -	\$ -
162	RETAINING WALL	TxDOT	556-7006	PIPE UNDERDRAINS (TY 6)(6")	LF	75.0	\$ -	\$ -
163	ILLUMINATION	TxDOT	610-7014	IN RD IL (U/P) (TY 1) (150W EQ) LED	EA	4.0	\$ -	\$ -
164	ILLUMINATION	TxDOT	610-7056	IN RD IL (TY AL) 30B-8 (250W EQ) LED	EA	8.0	\$ -	\$ -
165	ILLUMINATION	TxDOT	610-7072	IN RD IL (TY AL) 30T-8 (250W EQ) LED	EA	38.0	\$ -	\$ -
166	ILLUMINATION / TRAFFIC SIGNALS	TxDOT	618-7030	CONDUIT (PVC) (SCHD 40) (2")	LF	8,797.0	\$ -	\$ -
167	TRAFFIC SIGNALS	TxDOT	618-7031	CONDUIT (PVC) (SCHD 40) (2") (BORE)	LF	905.0	\$ -	\$ -
168	TRAFFIC SIGNALS	TxDOT	618-7036	CONDUIT (PVC) (SCHD 40) (3")	LF	515.0	\$ -	\$ -
169	TRAFFIC SIGNALS	TxDOT	618-7037	CONDUIT (PVC) (SCHD 40) (3") (BORE)	LF	805.0	\$ -	\$ -
170	TRAFFIC SIGNALS	TxDOT	618-7040	CONDUIT (PVC) (SCHD 40) (4")	LF	190.0	\$ -	\$ -
171	TRAFFIC SIGNALS	TxDOT	618-7041	CONDUIT (PVC) (SCHD 40) (4") (BORE)	LF	100.0	\$ -	\$ -
172	ILLUMINATION	TxDOT	618-7055	CONDT (PVC) (SCH 80) (2") (BORE)	LF	1,251.0	\$ -	\$ -
173	ILLUMINATION	TxDOT	618-7074	CONDT (RM) (1 1/4")	LF	78.0	\$ -	\$ -
174	ILLUMINATION	TxDOT	620-7007	ELEC CONDR (NO. 8) BARE	LF	10,201.0	\$ -	\$ -
175	ILLUMINATION	TxDOT	620-7008	ELEC CONDR (NO. 8) INSULATED	LF	20,664.0	\$ -	\$ -
176	TRAFFIC SIGNALS	TxDOT	620-7009	ELEC CONDR (NO. 6) BARE	LF	1,490.0	\$ -	\$ -
177	TRAFFIC SIGNALS	TxDOT	620-7010	ELEC CONDR (NO. 6) INSULATED	LF	110.0	\$ -	\$ -
178	TRAFFIC SIGNALS	TxDOT	621-7002	TRAY CABLE (3 CONDR) (12 AWG)	LF	5,448.0	\$ -	\$ -
179	TRAFFIC SIGNALS	TxDOT	621-7004	TRAY CABLE (3 CONDR) (8 AWG)	LF	2,100.0	\$ -	\$ -
180	ILLUMINATION / TRAFFIC SIGNALS	TxDOT	624-7008	GROUND BOX (TYPE D) (162992) W/ APRON	EA	64.0	\$ -	\$ -
181	ILLUMINATION	TxDOT	628-7052	ELC SRV TY A 240/480 060 (NS) SS (T) SP (O)	EA	2.0	\$ -	\$ -
182	TRAFFIC SIGNALS	TxDOT	628-7147	ELC SRV TY D 120/240 060 (NS) SS (E) PS (U)	EA	2.0	\$ -	\$ -
183	EROSION CONTROL	TxDOT	639S-A	ROCK BERM	LF	409.0	\$ -	\$ -
184	EROSION CONTROL	TxDOT	641S-A	STABILIZED CONSTRUCTION EXIT	EA	2.0	\$ -	\$ -
185	EROSION CONTROL	TxDOT	642S-A	SILT FENCE FOR EROSION CONTROL	LF	3,555.0	\$ -	\$ -
186	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7004	WK ZN PAV MRK NON-REMOV (W) 4" (SLD)	LF	33,250.0	\$ -	\$ -
187	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7012	WK ZN PAV MRK NON-REMOV (W) 8" (SLD)	LF	1,175.0	\$ -	\$ -
188	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7015	WK ZN PAV MRK NON-REMOV (W) 12" (SLD)	LF	690.0	\$ -	\$ -
189	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7017	WK ZN PAV MRK NON-REMOV (W) 24" (SLD)	LF	252.0	\$ -	\$ -
190	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7018	WK ZN PAV MRK NON-REMOV (W)(ARROW)	EA	7.0	\$ -	\$ -

ITEM NO.	SECTION TITLE	SPECIFICATION BID ITEM		DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
191	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7033	WK ZN PAV MRK NON-REMOV (Y) 4" (BRK)	LF	675.0	\$ -	\$ -
192	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7035	WK ZN PAV MRK NON-REMOV (Y) 4" (SLD)	LF	30,365.0	\$ -	\$ -
193	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7051	WK ZN PAV MRK REMOV (REFL) TY II-A-A	EA	1,589.0	\$ -	\$ -
194	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7062	WK ZN PAV MRK REMOV (W) 4" (DOT)	LF	1,370.0	\$ -	\$ -
195	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7064	WK ZN PAV MRK REMOV (W) 4" (SLD)	LF	1,120.0	\$ -	\$ -
196	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7096	WK ZN PAV MRK REMOV (Y) 4" (DOT)	LF	420.0	\$ -	\$ -
197	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7097	WK ZN PAV MRK REMOV (Y) 4" (SLD)	LF	1,370.0	\$ -	\$ -
198	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7112	WK ZN PAV MRK SHT TERM (TAB) TY W	EA	610.0	\$ -	\$ -
199	WORK ZONE TRAFFIC CONTROL	TxDOT	662-7114	WK ZN PAV MRK SHT TERM (TAB) TY Y-2	EA	760.0	\$ -	\$ -
200	WORK ZONE TRAFFIC CONTROL	TxDOT	677-7001	ELIM EXT PAV MRK & MRKS (4")	LF	32,705.0	\$ -	\$ -
201	WORK ZONE TRAFFIC CONTROL	TxDOT	677-7004	ELIM EXT PAV MRK & MRKS (8")	LF	90.0	\$ -	\$ -
202	WORK ZONE TRAFFIC CONTROL	TxDOT	677-7008	ELIM EXT PAV MRK & MRKS (24")	LF	256.0	\$ -	\$ -
203	TRAFFIC SIGNALS	TxDOT	680-7002	INSTALL HWY TRF SIG (ISOLATED)	EA	2.0	\$ -	\$ -
204	TRAFFIC SIGNALS	TxDOT	680-7004	REMOVING TRAFFIC SIGNALS	EA	2.0	\$ -	\$ -
205	TRAFFIC SIGNALS	TxDOT	681-7001	TEMP TRAF SIGNALS	EA	3.0	\$ -	\$ -
206	TRAFFIC SIGNALS	TxDOT	682-7001	VEH SIG SEC (12 IN) LED (GREEN)	EA	17.0	\$ -	\$ -
207	TRAFFIC SIGNALS	TxDOT	682-7002	VEH SIG SEC (12 IN) LED (GREEN)(ARROW)	EA	6.0	\$ -	\$ -
208	TRAFFIC SIGNALS	TxDOT	682-7003	VEH SIG SEC (12 IN) LED (YELLOW)	EA	17.0	\$ -	\$ -
209	TRAFFIC SIGNALS	TxDOT	682-7004	VEH SIG SEC (12 IN) LED (YELLOW)(ARROW)	EA	12.0	\$ -	\$ -
210	TRAFFIC SIGNALS	TxDOT	682-7005	VEH SIG SEC (12 IN) LED (RED)	EA	17.0	\$ -	\$ -
211	TRAFFIC SIGNALS	TxDOT	682-7006	VEH SIG SEC (12 IN) LED (RED)(ARROW)	EA	6.0	\$ -	\$ -
212	TRAFFIC SIGNALS	TxDOT	682-7018	PED SIG SEC (LED)(COUNTDOWN)	EA	18.0	\$ -	\$ -
213	TRAFFIC SIGNALS	TxDOT	682-7042	BACKPLATE W/REF BRDR (3 SEC)(VENT) ALUM	EA	17.0	\$ -	\$ -
214	TRAFFIC SIGNALS	TxDOT	682-7043	BACKPLATE W/REF BRDR (4 SEC)(VENT) ALUM	EA	6.0	\$ -	\$ -
215	TRAFFIC SIGNALS	TxDOT	684-7031	TRF SIG CBL (TY A)(14 AWG)(5 CONDR)	LF	1,023.0	\$ -	\$ -
216	TRAFFIC SIGNALS	TxDOT	684-7033	TRF SIG CBL (TY A)(14 AWG)(7 CONDR)	LF	388.0	\$ -	\$ -
217	TRAFFIC SIGNALS	TxDOT	684-7036	TRF SIG CBL (TY A)(14 AWG)(10 CONDR)	LF	2,035.0	\$ -	\$ -
218	TRAFFIC SIGNALS	TxDOT	684-7046	TRF SIG CBL (TY A)(14 AWG)(20 CONDR)	LF	1,550.0	\$ -	\$ -
219	SIGNING & PAVEMENT MARKINGS	TxDOT	685-7004	INSTALL RDSO FLSH BCN ASSM (SOLAR PWRD)	EA	2.0	\$ -	\$ -
220	SIGNING & PAVEMENT MARKINGS	TxDOT	685-7006	REMOVE RDSO FLSH BCN ASSM (SOLAR PWRD)	EA	2.0	\$ -	\$ -
221	TRAFFIC SIGNALS	TxDOT	686-7036	INS TRF SIG PL AM (S) 1 ARM (32') LUM & ILSN	LF	2.0	\$ -	\$ -
222	TRAFFIC SIGNALS	TxDOT	686-7040	INS TRF SIG PL AM (S) 1 ARM (36') LUM & ILSN	LF	1.0	\$ -	\$ -
223	TRAFFIC SIGNALS	TxDOT	686-7052	INS TRF SIG PL AM (S) 1 ARM (48') LUM & ILSN	LF	1.0	\$ -	\$ -
224	TRAFFIC SIGNALS	TxDOT	687-7001	PED POLE ASSEMBLY	EA	11.0	\$ -	\$ -
225	TRAFFIC SIGNALS	TxDOT	687-7003	RELOCATE PED POLE ASSEMBLY	EA	1.0	\$ -	\$ -
226	TRAFFIC SIGNALS	TxDOT	688-7001	PED DETECT PUSH BUTTON (APS)	EA	17.0	\$ -	\$ -
227	TRAFFIC SIGNALS	TxDOT	688-7003	PED DETECTOR CONTROLLER UNIT	EA	2.0	\$ -	\$ -
228	TRAFFIC SIGNALS	TxDOT	690-7025	REPLACEMENT OF SIGNAL HEAD ASSM	EA	2.0	\$ -	\$ -
229	MOBILIZATION	C.O.P.	7005-TM	TOTAL MOBILIZATION PAYMENT	LS	1.0	\$ -	\$ -
230	REMOVAL	TXDOT	772-7001	POST AND CABLE FENCE (REMOVAL)	LF	290.0	\$ -	\$ -
231	REMOVAL	TXDOT	772-7002	POST AND CABLE FENCE (REMV CONC ANCHOR)	EA	2.0	\$ -	\$ -
232	WORK ZONE TRAFFIC CONTROL	C.O.P.	8025-BBOND	BOND PROJECT SIGN	EA	2.0	\$ -	\$ -
233	WORK ZONE TRAFFIC CONTROL	C.O.P.	8035-MO	BARRICADES, SIGNS, AND TRAFFIC HANDLING	MO	24.0	\$ -	\$ -
234	SIGNING & PAVEMENT MARKINGS	C.O.P.	8425	IN SM RD SN SUP&AM 1-3/4" SQUARE TUBE	EA	68.0	\$ -	\$ -
235	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (W) 4" (DOT)(090MIL)	LF	114.0	\$ -	\$ -
236	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (W) 8" (SLD)(090MIL)	LF	4,953.0	\$ -	\$ -
237	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (W) 12" (SLD)(090MIL)	LF	337.0	\$ -	\$ -
238	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (W) 24" (SLD)(090MIL)	LF	2,678.0	\$ -	\$ -
239	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (W) (ARROW)(090MIL)	EA	53.0	\$ -	\$ -
240	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (W) (DBL ARROW)(090MIL)	EA	6.0	\$ -	\$ -
241	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (W) (WORD)(090MIL)	EA	37.0	\$ -	\$ -
242	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (W) 36" (YLD TRI)(090MIL)	EA	5.0	\$ -	\$ -
243	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (Y) 24" (SLD)(090MIL)	LF	36.0	\$ -	\$ -
244	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	RE PM W/RET REQ TY I (W) 4" (SLD)(090MIL)	LF	3,086.0	\$ -	\$ -
245	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	RE PM W/RET REQ TY I (Y) 4" (SLD)(090MIL)	LF	12,754.0	\$ -	\$ -
246	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	RE PM W/RET REQ TY I (W) 4" (BRK)(090MIL)	LF	480.0	\$ -	\$ -
247	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (W) 4" (DOT)	LF	114.0	\$ -	\$ -
248	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (W) 8" (SLD)	LF	4,953.0	\$ -	\$ -
249	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (W) 12" (SLD)	LF	337.0	\$ -	\$ -
250	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (W) 24" (SLD)	LF	2,678.0	\$ -	\$ -
251	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (W) (ARROW)	EA	53.0	\$ -	\$ -
252	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (W) (DBL ARROW)	EA	6.0	\$ -	\$ -
253	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY I (W) (WORD)	EA	37.0	\$ -	\$ -
254	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (W) 36" (YLD TRI)	EA	5.0	\$ -	\$ -

ITEM NO.	SECTION TITLE	SPECIFICATION BID ITEM		DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
255	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (Y) 24" (SLD)	LF	36.0	\$ -	\$ -
256	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (W) 4" (SLD)	LF	3,086.0	\$ -	\$ -
257	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (Y) 4" (SLD)	LF	12,754.0	\$ -	\$ -
258	SIGNING & PAVEMENT MARKINGS	C.O.P.	871S	REFL PAV MRK TY II (W) 4" (BRK)	LF	480.0	\$ -	\$ -
259	SIGNING & PAVEMENT MARKINGS	C.O.P.	873S	REFL PAV MRKR TY I-C	EA	153.0	\$ -	\$ -
260	SIGNING & PAVEMENT MARKINGS	C.O.P.	873S	REFL PAV MRKR TY II-C-R	EA	125.0	\$ -	\$ -
261	SIGNING & PAVEMENT MARKINGS	C.O.P.	873S	REFL PAV MRKR TY II-A-A	EA	331.0	\$ -	\$ -
262	SIGNING & PAVEMENT MARKINGS	C.O.P.	875S	PAV SURF PREP FOR MRK (4")	LF	1,046.0	\$ -	\$ -
263	SIGNING & PAVEMENT MARKINGS	C.O.P.	875S	PAV SURF PREP FOR MRK (8")	LF	280.0	\$ -	\$ -
264	SIGNING & PAVEMENT MARKINGS	C.O.P.	875S	PAV SURF PREP FOR MRK (ARROW)	EA	2.0	\$ -	\$ -
265	SIGNING & PAVEMENT MARKINGS	C.O.P.	875S	PAV SURF PREP FOR MRK (DBL ARROW)	EA	1.0	\$ -	\$ -
266	BRIDGE	TxDOT	400S-MOD	RELOCATE EXISTING TRUSS BRIDGE	LS	1.0	\$ -	\$ -
267	TRAFFIC SIGNALS	TxDOT	6001-7001	ILSN (6 S)	EA	4.0	\$ -	\$ -
268	TRAFFIC SIGNALS	TxDOT	6006-7001	VIVDS PROSR SYS	EA	2.0	\$ -	\$ -
269	TRAFFIC SIGNALS	TxDOT	6006-7002	VIVDS CAM ASSY FXD LNS	EA	8.0	\$ -	\$ -
270	TRAFFIC SIGNALS	TxDOT	6006-7007	VIVDS CABLING	LF	2,043.0	\$ -	\$ -
271	TRAFFIC SIGNALS	TxDOT	6007-7001	BBU SYSTEM (EXTERNAL BATTERY CABINET)	EA	2.0	\$ -	\$ -
272	TRAFFIC SIGNALS	TxDOT	6043-7002	COAXIAL CABLE	LF	320.0	\$ -	\$ -

TOTAL AMOUNT - BASE OFFER - IMMANUEL ROAD IMPROVEMENTS \$ -

01-3.1 Proposal Form Exhibit A

Project		Immanuel Road Improvements		Project No.
Owner		City of Plugerville		
Design Professional		Rodriguez Transportation Group		
Offeror				

Bid No.	Spec. No.	Item Description	Unit	Estimated Quantity	Unit Price	Amount	
Alternates to be considered for inclusion in the CIP CONSTRUCTION CONTRACT							
J-01					-	-	
J-02							
J-03							
K		Total Amount for Alternates (Sum of Extended Amounts for Each Alternate Line Item)				\$	-

Contract Times

L		Offeror agrees to reach Substantial Completion in		days
M		Offeror agrees to reach Final Completion in		days

Cost + Time Evaluation

N		Total Amount of Base Offer		
O		Offeror Days to Substantial Completion	0	days
P		Value per Day of Construction	\$ 1,350.00	per day
Q		Value for Days of Construction (O X P)	\$	-
R		Basis for Comparison of Proposals (N + Q)	\$	-

PROPOSAL SUBMITTED BY:

Offeror:

Signature:

Printed Name:

Title:

Date:

CITY OF PFLUGERVILLE QUALIFICATIONS STATEMENT

1. QUALIFICATIONS STATEMENT: The Qualifications Statement must include the information as described in this Section as a minimum. Failure to submit the required information in the Qualifications Statement may result in Owner considering the Proposal non-responsive and may result in rejection of the Proposal by Owner. Offerors may be required to provide supplemental information if requested by Owner to clarify, enhance, or supplement the information provided in the Qualifications Statement.
 - a. Offerors must provide the information requested in this Qualifications Statement using the forms attached to this Section. Pages are to be 8-1/2" x 11" using a minimum font size of ten (10). Offerors are advised to provide the requested information in sufficient detail.
 - b. Information that cannot be totally incorporated into the provided forms may be included as an appendix to the Proposal. The Offeror should include only information that is responsive to the questions and items presented in this Qualifications Statement.
 - d. Offerors may provide supplemental information to the Qualifications Statement, such as organizational brochures or other marketing information to help demonstrate their qualifications to Owner. This information may not be submitted as a substitute for the information specifically requested in this Section. The reference must include the specific paragraph or section that applies to that question or item if this information is included as an appendix to the information requested in this Section.
 - e. Provide a tab to separate materials responding to the categories listed in the Instructions that follow this Article.
2. INSTRUCTIONS FOR PREPARING QUALIFICATIONS STATEMENT:
 - a. Offeror's Organization and General Information:
 1. Provide general information about Offeror's organization using copies of **Table 1**. Provide the same information for each joint venture partner if Offeror is a joint venture.
 2. Provide information regarding the operational structure of Offeror's organization, including a list of officers, the limits of authority for these individuals with regards to the proposed Project, and documentation of authority to execute documents.
 3. Provide documentation showing Offeror's authority and qualification to do business in the State of Texas or a written covenant to obtain such authority prior to award of Contract.
 4. Provide documentation showing that the organization is licensed as a general contractor, including any applicable classifications and limitations or a written covenant to obtain such authority prior to award of a Contract.

5. Safety: Provide a narrative not to exceed four pages describing Offeror's success in implementing an effective project site safety program. Provide a narrative describing Offeror's safety program and a statement regarding the Offeror's commitment to safety. Do not provide copies of safety manuals or programs.
 6. Claims Experience and Litigation History: Provide a list of all claims or litigation involving owners on other construction projects that have been active over the last five (5) years or that are currently unresolved. Provide a narrative describing the issues being contested and when it is anticipated that the disputes will be resolved. Claims are to include only those items which have progressed through the change management process for the project and are being disputed by Offeror or the project owner.
- b. Experience and Qualifications of Proposed Key Personnel:
1. Provide a narrative not to exceed four (4) pages describing Offeror's project management structure and the qualifications of the project management team for this Project. Include an organization chart showing the relationship between Offeror and key Subcontractors and Suppliers.
 2. Provide resumes not exceeding two (2) pages for each individual proposed for the key personnel positions and their alternates. Resumes must describe the qualifications of the individual and include the following as a minimum: technical experience, managerial experience, education and formal training, primary language, and a work history which describes project experience, including the roles and responsibilities for each assignment. Additional information highlighting the experience which makes them the best candidate for the assignment should also be included. Focus on projects on which individuals proposed have had significant involvement in the last five (5) years and which demonstrate their experience with similar projects.
 3. Provide a narrative not to exceed two (2) pages for each project the proposed individuals have worked on that qualify as similar projects. Specifically identify the role and responsibilities of the individual on these similar projects. Projects selected must demonstrate the capabilities of the proposed key personnel.
- c. Project Experience and Past Performance of Offeror:
1. General Experience as a General Contractor: Provide a narrative not to exceed four (4) pages describing Offeror's experience as a general contractor and describe the organization's operating philosophy and approach to constructing, completing, and commissioning projects. Include a description of the organizations approach in the following areas:
 - a. Contract administration;
 - b. Management of subcontractors and suppliers;

- c. Managing equipment; and
- d. Managing changes to the project.

2. Project Experience:

- a. Provide a list of projects completed by Offeror in the last five (5) years using copies of **Table 2**.
- b. Provide detailed descriptions of projects which demonstrate the experience of Offeror's team with construction of similar projects. Experience must include, as a minimum, the satisfactory completion of at least five (5) similar projects within the last five (5) years. Offerors not meeting the requirement for similar projects may be disqualified as being non-responsive. Similar projects must include:
 - i. Pavement Construction and Subgrade Stabilization.
 - ii. Drainage (Storm Sewer).
 - iii. Retaining Walls and Bridges.
- c. Provide experience (if applicable) with projects containing work associated with "Relocation of Existing Truss Bridge". Projects selected must demonstrate the capabilities of the organization (key personnel, subcontractor, etc).
- d. Provide a narrative not to exceed two (2) pages for each project describing up to five (5) specific projects that qualify as similar projects. Projects selected must demonstrate the capabilities of the organization.
- e. Provide a narrative not to exceed ten (10) pages to describe the overall performance of the organization on these projects. This narrative may include references to letters of recommendation, project awards, and other references to demonstrate experience in constructing a project which meets Owner's expectations for a quality project constructed on time and within budget.

d. Offeror's Ability to Complete Projects within the Contract Price and Contract Times:

- 1. Provide a tabulation of budget performance on projects completed by Offeror within the last five (5) years using copies of **Table 3** to demonstrate the ability of Offeror to complete projects for the Contract Price. Notes may be added to each line item to describe circumstances for change orders beyond the control of Offeror.
- 2. Provide a tabulation of all projects completed by Offeror within the last five (5) years on **Table 4** to demonstrate performance in completing projects on time. Notes may be added to the tabulations to indicate the reasons for not meeting original contract completion dates.

e. Other Experience and Qualifications Information:

1. Offeror may provide a written narrative not to exceed ten (10) pages describing the planned approach for constructing this Project within the time indicated in the Proposal regarding:
 - a. The planned number of crews and their roles and responsibilities;
 - b. The equipment assigned to each crew; and
 - c. Processes for ancillary work such as concrete flatwork, installation of site appurtenances, and cleanup.
2. Do not provide a list of all equipment owned or available to the organization. Provide only the equipment to be allocated to this Project.

3. FORMS: The following tables/forms are attached to this Section:

Table	Description
1	General Information
2	Current Projects and Project Completed within the last 5 Years
3	Demonstration of Budget Performance
4	Demonstration of On-Time Performance

4. **CERTIFICATION:** By submitting this Qualifications Statement and related information, Offeror certifies that it has read this Qualifications Statement and that Offeror's responses are true and correct and contain no material misrepresentations, and that the individual signing below is authorized to make this certification on behalf of Offeror's organization.

Offeror: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Attest: _____
(individual's signature)

Designated Representative:

Name: _____

Title: _____

Address for giving notices:

Phone: _____ Email: _____

(Attach evidence of authority to sign if Offeror is a corporation, partnership, or a joint venture.)

Table 1- General Information

Organization			
Legal Name of Business			
Form of Business Entity	☐ Joint Venture ☐ Corporation ☐ General Partnership ☐ Limited Partnership		
Date Business was formed		State under which Business was formed	
State where Business has principal place of business and qualifies as a resident bidder			
Is this Business authorized to operate in the Project location		☐ Yes ☐ No ☐ Pending	
Is this Business licensed as a general contractor in the Project location		☐ Yes ☐ No ☐ Pending ☐ N/A	
List of companies, firms, or organizations that own any part of this Business.			
Name of Company, Firm, or Organization			Percent Ownership
Principal Office			
Primary Contact		Main Telephone Number	
Email Address		Website Address	
Physical Address of Business			
Regional Office			
Primary Contact		Main Telephone Number	
Email Address		Website Address	
Physical Address of Business			
Business History			
List of names that this Business currently has or anticipates operating under over the history of the Business, including the names of related companies presently doing business.			
Names of Organization		From Date	To Date
Indicators of Organization Size			
Average number of current full-time employees			
Estimate of total revenue for the current year			\$
Total revenue in previous year			\$

Table 2 - Current Projects and Project Completed Within the Last Five (5) Years

Name of Organization													
Project Owner					Project Name								
General Description of Project													
Project Cost					Date Project Completed								
Key Project Personnel	Project Manager			Project Superintendent			Safety Manager			Quality Control Manager			
Name													
Reference contact information (listing names indicates approval to contacting the names individuals as a reference)													
	Name			Title/Position			Organization			Telephone		Email	
Owner													
Designer													
Construction Manager													
Project Owner					Project Name								
General Description of Project													
Project Cost					Date Project Completed								
Key Project Personnel	Project Manager			Project Superintendent			Safety Manager			Quality Control Manager			
Name													
Reference contact information (listing names indicates approval to contacting the names individuals as a reference)													
	Name			Title/Position			Organization			Telephone		Email	
Owner													
Designer													
Construction Manager													
Project Owner					Project Name								
General Description of Project													
Project Cost					Date Project Completed								
Key Project Personnel	Project Manager			Project Superintendent			Safety Manager			Quality Control Manager			
Name													
Reference contact information (listing names indicates approval to contacting the names individuals as a reference)													
	Name			Title/Position			Organization			Telephone		Email	
Owner													
Designer													
Construction Manager													

Table 3 - Demonstration of Budget Performance

Name of Offeror							
Provide information on all projects completed by the Offeror within the last 5 years.							
Owner Name	Project Description	Original Contract Price	Value of Change Orders			Total Change Orders	Percent of Changes to Original Contract Price
			Owner Enhancements	Unforeseen Conditions	Design Issues		
Notes:							
Notes:							
Notes:							
Notes:							
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Table 4 - Demonstration of On-Time Performance

Name of Organization							
Provide information on all projects completed by the Organization within the last 5 years.							
Owner Name	Project Description	Original Contract Date for Substantial Completion	Original Contract Date for Final Completion	Amended Contract Date for Substantial Completion	Amended Contract Date for Final Completion	Actual Contract Date for Substantial Completion	Actual Contract Date for Final Completion
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End of Qualifications Statement.

**CITY OF PFLUGERVILLE STATE OF TEXAS TAX CODE,
CHAPTER 151 COMPLIANCE CERTIFICATE**

Contractor shall comply with all applicable sales, excise, and use tax requirements of the Texas Tax Code. The Contractor hereby certifies that the Contract Sum is divided as follows:

Tax exempt products, materials, and services (See Notes 1 and 2)	\$	_____
Taxable products, materials, and services (See Note 3)	\$	_____
Total (See Note 4)	\$	_____

Contractor: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Business Address:

Phone: _____ Email: _____

Note:

1. Exempt products and materials are those items purchased for the Project which are physically incorporated into the Project constructed for the City or are necessary and essential for providing the Work and are completely consumed for the Project. For purposes of this definition, products and materials are completely consumed if after being used once for its intended purpose it is used up or destroyed. Products and materials rented or leased for use in providing the Work cannot be completely consumed for the purposes of this definition.
2. Exempt services are those services performed at the Project Site where the Contract expressly requires the specific service to be provided or purchased by the person performing the service and is integral to completing the Work.
3. Products, materials, and services are not tax exempt if they are used by the Contractor but are not physically incorporated into the City's Project or are not consumed by construction or installation as defined above. Machinery or equipment and its accessories and repair and replacement parts used in providing the Work are not exempt.
4. The total sum of the amount for tax exempt and taxable products, materials, and services must equal the Contract Sum.

END OF SECTION

CITY OF PFLUGERVILLE COMPLIANCE TO TEXAS STATE

LAW REGARDING NONRESIDENT BIDDERS

Texas Government Code Chapter 2252 applies to the award of government contract to nonresident bidders. This chapter provides that:

“a government entity may not award a governmental contract to a nonresident bidder unless the nonresident underbids the lower bid submitted by a responsible resident bidder by an amount that is not less than the amount by which a resident bidder would be required to underbid the nonresident bidder to obtain a comparable contract in the state in which the nonresident’s principal place of business is located.”

“Nonresident bidder” refers to a person who is not a resident of Texas.

“Resident bidder” refers to a person whose principal place of business is in this state, including a contractor whose ultimate parent company or majority owner has its principal place of business in this state.

Check the statement that is correct for Bidder:

- ☐ Bidder (includes parent company or majority owner) qualifies as a resident bidder whose principal place of business is in the state of Texas.
- ☐ Bidder qualifies as a nonresident bidder whose principal place of business or residency is in the state of: _____

Any determination of state bidder preference law is based on the Texas Comptroller’s annual summary of other state bidder preference laws.

Bidder: _____
(typed or printed name of organization)

Signature: _____
(individual’s signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Business Address: _____

Phone: _____ Email: _____
(Attach evidence of authority to sign if Offeror is a corporation, partnership, or a joint venture.)

END OF SECTION

CONFLICT OF INTEREST QUESTIONNAIRE**FORM CIQ****For vendor doing business with local governmental entity**

This questionnaire reflects changes made to the law by H.B. 23, 84th Leg., Regular Session.

This questionnaire is being filed in accordance with Chapter 176 of the Local Government Code by a vendor who has a business relationship as defined by Section 176.001(1-a) with a local governmental entity and the vendor meets requirements under Section 176.006(a).

By law this questionnaire must be filed with the records administrator of the local governmental entity not later than the 7th business day after the date the vendor becomes aware of facts that require the statement to be filed. See Section 176.006(a-1), Local Government Code.

A vendor commits an offense if the vendor knowingly violates Section 176.006, Local Government Code. An offense under this section is a misdemeanor.

OFFICE USE ONLY

Date Received

1 Name of vendor who has a business relationship with local governmental entity.

2 ☐ Check this box if you are filing an update to a previously filed questionnaire. (The law requires that you file an updated completed questionnaire with the appropriate filing authority not later than the 7th business day after the date on which you became aware that the originally filed questionnaire was incomplete or inaccurate.)

3 Name of local government officer about whom the information is being disclosed._____
Name of Officer

4 Describe each employment or other business relationship with the local government officer, or a family member of the officer, as described by Section 176.003(a)(2)(A). Also describe any family relationship with the local government officer. Complete subparts A and B for each employment or business relationship described. Attach additional pages to this Form CIQ as necessary.

A. Is the local government officer or a family member of the officer receiving or likely to receive taxable income, other than investment income, from the vendor?

☐ Yes ☐ No

B. Is the vendor receiving or likely to receive taxable income, other than investment income, from or at the direction of the local government officer or a family member of the officer AND the taxable income is not received from the local governmental entity?

☐ Yes ☐ No

5 Describe each employment or business relationship that the vendor named in Section 1 maintains with a corporation or other business entity with respect to which the local government officer serves as an officer or director, or holds an ownership interest of one percent or more.

6 ☐ Check this box if the vendor has given the local government officer or a family member of the officer one or more gifts as described in Section 176.003(a)(2)(B), excluding gifts described in Section 176.003(a-1)

7_____
Signature of vendor doing business with the governmental entity_____
Date

CONFLICT OF INTEREST QUESTIONNAIRE
For vendor doing business with local governmental entity

A complete copy of Chapter 176 of the Local Government Code may be found at <http://www.statutes.legis.state.tx.us/Docs/LG/htm/LG.176.htm>. For easy reference, below are some of the sections cited on this form.

Local Government Code § 176.001(1-a): "Business relationship" means a connection between two or more parties based on commercial activity of one of the parties. The term does not include a connection based on:

- (A) a transaction that is subject to rate or fee regulation by a federal, state, or local governmental entity or an agency of a federal, state, or local governmental entity;
- (B) a transaction conducted at a price and subject to terms available to the public; or
- (C) a purchase or lease of goods or services from a person that is chartered by a state or federal agency and that is subject to regular examination by, and reporting to, that agency.

Local Government Code § 176.003(a)(2)(A) and (B):

(a) A local government officer shall file a conflicts disclosure statement with respect to a vendor if:

(2) the vendor:

(A) has an employment or other business relationship with the local government officer or a family member of the officer that results in the officer or family member receiving taxable income, other than investment income, that exceeds \$2,500 during the 12-month period preceding the date that the officer becomes aware that

- (i) a contract between the local governmental entity and vendor has been executed;
- or
- (ii) the local governmental entity is considering entering into a contract with the vendor;

(B) has given to the local government officer or a family member of the officer one or more gifts that have an aggregate value of more than \$100 in the 12-month period preceding the date the officer becomes aware that:

- (i) a contract between the local governmental entity and vendor has been executed; or
- (ii) the local governmental entity is considering entering into a contract with the vendor.

Local Government Code § 176.006(a) and (a-1)

(a) A vendor shall file a completed conflict of interest questionnaire if the vendor has a business relationship with a local governmental entity and:

- (1) has an employment or other business relationship with a local government officer of that local governmental entity, or a family member of the officer, described by Section 176.003(a)(2)(A);
- (2) has given a local government officer of that local governmental entity, or a family member of the officer, one or more gifts with the aggregate value specified by Section 176.003(a)(2)(B), excluding any gift described by Section 176.003(a-1); or
- (3) has a family relationship with a local government officer of that local governmental entity.

(a-1) The completed conflict of interest questionnaire must be filed with the appropriate records administrator not later than the seventh business day after the later of:

(1) the date that the vendor:

- (A) begins discussions or negotiations to enter into a contract with the local governmental entity; or
- (B) submits to the local governmental entity an application, response to a request for proposals or bids, correspondence, or another writing related to a potential contract with the local governmental entity; or

(2) the date the vendor becomes aware:

- (A) of an employment or other business relationship with a local government officer, or a family member of the officer, described by Subsection (a);
- (B) that the vendor has given one or more gifts described by Subsection (a); or
- (C) of a family relationship with a local government officer.

CITY OF PFLUGERVILLE NON-COLLUSION CERTIFICATION

STATE OF _____
COUNTY _____
OF _____

Contractor: **[Buyer]**
[Street address]
[City, state, zip code]

Contract: **Immanuel Road Improvements**

Contractor certifies that it has not been a party to any collusion among Contractors in the restraint of freedom of competition by agreement to submit a Bid or Proposal at a fixed price or to refrain from submitting a Bid or Proposal; or with any official or employee of the City as to quantity, quality, or price in the prospective contract, or any other terms of said prospective contract; or in any discussion between Contractors and any official of the City concerning exchange of money or other thing of value for special consideration in the letting of a contract.

Contractor: _____
(typed or printed name of organization)

Signature: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Business Address: _____

Phone: _____ Email: _____
(Attach evidence of authority to sign if Contractor is a corporation, partnership, or a joint venture.)

END OF SECTION

STATE OF TEXAS §
COUNTY OF TRAVIS §
CITY OF PFLUGERVILLE §

DNRBZ 2018 1026

The obligations of the parties under this BOND shall be performable in Travis County, Texas and shall be construed under the laws of the State of Texas. If legal action is necessary in connection with this BOND, exclusive venue shall be in Travis County, Texas.

Surety companies executing this BOND must appear on the United States Treasury Department's most current list (Circular 570, as amended) and otherwise be authorized to transact business in the State of Texas.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

Signed and Agreed to this _____ day of _____, 20_____.

SURETY (seal)

PRINCIPAL/CONTRACTOR

By: _____

By: _____

(Signature)

(Signature)

(Print Name)

(Print Name)

(Print Title)

(Print Title)

[ATTACH POWER OF ATTORNEY]

[Additional signatures, if any,
attached]

ATTEST: _____

ATTEST: _____

CITY OF PFLUGERVILLE CERTIFICATE OF INSURANCE

Contractor shall establish and provide certificates of insurance to the City satisfying the requirements for coverages established by **Article XI** of the General Conditions for City of Pflugerville CIP Construction Contracts. Delivery of said proof of insurance coverages shall be no later than the date of the Pre-Construction meeting and prior to the commencement of any Work under the Contract, in accordance with **Section 1.2.3** of the General Conditions.

END OF SECTION



CITY OF PFLUGERVILLE

PUBLIC WORKS & ENGINEERING DEPARTMENT

15500 Sun Light Near Way, #B
Pflugerville, Texas 78660
(512) 990-6400

CONSTRUCTION NOTICE OF INTENT TO AWARD

Month Day, 2024

[Name], [Title]

CONTRACTOR FIRM NAME

Address

City, Texas ZIP

Re: Immanuel Road Improvements

Contract Amount: \$XXXX

Dear [Insert Salutation],

On **City Council Date** the Rodriguez Transportation Group (RTG) and the City of Pflugerville CIP Engineering Department will recommend to the City Council that the contract for the **Immanuel Road Improvements** be awarded to **Contractor Firm Name**.

In preparation for the contract execution by the City of Pflugerville, the following items are being transmitted:

- Contract Document Checklist
- **5** Sets of Contract Documents for preparation and execution

Please adhere to the instructions contained in "Contract Documents Checklist" carefully. Upon receipt of all properly executed documents and City Council approvals, a Notice to Proceed will be issued to establish the official start date of the project.

Any questions regarding these instructions shall be directed to the Project Manager, Brad Limmi, at 512-990-6446. Please make arrangements to return these documents as soon as possible.

Sincerely,

Brad Limmi
Project Manager

Attachment: CONTRACT DOCUMENTS CHECKLIST

CONTRACT DOCUMENTS CHECKLIST

Check List instructions for “Immanuel Road Improvements” Project Contract Documents.

The City requires (5) five sets of original executed documents. All documents should be fully executed and dated for the date of the Council meeting, at which the Contract is actually awarded, identified below.

Council is scheduled to award the contract on [REDACTED]. Upon the completion and return of these documents the, City Manager will execute the Contract for the City at which time the Contractor will receive his copy.

Sections requiring specific attention:

NA 01-3.0	Bid Proposal - Print, sign and date, affix seal and insert the Bid Proposal as submitted via EBID, or Bid Proposal (hardcopy) submitted to the City.
☐ 01-11.0	City of Pflugerville Standard Capital Improvement Project (CIP) Construction Agreement between City and Contractor - Review Contractor information in the Standard agreement. Sign and date the Standard Form of Agreement on page 5. <u>Date all Documents</u>
☐ 01-12.0	Performance Bond - Sign and date the Performance Bond form.
☐ 01-13.0	Payment Bond - Sign and date the Payment Bond form.
☐ 01-14.0	One Year Warranty Bond - Sign and date the One-Year Warranty Bond form.
☐ XI	General Conditions - Insurance The insurance documentation shall comply within the general conditions and inserted into 01-8.1. Failure to comply with all requirements will result in rejection of insurance documents as non-compliant with contract requirements.
☐ Form 1295	Submittal of certificate Texas Ethics Commission https://www.ethics.state.tx.us/forms/1295.pdf
☐ Form HUB	Historically Underutilized Business – Complete form, Sign and date.
☐ Form CIQ	Conflict of Interest Questionnaire - Complete form, Sign and date.
☐ Form W-9	Complete form, Sign, and date. More information can be found at: https://www.irs.gov/forms-pubs/about-form-w-9

All of the above listed documents must be inserted in the Project Manual and their locations marked with a colored flag or tab for review by Staff prior to execution.

CONTRACTORS NOTICE TO PROCEED

[Long form Date]

Addressee

Company Name

Address 1

Address 2

Project Name – Project No. -

Contract Amount: \$

Dear (Addressee),

You are hereby notified to Proceed with the Work of the Contract for the above referenced Project. By agreement, the date of the commencement of the work (start date) shall be [Insert Start Date]. Per Article 2 of the Standard Form of Agreement the Substantial Completion of the Work shall be achieved within [Insert Days] calendar days, or [Insert Specific Date] and Final Completion within [Insert # of days] days, or [Insert specific date].

Article 2 of the Standard Form of Agreement also provides for an assessment of the sum of \$[Insert Liquidated Damages] per day as liquidated damages for each day that expires after the time specified for Substantial Completion.

The city has assigned Project Number [Insert Project #] and Purchase Order [Insert PO #] to this work, which should be referenced on all correspondence and pay applications pertaining to the project.

Please return the attached acceptance of Notice to Proceed to the Project Manager within *five (5) days*.

Please contact me at 512-990-6600 if you have any questions.

Sincerely,

PM Name

Project Manager – CIP

Attachment: ACCEPTANCE OF NOTICE TO PROCEED
EXECUTED CONTRACT

ACCEPTANCE OF NOTICE TO PROCEED

Purchase Order:
Project Name:
Contractor:
Contract Amount: \$
Notice to Proceed: Long Date

Receipt of the forgoing Notice to Proceed is hereby acknowledged, understood, and agreed to by:

(Name)

(Title)

**CITY OF PFLUGERVILLE STANDARD CAPITAL IMPROVEMENT PROJECT (CIP)
CONSTRUCTION AGREEMENT BETWEEN CITY AND CONTRACTOR**

THIS AGREEMENT is entered into by and between City of Pflugerville, Texas (CITY) and _____ (CONTRACTOR). CITY and CONTRACTOR, in consideration of the mutual covenants, obligations and responsibilities herein established, agree as follows:

SECTION I. Generally.

Terms. Terms used in this Agreement, unless the context clearly indicates otherwise, will have the meanings indicated in the General Conditions attached hereto.

Work. CONTRACTOR shall complete all Work as defined in the General Conditions, and as specified or indicated in the other Contract Documents. The Work is generally referred to as Immanuel Road Improvements regardless of whether the Work may only be a part of the Project, with the Work being generally described as follows:

Major items of the Work include: Roadway, Retaining Walls, Drainage, Bridges, Signing & Pavement Markings, Traffic Signals, Illumination & Pedestrian Facilities.

The Project. The Project, for which the Work under the Contract Documents may be the whole or only a part of, is generally described under Article I above.

Design Consultant. The Design Consultant for the Project is:

Rodriguez Transportation Group (RTG)
Project Manager: David Krizan, P.E.
4210 Spicewood Springs, Suite 108
Austin, TX 78759
512-231-9544
dkrizan@rtg-texas.com

who is referred to as such in the Contract Documents for the purposes stated therein. The CITY shall provide written notice to the CONTRACTOR if any information regarding this designation should change during the course of this Agreement.

SECTION II. Contract Times/Liquidated Damages.

Time of the Essence. All time limits for Milestones, if any, Substantial Completion, and Final Completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

Milestones, Substantial Completion and Final Completion. The Work will be Substantially Completed within ____ days after the date when the Contract Times commence to run as provided in **Section 1.2.4** of the General Conditions, and Finally Completed and ready for final payment in accordance with **Section 13.1** of the General Conditions within ____ days after the date when the Contract Times commence to run.

Milestones are outlined as follows:

MILESTONE 1

Milestone 1 (One-Way Traffic south of Wells Branch) is 140 calendar days. Time Charges for Milestone 1 will BEGIN when Immanuel Road, south of Wells Branch, has been converted to One-Way Traffic from

Bumblebee to Wells Branch Parkway (Phase 1, Step 1). Time Charges for Milestone 1 will END when Immanuel Road, south of Wells Branch Parkway, has been opened to Two-Way Traffic from Bumblebee to Wells Branch Parkway (Phase 2 lane arrangement south of Wells Branch Parkway).
Disincentive for Late Completion is \$1350 per day and there is no Incentive for Early Completion.

MILESTONE 2

Milestone 2 (One-Way Traffic from Pecan Street to Gatlinburg Drive) is 29 calendar days. Time Charges for Milestone 2 will BEGIN when Immanuel Road from Gatlinburg Dr. to Pecan Street, has been converted to One-Way Traffic from Gatlinburg Dr. to Pecan Street (Phase 1, Step 2). Time Charges for Milestone 2 will END when Immanuel Road from Gatlinburg Dr. to Pecan Street, has been opened to Two-Way Traffic from Gatlinburg Dr. to Pecan Street (Phase 2 lane arrangement).
Disincentive for Late Completion is \$1350 per day and there is no Incentive for Early Completion.

MILESTONE 3

Milestone 3 (One-Way Traffic from Oxford to Wells Branch) is 348 calendar days. Time Charges for Milestone 3 will BEGIN when Immanuel Road from Oxford to Wells Branch Parkway, has been converted to One-Way Traffic from Oxford to Wells Branch Parkway (Phase 1, Step 1). Time Charges for Milestone 3 will END when Immanuel Road from Oxford to Wells Branch Parkway, has been opened to Two-Way Traffic from Oxford to Wells Branch Parkway (Phase 3 lane arrangement).
Disincentive for Late Completion is \$1350 per day and there is no Incentive for Early Completion.

Liquidated Damages. CONTRACTOR and CITY recognize that time is of the essence of this Agreement and that CITY will suffer financial loss if the Work is not completed within the times specified in **Section II** herein above, plus any extensions thereof allowed in accordance with the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by CITY if the Work is not completed on time. Accordingly, instead of requiring any such proof, CITY and CONTRACTOR agree that as liquidated damages for delay, but expressly acknowledged herein as not being a penalty, **CONTRACTOR shall pay CITY \$1350 for each day that expires after the time specified in Section II herein for Substantial Completion until the Work is Substantially Complete.** After Substantial Completion, if CONTRACTOR shall neglect, refuse, or fail to complete the remaining Work within the Contract Time or any proper extension thereof granted by CITY for Final Completion, **CONTRACTOR shall pay CITY \$1350 for each day that expires after the time specified in Section II herein for Final Completion and readiness for final payment until the Work is completed and ready for final payment.**

SECTION III. Contract Sum.

CITY shall pay CONTRACTOR for completion of the Work in accordance with the Contract Documents an amount equal to the sum of the following, as applicable:

- (1) For all Work other than Unit Price Work, a Lump Sum of: **["Not Applicable"]**

_____ (\$_____).

The Lump Sum above includes all allowances computed in accordance with **Section 3.8** of the General Conditions.

- (2) For all Unit Price Work, an amount equal to the sum of the established unit price for each separately identified item of Unit Price Work times the estimated quantity of that item as follows:

See CONTRACTOR'S SUBMITTED BID PROPOSAL, which is incorporated herein by reference for all purposes.

Sum of all Unit Prices: _____ \$ _____ (dollars).

CONTRACTOR acknowledges that estimated quantities are not guaranteed and that the determination of actual quantities will be made in accordance with **Sections 9.3-9.6** of the General Conditions.

SECTION IV. Payments.

Submittal and Processing of Payments. CONTRACTOR shall submit Applications for Payment in accordance with **Article IX** of the General Conditions. CITY shall make progress payments on account of the Contract Sum on the basis of CONTRACTOR's Applications for Payment in accordance with **Article IX** of the General Conditions. Prior to Final Completion, progress payments will be made in an amount equal to authorized amount, less the applicable retainage percentage indicated within **Section 9.6** of the General Conditions, less permissible amounts withheld, in accordance with **Article IX** of the General Conditions.

SECTION V. Representations.

Representations. In order to induce CITY to enter into this Agreement CONTRACTOR makes the following representations in addition to those otherwise provided in the Contract Documents:

(1) CONTRACTOR has comprehensively evaluated the Contract Documents and the other information identified in the Bidding Documents and has visited the Project Site and is satisfied as to the Site conditions that may affect completion of the Work.

(2) CONTRACTOR has further carefully evaluated all: (a) information regarding subsurface conditions at or contiguous to the Site and all drawings relating to existing surface or subsurface structures at or contiguous to the Site that have been identified in the Contract Documents, if any; and (b) information regarding a Hazardous Environmental Condition, if any, at the Site as identified in Contract Documents.

(3) CONTRACTOR has obtained and carefully evaluated all additional or supplementary information concerning surface and subsurface conditions at or contiguous to the Site that may affect CONTRACTOR'S completion of the Work for the stated Contract Sum within the stated Contract Time. Accordingly, based on said evaluations, CONTRACTOR hereby acknowledges and confirms that no additional information is necessary for the performance of the Work at the Contract Sum, within the Contract Times, and in accordance with the conditions of the Contract Documents.

(4) Finally, CONTRACTOR has provided written notice of all discrepancies that CONTRACTOR has discovered in the Contract Documents to the City or Design Consultant, and hereby acknowledges that all such discrepancies have been resolved sufficiently by the Design Consultant

SECTION VI. Additional Terms.

Controlling Law/Venue. This Agreement shall be governed by the laws of the State of Texas without regard to its conflicts of laws. Venue for any dispute resolution or legal proceedings lies exclusively in the Courts of Travis County, Texas.

Waiver. The failure of either Party hereto to enforce any provision of this Agreement does not constitute a waiver of that provision, affect the enforceability of that provision, or the enforceability of the remainder of this Agreement.

Third Party Beneficiaries. Nothing in this Agreement is intended to be by the Parties hereto or shall be construed to create rights in any person or entity other than the Parties hereto.

Execution. This Agreement may be executed in one or more counterparts and may be exchanged by facsimile or other electronic means. It is stipulated and agreed that any counterpart containing a signature or facsimile signature of the authorized representatives of the respective Party will be deemed an original for all purposes.

Authorization. CONTRACTOR represents that CONTRACTOR has the power and authority to execute and enter into this Agreement. The execution and delivery of this Agreement and the performance of the Work hereunder has been duly authorized by all necessary corporate action, if applicable. Upon execution, this Agreement will constitute the binding and valid obligations of CONTRACTOR and shall be enforceable in accordance with its terms. CONTRACTOR further represents that it is in good standing in and qualified to do business in the State of Texas.

CITY Ordinance Compliance and Certification. CONTRACTOR represents that CONTRACTOR has fully read and understood the terms and conditions for eligibility to contract with the CITY pursuant to Chapter 38 of the CITY'S Code of Ordinances and by entering into this Agreement certifies that CONTRACTOR is qualified to contract with the CITY compliance with all applicable requirements.

Texas Government Code Compliance. CONTRACTOR acknowledges that the CITY may not enter into an Agreement with a company for goods and services unless the Agreement contains a written verification from the company that; (i) it does not Boycott Israel; and (ii) will not Boycott Israel during the term of the contract. (Texas Government Code, Chapter 2270). CONTRACTOR, by entering into this Agreement, hereby verifies and certifies that it does not Boycott Israel and agrees that during the term of this Agreement will not Boycott Israel as that term is defined in the Texas Government Code Section 808.001, as amended.

Certificate of Interested Parties (TEC Form 1295). CONTRACTOR acknowledges that for contracts needing CITY Council approval, the CITY may not accept or enter into a contract until it has received from the CONTRACTOR a completed, signed, and notarized TEC Form 1295 complete with a certificate number assigned by the Texas Ethics Commission ("TEC"), pursuant to Texas Government Code § 2252.908 and the rules promulgated thereunder by the TEC. CONTRACTOR understands that failure to provide said form complete with a certificate number assigned by the TEC may prohibit the City from entering into this Agreement. Pursuant to the rules prescribed by the TEC, the TEC Form 1295 must be completed online through the TEC's website, assigned a certificate number, printed, signed and notarized, and provided to the CITY. The TEC Form 1295 may accompany the bid or may be submitted separately but must be provided to the CITY prior to the award of this Agreement. Neither the City nor its Design Consultant have the ability to verify the information included in a TEC Form 1295, and neither have an obligation nor undertake responsibility for advising CONTRACTOR with respect to the proper completion of the TEC Form 1295.

Assignment of Contract. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound in accordance with the General Conditions.

Successors and Assigns. CITY and CONTRACTOR each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

Severability. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon CITY and CONTRACTOR, who agree that the Contract Documents shall be reformed to

replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

Remainder of this Page left Intentionally Blank.

In consideration for the mutual obligations, representations, terms and conditions herein recited, CITY and CONTRACTOR have agreed to and signed this Agreement to be effective on _____, (Effective Date).

CITY OF PFUGERVILLE, TEXAS:

CONTRACTOR:

By: _____

Sereniah Breland, City Manager

Attest _____

Karen Thompson, City Secretary

Address for giving notices:

Pflugerville, Texas 78660

CITY'S Designated Representative:

Name: Brad Limmi

Title: Project Manager

Address: _____

Phone/Fax: _____

Email: _____

By: _____

Name/Title

Attest _____

By: _____

Name/Title

Address for giving notices:

CONTRACTOR'S Designated Representative:

Name: _____

Title: _____

Address: _____

Phone/Fax: _____

Email: _____

STATUTORY PERFORMANCE BOND

STATE OF TEXAS §
COUNTY OF TRAVIS §
CITY OF PFLUGERVILLE §

The City of Pflugerville, a municipal corporation in the State of Texas (hereafter referred to as "City" or "Owner") and _____, a _____ with its principal place of business located at _____ (hereafter referred to as "Contractor" or "Principal") have entered into a Contract (hereafter referred to as "the Contract") dated _____, 20____ for the _____ Immanuel Road Improvements _____ Project (hereafter referred to as "the Project"). Said Contract is incorporated by reference into this Statutory Performance Bond, pursuant to Chapter 2253 of the Texas Government Code (hereafter referred to as "this Bond").

By virtue of this Bond, Contractor as Principal and _____ with its physical address at _____, a mailing address of _____ and a business telephone number of _____ as Surety (hereafter referred to as "Surety") do hereby acknowledge each to be bound to Owner as an Obligor in the maximum penal amount of _____ Dollars (\$_____), which represents one hundred percent (100%) of the Contract amount (hereafter referred to as the "Bond Sum"). Contractor and Surety hereby further bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally for payment of this Bond, to City as provided herein.

1. **GENERAL CONDITIONS.** It is a condition of this Bond that if Contractor promptly performs its Contract obligations (hereafter referred to as the "Work"), **including without limitation its warranty obligations established under the Contract**, Surety's obligations pursuant to this Bond are null and void. Otherwise, Surety's obligations shall remain in full force and effect. Surety waives any requirement to be notified of alterations or extensions of time, or any other duly authorized modifications, made by City to the Contract. Surety acknowledges and agrees that this Bond is being furnished to comply with Texas Government Code, Chapter 2253 and that any and all provisions provided in said statute are incorporated herein by reference. Any conflicts between this Bond and Texas Government Code, Chapter 2253 shall be resolved in favor of said statute. Upon making demand on this Bond, City shall make the Contract balance (equal to the total amount payable by City to Contractor pursuant to the Contract less amounts paid by City to Contractor), if any, available to Surety for completion of the Work.
2. **SURETY OBLIGATION.** If Contractor does not faithfully construct and complete said Work or honor its warranty obligations, as defined and established under its Contract with City, and City invokes its contractual rights and declares Contractor in default, Surety promptly shall remedy the default and, at City's sole option, Surety shall:
 - A. Within a reasonable time (but not later than fifteen (15) days after Surety receives written notice of Contractor's/Principal's Default), with written notice to City, step into and assume the role, all rights and all obligations of the defaulting Contractor/Principal under the Contract, including without limitation, responsibilities for the correction of defective work completed by the Contractor, additional legal, design professional and delay costs resulting from Contractor's default or resulting from Surety's actions or failure to act under the terms of this Bond, and liquidated damages provided under the Contract. Upon assumption of this role, Surety and all sureties directly shall contract with a Completion Contractor hired/engaged by Surety and all sureties to complete the structure(s), Work and

improvements, pursuant to the Contract with Contractor/Principal. The selection of the Completion Contractor must be approved in writing by City and such approval shall not unreasonably delayed, conditioned or withheld. Surety and all sureties solely shall be responsible for any and all costs incurred, up to the Bond Sum, to complete the structure(s), Work and improvements, or satisfy any warranty obligation pursuant to the Contract with Contractor/Principal; or

B. In the event Surety fails to contract with a Completion Contractor within sixty (60) days of receipt of City's written notice of Default, City may, at City's sole discretion, select a Completion Contractor in accordance with Texas Law and in accordance with the provisions of the Contract. In this event of Surety and all sureties failing to contract with a Completion Contractor within sixty (60) days of receipt of City's written notice of Default, Surety and all sureties then shall pay City any and all costs, up to the Bond Sum, for City's selected Completion Contractor to complete the structure(s), Work and improvements, or honor Contractor's warranty obligations, as defined and established in accordance with the provisions of the Contract with Contractor/Principal.

3. **QUALIFICATION.** Surety companies executing this Bond must appear on the United States Treasury Department's most current list (Circular 570, as amended) and be otherwise authorized to transact business in the State of Texas.
4. **VENUE.** The obligations of the parties under this Bond shall be performable in Travis County, Texas and shall be construed under the laws of the State of Texas. If legal action, such as civil litigation, is necessary in connection with this Bond, exclusive venue shall be in Travis County, Texas.

THIS BOND is entered into this _____ day of _____, 20____.

SURETY (seal)

By: _____
(Signature)

(Print Name)

(Print Title)

[ATTACH POWER OF ATTORNEY]

ATTEST: _____

CONTRACTOR

By: _____
(Signature)

(Print Name)

(Print Title)

[Additional signatures, if any, appear on
attached page]

ATTEST: _____

STATUTORY PAYMENT BOND

STATE OF TEXAS §
COUNTY OF TRAVIS §
CITY OF PFLUGERVILLE §

The **City of Pflugerville**, a municipal corporation in the State of Texas (hereafter referred to as "City") and _____, a _____ with its principal place of business located at _____ (hereafter referred to as "Contractor" or "Principal") have entered into a Contract (hereafter referred to as "the Contract") dated the ____ day of _____, 20__ for the Immanuel Road Improvements Project (hereafter referred to as "the Project"). Said Contract is incorporated by reference into this Statutory Payment Bond, pursuant to Chapter 2253 of the Texas Government Code (hereafter referred to as "this Bond").

By virtue of this Bond, Contractor as Principal and _____, with its physical address located at _____, a mailing address of _____ and a business telephone number of _____ as Surety (hereafter referred to as "Surety") do hereby acknowledge each to be bound to City as an Obligee in the maximum penal amount of _____ Dollars (\$_____), which represents one hundred percent (100%) of the Contract amount (hereafter referred to as the "Bond Sum"). Contractor and Surety hereby further bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally for payment of this Bond, as provided herein.

1. **GENERAL CONDITIONS.** It is a condition of this Bond that if Contractor promptly makes payment of all sums for all labor, services, materials and equipment furnished for use in the performance of the work required by the Contract, Surety's obligations pursuant to this Bond are null and void. Otherwise, Surety's obligations shall remain in full force and effect. Surety waives any requirement to be notified of alterations or extensions of time, or any other duly authorized modifications or changes, made by City to the Contract. Surety acknowledges and agrees that this Bond is being furnished to comply with Texas Government Code, Chapter 2253 and that any and all provisions provided in said statute are incorporated herein by reference. Any conflicts between this Bond and Texas Government Code, Chapter 2253 shall be resolved in favor of said statute.
2. **SURETY OBLIGATION.** Surety's obligation under this Bond is for the benefit and sole protection of all persons supplying labor, services, materials and equipment in the prosecution of said Contract (collectively, the "Claimant(s)"). Surety's obligation to the Claimant(s) shall not exceed the Bond Sum.
3. **QUALIFICATION.** Surety companies executing this Bond must appear on the United States Treasury Department's most current list (Circular 570, as amended) and be authorized to transact business in the Texas, hold a certificate of authority from the United States Secretary of the Treasury to qualify as a surety on obligations permitted or required under federal law, and/or be otherwise

qualified to act as a Surety under Texas Insurance Code, Chapter 3503.

4. **VENUE.** The obligations of the parties under this Bond shall be performable in Travis County, Texas and shall be construed under the laws of the State of Texas. If legal action, such as civil litigation, is necessary in connection with this Bond, exclusive venue shall be in Travis County, Texas.

THIS BOND is entered into this____day of_____, 20____.

SURETY (seal)

By:_____
(Signature)

(Print Name)

(Print Title)

[ATTACH POWER OF ATTORNEY]

ATTEST:_____

CONTRACTOR

By:_____
(Signature)

(Print Name)

(Print Title)

[Additional signatures, if any, appear on
attached page]

ATTEST:_____



WARRANTY BOND

Warranty Bond for

Immanuel Road Improvements

(Name of Plans)

Date: _____

Penal Sum: \$ _____ and _____/100
U.S. Dollars

OBLIGEE:

City of Pflugerville
PO Box 589
Pflugerville, Texas 78691
(512) 990-6300

PRINCIPAL:

Name: _____
Address: _____
Phone: () _____

SURETY:

Name: _____
Address: _____
Phone: () _____

KNOW ALL BY THESE PRESENTS,

That we _____ as
Principal, and

_____, a
Corporation of the State of _____, authorized to write Surety Bonds in the State
of Texas, as Surety, are jointly and severally held and firmly bound unto the City of Pflugerville,
Texas as Obligee, in the Penal Sum of

(\$ _____)

(Insert written amount = 35% of the cost of the improvements inspected)

which payment well and truly to be made we do bind ourselves, our and each of our heirs, executors, administrators, successors, and assigns jointly and severally, firmly by these presents.

WHEREAS, the said Principal has constructed, or caused to be constructed the following public infrastructure (“Improvements”) in accordance with the approved construction plans:

Immanuel Road Improvements

(Legal Description and items to be warranted [i.e. Streets, Drainage, Water, Wastewater, etc.])

WHEREAS, the City of Pflugerville requires the Principal to furnish a Warranty Bond in the amount of 35% of the cost of the Improvements guarantying all workmanship and materials used to construct the Improvements are free from any defect for a (1) one year period beginning at the date of acceptance. The Warranty Bond guarantees that the Principal will repair, or cause to be repaired, to the original condition at acceptance for (1) one year from the date of acceptance by the City of Pflugerville (“Warranty Period”), all defects in workmanship and material including any deterioration resulting from any defects in workmanship and materials of the Improvements, which may become apparent during the Warranty Period.

NOW, THEREFORE, THE CONDITIONS OF THIS OBLIGATION ARE SUCH that,

1. The foregoing recitals and statements are each and all true and correct.
2. Whenever Principal shall be, and is declared by the Obligee to be, in default with respect to its warranty of the Improvements, provided that the Obligee is not then in material default thereunder, Surety shall promptly take one of the following actions with the consent of the Obligee:
 - a. Not later than thirty (30) days following Surety’s receipt of written notice that the Principal had failed or refused to correct or repair the defects, Surety shall commence and complete construction, re-construction, replacement or repair of the Public Improvements in accordance with the City’s Unified Development Code, the City’s Engineering Design Guidelines and Construction Standards, and the City-approved construction plans for the Public Improvements (the “Plans”) applicable to the original construction; or
 - b. Notify the City if writing, not later than thirty (30) days following Surety’s receipt of written notice that the Principal has failed or refused to correct or repair the defects that the Surety elects not to complete, re-construct, replace or repair the Public Improvements. The Surety shall be obligated to pay the City, within the Penal Sum of the Bond, all loss, cost, and expense occasioned thereby. If the Surety fails to give such written notice, then it will be deemed to have elected not to complete, re-construct, replace, repair the Public Improvements, and shall be obligated to pay the City, within the Penal Sum of the Bond for all loss, cost, and expense occasioned thereby to complete, re-construct, replace or repair the Improvements.

In the event that Surety elects to proceed under 2(a) above, the contractor selected by Surety to perform such work shall be approved by Obligee, which approval shall not be unreasonably withheld.

3. If Surety does not proceed as provided in Paragraph 2 with reasonable promptness, Surety shall be deemed to be in default on this Bond fifteen days after receipt of an additional written notice from the Obligee to Surety demanding that Surety perform its obligations under this Bond, and the Obligee shall be entitled to enforce any remedy available to the Obligee. If Surety proceeds as provided in Subparagraph 2.b, and the Obligee refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice, the Obligee shall be entitled to enforce any remedy available to the Obligee.
4. After the Obligee has terminated the Principal's right to complete corrections of all defects in materials or workmanship, and if Surety elects to act under Subparagraph 2.a. or b., above, then the responsibilities of Surety to the Obligee shall not be greater than those of the Principal under the Agreement, and the responsibilities of the Obligee to Surety shall not be greater than those of the Obligee under the Agreement. To the limit of the Penal Sum to mitigate costs and damages on the Agreement, Surety is obligated without duplication for:
 - a. the responsibilities of the Principal for correction of defective work; and
 - b. actual damages, including but not limited to additional legal and design professional costs resulting from Principal's default, and resulting from the actions or failure to act of Surety under Paragraph 2.
5. No alteration, modification or supplement to the Warranty or the nature of the work to be performed thereunder, including without limitation any extension of time for performance, shall in any way affect the obligations of Surety under this bond. Surety waives notice of any alteration, modification, supplement or extension of time.
6. The Principal and Surety shall not have any obligations under this Bond to correct, repair or replace any damage to the Improvements caused by any third parties or damage resulting from lack of proper maintenance of the Improvements.
7. The obligations of the Principal and the Surety under this Bond does not include any obligation to maintain the Improvements.
8. The obligations of the Principal and Surety under this Bond shall terminate at the end of the Warranty Period and, at that time, this Bond shall become void and shall be of no further force or effect.

Signed, sealed and dated this _____ day of _____, 20_____.

PRINCIPAL:

Date: _____

By: _____

Name: _____

Title: _____

SURETY:

Date: _____

By: _____

Name: _____

Title: _____

**GENERAL CONDITIONS FOR
CITY OF PFLUGERVILLE CIP CONSTRUCTION CONTRACTS**

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GENERAL CONDITIONS FOR CITY OF PFLUGERVILLE CIP CONSTRUCTION CONTRACTS

ARTICLE I. GENERAL PROVISIONS

1.1 CONTRACT DEFINITIONS

Wherever used in the Contract Documents and printed with initial capital letters, the terms listed below shall have the meanings indicated, which are applicable to both the singular and plural thereof.

- 1.1.1 **“ALTERNATE”** means a variation in the Work in which City requires a price separate from the Base Bid. If an Alternate is accepted by City, the variation shall become a part of the Contract through award of the Contract and the Base Bid shall be adjusted to include the amount quoted as stated in the Notice of Award to Contractor. If an Alternate is accepted by City, and later deleted, City shall be entitled to a credit in the full value of the Alternate as priced in Contractor’s Bid Proposal.
- 1.1.2 **“AMENDMENT”** is a written modification of the Contract prepared by City or Design Consultant and signed by City and Contractor, (and approved by the Pflugerville City Council, if required) which authorizes an addition, deletion or revision in the Work (specifically the services) or an adjustment in the Contract Sum or the Contract Times and is issued on or after the Effective Date of the Contract.
- 1.1.3 **“BASE BID”** is the price quoted for the Work before Alternates are considered.
- 1.1.4 **“CHANGE ORDER”** refer to **Article VII** herein for definition.
- 1.1.5 **“CITY”** is defined in **Article II** herein.
- 1.1.6 **“CITY COUNCIL”** means the duly elected members of the City Council of the City of Pflugerville, Texas.
- 1.1.7 **“CONSTRUCTION OBSERVER/INSPECTOR”** (hereafter referred to as “COI”) is the authorized representative of the City, or its designee department, assigned by City to observe and inspect any or all parts of the Project and the materials to be used therein. Also referred to herein as Resident Inspector.
- 1.1.8 **“CONTRACT”** means the Contract Documents which represent the entire and integrated agreement between City and Contractor and supersede all prior negotiations, representations or agreements, either written or oral. The terms and conditions of the Contract Documents may be changed only in writing by a Field Work Directive, Change Order or Amendment. The Contract Documents shall not be construed to create a contractual relationship of any kind between: 1) Design Consultant and Contractor; 2) City and a Subcontractor or Sub-Subcontractor; or 3) any persons or entities other than City and Contractor.
- 1.1.9 **“CONTRACT DOCUMENTS”** means the Construction Contract between City and Contractor, which consists of, but is not limited to, the following: the solicitation (bidding) documents, including the various contract-based certifications, the Notice of Award, an enabling City of Pflugerville Resolution, if applicable, and all other contract-related documents, which include:
 - (1) Standard CIP Construction Agreement;
 - (2) General Conditions for CIP Construction Contracts;
 - (3) Vertical and/or Horizontal specific Special Conditions for CIP Construction Contracts, if

- included;
- (4) Drawings;
- (5) Specifications;
- (6) addenda issued prior to the close of the solicitation period;
- (7) other documents listed in the Contract, including Field Work Directives, Change Orders and/or Amendments, Notice to Proceed, performance and payment bonds; and
- (8) a written order for a minor change in the Work issued by Design Consultant and/or City, as described in **Article VII** herein.

The geotechnical and subsurface reports, which City may have provided to Contractor, if any, specifically are excluded from the Contract Documents.

- 1.1.10 **“CONTRACT TIME”** means, unless otherwise provided, the period of time, including any authorized adjustments, allotted in the Contract Documents for Substantial and/or Final Completion of the Work. Contract Time or Times also refers to Milestones designated in **Section II** of the City of Pflugerville Standard Capital Improvement Project (CIP) Construction Agreement Between City and Contractor and reflected in the Work Progress Schedule.
- 1.1.11 **“CONTRACTOR”** means the entity entering into a Contract with City to complete the Work. Contractor, as used herein, includes Construction Manager at Risk or other applicable entities performing work under a Contract with City.
- 1.1.12 **“DAY”** as used in the Contract Documents shall mean Calendar Day, unless otherwise specifically defined. A Calendar Day is a day of 24 hours, measured from midnight to the next midnight, unless otherwise specifically stipulated.
- 1.1.13 **“DEPARTMENT”** means the designated Department of the City of Pflugerville, Texas for Contract management purposes.
- 1.1.14 **“DESIGN CONSULTANT”** means, unless the context clearly indicates otherwise, an Engineer, Architect or other Design Consultant in private practice, licensed to do work in Texas and retained for a specific project under a contractual agreement with City.
- 1.1.15 **“DRAWINGS”** (also referred to herein as **“PLANS”**) are the graphic and pictorial portions of the Contract Documents, wherever located and whenever issued, showing the design, location and dimensions of Work, generally including elevations, sections, details, schedules and diagrams.
- 1.1.16 **“FIELD WORK DIRECTIVES” OR “FORCE ACCOUNT”** is a written order signed by City directing a change in the Work prior to agreement and adjustment, if any, in the Contract Sum and/or Contract Time, as further defined in **Section 7.3** herein.
- 1.1.17 **“HAZARDOUS SUBSTANCE”** is defined to include the following:
 - (a) any asbestos or any material which contains any hydrated mineral silicate, including chrysotile, amosite, crocidolite, tremolite, anthophyllite or actinolite, whether friable or non-friable;
 - (b) any polychlorinated biphenyls (“PCBs”), or PCB-containing materials, or fluids;
 - (c) radon;
 - (d) any other hazardous, radioactive, toxic or noxious substance, material, pollutant, or solid, liquid or gaseous waste; any pollutant or contaminant (including but not limited to petroleum, petroleum hydrocarbons, petroleum products, crude oil or any fractions

thereof, any oil or gas exploration or production waste, any natural gas, synthetic gas or any mixture thereof, lead, or other toxic metals) which in its condition, concentration or area of release could have a significant effect on human health, the environment, or natural resources;

- (e) any substance, whether by its nature or its use, is subject to regulation or requires environmental investigation, monitoring, or remediation under any federal, state, or local environmental laws, rules, or regulations;
- (f) any underground storage tanks, as defined in 42 U.S.C. Section 6991(1)(A)(I) (including those defined by Section 9001(1) of the 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act, 42 U.S.C. Section 6901 et seq.; the Texas Water Code Annotated Section 26.344; and Title 30 of the Texas Administrative Code Sections 334.3 and 334.4), whether empty, filled or partially filled with any substance; and
- (g) any other hazardous material, hazardous waste, hazardous substance, solid waste, and toxic substance as those or similar terms are defined under any federal, state, or local environmental laws, rules, or regulations.

- 1.1.18 **“LIQUIDATED DAMAGES”** reflect the daily monetary compensation, as designated in the City’s Standard Capital Improvement Project (CIP) Construction Agreement Between City and Contractor, to be paid to City by Contractor for losses/damages incurred by City as a result of the Contractor’s failure to achieve the contractual dates for Substantial Completion and/or Final Completion of the Project.
- 1.1.19 **“MILESTONE”** means a date certain established by **Section II** of the City of Pflugerville Standard Capital Improvement Project (CIP) Construction Agreement Between City and Contractor that establishes a substantial and/or final completion date of a portion of the Work prior to completion of the entirety of the Work.
- 1.1.20 **“NOTICE TO PROCEED (HEREIN ALSO REFERRED TO AS “WORK PROJECT AUTHORIZATION” OR “NTP”)**” is a written notice given by City to Contractor establishing the date on which the Contract Time shall commence to run and the date on which Contractor may begin performance of its contractual obligations.
- 1.1.21 **“OWNER”** is defined in **Article II** herein.
- 1.1.22 **“OWNER’S DESIGNATED REPRESENTATIVE (ODR)”** means the person(s) designated by City to act for City.
- 1.1.23 **“PARTY”** shall refer to City or Contractor individually herein.
- 1.1.24 **“PARTIES”** shall refer to City and Contractor collectively herein.
- 1.1.25 **“PROJECT”** means the total design and construction of Work performed under the Contract Documents and may be the whole or a part of the Project and which may include construction by City or by separate contractors. All references in these General Conditions to or concerning the Work or the Site of the Work shall use the term “Project,” notwithstanding the Work referenced may only be a part of the Project.
- 1.1.26 **“PROJECT MANAGEMENT TEAM”** is composed of City, its representatives, Design Consultant and Program Manager (if any) for this Work.
- 1.1.27 **“SITE”** means the land(s) or area(s) (as indicated in the Contract Documents) furnished by City, upon

which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by City which are designated for the use of Contractor.

- 1.128 **“SPECIAL CONDITIONS”** are terms and conditions to a contractual agreement which supplement and are superior to these General Conditions and grant greater authority or impose greater restrictions upon Contractor, beyond those granted or imposed in these General Conditions.
- 1.129 **“SPECIFICATIONS”** are those elements of the Contract Documents consisting of the written requirements for materials, equipment, construction systems, standards, workmanship for the Work, performance of related services and other technical requirements.
- 1.130 **“SUBSTANTIAL COMPLETION”** is the date certified by City and Design Consultant, in accordance with **Section 9.7** herein, when the Work, or a designated portion thereof, is sufficiently complete in accordance with the Contract Documents so as to be operational and fit for the intended use by City.
- 1.131 **“TEMPORARY BENCH MARKS (TBM)”** are temporary affixed marks which establish the exact elevation of a place; TBMs are used by surveyors in measuring site elevations or as a starting point for surveys.
- 1.132 **“WORK”** means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all labor, materials, equipment and services provided or to be provided by Contractor, or any Subcontractors, Sub-Subcontractors, material suppliers or any other entities for which Contractor is responsible, to fulfill the Contractor’s obligations. The Work may constitute the whole or a part of the Project.
- 1.133 **OTHER DEFINITIONS.** As used in the Contract Documents, the following additional terms have the following meanings:
 - (a) “provide” means to furnish, install, fabricate, deliver and erect, including all services, materials, appurtenances and all other expenses necessary to complete in place and ready for operation or use;
 - (b) “shall” or “will” means the mandatory action of the Party of which reference is being made;
 - (c) “as required” means as prescribed in the Contract Documents; and
 - (d) “as necessary” means all action essential or needed to complete the work in accordance with the Contract Documents and applicable laws, ordinances, construction codes and regulations.

1.2 PRELIMINARY MATTERS

- 1.2.1 **NOTICE OF AWARD.** Upon the Pflugerville City Council’s formal authorization to issue a contract, a Notice of Award Letter shall be sent to Contractor by the applicable City Department or ODR, notifying Contractor of the award of a contract. In its Notice of Award Letter, Contractor shall be informed of a date certain by which Contractor’s bond(s) and evidence of insurance shall be delivered to the Department or ODR.
- 1.2.2 **DELIVERY OF CONTRACT AND BONDS.** Contractor shall, in accordance with **Section 11.3 herein**, deliver a fully executed Contract to City, along with such bonds as Contractor may be required to furnish, including, but not limited to, required payment and performance bonds in the form and amount specified in the Contract Documents and these General Conditions.
- 1.2.3 **DELIVERY OF EVIDENCE OF INSURANCE.** Not later than the Pre-Construction meeting, and

prior to the commencement of any Work under this Contract, Contractor shall have delivered evidence of insurance to City in accordance with **Article X1** herein. Contractor shall have furnished an original completed Certificate of Insurance and a copy of all insurance policies, together with all required endorsements thereto, required by the Contract Documents to the City, or its delegated Department or ODR, clearly labeled with the name of the Project and which shall contain all information required by the Contract Documents. Contractor shall be prohibited from commencing the Work and City shall have no duty to pay or perform under this Contract until such evidence of insurance is delivered to City. No officer or employee, other than City's Risk Management Department, shall have authority to waive this requirement.

- 1.2.4 **NOTICE TO PROCEED AND COMMENCEMENT OF CONTRACT TIMES.** Unless otherwise stated on the Notice to Proceed, the Contract Time shall commence to run on the date stated on the Notice to Proceed. No Work shall commence any earlier than the date stated on Notice to Proceed and no Work shall be performed by Contractor or any Subcontractor prior to issuance of the Notice to Proceed. Any work commenced prior to Contractor receiving a Notice to Proceed is performed at Contractor's sole risk and expense.
- 1.2.5 **SUBMISSION OF PROJECT SCHEDULE(S).** Prior to commencement of any Work (unless otherwise specified elsewhere in the Contract Documents), Contractor shall submit to the ODR or Director of the Department or his/her designee the Project schedule(s), as defined in **Section 3.10** herein, a minimum of fifteen (15) days prior to the Pre-Construction Conference.
- 1.2.6 **PRE-CONSTRUCTION CONFERENCE.** Before Contractor commences any Work on the Project, a Pre-Construction Conference attended by Contractor, Design Consultant, City's Designated Representative(s) and others, as appropriate, shall be held to establish a working understanding among the Parties as to the Work and discuss, at minimum: the Project Schedule(s) referenced in this **Article 1**; the procedures for handling Shop Drawings and other submittals; the processing of Applications for Payment; and Contractor maintaining required records. The Notice to Proceed may be issued at the Pre-Construction Conference or issued by City at any time at City's discretion. Said issuance of the Notice to Proceed shall not be unreasonably withheld or delayed by City.
- 1.2.7 Payments for services, goods, work, equipment and materials are contingent upon and subject to the availability and appropriation of funds and/or the sale of future City of Pflugerville Certificates of Obligation and/or General Obligation Bonds in accordance with adopted budgets. In the event funds are not available, appropriated or encumbered to fund a Project, then, at City's discretion, this Contract may be terminated immediately with no additional liability to City.

1.3 CONTRACT DOCUMENTS

- 1.3.1 **EXECUTION OF CONTRACT DOCUMENTS.** Execution of the Contract by Contractor is a representation Contractor has been provided unrestricted access to the existing improvements and conditions on the Project Site, Contractor thoroughly has investigated the conditions at the Site and the general local conditions affecting the Work and Contractor's investigation was instrumental in preparing its bid or proposal submitted to City to perform the Work, upon which the City has justifiably relied upon when entering into this Contract. Contractor shall not make or be entitled to any claim for any adjustment to the Contract Time or the Contract Sum arising from conditions which Contractor discovered or, in the exercise of reasonable care, should have discovered in Contractor's investigation.
- 1.3.2 **OWNERSHIP AND USE OF DRAWINGS, SPECIFICATIONS AND OTHER INSTRUMENTS OF SERVICE.** The Drawings, Specifications and other documents, including those in electronic form, prepared by Design Consultant, its Consultants or other Consultants retained by City for the Project, which describe the Work to be executed by Contractor (collectively referred to as the "Construction Documents")

are and shall remain the property of City, whether the Project for which they are made is executed or not. Contractor shall be permitted to retain one record set. Neither Contractor nor any Subcontractor, sub-Subcontractor or material or equipment supplier shall own or claim a copyright in the Drawings, Specifications and other documents prepared by Design Consultant or Design Consultant's Consultants. All copies of Construction Documents, except Contractor's record set, shall be returned or suitably accounted for to Design Consultant on request and upon completion of the Work. The Drawings, Specifications and other documents prepared by Design Consultant and Design Consultant's Consultants, along with copies thereof furnished to Contractor, are for use solely with respect to this Project. The drawings, Specifications or other documents are not to be used by Contractor or any Subcontractor or material or equipment supplier on other projects or for additions to this Project outside the scope of the Work without the specific written consent of City. Any such use without written authorization shall be at the sole risk and liability of Contractor. Contractor, Subcontractors and material or equipment suppliers are authorized to use and reproduce applicable portions of the Drawings, Specifications and other documents prepared by the Design Consultant and the Design Consultant's Consultants appropriate to and for use in the execution of their Work under the Contract Documents. All copies made under this authorization shall bear the statutory copyright notice, if any, shown on the Drawings, Specifications and other documents prepared by Design Consultant and Design Consultant's Consultants. Submittal or distribution to meet official regulatory requirements or for other purposes, in connection with this Project, is not to be construed as publication.

1321 All of Contractor's non-proprietary, documentary Work product, including reports and correspondence to City, prepared pursuant to this Contract, shall be the property of City and, upon completion of this Contract and upon written request by City, promptly shall be delivered to City in a reasonably organized form, without restriction on its future use by City. For the avoidance of doubt, documentary Work product does not include privileged communications, proprietary information and documents used to prepare Contractor's Bid Proposal.

1322 Contractor may retain for its files any copies of documents it chooses to retain and may use its Work product as it deems fit. Any materially-significant Work product lost or destroyed by Contractor shall be replaced or reproduced at Contractor's non-reimbursable sole cost. In addition, City shall have access during normal business hours, during the duration this Contract is in effect and for four (4) years after the final completion of the Work, unless there is an ongoing dispute under the Contract, then such access period shall extend longer until final resolution of the dispute, to all of Contractor's records and documents covering reimbursable expenses, actual base hourly rates, time cards and annual salary escalation records maintained in connection with this Contract for purposes of auditing same at the sole cost of City. The purpose of any such audit shall be for the verification of such costs. Contractor shall not be required to keep records of, or provide access to, the makeup of any negotiated and agreed-to lump sums, unit prices or fixed overhead and profit multipliers. Nothing herein shall deny Contractor the right to retain duplicates. Refusal by Contractor to comply with the provisions hereof shall entitle City to withhold any payment(s) to Contractor until compliance is obtained.

1.3.3 **CORRELATION AND INTENT.** The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by Contractor. The Contract Documents are complementary and what is required by one shall be as binding as if required by all. Performance by Contractor shall be required only to the extent consistent with the Contract Documents and which reasonably is inferable from the Contract Documents as deemed necessary to produce the indicated results. Subject to this **Section 1.3.3** and the specific provisions of the subsections contained hereunder, with the exception of **Subsection 1.3.3.4**, should the Contract Documents be inconsistent in terms of quality and quantity of the Work indicated, Contract pricing shall be based on the better quality and greater quantity of work indicated as determined in the City's reasonable discretion. In cases of discrepancy between any drawing and the dimension figures written

thereon:

- (1) the dimension figures shall govern over scaled dimensions;
 - (2) Detailed Drawings and accompanying notations shall govern over general Drawings; and
 - (3) Specifications shall govern over Drawings, subject to this **Section 1.3.3** herein.
- 1331 Organization of the Specifications into divisions, sections, articles, and the arrangement of Drawings shall not control Contractor in dividing the Work among Subcontractors or establishing the extent of Work to be performed by any trade.
- 1332 Unless otherwise stated in the Contract Documents, words having well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings. Where the phrases "directed by", "ordered by" or "to the satisfaction of" City, Design Consultant or City's Resident Inspector or other specified designation occur, it is understood the directions, orders or instructions to which they relate are those within the scope of and authorized by the Contract Documents.
- 1333 Reference to manufacturer's instructions, standard specifications, manuals or codes of any technical society, organization or association, laws or regulations of any governmental authority, or to any other documents, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code or laws or regulations in effect at the time of opening of Contractor's Bid Proposal, except as otherwise may be specifically stated or where a particular issue is indicated. Municipal and utility standards shall govern except in case of conflict with the Specifications. In case of a conflict between the Specifications and the referenced standard, the more stringent shall govern.
- 1334 The most recently issued Document takes precedence over previous issues of the same Document. In the event that a conflict exists between the various components of the Contract Documents, the order of precedence to resolve the conflict is as follows, with the highest authority listed herein as "(a)" and thereafter in descending order of authority:
 - (a) Modifications or Amendments to the Project Contract signed by Contractor, City and Design Consultant;
 - (b) Addenda, with those of later date(s) having precedence over those with earlier date(s);
 - (c) Standard Capital Improvement Project (CIP) construction agreement
 - (d) Special Conditions for CIP Construction Contracts;
 - (e) General Conditions for CIP Construction Contracts;
 - (f) Special Provisions, if any;
 - (g) Specifications;
 - (h) Drawings; and
 - (i) Solicitation (bidding) documents.
- 1335 Reserved.
- 1336 In the Drawings and Specifications, where certain products, manufacturer's trade names or catalog numbers are given, such information is given for the sole and express purpose of establishing a standard of function, dimension, appearance and quality of design in harmony with the Work and is not intended for the purpose of limiting competition, unless specified as a sole source. Materials or equipment shall not be substituted unless such a substitution has been specifically accepted for use on this Project by City and Design Consultant.

- 1337 When the work is governed by reference to standards, building codes, manufacturer's instructions or other documents, unless otherwise specified, the edition currently in place as of the date of the submission of the Bid Proposal shall apply.
- 1338 Requirements of public authorities apply as minimum requirements only and do not supersede more stringent specified requirements.
- 1339 Special Provisions, if any, shall be issued by City directly to Contractor, shall become part of the Project Specifications and shall modify City's Standard Specifications.

ARTICLE II. CITY

2.1 GENERAL

- 2.1.1 The City of Pflugerville, Texas, a home-rule, Texas Municipal Corporation located in Travis and Williamson Counties and identified as "City" or as "Owner" in the Contract and these General Conditions, is referred to throughout the Contract Documents as if singular in number. City shall designate in writing to Contractor a representative (hereafter referred to as "City's Designated Representative" or "ODR") who shall act as the City's representative with respect to all matters concerning this Contract. Whenever the term "City" or "City" is found in this Contract or the Contract Documents, such term shall include City's agents, elected officials, employees, officers, directors, volunteers, representatives, successors and assigns.

2.2 INFORMATION AND SERVICES TO BE PROVIDED BY CITY

- 2.2.1 City shall provide and maintain the general schedule, if any, for the Project. The general schedule shall set forth City's plan for Milestone dates, Substantial Completion and Final Completion of the Project.
- 2.2.2 City shall furnish surveys, if in existence and in City's possession, describing physical characteristics, legal limitations and utility locations. The furnishing of these surveys and reports are for Contractor's convenience only and the City shall not be liable for any Contract Sum or Contract Time adjustment due to discrepancies therein found, unless otherwise specifically provided in the Contract Documents. Further, furnishing of said surveys and reports shall not relieve Contractor of any of its duties under the Contract Documents or these General Conditions. Information or services required of City by the Contract Documents shall be furnished by City with reasonable promptness following actual receipt of a written request from Contractor. It is incumbent upon Contractor to identify, establish and maintain a current schedule of latest dates for submittal and approval by City, as required in **Section 3.10** herein, including when such information or services must be delivered. If City delivers the information or services to Contractor as scheduled and Contractor is not prepared to accept or act on such information or services, then Contractor shall reimburse City for all extra costs incurred by holding, storage, retention or performance, including redeliveries by City in order to comply with the current schedule.
- ~~2.2.3 Unless otherwise provided in the Contract Documents, Contractor shall be furnished, free of charge, up to two (2) complete sets of the Plans and Specifications by Design Consultant. Additional complete sets of Plans and Specifications, if requested by Contractor, shall be furnished to Contractor at reproduction cost.~~
- 2.2.4 City's personnel may, but are not required to, be present at the construction site during progress of the Work, along with Design Consultant in the performance of its duties, to verify Contractor's record of the number of workers employed on the Work site, the workers' occupational classification, the time

each worker is engaged in the Work and the equipment used by the workers in the performance of the Work, for purpose of verification of Contractor's Applications for Payment and payroll records.

- 2.2.5 City shall reimburse Contractor for the necessary Project-related approvals, fees and required permits with no markup paid to Contractor for these necessary Project-related approvals, fees and required permits costs, unless said costs are stipulated in the Contract Documents as a part of Contractor's cost of Work.
- 2.2.6 **CITY'S RIGHT TO STOP THE WORK.** If Contractor fails to correct Work deemed by City not in accordance with the requirements of the Contract Documents, as required by **Section 12.3** herein, fails to carry out Work in accordance with the Contract Documents or fails to submit its preliminary or updated schedule(s), bond(s), insurance certificate(s) or any other required submittals, City may issue a written order to Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated. The right of City to stop the Work shall not give rise to any duty on the part of City to exercise this right for the benefit of the Contractor or any other person or entity. This right shall be in addition to and not in restriction of City's rights pursuant to **Section 12.3** herein. City's issuance of an order to Contractor to stop the Work shall not give rise to any claim by Contractor for additional time, cost or general conditions costs.
- 2.2.7 **CITY'S RIGHT TO CARRY OUT THE WORK.** If Contractor defaults, neglects or fails to carry out the Work in accordance with the Contract Documents and fails, within a three (3) work-day period after receipt of written notice from City, to commence and continue correction of such default, neglect or failure with diligence and promptness, City may, without prejudice to other remedies City may have, correct such deficiencies, neglect or failure. In such case, an appropriate Change Order may be issued deducting from payments then or thereafter due Contractor reflecting the reasonable cost of correcting such deficiencies, neglect or failure of Contractor, including all of City's incurred expenses and compensation for Design Consultant's additional services made necessary by such default, neglect or failure of Contractor. If payments then or thereafter due Contractor are not sufficient to cover such amounts for the Work performed, Contractor shall pay the difference to City.

ARTICLE III. CONTRACTOR

3.1 GENERAL

- 3.1.1 Contractor is the person or entity identified as such in the Contract and is referred to throughout the Contract Documents as if singular in number. The term "Contractor" means the Contractor or the Contractor's authorized representative.
- 3.1.2 Contractor shall perform the Work in a good and workmanlike manner, except to the extent the Contract Documents expressly specify a higher degree of finish or workmanship.
- 3.1.3 Contractor shall not be relieved of its obligations, responsibilities or duties to perform the Work in accordance with the Contract Documents, either by any activities or duties of Design Consultant in Design Consultant's administration of the Contract or by tests, inspections or approvals required or performed by City or any person other than the Contractor.
- 3.1.4 *Work Week.* Unless otherwise superseded by the Special Conditions or revised in accordance with this **Section 3.1.4**, Site Work shall only be performed by the Contractor under this Contract from 7:00 a.m. to 6:00 p.m., Monday through Friday of each week, which shall be considered the Work Week for all purposes. Contract Times, however, shall be calculated solely on the basis of Calendar Days

as hereinabove defined and the designation of a Work Week shall have no bearing on these calculations. In the absence of Special Conditions extending or otherwise modifying the Work Week, in the event that Contractor desires to extend the Work Week for good cause shown, Contractor may request such extension detailing the reasons for such request in writing to the City. City shall consider said request and grant, modify or reject such request, in City's sole discretion, it being understood and agreed to by the parties hereto that the Contract Time factors in days not included within the Work Week for Work completion.

3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

3.2.1 Since the Contract Documents are complementary, before starting each portion of the Work, Contractor carefully shall:

- (1) study and compare the various Drawings and other Contract Documents relative to that portion of the Work and the information furnished by City;
- (2) take field measurements of any existing conditions related to that portion of the Work; and
- (3) observe any conditions at the Site affecting the Work.

Any error, inconsistencies or omissions discovered by Contractor shall be promptly reported to City via a Request for Information in such form as City may require.

3.2.1.1 The exactness of existing grades, elevations, dimensions or locations given on any Drawings issued by Design Consultant, or the work installed by other contractors, is not guaranteed by City. Contractor shall, therefore, satisfy itself as to the accuracy of all grades, elevations, dimensions and locations.

3.2.1.2 In all cases of interconnection of its Work with existing conditions or with work performed by others, Contractor shall verify at the site all dimensions relating to such existing or other work. Any errors due to Contractor's failure to so verify all such grades, elevations, dimensions or locations promptly shall be rectified by Contractor without any additional cost to City.

322 As between City and Contractor, and subject to the provisions of **Section 3.2.4** below, Contractor has no responsibility for the timely delivery, completeness, accuracy and/or sufficiency of the Specifications or Drawings (or any errors, omissions, or ambiguities therein), and is not responsible for any failure of the design of the facilities or structures as reflected thereon to be suitable, sound or safe. Contractor shall be deemed to have satisfied itself as to the design contained in and reflected by the Specifications and the Drawings. In particular, but without prejudice to the generality of the foregoing, Contractor shall review the Contract Documents to establish:

3.2.2.1 the information is sufficiently complete to perform the Work; and

3.2.2.2 there are no obvious or patent ambiguities, inaccuracies or inconsistencies within or between the documents forming the Contract; and

3.2.2.3 Contractor shall work with the aforementioned Contract Documents so as to perform the Work and of each and every part thereof to ensure the Work and each and every part thereof shall, jointly and severally, be in accordance with the requirements of the Contract Documents and, in particular but without limiting the generality of the foregoing, the Work as a whole and, as appropriate, each and every part thereof, shall comply with the requirements of any

performance Specifications.

323 Any design errors or omissions noted by Contractor during its review promptly shall be reported to City, but it is recognized the Contractor's review is made in Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents. Contractor is not required to ascertain if Contract Documents are in accordance with applicable laws, statutes, ordinances, building codes, and rules and regulations, but any nonconformity discovered by or made known to Contractor promptly shall be reported both to City and Design Consultant.

324 If Contractor believes additional cost or time is involved because of clarifications or instructions issued by Design Consultant, in response to the Contractor's Notices or Requests for Information, Contractor shall make Claims as provided in **Section 4.3** herein. If Contractor fails to perform the obligations of **Section 3.2.1** and **Section 3.2.2** herein, Contractor shall pay such costs and damages to City, to include applicable Liquidated Damages, as would have been avoided if Contractor had performed such obligations. Contractor shall not be liable to City or Design Consultant for damages resulting from errors, inconsistencies or omissions in the Contract Documents or for differences between field measurements or conditions and the Contract Documents, unless Contractor recognized or should have recognized such error, inconsistency, omission or differences and knowingly failed to report it to City and Design Consultant, as required by this **Section 3.2.4**.

325 **DIFFERING SITE CONDITIONS.** Contractor promptly shall, before such discovered conditions and/or structures are disturbed, notify City in writing of differing site conditions. Differing site conditions are defined as subsurface or latent physical and/or structural conditions at the Site differing materially from those indicated in the Plans, Specifications and other Contract Documents or newly discovered and previously unknown physical conditions at the Site of an unusual nature differing materially from those geophysical conditions typically encountered in the type Work being performed and generally being recognized as not indigenous to the Pflugerville, Travis County, Texas environs.

City and/or Design Consultant promptly shall investigate the reported physical and/or structural conditions and shall determine whether or not the physical and/or structural conditions do materially so differ and thereby cause an increase or decrease in Contractor's cost of and/or time required for performance of any part of the Work under this Contract. In the event City reasonably determines the physical and/or structural conditions materially so differ, a negotiated and equitable adjustment shall be made to the Contract Time and/or Contract Sum and a Change Order promptly shall be issued by City.

3.2.5.1 No claim of Contractor under this **Section 3.2.5** shall be allowed unless Contractor has given the written notice called for above, prior to disturbing the discovered conditions and/or structures.

3.2.5.2 No Contract adjustment shall be allowed under this **Section 3.2.5** for any effects caused on unchanged work.

3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

331 Contractor shall supervise, inspect and direct the Work competently and efficiently, exercising the skill and attention of a reasonably prudent Contractor, devoting such attention and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor solely shall be responsible for the means, methods, techniques, sequences, procedures and coordination of all portions of the Work under the Contract, unless the Contract Documents give other

specific instructions concerning these matters. If the Contract Documents give specific instructions concerning construction means, methods and/or techniques, Contractor then shall evaluate the jobsite safety thereof and, except as stated herein below, shall be fully and solely responsible for the jobsite safety of such means, methods, techniques, sequences or procedures. If, upon its evaluation, Contractor determines such means, methods, techniques, sequences or procedures may not be safe, Contractor shall give timely written notice to City and Design Consultant and Contractor shall not proceed with that portion of the Work without further written instructions from City. Sequencing and procedures shall be coordinated and agreed upon by City, Design Consultant and Contractor.

332 Contractor shall be responsible to City for the acts and omissions of Contractor's agents and employees, Subcontractors and their agents and employees and other persons or entities performing portions of the Work for or on behalf of Contractor or any of its Subcontractors.

333 Contractor shall be responsible for inspection of portions of Work already performed, to determine which such portion are in proper condition to receive subsequent Work.

334 Contractor shall bear responsibility for design and execution of acceptable trenching and shoring procedures, in accordance with Texas Government Code, Section 2166.303 and Texas Health and Safety Code, Subchapter C, Sections 756.021, et seq.

335 It is understood and agreed the relationship of Contractor to City shall be of an independent contractor. Nothing contained or inferable in the Contract documents shall be read, deemed or construed to make Contractor the agent, servant or employee of City or create any partnership, joint venture or other association between City and Contractor. Any direction or instruction by City, in respect of the Work, shall relate to the results City desires to obtain from the Work and shall in no way affect Contractor's independent contractor status, as described herein.

336 Contractor shall review Subcontractor(s) written safety programs, procedures and precautions in connection with performance of the Work. However, Contractor's duties shall not relieve any Subcontractor(s) or any other person or entity (e.g. a supplier), including any person or entity with whom Contractor does not have a contractual relationship, of their responsibility or liability relative to compliance with all applicable federal, state and local laws, rules, regulations and ordinances, which shall include the obligation to provide for the safety of their employees, persons, and property and their requirements to maintain a work environment free of recognized hazards. The foregoing notwithstanding, the requirements of this **Section 3.3.6** are not intended to impose upon Contractor any additional obligations Contractor would not have under any applicable state or federal laws including, but not limited to, any rules, regulations or statutes pertaining to the Occupational Safety and Health Administration.

3.4 LABOR AND MATERIALS

341 Unless otherwise provided in the Contract Documents, Contractor shall provide and pay for all labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

342 **PREVAILING WAGE RATE AND LABOR STANDARD PROVISIONS.** The Provisions of Chapter 2258 of the Texas Government Code expressly are made a part of this Contract. In accordance therewith, a schedule of the general prevailing rate of per diem wages in this locality for each craft or type of worker needed to perform this Contract is part of the Contract Documents for all purposes. Contractor shall forfeit, as a penalty to City, sixty dollars (\$60.00) for each laborer, worker or mechanic employed for each calendar day, or portion thereof, in which such laborer, worker or mechanic is paid

less than the stipulated prevailing wage rates for any work done under this Contract by the Contractor or any Subcontractor employed on the project. The establishment of prevailing wage rates, pursuant to Chapter 2258 of the Texas Government Code, shall not be construed to relieve Contractor from its obligation under any federal or state law, regarding the wages to be paid to or hours worked by laborers, workers or mechanics, insofar as applicable to the work to be performed hereunder.

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SUBSTITUTIONS

3.4.3.1 Contractor's proposed substitutions and alternates may be rejected by City without explanation and shall be considered by City only under one or more of the following conditions:

- (a) the proposal is required for compliance with interpretation of code requirements or insurance regulations then existing;
- (b) specified products are unavailable through no fault of Contractor; and
- (c) when in the judgment of City or Design Consultant, a substitution substantially would be in City's best interests in terms of cost, time or other considerations.

3.4.3.2 Contractor shall submit to City and Design Consultant:

- (a) a full explanation of the proposed substitution and submittal of all supporting data, including technical information, catalog cuts, warranties, test results, installation instructions, operating procedures and other like information necessary for a complete evaluation of the substitution;
- (b) a written explanation of the reasons the substitution is necessary, including the benefits to City and to the Work, in the event the substitution is acceptable to City;
- (c) the adjustment, if any, in the Contract Sum;
- (d) the adjustment, if any, in the Contract Time and the construction schedule; and
- (e) in the event of a substitution under **Section 3.4.3.1** herein, an affidavit stating:
 - (1) Contractor's proposed substitution conforms to and meets all the requirements of the pertinent Specifications and requirements shown on the Drawings; and
 - (2) Contractor accepts the warranty and correction obligations in connection with the proposed substitution as if originally specified by Design Consultant.

Proposals for substitutions shall be submitted to Design Consultant in sufficient time to allow Design Consultant no less than twenty-one (21) calendar days for review. No substitutions shall be considered or allowed without Contractor's submittal of complete substantiating data and information as stated hereinbefore.

3.4.3.3 In the event of a substitution submittal under this **Section 3.4.3**, and whether or not any such proposed substitution is accepted by City or Design Consultant, Contractor shall reimburse City, at City's reasonable discretion, for any fees incurred and charged by Design Consultant or other Consultants for evaluating each proposed substitute.

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Contractor shall, at all times, enforce strict discipline and good order among persons working on the Project and shall not employ or continue to employ any unfit person on the Project or any person not skilled in the assigned work. Contractor shall be liable for and responsible to City for all acts and omissions of its employees, all tiers of its Subcontractors, material suppliers, anyone who Contractor may allow to perform any Work on the Project and their respective officers, agents, employees, and Consultants who Contractor may allow to come on the job site, with the exception of City or City's Designee. City, at any time, for any reason or for no reason, may direct Contractor to remove any

employee, Subcontractor, material supplier or anyone else from the Project and Contractor promptly shall comply with City's direction. In addition, if Contractor receives written notice from City complaining about any Subcontractor, employee or anyone who is a hindrance to the proper or timely execution of the Work, Contractor shall remedy such complaint without delay to the Project and at no additional cost to City. This provision shall be included in all contracts between Contractor and all Subcontractors of all tiers.

- 345 Contractor recognizes, accepts and hereby acknowledges the Project Site is a public facility representing the City of Pflugerville. As such, Contractor shall prohibit the possession or use of alcohol, controlled substances, tobacco and any prohibited weapons on the Project Site and shall require appropriate dress of Contractor's forces consistent with the nature of the Work being performed, including the wearing of shirts at all times. Harassment of any kind, including sexual harassment, of employees of Contractor or any Subcontractor, employees or Consultants of City or of any visitor to the Project site, by Contractor, employee(s) of Contractor, a Subcontractor or an employee of Subcontractor strictly is forbidden. Any person, Contractor, employee of Contractor, Subcontractor or employee of Subcontractor who is found to have engaged in such conduct shall be subject to appropriate disciplinary action by Contractor and/or City, including the removal and exclusion of the violating person(s) or employee(s) of Contractor or Subcontractor from the Project Site and, if City so elects, termination from the Project.
- 346 All materials and installed equipment shall be as specified in the Contract Documents and, if not so specified, shall be new and of good quality, except as otherwise provided in the Contract Documents. If required by City or Design Consultant, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind and quality of materials and equipment installed. Contractor may make substitutions only with the consent of City, after Contractor's compliance with **Section 3.4.3** herein.
- 347 All materials shall be shipped, stored and handled in a manner which shall protect and ensure their condition at the time of incorporation in the Work. After installation, all materials shall be properly protected against damage to ensure they are in the condition as required by **Section 3.5.1** herein when the Work is Substantially Completed or City takes over use and occupancy, whichever is earlier. Materials not meeting Contract requirements or that do not produce satisfactory results shall be rejected by City, unless City or Design Consultant approves corrective actions. Upon rejection, Contractor immediately shall remove and replace rejected materials. If Contractor does not comply with these requirements, City may remove and replace defective material and all costs incurred by City for testing, removal and replacement of rejected materials shall be deducted from any money due or owed to Contractor.

The source of supply of each of the materials shall be approved by City or Design Consultant before delivery is started and, at the option of City, may be sampled and tested by City for determining compliance with the governing Specifications before delivery is started. If it is found after trial sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, Contractor shall furnish materials from other approved sources. Only materials conforming to the requirements of the Contract documents and approved by City shall be used by Contractor in the work. All materials being used by Contractor are subject to inspection or test at any time during preparation or use. Any material which has been tested and accepted at the source of supply may be subjected to a check test after delivery and all materials which, when retested, do not meet the requirements of the Specifications shall be rejected. No material which, after approval, has in any way become unfit for use shall be used in the Work.

If, for any reason, Contractor selects a material which is approved for use by City or Design Consultant by sampling, testing or other means, and Contractor decides to change to a different material requiring

additional sampling and testing by City for approval, Contractor shall pay for any expense incurred by City for such additional sampling and testing and the costs incurred by City shall be deducted from any money due or owed to Contractor.

- 348 Contractor shall procure and furnish to City all guarantees, warranties, spares and maintenance manuals called for by the Specifications or which normally are provided by a manufacturer. The maintenance manual shall include a catalog for any equipment, materials, supplies or parts used in the inspection, calibration, maintenance or repair of the equipment and items in the catalog shall be readily available for purchase.
- 349 During construction of the Work and for four (4) years after final completion or longer if, during the duration of this Contract or during the four (4) years after the final completion of the Work, a dispute between any parties to this Project exists, Contractor shall retain and shall require all Subcontractors to retain for inspection and audit by City all books, accounts, reports, files, time cards, material invoices, payrolls and evidence of all other direct or indirect costs related to the bidding and performance of this Work. Upon request by City, a legible copy or the original of any or all such records shall be produced by Contractor at the administrative office of City. To the extent it requests copies of such documents, City shall reimburse Contractor and its Subcontractors for copying costs. Contractor shall not be required to keep records of or provide access to the makeup of any negotiated and agreed-to lump sums, unit prices or fixed overhead and profit multipliers.

3.5 WARRANTY

- 351 Contractor warrants and guarantees materials and equipment furnished and installed under the Contract shall be new and of good quality, unless otherwise required or permitted by the Contract Documents, the Work shall be free from defects not inherent in the quality required or permitted and the Work shall conform to the requirements of the Contract Documents. Contractor acknowledges and agrees that the Performance Bond provided under **Section 11.3.1.1** herein shall include and ensure coverage for all warranty obligations contemplated by this **Section 3.5** and otherwise provided by the Contract Documents, but this coverage shall in no event be construed as the City's exclusive recourse in the event of Contractor's non-performance of its obligations provided herein. Work not conforming to this warranty and these requirements, including substitutions not properly approved and authorized by City, may be considered defective. Contractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, normal wear and tear and normal usage, and additional damage or defects caused by City's failure to promptly notify Contractor. If required by City, Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.
- 352 A right of action by City for any breach of Contractor's express warranty herein shall be in addition to, and not in lieu of, any other remedies City may have under this Contract at law or in equity, regarding any defective Work.
- 353 The warranty provided in **Section 3.5.1** herein shall be in addition to and not in limitation of any other warranty or remedy required by law or by the Contract Documents. Such warranty shall be interpreted to require Contractor, upon written demand by City as herein provided, to replace defective materials and equipment and re-execute any defective Work disclosed to the Contractor by City within a period of one (1) year after Substantial Completion, if applicable, or Final Completion of the applicable Work or, in the event of a latent defect, within one (1) year after discovery thereof by City.
- 354 All warranties shall be assignable by City. Submittal of all warranties and guarantees are required as a prerequisite to the final payment.

- 355 Except when a longer warranty time is specifically called for in the Specifications or is otherwise provided by law or by manufacturer, all warranties shall be at minimum for twelve (12) months and shall be in form and content otherwise reasonably satisfactory to City. City and Contractor acknowledge the Project may involve construction work on more than one (1) building or section of infrastructure of City's. While the overall Project shall have a single date for Substantial Completion of the Work and Final Completion of the Work, each building, section of infrastructure or approved phase of each section of infrastructure may have its own separate and independent date of Substantial Completion or Final Completion.
- 356 If separate dates for Substantial Completion and Final Completion are established and granted by City, at City's sole discretion and as a result of City electing partially to occupy areas prior to the Project's overall date for Substantial Completion, Contractor shall maintain a complete and accurate schedule of the dates of Substantial Completion and, if City accepts partial occupancy of those completed areas, the dates upon which the one (1) year warranty on each building, phase or section of infrastructure granted Substantial Completion shall expire. If separate dates are granted, Contractor agrees to provide notice of the warranty expiration date(s) to City and Design Consultant at least one (1) month prior to the expiration of the one (1) year warranty period on each building, section of infrastructure or each phase of the section of infrastructure which has achieved Substantial Completion.
- 357 Prior to termination of any one (1) year warranty period, Contractor shall, upon request of City, accompany City and Design Consultant on re-inspection of the building, section of infrastructure or phase of the section of infrastructure and be responsible for correcting any reasonable additional deficiencies not caused by City or by the use of the building, section of infrastructure or phase of the section of infrastructure observed and/or reported during the re-inspection.
- 358 For warranties required in this **Section 3.5** and otherwise provided by the Contract Documents, City shall notify Contractor of deficiencies and Contractor shall start remedying these defects within seven (7) calendar days of initial notification from City, unless a longer commencement date is agreed to by the City in writing for good cause shown. Following commencement, Contractor shall prosecute the work without interruption until accepted by City and Design Consultant, even though such prosecution may extend beyond the limit of the warranty period. In the event that Contractor should fail to so perform, City shall require Contractor's surety to perform under the Performance Bond provided in **Section 11.3.1.1** herein and/or take any other action available to the City at law or in equity to secure performance of Contractor's obligations under this **Section 3.5** and the Contract Documents. If Contractor fails to provide notice of the expiration of the one (1) year warranty period at least one (1) month prior to the expiration date and conduct the required walk through with City, Contractor's warranty obligations described in this **Section 3.5** shall continue until such inspection is conducted and any deficiencies found in the inspection is corrected.
- 359 Warranties shall become effective on a date established by City in accordance with the Contract Documents. This date shall be the date of Substantial Completion, if applicable, or Final Completion of the entire Work, unless otherwise provided in any Certificate of Partial Substantial Completion approved by the Parties, except for Work to be completed or corrected after the date of Substantial Completion and prior to final payment and those occurrences addressed in **Section 3.5.11** herein. Warranties for Work to be completed or corrected after the date of Substantial Completion and prior to Final Completion shall become effective on the later of the date the Work is completed or corrected and accepted by City and Design Consultant or the date of Final Completion of the Work.
- 35.10 Neither final payment nor compliance by Contractor with any provision in the Contract Documents shall constitute an acceptance of Work not done in accordance with the Contract Documents or relieve Contractor or its sureties of liability, with respect to any warranties or responsibility for faulty materials and workmanship. Contractor warrants all Work shall conform to the requirements of the Contract

Documents.

35.11 Contractor agrees to assign to City, at the time of Final Completion of the Work, any and all manufacturer's warranties relating to materials and labor used in the Work and further agrees to perform the Work in such manner so as to preserve any and all such manufacturer's warranties, provided such assignment shall contain a reservation of Contractor's right also to enforce the manufacturer's warranties. As a condition precedent to final payment, Contractor shall prepare a notebook with reference tabs and submit three (3) copies of the notebook to City which shall include a complete set of warranties from Subcontractors, manufacturers or suppliers, as appropriate, and executed by and between Contractor and City, as required under this Contract, with a specified warranty commencement date, as required by the Contract Documents. Copies of the complete set of warranties from Subcontractors, manufacturers and/or suppliers, as appropriate, executed by Contractor as required by the Contract Documents, with and between City and Contractor. A specified warranty commencement date, as required by the Contract Documents, also shall be submitted to City in an electronic format (PDF) on a USB flash drive.

3.6 **TAXES.** Contractor shall not include in the Contract Sum or any modification thereto any amount for sales, use or similar taxes for which City is exempt. Upon request by Contractor, City shall provide Contractor with a tax exemption certificate or other documentation necessary to establish City's exemption from such taxes.

3.7 PERMITS, FEES AND NOTICES

37.1 **PERMITS.** Unless otherwise provided in the Contract Documents or by City, as per **Section 2.2.5** herein, it is the responsibility of and Contractor shall secure all permits, licenses and inspections. City and Design Consultant may assist Contractor, when necessary, in obtaining such permits, licenses and inspections necessary for the proper execution and completion of the work. If required for the Work, Contractor shall prepare and submit any paperwork, plans, notices, etc. necessary to comply with Texas Pollutant Discharge Elimination System (hereafter referred to as "TPDES") regulations of the Texas Commission on Environmental Quality as required by the Texas Water Code and the federal Clean Water Act.

37.2 Contractor shall comply with and give all notices required by law, ordinance, rule, regulations and lawful orders of public authorities applicable to performance of the Work.

37.3 It is not Contractor's responsibility to ascertain the Contract Documents are in accordance with applicable laws, statutes, ordinances, building codes and rules and regulations. However, if Contractor observes portions of the Contract Documents are at variance therewith, Contractor promptly shall notify City and Design Consultant in writing of any variances and all necessary changes shall be accomplished by appropriate modification(s) before Contractor performs any Work affected by such modification(s).

37.4 If Contractor performs Work knowing Work is contrary to laws, statutes, ordinances, building codes and rules and regulations, without such notice to and approval from City and Design Consultant, Contractor shall assume sole responsibility for performing such Work and shall bear all costs attributable to correct such Work.

37.5 Contractor also shall secure all permits and approvals and pay all fees and expenses, if any, associated with TPDES regulations of the Texas Commission on Environmental Quality, as well as those required by any federal regulations or local authorities, if applicable, which require completion of documentation and/or acquisition of a "Land Disturbing Activities Permit" for a Project. Contractor's obligations under this paragraph do not require it to perform engineering services during the pre-

construction phase to prepare proper drainage for the Project Site. However, any drainage alterations made by Contractor during the construction process, which require the issuance of a permit, shall be at Contractor's sole cost. It shall be Contractor's responsibility to prepare and submit the permit approval documentation provided by the regulatory agencies prior to beginning any Work.

3.8 ALLOWANCES

- 381 Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as City may direct, but Contractor shall not be required to employ persons or entities to whom Contractor has reasonable objection.
- 382 Unless otherwise provided in the Contract Documents:
- 3.8.2.1 Allowances shall cover the cost to Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- 3.8.2.2 Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit and other expenses, contemplated for stated allowance, shall be included in the allowances;
- 3.8.2.3 Whenever actual costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order and in accordance with **Article VII** herein. The amount of the Change Order shall reflect both the difference between actual costs and the allowances under **Section 3.8.2.1** herein and all changes in Contractor's costs under **Section 3.8.2.2** herein.
- 383 Materials and equipment under an allowance shall be selected by City within such time as is reasonably specified by Contractor as necessary to avoid any delay in the Work.

3.9 SUPERINTENDENT/KEY PERSONNEL

- 391 At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who is able to communicate fluently in English, along with any necessary assistant(s) who is/are satisfactory to City. Any superintendent designee shall be identified in writing to City promptly after City issues written Notice to Proceed. The superintendent shall represent Contractor at all times and all directions given to the superintendent shall be binding on Contractor. The designated superintendent shall not be replaced without written notice to and the approval of City, which approval shall not be unreasonably withheld, except with good reason (including any termination or disability of the superintendent) or under extraordinary circumstances. The superintendent may not be employed on any other project prior to Final Completion of the Work without the approval of City, which approval shall not be unreasonably withheld.
- 392 Contractor shall furnish an updated list to Design Consultant and City of all Architects, Engineers, Consultants, Sub-Consultants, job-site superintendents, Subcontractors and suppliers involved in the Project construction indicated in Contractor's submitted Bid Proposal.
- 3.9.2.1 City, upon the showing of good and reasonable cause, may reject or require removal of any Architect, Engineer, Consultant, Sub-Consultant, job superintendent, employee of the Contractor, Subcontractor or sub- Subcontractor and/or supplier involved in the Project.
- 3.9.2.2 Contractor shall provide an adequate staff for the proper coordination and expedition of the Work. City reserves the right to require Contractor to remove from the Project any

employee(s) City, at its sole discretion, deems incompetent, careless, insubordinate, unnecessary or in violation of any provision in these Contract Documents. This provision is applicable to Subcontractors, sub-Subcontractors and their employees.

3.9.2.3 City reserves the right to utilize one or more of its employees or Consultants to function in the capacity of City's Inspector or COI, whose primary function shall be daily inspections, checking pay requests or construction timelines and the verification of the storage of supplies and materials.

3.9.2.4 Contractor shall not change any key personnel or key Subcontractors without the prior written consent of City, which consent shall not be unreasonably withheld. In the event key personnel leaves Contractor's employment, such key personnel's replacement shall be subject to City's reasonable approval.

3.10 CONTRACTOR'S PROJECT SCHEDULES

3.101 **PROJECT SCHEDULE METHOD.** Contractor shall create and maintain a Critical Path Method (hereafter referred to as "CPM") Project Schedule, showing the manner of execution of Work which Contractor intends to follow, in order to complete the Project within the allotted time. The Project Schedule shall employ computerized CPM for the planning, scheduling and reporting of Work, as described in this **Section 3.10**. Contractor shall create and maintain the Project Schedule using project management scheduling software compatible with City's project management scheduling software, if any. The observance of the requirements herein is an essential part of the Work to be performed under the Contract.

3.102 **SCHEDULING PERSONNEL.** Unless otherwise indicated in writing by City, Contractor shall create and maintain the Project Schedule. Contractor's Scheduler shall be proficient in CPM analysis, possess sufficient experience to be able to perform required tasks on the specified software and able to prepare and interpret reports from the software. Scheduler shall be made available for discussion or meetings when requested by City.

3.103 PROJECT SCHEDULE SUBMISSION

3.10.3.1 Unless indicated otherwise, Contractor shall submit Project Schedule(s) for the Work in relation to the entire Project to City and Design Consultant at least fifteen (15) calendar days prior to the pre-construction conference.

3.10.3.2 All Project Schedule submittals shall be in electronic form to include PDF plots of the schedule, a PDF plot defining the Critical Path and two week look-ahead, and include the native compatible scheduling file format. Contractor shall submit the schedule to City and Design Consultant via electronic mail, CD-Rom or any other electronic format acceptable to City.

3.10.3.3 This initial Project Schedule shall indicate the dates for starting and completing the various aspects/phases required to complete the Work, including mobilization, procurement, installation, testing, inspection and acceptance of all the Work of the Contract, including any contractually mandated Milestone dates. The Project Schedule shall not exceed the time limits set forth in the Contract Documents. Contractor shall organize the Project Schedule and provide adequate detail so the Schedule is capable of measuring and forecasting the effect of delaying events on completed and uncompleted activities.

3.10.3.4 The Project Schedule shall show the order in which Contractor proposes to carry

out the Work in accordance with the final approved phasing plan, if any, and the anticipated start and completion dates of each phase of the Work. The Project Schedule shall be in the form of a time scaled work progress chart, to indicate the percentage of Work scheduled for completion at various critical Milestones.

3.10.3.5 Contractor shall maintain a schedule of Shop Drawings and Sample Submittals and each submitted Shop Drawing and Sample Submittal shall list each required submittal and the expected time(s) for submitting, reviewing and processing such submittal.

3.10.3.6 City shall review the Project Schedule within fifteen (15) calendar days for compliance with the Specifications and notify Contractor of its acceptability.

3.104 **PROJECT SCHEDULE SEQUENCING.** The Project Schedule shall show the sequence and interdependence of activities required for complete performance of the Work. Contractor shall be responsible for assuring all Work sequences are logical and show a coordinated plan of Work in accordance with the sequence of work outlined in the Plans. The purpose of City requiring the Project Schedule shall be to:

3.10.4.1 Ensure adequate planning during the execution and progress of the Work in accordance with the allowable number of calendar days and all Milestones;

3.10.4.2 Assure coordination of the efforts of Contractor, City, utilities and others that may be involved in the Project and those activities are included in the Schedule highlighting coordination points with others;

3.10.4.3 Assist Contractor and City in monitoring the progress of the Work and evaluating proposed changes to the Contract; and

3.10.4.4 Assist City in administering the Contract Time requirements.

3.105 **PROJECT SCHEDULE ACTIVITIES.** Contractor shall provide City a legend for all abbreviations used. The activities shall be coded so organized plots of the Project Schedule may be produced. Typical activity coding includes traffic control phase, location and work type. Contractor shall show an estimated production rate per working day for each Work activity. Activity durations shall be based on production rates shown. Each activity on the Project Schedule shall include:

3.10.5.1 An activity number utilizing an alphanumeric designation system agreeable to City;

3.10.5.2 A concise description of the Work represented by the activity; and

3.10.5.3 Activity durations in whole work days, with a maximum of twenty (20) work days. Durations greater than twenty (20) work days may be used for non-construction activities (mobilization, submittal preparation, curing, etc.), and other activities mutually agreeable between City and Contractor.

3.106 **PROJECT SCHEDULE WORK DURATION AND RESOURCES**

3.10.6.1 The Project Schedule layout shall be grouped by Project and then by Work Breakdown Structure (hereafter referred to as “WBS”) for organizational purposes.

3.10.6.2 The original and remaining Work duration shall be displayed. The grouping band shall, by default, report Work days planned. One additional level of effort activity shall be added to the schedule as a “time calculator” with a seven (7) day calendar without holidays reflected. The calculation of days should be reflected in the appropriate duration columns.

3.10.6.3 Contractor shall update working day calendars originally created by City and included as part of the Bid Solicitation for the days Contractor plans to work. Contractor shall designate all City holidays as non-working days (holidays). For dates beyond the then-current calendar year, Contractor shall assume City holidays are the same as the current calendar year.

3.10.6.4 Seasonal weather conditions shall be considered and included in the Project Schedule for all work influenced by temperature and/or precipitation. Seasonal weather conditions shall be determined by an assessment of average historical climatic conditions. Average historical weather data is available through the National Oceanic and Atmospheric Administration (hereafter referred to as “NOAA”). These effects shall be simulated through the use of work calendars for each major work type (i.e., earthwork, concrete paving, structures, asphalt, drainage, etc.). Project and work calendars should be updated each month to show days actually able to work on the various work activities.

3.10.6.5 Only City-responsible delays in activities affecting Milestone dates or the Contract completion date(s), or unusually severe weather as determined under **Section 4.3.6** herein, as determined by CPM analysis, shall be considered for a Contract Time extension.

3.10.7 PROJECT SCHEDULE - OTHER REQUIREMENTS. The Project Schedule shall:

3.10.7.1 have all Work coded and organized by WBS. An example of an acceptable WBS shall be provided, upon written request, by City to Contractor;

3.10.7.2 reflect Duration Percent complete as the percent complete type;

3.10.7.3 reflect Fixed Units as the duration type;

3.10.7.4 include submittals with a logical tie to what each drives;

3.10.7.5 add proposed Change Order(s) and those Change Order(s) shall be reflected on the Schedule as proposed Change Order(s). This task shall be linked to the schedule with logical ties and approved by City. Upon approval of a Change Order, a task shall be renamed and shall identify Work performed and Change Order number and resources shall be added to the task;

3.10.7.6 only have constraints in accordance with the Plans;

3.10.7.7 include activity dates for material delivery;

3.10.7.8 disallow default progress; and

3.10.7.9 include a detailed explanation in the Project narrative, if Work is performed out of sequence.

3.10.8 PROJECT SCHEDULE JOINT REVIEW AND ACCEPTANCE

- 3.10.81 The Project Schedule and successive updates or revisions thereof are for Contractor's use in managing the Work. The Project Schedule is for the information of City and to demonstrate Contractor has complied with requirements for planning the Work.
- 3.10.82 Within fifteen (15) calendar days of receipt of Contractor's proposed Project Schedule, City shall evaluate the Schedule for compliance with this specification and notify Contractor of its findings. If City requests a revision or justification, Contractor shall provide satisfaction to City within seven (7) calendar days. If Contractor submits a Project Schedule for acceptance, based on a sequence of work not shown in the Plans, Contractor shall notify City in writing of said sequence of work, separate from the Schedule submittal.
- 3.10.83 City's review and acceptance of Contractor's Project Schedule is solely for conformance to the requirements of the Contract Documents. Review and acceptance by City of Contractor's Project Schedule does not relieve Contractor of any of its responsibility for the Project Schedule, Contractor's ability to meet interim Milestone dates (if so specified) or meeting the Contract completion date, nor does such review and acceptance expressly or by implication warrant, acknowledge or admit the reasonableness of the logic, durations, manpower or equipment loading of Contractor's Project Schedule. In the event Contractor fails to define any element of Work, activity or logic and City's review does not detect this omission or error, such omission or error, whether or when discovered by Contractor or City, shall be corrected by Contractor at the next monthly schedule update and shall not affect the Project or Contract completion date.
- 3.10.84 Acceptance of the Project Schedule, or update and/or revision thereto, does not indicate any approval of Contractor's proposed sequences and duration.
- 3.10.85 Acceptance by City of the Project Schedule or updated Project Schedule which exceeds contractual time does not alleviate the Contractor's obligation to meet the contractual completion date.
- 3.10.86 Acceptance of a Project Schedule update or revision indicating early or late completion does not constitute City's consent to any changes, alter the terms of the Contract, waive either Contractor's responsibility for timely completion, or waive City's right to damages for Contractor's failure to do so.
- 3.10.87 Contractor's scheduled dates for completion of any activity or of the entire Work do not constitute a change in terms of the Contract. Change Orders are the only method of modifying the completion date(s) and Contract time.
- 3.10.88 Submittal of a schedule, schedule revision or schedule update constitutes Contractor's representation to City, as of the date of the submittal, of the accurate depiction of all progress to date and Contractor shall follow the schedule as submitted in performing the Work.

3.10.9 PROJECT SCHEDULE UPDATES AND REVISIONS

- 3.10.9.1 The Project Schedule shall be updated monthly, at a minimum, to reflect progress to date and current plans for completing the Work. An electronic copy of the update shall be submitted to City and Design Consultant as directed. City has no duty to make progress payments to Contractor unless Contractor's payment application is accompanied by the updated Project Schedule. The anticipated date of Substantial Completion shall show all extensions of time granted through Change Order(s) as of the date of the update.

- 3.1092 The Project Schedule update shall be submitted no later than the date the pay application is submitted.
- 3.1093 Contractor shall meet with City each month, at a scheduled Project Schedule update meeting, to review actual progress made through the date of the schedule update, as determined by City. Contractor shall bring one record copy of the Drawings marked up to reflect current progress for City inspection. The review of progress shall include dates of activities actually started and/or completed, the percentage of Work completed, the remaining duration of each activity started and/or completed and the amount of Work still to complete, with an analysis of the relationship between the remaining duration of the activity and the quantity of material to install over that given period of time with a citation of past productivity.
- 3.1094 The monthly Schedule Update shall include a progress narrative, explaining the Project's progress, identifying all progress made out of sequence, defining the Critical Path, identification of any potential delays, and other relevant data. A Project Schedule Narrative template shall be required for the narrative. Upon request, City shall supply said template to Contractor.
- 3.1095 Each Schedule shall segregate the Work into a sufficient number of activities to facilitate the efficient use of critical path method scheduling by Contractor, City and Design Consultant. The Project Schedule layout shall be grouped first by Project then by WBS. The layout shall include the following columns:
- (1) Activity ID
 - (2) Activity Description
 - (3) Original Durations
 - (4) Remaining Durations
 - (5) Early Start and Early Finish Dates
 - (6) Late Start and Late Finish Dates
 - (7) Total Float
 - (8) Performance Percent Complete
 - (9) Display logic and target bars in the Gantt bar chart view
- 3.1096 Each schedule shall include activities representing manufacturing, fabrication or ordering lead time for materials, equipment or other items for which Design Consultant is required to review submittals, shop drawings, product data or samples.
- 3.1097 Each schedule, other than the initial Project Schedule, shall:
- (1) indicate the activities, or portions thereof, which have been completed;
 - (2) reflect the actual time for completion of such activities; and
 - (3) reflect any changes to the sequence or planned duration of all activities.
- 3.1098 If any updated schedule exceeds the time limits set forth in the Contract Documents for Substantial Completion or Final Completion of the Work, Contractor shall include, along with its updated schedule, a statement of the reasons for the anticipated delay in achieving Substantial Completion of the Work and Contractor's planned course of action for completing the Work within the time limits set forth in the Contract Documents. If Contractor asserts the failure of City or Design Consultant to provide requested and required information to

Contractor as the reason for anticipated delay in completion, Contractor also shall specify what information has been requested and is required from City or Design Consultant.

3.109.9 Neither City nor Contractor shall have exclusive ownership of float time in the schedule and all float time shall inure to the benefit of the Project.

3.109.10 Submission of any schedule under this Contract constitutes a representation by Contractor, as of the date of the submittal:

- (1) the schedule represents the sequence in which Contractor intends to prosecute the remaining Work;
- (2) the schedule represents the actual sequence and duration used to prosecute the completed Work;
- (3) to the best of its knowledge and belief, Contractor is able to complete the remaining Work in the sequence and time indicated; and
- (4) Contractor intends to complete the remaining work in the sequence and time indicated.

3.109.11 If Contractor desires to make major changes in the Project Schedule, Contractor shall notify City in writing and submit the proposed schedule revision. The written notification shall include the reason for the proposed revision, what the revision is composed of and how the revision was incorporated into the schedule. Major changes are hereby defined as those affecting compliance with the Contract requirements and/or those that change the Project's critical path. All other changes may be accomplished through the monthly updating process without written notification. Refer to 3.10.8.7 for major changes that affect Contract completion dates and Contract Time.

3.10.10 COMPLETION OF WORK

3.10.10.1 Contractor is accountable for Substantially Completing and Finally Completing the Work in the Contract Time or as otherwise amended by Change Order.

3.10.10.2 If, in the sole judgment of City, the Schedule update reflects Work is behind schedule and the rate of performance of Work is inadequate to regain scheduled progress to insure Contractor achieving any Project Milestones (including, but not limited to, Substantial and/or Final Completion) in accordance with the Project Schedule, City may, at its sole option, give written notice to Contractor and direct Contractor, at Contractor's sole expense, to propose and adopt a plan to accelerate the Work so the Work conforms to the Project Schedule and Project Milestones previously agreed upon. Contractor may, but is not limited to, propose:

- (1) increasing Project work forces;
- (2) increasing Project equipment or tools;
- (3) increasing the hours of work or number of shifts per day;
- (4) expediting the delivery of Project materials;
- (5) changing, with the approval of City, the schedule logic and Work sequences; or
- (6) taking some other action as Contractor may proposes, if acceptable to City.

3.10.10.3 Within ten (10) calendar days after such notice from City, Contractor shall notify City in writing of the specific measures taken and/or planned to be taken to increase the rate of progress of Work on the Project. Contractor shall include an estimate as to the date of scheduled full progress recovery and an updated Project Schedule, illustrating Contractor's plan for achieving timely completion of the Project Milestones and the Project's Substantial and/or Final Completion.

3.10.104 Should City deem Contractor's plan of action inadequate to achieve the desired acceleration to bring the Work back on the Project Schedule and achieve Substantial Completion on time, City shall have the right to order Contractor, at Contractor's sole expense, to take any corrective measures City deems necessary to expedite the progress of Work including, without limitations:

- (1) increasing work forces and hours, to include Contractor working additional shifts of overtime;
- (2) supplying additional manpower, equipment and facilities;
- (3) re-sequencing the Work;
- (4) expediting the fabrication and supply of materials; and/or
- (5) other similar measures City may direct (hereafter (1) – (5) herein above collectively referred to as "Extraordinary Measures").

Such Extraordinary Measures City directs shall continue until the progress of the Work complies with the Milestone required by the Contract Documents and any additional expense, including additional expense incurred by the City, shall be borne solely by the Contractor, except as authorized by **Section 4.3.11** herein.

3.10.105 City's right to require Extraordinary Measures solely is for the purpose of ensuring Project Milestones and Substantial and/or Final Completion of the Work is achieved within the Contract Time. Contractor shall not be entitled to an adjustment in the Contract Sum in connection with Extraordinary Measures required by City under or pursuant to this **Section 3.10**, except as may be provided under the provisions of **Section 4.3.11** herein.

3.10.106 City may exercise the rights furnished pursuant to this **Section 3.10** as frequently as City deems necessary to ensure Contractor's performance of the Work is in compliance with any Milestone date or completion date(s) set forth in the Contract Documents.

3.10.107 Contractor shall recommend to City and Design Consultant a schedule for procurement of long-lead time items, which shall constitute part of the Work as required to meet the Project Schedule.

3.10.11 PROJECT SCHEDULE TIME IMPACT ANALYSIS

Contractor shall notify City when an impact may justify an extension of Contract Time or adjustment of Milestone dates. Said notice shall be made by Contractor in writing as soon as possible, but no later than the end of the next estimate period after the commencement of an impact or the notice for a change is given to Contractor. Not providing notice to City within twenty (20) calendar days after receipt shall indicate Contractor's approval of the time charges as shown on that time statement. Future consideration of that statement shall not be permitted, and Contractor forfeits its right to subsequently request a time extension or time suspension.

3.10.11.1 When changes are initiated, or impacts are experienced, Contractor shall submit to City a written Time Impact Analysis describing the influence of each change or impact. A "Time Impact Analysis" is an evaluation of the effects of changes in the construction sequence, contract, Plans or site conditions on Contractor's plan for constructing the Project, as represented by the Project Schedule. The purpose of the Time Impact Analysis is to determine if the overall Project has been delayed and, if necessary, to provide Contractor and City a basis for making adjustments to the Contract.

3.10.11.2 A Time Impact Analysis shall consist of one or all of the steps listed below:

- (1) Establish the status of the Project before the impact using the most recent Project Schedule Update prior to the impact occurrence.
- (2) Predict the effect of the impact on the most recent Project Schedule Update prior to the impact occurrence. This requires estimating the duration of the impact and inserting the impact into the schedule update. Any other changes made to the schedule including modifications to the calendars or constraints shall be noted.
- (3) Track the effects of the impact on the schedule during its occurrence. Note any changes in sequencing and mitigation efforts.
- (4) Compare the status of the work prior to the impact (**#1 above**) to the prediction of the effect of the impact (**#2 above**), and to the status of the work during and after the effects of the impact are over (**#3 above**). Note: if an impact causes a lack of access to a portion of the Project, the effects of the impact may extend to include a reasonable period for remobilization.

3.10.11.3 The Time Impact Analysis shall be electronically submitted to City. If the Project Schedule is revised after the submittal of a Time Impact Analysis but prior to its approval, Contractor promptly shall indicate in writing to City the need for any modification to its Time Impact Analysis. One (1) copy of each Time Impact Analysis shall be submitted within fourteen (14) calendar days after the completion of an impact. City may require **Step 1** and **Step 2** in **Section 3.10.11.2** herein of the Time Impact Analysis be submitted at the commencement of the impact, if needed to make a decision regarding the suspension of Contract Time. Approval or rejection of each Time Impact Analysis by City shall be made within fourteen (14) calendar days after receipt, unless subsequent meetings and negotiations are necessary.

3.11 DOCUMENTS AND SAMPLES AT THE SITE

- 3.11.1 Contractor shall maintain, on Site and for City's use, one record copy of the Drawings, Specifications, Addenda, Change Orders and other Amendments, in good order and currently marked, to record field changes and selections made during construction, along with one record copy of approved Shop Drawings, Product Data, Samples and similar required submittals. These record copies also shall be available to Design Consultant and shall be delivered to Design Consultant for submittal to City upon completion of the Work.
- 3.11.2 Contractor shall at all times maintain job records including, but not limited to, invoices, payment records, payroll records, daily reports, logs, diaries and job meeting minutes applicable to the Project. Contractor shall make such reports and records available for inspection by City, Design Consultant and/or their respective agents, during normal business hours if requested by City.

3.12 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- 3.12.1 Shop Drawings are drawings, diagrams, illustrations, schedules, performance charts, brochures and other data prepared and furnished by Contractor or its agents, manufacturers, suppliers or distributors and which illustrate and detail some portion of the Work.
- 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by Contractor to illustrate materials or equipment for some portion of the Work.
- 3.12.3 Samples are physical samples of materials, equipment or workmanship representative of some portion of

the Work, furnished by the Contractor to City, to assist City and Design Consultant in the establishment of workmanship and quality standards by which the Work shall be judged.

- 3.124 Shop Drawings, Product Data, Samples and similar submittals are not Contract Documents. The purpose of their submittals is to demonstrate, for those portions of the Work for which submittals are required by the Contract Documents, the way by which Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents. Review by Design Consultant is subject to the limitations of **Section 4.2.6** herein. Informational submittals, upon which Design Consultant is not expected to take responsive action, may be so identified in the Contract Documents. Submittals which are not required by the Contract Documents may be returned by the Design Consultant without action.
- 3.125 Contractor shall review for compliance with the Contract Documents, approve and submit to Design Consultant Shop Drawings, Product Data, Samples and similar submittals required by the Contract Documents with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of City or of separate contractors. Submittals which are not marked as reviewed for compliance with the Contract Documents and approved by Contractor may be returned by Design Consultant without action.
- 3.126 By approving and submitting Shop Drawings, Product Data, Samples and similar submittals, Contractor represents it has determined and verified materials, field measurements and filed construction criteria related thereto, or shall do so, and has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.
- 3.127 Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittal and review has been approved by Design Consultant. Design Consultant shall review and return such submittals within ten (10) calendar days or within a reasonable period so as to not delay the project.
- 3.128 The Work shall be in accordance with approved submittals, except Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by Design Consultant's approval of Shop Drawings, Product Data, Samples or similar submittals unless Contractor specifically has informed Design Consultant in writing of such deviation at the time of submittal and:
- (1) Design Consultant has given written approval in the specific deviation as a minor change in the Work; or
 - (2) a Change Order or Field Work Directive has been issued authorizing the deviation. Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by Design Consultant's approval thereof.
- 3.129 Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples or similar submittals, to revisions other than those requested by Design Consultant on previous submittals. In the absence of such written notice, Design Consultant's approval of a resubmission shall not apply to such revisions.
- 3.1210 Contractor shall not be required to provide professional services which constitute the practice of architecture or engineering unless such services specifically are required by the Contract Documents for a portion of the Work or unless Contractor needs to provide such services in order to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law. If

professional design services or certifications by a design professional related to systems, materials or equipment specifically are required of Contractor by the Contract Documents, City and Design Consultant shall specify all performance and design criteria such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly Texas-licensed design professional, whose signature and seal shall appear on all drawings, calculations, Specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Design Consultant. City and Design Consultant shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided City and Design Consultant have specified to Contractor all performance and design criteria such identified services must satisfy. Pursuant to this **Section 3.12.10**, Design Consultant shall review, approve or take other appropriate action on submittals only for the limited purpose of checking of conformance with information given and the design concept expressed in the Contract Documents. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

3.13 **ACCESS TO WORK.** Contractor shall provide City and Design Consultant access to Work in preparation and in progress, wherever located.

3.14 **PATENT FEES AND ROYALTIES.** Contractor shall pay all license fees and royalties and assume all costs incident to the use of the performance of the Work or the incorporation in the Work of any invention, design, process, product or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of City its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by City in the Contract Documents.

3.15 INDEMNITY PROVISIONS

3.15.1 **CONTRACTOR COVENANTS AND AGREES TO FULLY INDEMNIFY, DEFEND AND HOLD HARMLESS, CITY AND ITS ELECTED OFFICIALS, EMPLOYEES, OFFICERS, DIRECTORS, VOLUNTEERS AND REPRESENTATIVES OF CITY, INDIVIDUALLY AND COLLECTIVELY, FROM AND AGAINST ANY AND ALL COSTS, CLAIMS (INCLUDING THIRD-PARTY CLAIMS), LIENS, DAMAGES, LOSSES, EXPENSES, FEES, FINES, PENALTIES, PROCEEDINGS, ACTIONS, DEMANDS, CAUSES OF ACTION, LIABILITY AND SUITS OF ANY KIND AND NATURE, INCLUDING BUT NOT LIMITED TO, PERSONAL OR BODILY INJURY, DEATH AND PROPERTY DAMAGE, MADE UPON CITY DIRECTLY OR INDIRECTLY ARISING OUT OF, RESULTING FROM OR RELATED TO CONTRACTOR'S ACTIVITIES UNDER THIS CONTRACT, INCLUDING ANY ACTS OR OMISSIONS OF CONTRACTOR, ANY AGENT, OFFICER, DIRECTOR, REPRESENTATIVE, EMPLOYEE, CONSULTANT OR SUBCONTRACTOR OF CONTRACTOR AND CONTRACTOR'S AND ITS SUBCONTRACTOR'S RESPECTIVE OFFICERS, AGENTS EMPLOYEES, DIRECTORS AND REPRESENTATIVES WHILE IN THE EXERCISE OF THE RIGHTS OR PERFORMANCE OF THE DUTIES UNDER THIS CONTRACT. THE INDEMNITY PROVIDED FOR IN THIS PARAGRAPH SHALL NOT APPLY TO ANY LIABILITY RESULTING FROM THE NEGLIGENCE OF CITY, ITS OFFICERS OR ITS EMPLOYEES IN INSTANCES WHERE SUCH NEGLIGENCE CAUSES PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE. IN THE EVENT CONTRACTOR AND CITY ARE FOUND JOINTLY LIABLE BY A COURT OF COMPETENT JURISDICTION, LIABILITY SHALL BE APPORTIONED COMPARATIVELY IN ACCORDANCE WITH THE LAWS FOR THE STATE OF TEXAS, WITHOUT, HOWEVER, WAIVING ANY GOVERNMENTAL IMMUNITY AVAILABLE TO CITY UNDER TEXAS**

LAW AND WITHOUT WAIVING ANY DEFENSES OF THE PARTIES UNDER TEXAS LAW.

- 3.152 The provisions of this Indemnity solely are for the benefit of the Parties hereto and not intended to create or grant any rights, contractual or otherwise, to any other person or entity. Contractor shall advise City in writing within twenty-four (24) hours of any claim or demand against City or Contractor known to Contractor related to or arising out of Contractor's activities under this Contract and shall see to the investigation and defense of such claim or demand at Contractor's sole cost. City shall have the right, at its option and at its own expense, to participate in such defense without relieving Contractor of any of its obligations under this **Section 3.15**.
- 3.153 **INTELLECTUAL PROPERTY INDEMNIFICATION. CONTRACTOR SHALL PROTECT, INDEMNIFY, AND DEFEND AND/OR HANDLE AT ITS OWN COST AND EXPENSE ANY CLAIM OR ACTION AGAINST CITY, ITS ELECTED OFFICIALS, EMPLOYEES, OFFICERS, DIRECTORS, VOLUNTEERS AND REPRESENTATIVES OF CITY, INDIVIDUALLY OR COLLECTIVELY, FOR INFRINGEMENT OF ANY UNITED STATES PATENT, COPYRIGHT OR SIMILAR PROPERTY RIGHT INCLUDING, BUT NOT LIMITED TO, MISAPPROPRIATION OF TRADE SECRETS AND ANY INFRINGEMENT BY CONTRACTOR AND ITS EMPLOYEE OR ITS SUBCONTRACTORS AND THEIR AGENTS, SERVANTS AND EMPLOYEES, BASED ON ANY DELIVERABLE OR ANY OTHER MATERIALS FURNISHED HEREUNDER BY CONTRACTOR AND USED BY EITHER CITY OR CONTRACTOR WITHIN THE SCOPE OF THIS CONTRACT (UNLESS SAID INFRINGEMENT RESULTS DIRECTLY FROM CONTRACTOR'S COMPLIANCE WITH CITY'S WRITTEN STANDARDS OR SPECIFICATIONS).** Contractor does not warrant against infringement by reason of City's or Design Consultant's design of articles or their use in combination with other materials or in the operation of any process. Contractor shall have the sole right to conduct the defense of any such claim or action and all negotiations for its settlement or compromise, unless otherwise mutually agreed upon, expressed in writing and signed by the Parties hereto. Contractor agrees to consult with City's City Attorney during such defense or negotiations and make good faith efforts to avoid any position adverse to the interest of City. City shall make available to Contractor any deliverables and/or works made for hire by Contractor necessary to the defense of Contractor against any claim of infringement for the duration of Contractor's legal defense.
- 3.154 If such infringement claim or action has occurred or, in Contractor's judgment, is likely to occur, City shall allow Contractor, at Contractor's option and expense, (unless such infringement results directly from Contractor's compliance with City's written standards or Specifications or by reason of City's or Design Consultants' design of articles or their use in combination with other materials or in the operation of any process for which City shall be liable) to elect to:
- (1) procure for City the right to continue using said deliverable and/or materials;
 - (2) modify such deliverable and/or materials to become non-infringing (provided such modification does not adversely affect City's intended use of the deliverable and/or materials as contemplated hereunder);
 - (3) replace said deliverable and/or materials with an equally suitable, compatible and functionally equivalent non- infringing deliverable and/or materials at no additional charge to City; or
 - (4) if none of the foregoing alternatives is reasonably available to Contractor, upon written request, City shall return the deliverable and/or materials in question to Contractor and Contractor shall refund all monies paid by City, with respect to such deliverable and/or materials, and accept return of same. If any such cure provided for in this **Section 3.15** shall fail to satisfy the third-party claimant, these actions shall not relieve Contractor from

its defense and indemnity obligations set forth in this **Section 3.15**.

- 3.155 The Indemnification obligations under this **Section 3.15** shall not be limited in any way by the limits of any insurance coverage or any limitation on the amount or type of damages, compensation or benefits payable by, for or to Contractor or any Subcontractor, supplier or any other individual or entity under any insurance policy, workers' compensation acts, disability benefit acts or other employee benefits acts.
- 3.156 **WORKER SAFETY.** The Indemnification hereunder shall include, without limiting the generality of the foregoing, liability which could arise to City, its agents, Consultants and/or representatives or Design Consultant pursuant to State statutes for the safety of workers and, in addition, all Federal statutes and rules existing there under for protection, occupational safety and health to workers. It is agreed the primary obligation of Contractor is to comply with these statutes in the performance by Contractor of the Work and the obligations of City, its agents, Consultants and representatives under said statutes are secondary to that of Contractor.
- 3.157 **DEFENSE COUNSEL.** City shall have the right to approve defense counsel, of which approval shall not be unreasonably withheld, to be retained by Contractor in fulfilling its obligation hereunder to defend and indemnify City, unless such right is expressly waived by City in writing. Contractor shall retain City- approved defense counsel within ten (10) calendar days of City's written notice City is invoking its right to Indemnification under this Contract. If Contractor fails to retain counsel within such time period, City shall have the right to retain defense counsel on its own behalf and Contractor shall be liable for all costs incurred by City. City also shall have the right, at its option, to be represented by advisory counsel of its own selection and at its own expense, without waiving the foregoing.
- 3.16 **REPRESENTATIONS AND WARRANTIES.** Contractor represents and warrants the following to City (in addition to the other representations and warranties contained in the Contract Documents), as an inducement to City to execute this Contract, which representations and warranties shall survive the execution and delivery of the Contract and the Final Completion of the Work, Contractor:
- 3.161 is financially solvent, able to pay its debts as they mature and possessed of sufficient working capital to complete the Work and perform its obligations under the Contract Documents;
- 3.162 is able to furnish the plant, tools, materials, supplies, equipment and labor required to complete the Work and perform its obligations hereunder and has sufficient experience and competence to do so;
- 3.163 is authorized to do business in the State of Texas and properly is licensed by all necessary governmental, public and quasi-public authorities having jurisdiction over it, the Work and the site of the Project;
- 3.164 is acting within its duly authorized powers to execute this Contract and execute the performance and obligations thereof; and
- 3.165 had directed its duly authorized representative(s) to visit the Site of the Work, familiarize itself with the local conditions under which the Work is to be performed and correlated its observations with the requirements of the Contract Documents.

ARTICLE IV. ADMINISTRATION OF THE CONTRACT

- 4.1 DESIGN CONSULTANT.** A Design Consultant is a person registered as an Architect pursuant to Tex. Occupations Code Ann., Chapter 1051, a Landscape Architect pursuant to Texas Occupations Code, Chapter 1052, and/or a person licensed as a professional Engineer pursuant to Texas

Occupations Code, Chapter 1001, or a firm employed by City to provide professional architectural or engineering services and exercising overall responsibility for the design of a Project or a significant portion thereof, and performing certain contract administration responsibilities as set forth in its contract and these General Conditions. If the employment of a Design Consultant is terminated, City shall employ a new Design Consultant whose status under the Contract Documents shall be that of the former Design Consultant.

42 ROLES IN ADMINISTRATION OF THE CONTRACT

42.1 City and Design Consultant shall provide administration of the Contract, as described in the Contract Documents, and Design Consultant shall be City's representative:

- (1) during construction;
- (2) until final payment is due; and
- (3) with City's concurrence, from time to time during the one-year period for correction of Work described in **Article XII** herein.

Design Consultant only shall have authority to act on behalf of City to the extent provided in the Contract Documents, unless otherwise modified in writing by City in accordance with other provisions of the Contract Documents.

42.2 City's instruction to Contractor may be issued through Design Consultant and City reserves the right to issue instructions directly to Contractor through the ODR or through other designated City representatives. Contractor understands City may modify the authority of such Design Consultant as provided in the terms of its contractual relationship with Design Consultant, and City shall, in such event, be vested with powers formerly exercised by such Design Consultant, provided written notice of such modification immediately shall be served on Contractor. Nothing herein shall authorize independent agreements between Contractor and Design Consultant, nor shall Design Consultant be deemed to have a legal relationship with Contractor.

42.3 Neither Design Consultant nor City shall have control over, charge of nor be responsible for the construction means, methods or techniques, or for the safety precautions, quality control program and other programs in connection with the Work, since these solely are Contractor's rights and responsibilities under the Contract Documents. Sequencing and procedures shall be coordinated and agreed upon by City, Design Consultant and Contractor and shall remain the responsibility of Contractor for implementation.

42.4 Design Consultant shall not be responsible for Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. Design Consultant shall not have control over, charge of and shall not be responsible for acts or omissions of Contractor, Subcontractor, their respective agents, employees or any other persons or entities performing portions of the Work.

42.5 City and Contractor shall endeavor to communicate with each other directly, through Design Consultant and/or through the ODR about matters arising out of or relating to the Contract. Communications by and with Design Consultant's Consultants shall be through Design Consultant. Communications by City and Design Consultant with Contractor's employees Subcontractors and material suppliers shall be through Contractor. All communications by and with City's separate contractors shall be through City.

42.6 Design Consultant shall review and approve or take other appropriate action upon Contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of

checking for conformance with information given and the design concept expressed in the Contract Documents. Design Consultant shall perform these reviews in a timely fashion so as to not delay the Work. Design Consultant promptly shall respond to submittals such as Shop Drawings, Product Data and Samples pursuant to the procedures set forth in the Project Specifications. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of equipment or systems, all of which remain the responsibility of Contractor as required by the Contract Documents. Design Consultant's review of Contractor's submittals shall not relieve the Contractor of the obligations under **Sections 3.3, 3.5 and 3.12** herein. Design Consultant's review shall not constitute approval of safety precautions or, unless otherwise specifically stated by Design Consultant, any construction means, methods, techniques, sequences or procedures. Design Consultant's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

- 4.2.7 Upon written request of City or Contractor, Design Consultant shall issue its interpretation of the requirements of the Plans and Specifications. Design Consultant's response to such requests shall be made in writing within a time limit agreed upon or otherwise with reasonable promptness. If no agreement is made concerning the time within which interpretations required of Design Consultant shall be furnished in compliance with this **Section 4.2**, then no delay shall be recognized on account of any failure by Design Consultant to furnish such interpretations except for actual substantiated delays, for which Contractor is not responsible, occurring more than fifteen (15) calendar days after written request is made for the interpretations.
- 4.2.8 Interpretations and decisions of Design Consultant shall be consistent with the intent of and reasonably inferable from the Contract Documents and shall be in writing or in the form of drawings.
- 4.2.9 Design Consultant's decisions on matters relating to aesthetic effect shall be final if consistent with the intent expressed in the Contract Documents and not expressly overruled in writing by City.

4.3 CLAIMS AND DISPUTES

- 4.3.1 **DEFINITION.** A Claim is a demand or assertion by one of the Parties seeking, as a matter of right, an adjustment or interpretation of Contract terms, payment of money, extension of time or other relief, with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between City and Contractor arising out of or relating to the Contract. Claims must be initiated by written notice. Every Claim of Contractor, whether for additional compensation, additional time or other relief including, but not limited to, claims arising from concealed conditions, shall be signed and sworn to by an authorized corporate officer (if not a corporation, then an official of the company authorized to bind Contractor by his/her signature) of Contractor, verifying the truth and accuracy of the Claim. The responsibility to substantiate a Claim shall rest with the Party making the Claim.
- 4.3.2 **TIME LIMIT ON CLAIMS.** Except for those Claims resulting from unusually severe weather, as addressed in **Section 4.3.6**, or other circumstances specifically exempted or modified herein, Contractor Claims must be initiated within twenty (20) calendar days after occurrence of the event giving rise to such Claim. Claims by Contractor must be submitted by written notice to both City and Design Consultant. Claims by City must be submitted by written notice to Contractor. Failure by Contractor to submit written notice of the Claim within twenty (20) calendar days shall constitute a waiver of such Claim.
- 4.3.3 CONTINUING CONTRACT PERFORMANCE.** Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in **Sections 4.5.1** or as otherwise provided herein, Contractor shall proceed diligently with performance of the Contract and City shall continue to make payments in accordance with the Contract Documents.

4.3.4 **CLAIMS FOR CONCEALED OR UNKNOWN CONDITIONS.** If conditions are encountered at the Site which either are subsurface or are otherwise concealed physical conditions which were not known to Contractor and which differ materially from those indicated in the Contract Documents or in the reports of investigations and tests of subsurface and latent physical conditions provided by City to Contractor prior to the preparation by Contractor of its Bid, as referred to above, or are unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents in the general vicinity of the Project site, then Contractor promptly shall notify City and Design Consultant of such conditions before conditions are disturbed, and in no event more than three (3) workdays after first observation of the conditions. Upon notification by Contractor, Design Consultant promptly shall investigate such conditions and report its findings to City. If City and Contractor cannot agree on an adjustment to the Contract Sum or Contract Time, the adjustment shall be subject to dispute resolution pursuant to **Section 4.4** herein.

4.3.5 **CLAIMS FOR ADDITIONAL COST.** If Contractor wishes to make a Claim for an increase in the Contract Sum, written notice as provided in this **Section 4.3** shall be given and must be accepted by City before proceeding to execute the Work, provided prior notice is not required for Claims relating to an emergency endangering life or property. Contractor shall file a Claim in accordance with this **Section 4.3** if Contractor believes additional cost is involved for reasons including, but not limited to:

- (1) a written interpretation from Design Consultant;
- (2) an order by City to stop the Work where Contractor was not at fault;
- (3) a written order for a minor change in the Work issued by Design Consultant;
- (4) failure of payment by City;
- (5) termination of the Contract by City for convenience;
- (6) City's suspension; or
- (7) other reasonable grounds.

4.3.6 **CLAIMS FOR ADDITIONAL TIME**

4.3.6.1 If Contractor wishes to make Claim for an increase in the Contract Time, written notice, as required in this **Section 4.3**, shall be given. Contractor's Claim shall include an estimate of probable impact of delay on progress of the Work in accordance with **Section 3.10.11** herein. In the case of a continuing delay, only one Claim is necessary.

4.3.6.2 Contractor shall be entitled to an extension of the Contract Time for delays or disruptions due to unusually severe weather in excess of weather normally experienced at the job site, as determined from climatological data set forth by National Weather Service and which affects the Project's critical path. Contractor shall bear the entire economic risk of all weather delays and disruptions. Contractor shall not be entitled to any increase in the Contract Sum by reason of such delays or disruptions. Requests for an extension of time, pursuant to this **Section 4.3.6**, shall be submitted to City and Design Consultant not later than the fifteenth (15th) calendar day of the month following the month during which the delays or disruptions occurred and shall include documentation and all details reasonably available, demonstrating the nature and duration of the delays or disruptions and their effect on the critical path of the Schedule. Any time extension granted to Contractor for either Vertical or Horizontal projects under **Section 4.3.6** shall be non-compensatory. Time extensions will not be granted for rain, wind, flood, or other natural weather event or phenomena of normal intensity for the locality where the Work is performed. For purpose of determining the extent of a delay attributable to unusual rainfall,

the number of rain days experienced during a month will be compared to the normal weather recorded and expected for Austin, Texas. Normal rainfall compiled by the State climatologist, based on U.S. Weather Bureau Records for Austin, Texas, is considered to be a part of this Calendar Day Contract, and is not a justification for an extension of Contract Time. Listed below as follows are the mean number of days in which there occurred 0.01 inch or more of precipitation, which are considered herein as normal rainfall:

January	8 days
February	8 days
March	7 days
April	7 days
May	9 days
June	6 days
July	5 days
August	5 days
September	8 days
October	8 days
November	8 days
December	8 days

- 4.3.7 **INJURY OR DAMAGE TO PERSON OR PROPERTY.** If either Party to the Contract suffers injury or damage to person or property because of an act or omission of the other Party or an act or omission of others for whose acts such other Party legally is responsible (including, with respect to City, the acts or omissions of City's separate contractors), written notice of such injury or damage, whether or not insured, shall be given to the other Party within a reasonable time not exceeding three (3) calendar days after the discovery of the injury or damage. The written notice shall provide sufficient detail to enable the other Party to investigate the injury or damage.
- 4.3.8 **CHANGE IN UNIT PRICES.** As applicable, if unit prices are stated in the Contract Documents or subsequently are agreed upon by City and Contractor and if quantities originally contemplated are materially changed in a proposed Change Order or Field Work Directive, such that the application of such unit prices to quantities of Work proposed shall cause substantial inequity to City or Contractor, the applicable unit prices shall be equitably adjusted. Unit prices established in the Contract documents may only be modified when a Change Order or Field Work Directive causes a material change in quantity to a Major Bid Item. A Major Bid Item is defined as a single bid item constituting a minimum of five percent (5%) of the total contract value. A material change in quantity is defined as an increase or decrease of twenty five percent (25%) or more of the units of an individual bid item or an increase or decrease of twenty five percent (25%) or more of the dollar value of a lump sum bid item. Revised unit pricing only shall apply to the quantity of a major bid item in excess of a twenty five percent (25%) increase or decrease of the original Contract quantity.
- 4.3.9 **CLAIMS FOR CONSEQUENTIAL AND OTHER DAMAGES.** Except as otherwise provided in this Contract, in calculating the amount of any Claim or any measure of damages for breach of contract (such provision to survive any termination following such breach), the following standards shall apply both to Claims by Contractor and to Claims by City:
- 43.9.1 No consequential, indirect, incidental, punitive or exemplary damages shall be allowed, whether or not foreseeable, regardless of whether based on breach of contract, tort (including negligence), indemnity, strict liability or other bases of liability.
- 43.9.2 No recovery shall be based on a comparison of planned expenditures to total actual expenditures, on estimated losses of labor efficiency, on a comparison of planned man loading

to actual man loading, based on cumulative impact or on any other similar analysis, including without limitation the measured mile approach, used to show total cost or other damages.

- 43.9.3 Damages are limited to extra costs specifically shown to directly have been caused by a proven wrong for which the other Party is claimed to be responsible.
- 43.9.4 The maximum amount of any recovery for delay, to the extent damages for delay are not otherwise disallowed by the terms of the Contract Documents, shall be as is provided in **Article VIII** herein.
- 43.9.5 No damages shall be allowed for home office overhead or other home office charges or any *Eichleay* formula calculation, except or unless as expressly authorized by the Contract Documents.
- 43.9.6 No profit shall be allowed on any damage Claim, except or unless as expressly authorized by the Contract Documents.

4.3.10 **SUBCONTRACTOR PASS-THROUGH CLAIMS.** In the event any Subcontractor of Contractor asserts a Claim to Contractor that Contractor seeks to pass through to City under the Contract Documents, any entitlement to submit and assert the Claim as to City shall be subject to:

43.10.1 the requirements of **Section 4.3** herein of these General Conditions; and 4.3.10, including the following additional three (3) requirements listed below, all three of said additional requirements shall be conditions precedent to the entitlement of Contractor to seek and assert such Claim against City:

(1) Contractor shall:

- (a) have direct legal liability as a matter of contract, common law or statutory law to Subcontractor for the claim Subcontractor is asserting; or
- (b) have entered into a written liquidating agreement with Subcontractor, prior to the Claim's occurrence, under which Contractor has agreed to be legally responsible to the Subcontractor for pursuing the assertion of such Claim against City under said Contract and for paying to Subcontractor any amount that may be recovered, less Contractor's included markup (subject to the limits in the Contract Documents for any markup). The relationship, liability or responsibilities shall be identified in writing by Contractor to City at the time such Claim is submitted to City and a copy of any liquidating agreement shall be included by Contractor in the Claim submittal materials.

(2) Contractor shall have reviewed the Claim of the Subcontractor prior to its submittal to City and independently shall have evaluated such Claim in good faith to determine the extent to which the Claim is believed in good faith to be valid. Contractor shall inform City in writing that it has made a review, evaluation and determination the Claim is being made in good faith and the claim is believed to be valid.

(3) Subcontractor making the Claim to Contractor shall certify to both Contractor and City Subcontractor has compiled, reviewed and evaluated the merits of such Claim and the Claim is believed in good faith by Subcontractor to be valid. A copy of the certification by Subcontractor shall be included by Contractor in the Claim submittal materials.

43.10.2 Any failure of Contractor to comply with any of the foregoing requirements and conditions

precedent with regard to any such Claim shall constitute a waiver of any entitlement to submit or pursue such Claim.

43.103 Receipt and review of a Claim by City under this **Section 4.3** shall not be construed as a waiver of any defenses to the Claim available to City under the Contract Documents or at law.

4.3.11 **CITY'S RIGHT TO ORDER ACCELERATION AND TO DENY CLAIMED AND APPROPRIATE TIME EXTENSIONS, IN WHOLE OR IN PART.** Contractor acknowledges and agrees Substantial Completion of the Work by or before the Scheduled Completion Date is of substantial and critical importance to City. The following provisions, therefore, shall apply:

43.11.1 If Contractor falls behind the approved construction schedule for whatever reason, City shall have the right, in City's sole discretion, to order Contractor to develop a schedule recovery plan to alter its work sequences or to otherwise accelerate its progress in such a manner as to achieve Substantial Completion on or before the Contract Time completion date or such other date as City reasonably may direct. Upon receipt, Contractor shall take any and all action necessary to comply with City's order. In such event, any possible right, if any, of Contractor to additional compensation for any acceleration shall be subject to the terms of this **Section 4.3.11**.

43.11.2 In the event City agrees Contractor is entitled to an extension of Contract Time and Contractor properly has initiated a Claim for a time extension in accordance with **Section 4.3.6** herein, City shall have the right, in City's sole discretion, to deny any portion of Contractor's Claim for an extension of Contract Time and order Contractor to exercise its commercially reasonable efforts to achieve Substantial Completion on or before the contractual date established, but for the existence of the event giving rise to the Claim, by giving written notice to Contractor provided within fourteen (14) calendar days after receipt of Contractor's Claim. If City denies Contractor's claim for an extension of Contract Time under this **Section 4.3.11**, either in whole or in part, Contractor shall proceed to prosecute the Work in such a manner as to achieve Substantial Completion on or before the then- existing Scheduled Completion Date. If, after initiating good faith acceleration efforts and it is shown, through no fault of Contractor, Contractor fell behind on the approved construction schedule and Contractor still is unable to achieve Substantial Completion within the originally scheduled Contract Time, City shall not be entitled to Liquidated Damages. Nothing in this **Section 4.3.11.2** shall prohibit Contractor from filing a Claim for an extension of time Contractor feels it may be owed.

43.11.3 If City orders Contractor to accelerate the Work under **Section 4.3.11.2** herein, and Contractor would have been entitled to a time extension for a reason specifically allowed under the Contract Documents for an amount of time that would have justified approval by City if not for the need and right to complete the Project within the stipulated period, Contractor may initiate a Claim for schedule recovery or acceleration costs, pursuant to **Section 4.3.1** herein. Any resulting Claim for these costs properly initiated by Contractor under **Section 4.3.1** herein shall be limited to those reasonable and documented direct costs of labor, materials, equipment and supervision solely and directly attributable to the actual recovery or acceleration activity necessary for Contractor to bring the Work back within the then existing approved construction schedule. These direct costs of Contractor include, but are not limited to, the premium portion of overtime pay for additional crew, shift, or equipment costs, if requested in advance by Contractor and approved in writing by City. A percentage markup for the prorated cost of premium on the existing performance and payment bonds and required insurance, profit and field overhead, not to exceed the markups permitted by this Contract, shall be allowed on the claimed costs. **NO OTHER MARKUP FOR PROFIT, OVERHEAD (INCLUDING, BUT NOT LIMITED TO, HOME OFFICE OVERHEAD) OR ANY OTHER COSTS SHALL BE ALLOWED ON ANY ACCELERATION CLAIM.** City shall not be liable for any costs

related to an acceleration claim other than those described in this **Section 4.3.11**.

- 4.3.12 **NO WAIVER OF GOVERNMENTAL IMMUNITY.** Nothing in this Contract shall be construed to waive City's Governmental Immunity from a lawsuit, which Immunity is expressly retained to the extent it is not clearly and unambiguously waived by State law.

4.4 RESOLUTION OF CLAIMS AND DISPUTES

- 4.4.1 Claims by Contractor against City and Claims by City against Contractor, including those alleging an error or omission by Design Consultant but excluding those arising under **Section 10.3** and **Section 10.4** herein, shall be referred initially to Design Consultant for consideration and recommendation to City.
- 4.4.2 An initial recommendation by Design Consultant shall be required as a condition precedent to mediation or litigation of all Claims by the Parties arising prior to the date final payment is due, unless thirty (30) calendar days have passed after the Claim has been referred to Design Consultant with no recommendation having been rendered by Design Consultant.
- 4.4.3 Design Consultant shall review Claims and, within ten (10) work days of receipt of a Claim, take one or more of the following actions:
- (1) request additional supporting data from the Party making the Claim;
 - (2) issue an initial recommendation;
 - (3) suggest a compromise; or
 - (4) advise the Parties that Design Consultant is unable to issue an initial Recommendation, due to a lack of sufficient information or conflict of interest.
- 4.4.4 Following receipt of Design Consultant's initial recommendation regarding a Claim, City and Contractor shall attempt to reach agreement as to any adjustment to the Contract Sum and/or Contract Time. If no agreement is reached, either Party may request mediation of the dispute, pursuant to **Section 4.5** herein.
- 4.4.5 If Design Consultant requests either or any Party to provide a response to a Claim or to furnish additional supporting data, such requested Party shall provide a response or the requested supporting data to Design Consultant, advise Design Consultant when the response or supporting data shall be furnished or advise Design Consultant that no response or supporting data shall be furnished.
- 4.4.6 With receipt of all information requested by Design Consultant, Design Consultant shall review the Claim and all received information within ten (10) calendar days of receipt of the information and shall take one of the following actions:
- (1) issue a recommendation;
 - (2) suggest a compromise; or
 - (3) advise the Parties Design Consultant is unable to issue a recommendation due to lack information or conflict of interest.
- 4.4.7 Upon Design Consultant's action or inaction, the Parties may agree to accept recommendations made by either Party or may request mediation of the dispute pursuant to **Section 4.5** herein.
- 4.4.8 **WAIVER OF LIEN.** It is understood that, by virtue of this Contract, no mechanic, contractor, material man, artisan or laborer, whether skilled or unskilled, ever shall, in any manner, have a claim or acquire

any lien upon the building or any of the improvements of whatever nature or kind so erected or to be erected by virtue of this Contract, nor upon any of the land upon which said building or any of the improvements are so erected, built or situated.

4.5 ALTERNATIVE DISPUTE RESOLUTION

- 4.5.1 **CONTINUATION OF WORK PENDING DISPUTE RESOLUTION.** Each Party is required to continue to perform its obligations under this Contract pending the final resolution of any dispute arising out of or relating to this Contract, unless it would be impossible or impracticable under the circumstances then present.
- 4.5.2 **REQUIREMENT FOR SENIOR LEVEL NEGOTIATIONS.** Before invoking mediation or any other alternative dispute process set forth herein, the Parties to this Contract agree that they first shall try to resolve any dispute arising out of or related to this Contract through discussions directly between those senior management representatives within their respective organizations who have overall managerial responsibility for the Project. Both City and Contractor agree that this step shall be a condition precedent to use of any other alternative dispute resolution process. If the Parties' senior management representatives cannot resolve the dispute within thirty (30) calendar days after a Party delivers a written notice of such dispute to the other, then the Parties shall proceed with the alternative dispute resolution process contained in **Section 4.5** herein, including mediation and/or litigation. All negotiations pursuant to this **Section 4.5** are confidential and shall be treated as compromise and settlement negotiations for purposes of applicable rules of evidence.
- 4.5.3 **MEDIATION.** In the event that City and/or Contractor contend that the other has committed a material breach of this Contract, or the Parties cannot reach a resolution of a claim or dispute pursuant to **Section 4.4** herein, as a condition precedent to filing a lawsuit, either Party shall request mediation of the dispute with the following requirements:
- 4.5.3.1 Request for mediation shall be in writing and shall request that the mediation commence not less than thirty (30) or more than ninety (90) calendar days following the date of the request, except upon agreement of both Parties.
- 4.5.3.2 In the event City and Contractor are unable to agree to a date for the mediation or to the identity of the mediator(s) within thirty (30) calendar days following the date of the request for mediation, all conditions precedent in this **Section 4.5** shall be deemed to have occurred.
- 4.5.3.3 The Parties shall share the mediator's fee and any mediation filing fees equally. Venue for any mediation or lawsuit arising under this Contract shall be in Travis County, Texas. Any agreement reached in mediation shall be enforceable as a settlement agreement in any court having jurisdiction thereof. No provision of this Contract shall waive any immunity or defense. No provision of this Contract is consent to a suit.

ARTICLE V. SUBCONTRACTORS

5.1 DEFINITION

A Subcontractor is defined and used herein as a person or entity that has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor, Sub-Consultant or an authorized representative of Subcontractor or Sub-Consultant. The term "Subcontractor" does not include a separate contractor or Subcontractor of a separate contractor.

5.2 AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK

- 5.2.1 Contractor shall, prior to entering into an agreement with such Subcontractor, notify City in writing of the names of all proposed first-tier Subcontractors for the Work.
- 5.2.2 Contractor shall not employ any Subcontractor or other person or organization (including those who are to furnish the principal items of materials or equipment), whether initially or as a substitute, against whom City may have reasonable objection. A Subcontractor or other person or organization identified in writing to City, prior to the Notice of Award and not objected to in writing by City prior to the Notice of Award, shall be deemed acceptable to City. Acceptance of any Subcontractor, other person or organization by City shall not constitute a waiver of any right of City to reject defective Work. If City, after due investigation, has reasonable objection to any Subcontractor, other person or organization proposed by Contractor after the Notice of Award, Contractor shall be required to submit an acceptable substitute. Contractor shall not be required to employ any Subcontractor, other person or organization against whom Contractor has reasonable objection.
- 5.2.3 Contractor shall be fully responsible to City for all acts and omissions of its Subcontractors, persons and organizations directly or indirectly employed by them and persons and organizations for whose acts any of them may be liable to the same extent that Contractor is responsible for the acts and omissions of persons directly employed by Contractor. Nothing in the Contract Documents shall create any contractual relationship between City and any Subcontractor or other person or organization having a direct contract with Contractor, nor shall it create any obligation on the part of City to pay or to see to the payment of any moneys due any Subcontractor or other person or organization, except as may otherwise be required by law. City may furnish to any Subcontractor or other person or organization, to the extent practicable, evidence of amounts paid to Contractor on account of specific Work done.
- 5.2.4 The divisions and sections of the Specifications, as well as the identifications of any Drawings, shall not control Contractor in dividing the Work among Subcontractors or delineating the Work to be performed by any specific trade.
- 5.2.5 All Work performed for Contractor by a Subcontractor shall be performed pursuant to an appropriate agreement between Contractor and Subcontractor, which specifically binds Subcontractor to the applicable terms and conditions of the Contract Documents for the benefit of City.

5.3 SUB-CONTRACTUAL RELATIONS

- 5.3.1 By appropriate agreement, written where legally required for validity, Contractor shall require each Subcontractor, to the extent of the Work to be performed by Subcontractor, to be bound to Contractor by the same terms and conditions of the Contract Documents. Through that binding commitment, Subcontractor shall assume all the obligations and responsibilities, including the responsibility for safety of Subcontractor's Work and workers, which Contractor, by these Documents, assumes toward City and Design Consultant. Each Subcontractor agreement shall preserve and protect the rights of City and Design Consultant under the Contract Documents, with respect to the Work to be performed by Subcontractor, so that subcontracting thereof shall not prejudice such rights. Where appropriate, Contractor shall require each Subcontractor to enter into similar agreements with Sub-Subcontractors. Contractor shall make available to each proposed Subcontractor, prior to the execution of all Subcontractor agreement(s), copies of the Contract Documents to which Subcontractor(s) shall be bound. Subcontractors similarly shall make copies of applicable portions of such documents available to their respective proposed Sub-Subcontractors.

5.4 CONTINGENT ASSIGNMENT OF SUBCONTRACTS

Each Subcontractor agreement for a portion of the Work assigned by Contractor to City shall provide:

- 5.4.1 an assignment is effective only after termination of the Contract by City and only for those Subcontractor agreements which City accepts by notifying Subcontractor and Contractor in writing; and
- 5.4.2 an assignment is subject to the prior rights of the Surety, if any, obligated under bond relating to the Contract.
- 5.4.3 upon any such assignment, if the Work has been suspended for more than ninety (90) calendar days, Subcontractor's compensation equally shall be adjusted for increase in cost resulting from the suspension.

ARTICLE VI. CONSTRUCTION BY CITY OR BY SEPARATE CONTRACTS

6.1 CITY'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS

- 6.1.1 City reserves the right to perform construction or operations related to the Project with City's own forces and to award separate contracts in connection with other portions of the Project or other construction or operations on the Site under General Conditions of the Contract identical or substantially similar to these. If Contractor claims that a delay or additional cost is involved, due to such action by City, Contractor shall make a Claim as provided in **Section 4.3** herein.
- 6.1.2 When separate contracts are awarded for different portions of the Project or for other construction or operations on the Project Site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor that executes each separate City-Contractor contract.
- 6.1.3 City shall provide for coordination of the activities of City's own forces and of each separate contractor with the Work of Contractor and Contractor fully shall cooperate with said coordination. Contractor shall participate with other separate contractors and City in reviewing all construction schedules when directed by City to do so. Contractor shall make any revisions to its construction schedule deemed necessary after said joint review and mutual agreement. The revised construction schedules then shall constitute the schedules to be used by Contractor, separate contractors and City until subsequently revised.
- 6.1.4 Unless otherwise provided in the Contract Documents, when City and City's own forces perform construction or operation related to the Project, City shall be subject to the same obligations and to have the same rights that apply to Contractor under these General Conditions and the Contract Documents.

6.2 MUTUAL RESPONSIBILITY

- 6.2.1 Contractor shall afford City and City's separate contractor(s) reasonable opportunity for the introduction and storage of materials and equipment, the performance of their activities and the coordination of Contractor's construction and operations with theirs, as required by the Contract Documents.
- 6.2.2 If part of Contractor's Work depends upon the construction or operations by City or a separate

contractor for the proper execution or results, Contractor shall, prior to proceeding with that portion of the Work, promptly report to City apparent discrepancies or defects in such other construction that would render it unsuitable for such proper execution and results. Failure of Contractor to so report shall constitute an acknowledgment that City's separate contractor's completed or partially completed construction is fit and proper to receive Contractor's Work, except as to defects not then reasonably discoverable.

- 6.2.3 City shall be reimbursed by Contractor for costs incurred by City which are payable to a separate contractor because of delays, improperly timed activities or defective construction of Contractor. City shall be responsible to Contractor for costs incurred by Contractor because of delays, improperly timed activities and damage to the Work or defective construction of City's separate contractor(s). Any such Claims shall be processed in accordance with **Section 4.3** herein.
- 6.2.4 Contractor promptly shall remedy any damage wrongfully caused by Contractor or its Subcontractor(s) to any completed or partially completed construction or to property of City or City's separate contractor(s), as provided herein.
- 6.2.5 City and each separate contractor shall have the same responsibilities for cutting and patching as are described for Contractor in **Section 3.14** herein.
- 6.3 CITY'S RIGHT TO CLEAN UP.** If a dispute arises among or between Contractor, City's separate contractor(s) and City, as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, City may clean up and those costs shall be allocated amongst those parties determined responsible.

ARTICLE VII. CHANGES IN THE WORK

7.1 GENERAL

- 7.1.1 Changes in the Work may be accomplished, after the execution of the Contract and without invalidating the Contract, by Change Order, Field Work Directive/Force Account or order for a minor change in the Work that does not affect the Contract Time or the Contract Sum, subject to the limitations stated in this **Article VII** and elsewhere in the Contract Documents.
- 7.1.2 A Change Order shall be based upon agreement between City and Contractor; a Field Work Directive requires a directive by City and, if necessary, Design Consultant and may or may not be agreed to by Contractor; and an order for a minor change in the Work that does not affect the Contract Time or the Contract Sum may be issued by City.
- 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents and Contractor promptly shall proceed with the changed Work, unless otherwise provided in a Change Order, Field Work Directive or order for a minor change in the Work or in this **Article VII**.
- 7.1.4 Changes resulting from Change Orders, Field Work Directives or orders for minor changes shall be recorded by Contractor on the As-Built record documents.

7.2 CHANGE ORDERS

- 7.2.1 A Change Order is a written modification of the Contract signed by both City and Contractor (and approved by City Council, if required) that authorizes an addition, deletion or revision in the Work or an adjustment in the Contract Sum or the Contract Times and is issued on or after the Effective Date of the

Contract.

722 Methods used in determining adjustments to the Contract Sum may include those listed in **Section 7.3.4** herein.

723 Acceptance of a Change Order by Contractor shall constitute a full accord and satisfaction for any and all claims and costs of any kind, whether direct or indirect, including, but not limited to impact, delay or acceleration damages arising from the subject matter of the Change Order, regardless of the number or scope of Change Orders associated with the Project. Each Change Order shall be specific and final as to prices and any extensions of time, with no reservations or other provisions allowing for future additional money or time as a result of the particular changes identified and fully compensated in the Change Order. The execution of a Change Order by Contractor shall constitute conclusive evidence of Contractor's agreement to the ordered changes in the Work, cost and additional time, if any. This Contract, as amended, forever releases any Claim against City for additional time or compensation for matters relating to or arising out of or resulting from the Work included within or affected by the executed Change Order, whether foreseen or unforeseen. This release of any Claim applies to Claims related to the cumulative impact of all Change Orders and to any Claim related to delay or the effect of a change on unchanged Work.

724 City or Design Consultant shall prepare Change Orders and Field Work Directives and shall have authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time. Such changes shall be effected by written order, which Contractor promptly shall carry out and record on the As-Built record documents.

725 Contractor and Subcontractors shall be entitled to include overhead and profit in any Change Order only as provided by Project Specifications and subject to the other terms and limitations of this Contract. Maximum allowable markups for Change Order pricing, when said pricing is not determined through unit prices, are established as follows:

7.2.5.1 **Labor.** Contractor shall be allowed the documented payroll rates for each hour laborers and foremen actually shall be engaged in the Work. Contractor shall be allowed to receive an additional twenty five percent (25%) as compensation, based on the total wages paid said laborers and foremen. No charge shall be made by Contractor for organization or overhead expenses. For costs of premiums on public liability and workers compensation insurance(s), Social Security and unemployment insurance taxes, an amount equal to fifty five percent (55%) of the sum of the labor cost, excluding the twenty five percent (25%) documented payroll rate compensation allowed herein, shall be the established maximum allowable labor burden cost. No charge for superintendence shall be made unless considered necessary and approved by City or a Change Order includes an extension of the Contract Time.

7.2.5.2 **Materials.** Contractor shall be allowed to receive the actual cost, including freight charges, for materials used on such Work, including an additional twenty five percent (25%) of the actual cost as compensation. When material invoices indicate an available discount, the actual cost shall be determined as the invoiced price less the available discount.

7.2.5.3 **Equipment.** For Contractor-owned machinery, trucks, power tools or other equipment, necessary for use on Change Order work, the Rental Rate Blue Book for Construction Equipment (hereafter referred to as "Blue Book") rate, as modified by the following, shall be used to establish Contractor's allowable hourly rental rates. Equipment used shall be at the rates in effect for each section of the Blue Book at the time of use. The following formula shall be used to compute the hourly rates:

$$H = \frac{M \times R1 \times R2}{176} + OP$$

Where

H = Hourly Rate
M = Monthly Rate
R1 = Rate Adjustment Factor
R2 = Regional Adjustment Factor
OP = Operating Costs

If Contractor-owned machinery and/or equipment is not available and equipment is rented from an outside source, the hourly rate shall be established by dividing the actual invoice cost by the actual number of hours the equipment is involved in the Work. City reserves the right to limit the hourly rate to comparable Blue Book rates. When the invoice specifies the rental rate does not include fuel, lubricants, repairs and servicing, the Blue Book hourly operating cost shall be allowed to be added for each hour the equipment operates. The allowable equipment hourly rates shall be paid for each hour the equipment is involved in the Work and an additional maximum of fifteen percent (15%) may be added as compensation.

7.2.5.4 Subcontractor Markups. Contractor shall be allowed administrative cost only when extra Work, ordered by City, is performed by a Subcontractor or Subcontractors. The maximum allowable payment for administrative cost shall not exceed five percent (5%) of the total Subcontractor work. Off-duty peace officers and patrol cruisers shall be considered as Subcontractors, with regard to consideration of allowable contractor markups.

7.3 FIELD WORK DIRECTIVES

- 731 A Field Work Directive is a written directive signed by City and, if necessary, Design Consultant directing a change in the Work prior to agreement on an adjustment, if any, in the Contract Sum or Contract time, or both. City may, by Field Work Directive and without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions or other revisions, with any changes to the Contract Sum and/or the Contract Time to be adjusted according to the terms of this **Section 7.3**.
- 732 A Field Work Directive shall be used in the absence of total agreement on the terms of a Change Order. City shall issue a Field Work Directive to Contractor with a defined Not-To-Exceed dollar amount for the scope of Work defined.
- 733 Upon receipt of a Field Work Directive, Contractor promptly shall proceed with the change in the Work involved and, in writing, advise City of the Contractor's agreement or disagreement with the method, if any, provided in the Field Work Directive for determining the proposed adjustment in the Contract Sum or Contract Time.
- 734 If the Field Work Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods, as applicable:
- 7.3.4.1 mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
- 7.3.4.2 prices, including unit prices, stated in the Contract Documents or subsequently agreed upon;

7.3.4.3 cost to be determined in a manner agreed upon by City and Contractor and a mutually acceptable fixed or percentage fee; or

7.3.4.4 as provided in **Section 7.3.6** herein.

735 If Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the method and the adjustment shall initially be determined by Design Consultant on the basis of reasonable costs and savings attributable to the change including, in case of an increase in the Contract Sum, as applicable, a reasonable allowance for overhead and profit. In such case, and also under **Section 7.3.4.3** herein, Contractor shall keep and present, in such form as City may prescribe, an itemized and detailed accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this **Section 7.3.5** shall be limited to the following:

7.3.5.1 costs of all labor, including social security, old age and unemployment insurance, fringe benefits required by Law, agreement or custom, and workers' compensation insurance;

7.3.5.2 costs of all materials, supplies and equipment, including cost of transportation, storage installation, maintenance, dismantling and removal, whether incorporated or consumed;

7.3.5.3 rental costs of all machinery and equipment, exclusive of hand tools, whether rented from Contractor or others, including costs of transportation, installation, minor repairs and replacements, dismantling and removal;

7.3.5.4 expenses incurred in accordance with Contractor's standard personnel policy for travel approved in writing by City in advance;

7.3.5.5 costs of premiums for all bonds and insurance, permit fees and allowable sales, use or similar taxes related to the Work;

7.3.5.6 all additional costs of supervision and field office personnel directly attributable to the change; and

7.3.5.7 all payments made by the Contractor to Subcontractors.

736 The amount of credit to be allowed by Contractor to City for a deletion or change which results in a net decrease in the Contract Sum shall be actual net cost of the deleted or change Work, plus Contractor's allocated percent for profit and overhead, as confirmed by Design Consultant, subject to any equitable adjustment recommended by Design Consultant and approved by City. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase or decrease, if any, with respect to that change.

737 If City and Contractor agree with the determination made by Design Consultant concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and shall be recorded by preparation and execution of an appropriate Change Order.

738 If City and Contractor cannot reach an agreement on either an adjustment on the Contract Sum and Contract Time, pursuant to an issued Field Work Directive, City and Contractor shall execute a Change Order for the adjustment on the Contract Sum or Contract Time, if any, the Parties do agree upon for the Work performed and Contractor reserves the right to file a Claim for any disagreements in Contract Sum or Contract Time not addressed in the Change Order, pursuant to **Section 4.3** herein. If City and

Contractor cannot agree on both the adjustment in the Contract Sum and the Contract Time associated with an issued Field Work Directive, City unilaterally shall file a Change Order listing City's adjustments in the Contract Sum and/or Contract Time and Contractor reserves the right to file a Claim for payment and/or time, pursuant to **Section 4.3** herein.

- 739 Maximum allowable markups for Field Work Directives shall follow the allowable markups established in **Section 7.2.5** herein.

7.4 ORDER FOR MINOR CHANGES TO THE WORK. City or Design Consultant both shall have authority to order minor changes in the Work not involving adjustment in the Contract Sum or extension of the Contract Time and not inconsistent with the intent of the Contract Documents. Such changes shall be effected by written order and shall be binding on City and Contractor. Contractor promptly shall carry out such written orders and record such changes in the As-Built drawings.

7.5 TIME REQUIRED TO PROCESS CHANGE ORDERS

- 751 All responses by Contractor to proposal requests from City or Design Consultant shall be accompanied by a complete itemized breakdown of costs. Responses to proposal requests shall be submitted sufficiently in advance of the required work to allow City and Design Consultant a minimum of thirty (30) calendar days after receipt by City to review the itemized breakdown and to prepare or distribute additional documents as may be necessary. Each of Contractor's responses to proposal requests shall include a statement that the cost and additional time described and requested in Contractor's response represents the complete, total and final cost and additional Contract Time associated with the extra work, change, addition to, omission, deviation, substitution or other grounds for seeking extra compensation or additional time under the Contract Documents, without reservation or further recourse.
- 752 All Change Orders require written approval by either City or City Council or, where authorized by the state law and City ordinance, by City's City Manager or designee, pursuant to Administrative Action. The approval process requires a minimum of forty-five (45) calendar days after submission to City in final form with all supporting data. Receipt of a submission by City does not constitute acceptance or approval of a proposal, nor does it constitute a warranty that the proposal shall be authorized by City or City Council Resolution or Administrative Action. **THE TIME REQUIRED FOR THE APPROVAL PROCESS SHALL NOT BE CONSIDERED A DELAY AND NO EXTENSIONS TO THE CONTRACT TIME OR INCREASE IN THE CONTRACT SUM SHALL BE CONSIDERED OR GRANTED AS A RESULT OF THIS PROCESS.** Pending the approval of a Change Order as described above, Contractor shall proceed with the work under a pending Change Order only if directed in writing to do so by CITY.

ARTICLE VIII. TIME

8.1 PROGRESS AND COMPLETION

- 8.1.1 **TIME LIMITS STATED IN THE CONTRACT DOCUMENTS ARE OF THE ESSENCE OF THE CONTRACT.** Time is of the essence in this Contract as completion of the Work within the Contract Time, as revised in accordance with the Contract, is a significant component of the City's consideration and inducement to enter into the same with Contractor. By executing the Contract, Contractor confirms that the Contract Time is a reasonable period for performing the Work.
- 8.1.2 Contractor shall proceed with the Work expeditiously using adequate forces and shall achieve Milestones and Substantial Completion, as applicable, and Final Completion within the Contract Time.

8.2 DELAYS AND EXTENSIONS OF TIME

- 8.2.1 Neither City nor Contractor, except as provided for in this **Section 8.2**, shall be liable to the other for any delay to Contractor's Work by reason of fire, act of God, riot, strike, or similar event of force majeure, or any other cause beyond the respective party's reasonable control. Should any of these listed factors delay the Work's critical path, as evidenced by a Time Impact Analysis developed by Contractor and verified by Design Consultant, Program Manager and City, Contractor shall receive an extension of the Contract Times equal to the delay if a written Claim is made within twenty (20) calendar days of the delaying event and subsequently granted by City, all in accordance with **Section 4.3** herein. Under no circumstances shall City be liable to pay Contractor any compensation for such delays. Note that any request for an extension of time due to delays or disruption caused by unusually severe weather are addressed in **Section 4.3.6.2** herein.
- 8.2.2 Should Contractor be delayed solely and exclusively by the intentional act or default of City or Design Consultant, whether foreseen or unforeseen, and should any of these factors delay the Project's critical path, as evidenced by a Time Impact Analysis developed by Contractor and verified by Design Consultant, Program Manager and City, Contractor shall receive an extension of the Contract Time equal to the verified delay or portion thereof if a written Claim is made within twenty (20) calendar days of the occurrence of the intentional act or default of City or Design Consultant and subsequently granted by City, all in accordance with **Section 4.3** herein. In addition, Contractor, upon timely notice of its Claim to the City, with substantiation by City and Design Consultant and upon approval of City, shall be entitled to an adjustment of Contract Sum for its Project facilities, limited to directly incurred incremental daily costs attributable to machine or equipment rentals, barricade or fence rentals, and similar non-labor related costs, and field management overhead expenses on a per diem basis for the particular Project delayed and for the period of the critical path delay directly and exclusively attributable to a City-caused event. Any such adjustment to Contract Sum shall be subject to the limitations of this Contract, including without limitation, **Section 4.3** herein. In no event shall Contractor be entitled to home office, other off-site expenses or any other damages of any kind from whatever source derived.

Contractor shall be entitled to standby costs only when directed to standby in writing by City. Standby costs may include actual documented Project overhead costs of Contractor, consisting of administrative and supervisory expenses incurred at the Project Site. Standby equipment costs shall not be allowed during periods when the equipment would otherwise have been idle. For Projects where Contractor is working a five (5) day Work Week, as defined in **Section 3.1.4** herein, with a Working Day measured from 6:00 a.m. to Dusk Monday through Friday, no more than eight (8) hours of standby time shall be paid during a 24-hour day, no more than forty (40) hours shall be paid per week for standby time and no more than one hundred and seventy six (176) hours per month shall be paid of standby time. Standby time shall be computed at fifty percent (50%) of the rates found in the Rental Rate Blue Book for Construction Equipment and shall be calculated by dividing the monthly rate found in the Blue Book by 176, then multiplying that total by the regional adjustment factor and the rate adjustment factor. Operating costs shall not be charged by Contractor.

For Projects where Contractor is working a six (6) day Work Week, as defined in **Section 3.1.4** herein with a Working Day measured from 6:00 a.m. to Dusk Monday through Saturday, no more than eight (8) hours of standby time shall be paid during a 24-hour day, no more than forty eight (48) hours shall be paid per week for standby time and no more than two hundred and eight (208) hours per month shall be paid of standby time. Standby time shall be computed at fifty percent (50%) of the rates found in the Rental Rate Blue Book for Construction Equipment and shall be calculated by dividing the monthly rate found in the Blue Book by 208, then multiplying that total by the regional adjustment factor and the rate adjustment factor. Operating costs shall not be charged by Contractor.

- 8.2.3 Claims relating to time shall be made in accordance with applicable provisions of **Section 4.3** herein.
- 8.2.4 This Contract does not permit the recovery of damages by Contractor for delay, disruption or acceleration, other than those described in **Section 8.2.2** and **Section 4.3** herein and limited to those justified by a Time Impact Analysis. Contractor agrees that it shall be fully compensated for all delays solely by an extension of non-compensatory time or as contemplated in **Section 8.2.2** herein.

ARTICLE IX. PAYMENTS AND COMPLETION

- 91 CONTRACT SUM.** The Contract Sum is stated in the Contract and, including authorized adjustments, is the total maximum not-to-exceed amount payable by City to Contractor for performance of the Work under the Contract Documents. Contractor accepts and agrees that all payments pursuant to this Contract are subject to the availability and appropriation of funds by the Pflugerville City Council. If funds are not available and/or appropriated, this Contract shall immediately be terminated with no liability to any Party to this Contract.

92 SCHEDULE OF VALUES

- 9.2.1 A Schedule of Values for all of the Work shall be submitted by Contractor and shall include quantities and prices of items which, when added together, equal a contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Where applicable, overhead and profit shall be included as a separate line item.
- 9.2.2 Before the first Application for Payment, Contractor shall submit to City and Design Consultant a Schedule of Values allocated to various portions of the Work, prepared in such form and supported by such data to substantiate its accuracy as City and Design Consultant may require. This schedule, unless objected to by Design Consultant or City, shall be used as a basis for reviewing Contractor's Applications for Payment.

93 APPLICATIONS FOR PAYMENT

- 9.3.1 Contractor shall submit Applications for Payment to City electronically, at minimum, every thirty (30) days throughout the duration of the Project. Contractor electronically shall attach to its Application for Payment all data substantiating Contractor's right to payment as City or Design Consultant may require, such as copies of requisitions from Subcontractors and material suppliers reflecting retainage, if provided for in the Contract Documents, and reflecting a deduction for Liquidated Damages, if applicable. Applications for Payment shall not include requests for payment for portions of the Work which Contractor does not intend to pay to a Subcontractor or material supplier, unless such Work has been performed by others whom Contractor intends to pay.
- 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the Site for subsequent incorporation in the Work and verified by City. If approved in advance in writing by City, payment similarly may be made for materials and equipment suitably stored off the Site at a location agreed upon in writing and verified by City. Payment for materials and equipment stored on or off the Site shall be conditioned upon compliance by Contractor with procedures reasonably satisfactory to City to establish City's title to such materials and equipment or otherwise protect City's interest. Contractor solely shall be responsible for payment of all costs of applicable insurance, storage and transportation to the site for materials and equipment stored off the site.
- 9.3.3 Contractor warrants that, upon submittal of an Application for Payment, all Work for which payment

previously has been received from City shall, to the best of Contractor's knowledge, information and belief, be free and clear of liens, claims, security interests or encumbrances in favor of Contractor, Subcontractors, material suppliers or other persons or entities making a claim by reason of having provided labor, materials and equipment relating to the Work. **CONTRACTOR SHALL INDEMNIFY AND HOLD CITY HARMLESS FROM ANY LIENS, CLAIMS, SECURITY INTEREST OR ENCUMBRANCES FILED BY CONTRACTOR, SUBCONTRACTORS OR ANYONE CLAIMING BY, THROUGH OR UNDER CONTRACTOR OR SUBCONTRACTOR(S) FOR ITEMS COVERED BY PAYMENTS MADE BY CITY TO CONTRACTOR.**

- 93.4 By submission of an Application for Payment, Contractor certifies that there are no known liens or bond claims outstanding as of the date of said Application for Payment, that all due and payable bills with respect to the Work have been paid to date or are included in the amount requested in the current application and, except for such bills not paid but so included, there is no known basis for the filing of any liens or bond claims relating to the Work and that releases from all Subcontractors and Contractor's material men have been obtained in such form as to constitute an effective release of lien or claim under the laws of the State of Texas covering all Work theretofore performed and for which payment has been made by City to Contractor; provided if any of the foregoing is not true and cannot be certified, Contractor shall revise the certificate as appropriate and identify all exceptions to the requested certifications.

94 PAY APPLICATION APPROVAL

- 94.1 Design Consultant shall, within five (5) business days after the electronic receipt of Contractor's Application for Payment, either approve the Application for Payment or reject the Application for Payment and state on the electronic notification to Contractor and City the Design Consultant's reasons for withholding approval, as provided in **Section 9.5.1** herein.
- 94.2 The certification of an Application for Payment shall constitute a representation by Design Consultant to City, based on Design Consultant's evaluation of the Work and the data comprising the Application for Payment, that the Work has progressed to the point indicated and that, to the best of Design Consultant's knowledge, information and belief, the quality of the Work is in accordance with the Contract Documents. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion and to any specific qualifications expressed by Design Consultant. The issuance of a Certificate for Payment further shall constitute a representation that Contractor is entitled to payment in the amount certified. However, the issuance of a Certificate for Payment shall not be a representation Design Consultant has:
- (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work;
 - (2) reviewed construction means, methods, techniques, sequences or procedures;
 - (3) reviewed copies of requisitions received from Subcontractors and material suppliers and other data requested by City to substantiate Contractor's right to payment; or
 - (4) made an examination to ascertain how or for what purpose Contractor has used money previously paid on account of the Contract Sum.

95 DECISIONS TO REJECT APPLICATION FOR PAYMENT

- 95.1 The Application for Payment may be rejected to protect City for any of the following reasons:

9.5.1.1 Work not performed or defective;

9.5.1.2 third party claims filed or reasonable evidence indicating a probable filing of such claims for which Contractor is responsible hereunder unless security acceptable to City is provided by Contractor;

9.5.1.3 failure of Contractor to make payments properly to Subcontractors or for labor, materials or equipment;

9.5.1.4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum and Contractor has failed to provide City adequate assurance of its continued performance within a reasonable time after demand;

9.5.1.5 damage to City or another contractor;

9.5.1.6 reasonable evidence that the Work shall not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or Liquidated Damages for the anticipated delay;

9.5.1.7 persistent failure by Contractor to carry out the Work in accordance with the Contract Documents;

9.5.1.8 the applicable Liquidated Damages were not included in the Application for Payment;

9.5.1.9 billing for unapproved/unverified materials stored off Site; or

9.5.1.10 a current schedule update has not been submitted by Contractor.

952 City shall not be deemed in default by reason of rejecting Application for Payment as provided for in **Section 9.5.1** herein.

9.6 PROGRESS PAYMENTS

96.1 After the final approval of the Application for Payment, City may make payment in the manner and within the time provided in the Contract Documents.

962 During the latter part of each month, as the Work progresses on all City Contracts regardless of Contract Sum, City and Contractor shall determine the cost of the labor and materials incorporated into the Work during that month and actual invoiced cost of Contractor-acquired materials stored on the Project Site, and/or within off-site storage facilities either owned or leased by Contractor. Upon receipt of a complete and mathematically accurate Application for Payment from Contractor, City shall make payments, in accordance with **Article IX** herein, to Contractor within thirty (30) calendar days on Contracts totaling four hundred thousand dollars (\$400,000.00) or less, based upon such cost determination and at the Contract prices in a sum equivalent to ninety percent (90%) of each such invoice. The remaining ten percent (10%) retainage shall be held by City until the Final Completion. However, where the Contract amount exceeds four hundred thousand dollars (\$400,000.00), installments shall be paid to Contractor at the rate of ninety-five percent (95%) of each monthly invoice within thirty (30) calendar days of City receipt of a complete and mathematically accurate Application for Payment from the Contractor, and the retainage held until Final Completion shall be five percent (5%).

- 963 City's payment of installments shall not, in any way, be deemed to be a final acceptance by City of any part of the Work, shall not prejudice City in the final settlement of the Contract account or shall not relieve Contractor from completion of the Work herein provided.
- 964 Contractor shall, within ten (10) calendar days following receipt of payment from City, pay all bills for labor and materials performed and furnished by others in connection with the construction, furnishing and equipping of the improvements and the performance of the work, and shall, if requested, provide City with written evidence of such payment. Contractor's failure to make payments or provide written evidence of such payments within such time shall constitute a material breach of this Contract, unless Contractor is able to demonstrate to City bona fide disputes associated with the unpaid Subcontractor(s) or supplier(s) and its/their work. Contractor shall include a provision in each of its subcontracts imposing the same written documentation of payment obligations on its Subcontractors as are applicable to Contractor hereunder, and if City so requests, shall provide copies of such Subcontractor payments to City. If Contractor has failed to make payment promptly to Contractor's Subcontractors or for materials or labor used in the Work for which City has made payment to the Contractor, City shall be entitled to withhold payment to Contractor to the extent necessary to protect City.
- 965 City and/or Design Consultant shall, if practicable and upon request, furnish to Subcontractor information regarding percentages of completion or amounts applied for by Contractor and action taken thereon by City and Design Consultant on account of portions of the Work done by such Subcontractor.
- 966 Neither City nor Design Consultant shall have an obligation to pay or to see to the payment of money to a Subcontractor, except as may otherwise be required by law, if any.
- 967 Payments to material suppliers shall be treated in a manner similar to that provided in **Section 9.6.2, Section 9.6.3** and **Section 9.6.4** herein regarding Subcontractors.
- 968 A Certificate for Payment, a progress payment or a partial or entire use or occupancy of the Project by City shall not constitute acceptance of Work that was not performed or furnished in accordance with the Contract Documents.
- 969 Contractor shall, as a condition precedent to any obligation of City under this Contract, provide to City payment and performance bonds in the full penal amount of the Contract, in accordance with Texas Government Code Chapter 2253.

9.7 SUBSTANTIAL COMPLETION

- 971 Substantial Completion is defined as the stage in the progress of the Work when the Work, or a designated portion thereof, which City agrees to accept separately, sufficiently is complete, in accordance with the Contract Documents, so City may occupy or utilize the Work or a designated portion thereof for its intended use. In the event Substantial Completion is not achieved by the designated date, or the date extended by issued and accepted Change Order(s), City may withhold payment of sums necessary to pay the estimated Liquidated Damages due City. City shall be entitled, at any time, to deduct out of any sums due to Contractor any or all Liquidated Damages due City in accordance with the Contract between City and Contractor.
- 972 When Contractor considers that the Work, or a portion thereof which City agrees to accept separately, is Substantially Complete, Contractor shall prepare and submit to City and Design Consultant a preliminary comprehensive list of items to be completed or corrected prior to Final Completion and final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

- 973 Upon receipt of Contractor's list of items to be completed or corrected, City and Design Consultant shall make a Site inspection to determine whether the Work or designated portion thereof is Substantially Complete. If City's or Design Consultant's inspection discloses any item, whether or not it was included on Contractor's list of items to be completed or corrected, which is not sufficiently complete or correct in accordance with the Contract Documents so that City may occupy or utilize the Work or designated portion thereof for its intended use, Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon written notification by City or Design Consultant. In such case, Contractor then shall submit a request for another inspection by City and Design Consultant to determine Substantial Completion and Contractor shall be responsible for all costs incurred and associated with re-inspection.
- 974 When the Work, or the designated portion thereof which City agrees to accept separately, is Substantially Complete, Design Consultant or City shall prepare a Certificate of Substantial Completion (Vertical Projects) or a Letter of Conditional Approval (Horizontal Projects) which shall:
- (1) establish the date of Substantial Completion (which shall be the date on which the Work met the requirements under the Contract Documents for Substantial Completion);
 - (2) establish responsibilities of City and Contractor, as agreed to by City and Contractor, for security, maintenance, heat, utilities, damage to the Work and insurance; and
 - (3) confirm the time limit by which Contractor shall complete all items on the list accompanying the Certificate.

Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work, or the designated portion thereof, unless otherwise provided in the Certificate of Substantial Completion.

9.8 PARTIAL OCCUPANCY OR USE

- 981 City may occupy or use any completed or partially completed portion of the Work at any stage of the Work when such partially completed portion is designated by separate agreement with Contractor, provided such occupancy or use is consented to by the insurer, as required under **Section 11.2.5** herein and authorized by public authorities having jurisdiction over the Work. Such partial occupancy or use may commence whether or not the portion is Substantially Complete, provided City and Contractor have accepted in writing the responsibilities assigned to each of them for security, maintenance, heat, utilities, damage to the Work and insurance and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When Contractor considers a portion of the Work to be Substantially Complete, Contractor shall prepare and submit a list of items to be completed or corrected prior to Final Completion and final payment and submit such list to City and Design Consultant, as provided under **Section 9.7.2** herein. Consent of Contractor to partial occupancy or use shall not be unreasonably withheld, conditioned or delayed. The state of the progress of the Work shall be determined by written agreement between City and Contractor or, if no agreement is reached, by the decision of Design Consultant.
- 982 Immediately prior to such partial occupancy or use, City, Contractor and Design Consultant collectively shall inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.
- 983 Unless expressly agreed upon in writing, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

- 984 Upon such partial occupancy or use, and upon Substantial Completion, City may assume responsibility for maintenance, security and insuring that portion of the Work that it has put into use.
- 985 Partial occupancy or use by City does not constitute Substantial Completion and does not start any warranty period(s).

9.9 FINAL COMPLETION AND FINAL PAYMENT

- 991 When all of the Work finally is completed and ready for final inspection, Contractor shall notify City and Design Consultant thereof in writing. Thereupon, City and Design Consultant shall make final inspection of the Work and, if the Work is complete in full accordance with this Contract and this Contract has been fully performed, the final Application for Payment may be submitted. If City and Design Consultant are unable to approve the final Application for Payment for reasons for which Contractor is responsible and City and Design Consultant are required to repeat a final inspection of the Work, Contractor shall be responsible for all costs incurred and associated with such repeat final inspection(s) and said costs may be deducted by City from the Contractor's retainage.
- 992 Contractor shall not be entitled to payment of retainage unless and until it submits to City its affidavit that the payrolls, invoices for materials and equipment, and other liabilities, to include Liquidated Damages, connected with the Work for which City or City's property might be responsible fully have been paid or otherwise satisfied or shall be paid from final payment; releases and waivers of liens from all Subcontractors of Contractor and of any and all other parties required by Design Consultant or City that either are unconditional or conditional on receipt of final payment; Certificates of insurance showing continuation of required insurance coverage; such other documents as City may request; and consent of Surety to final payment. A Retainage Checklist shall be provided by City to Contractor upon request.
- 993 If, after Substantial Completion of the Work, Final Completion of the Work materially is delayed through no fault of Contractor nor by Issuance of Change Orders affecting Final Completion of the Work, and Design Consultant so confirms, City shall, upon application by Contractor and certification by Design Consultant and without terminating the Contract, make payment of the balance due Contractor for that portion of the work fully completed and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of Surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Design Consultant, prior to certification of such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.
- 994 Request for final payment by Contractor shall constitute a waiver of all claims against City, except those previously made in writing and identified by the Contractor as unsettled at the time of final Application for Payment.

- 9.10 **ADDITIONAL INSPECTIONS.** In addition to any Liquidated Damages accrued by and payable to City by Contractor, City shall be entitled to deduct from the Contract Sum amounts due to Contractor by City to compensate Design Consultant for any additional inspections or services provided by Design Consultant, provided Design Consultant undertook these additional inspections or services due to the fault or negligence of Contractor if:

- (1) Design Consultant is required to make more than one inspection to determine if Substantial Completion has been achieved by Contractor; or
- Design Consultant is required to make more than one inspection to determine if Final Completion has been achieved by Contractor.

ARTICLE X. PROTECTION OF PERSONS AND PROPERTY

10.1 SAFETY PRECAUTIONS AND PROGRAMS

- 10.1.1 Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Contract. Contractor shall develop a safety program applicable to each job site and to the Work to be done, review such program with City in advance of beginning the Work, and enforce such program at all times. Further, Contractor shall comply with all applicable laws and regulations including, but not limited to, the standards and regulations promulgated by the Secretary of Labor under the Occupational Safety and Health Act of 1970 (OSHA) and any other legislation enacted for the safety and health of Contractor employees. City shall have the right, but not the obligation, to inspect and verify Contractor's compliance with Contractor's responsibility for protecting the safety and health of its employees and Subcontractor.
- 10.1.2 Contractor shall notify City immediately, by telephone with prompt confirmation in writing, of all injuries and fatalities including, but not limited to, copies of all reports and other documents filed or provided to Contractor's insurers and the State of Texas in connection with such injuries or fatalities.
- 10.1.3 Contractor has adopted or shall adopt its own policy to assure a drug and alcohol-free work place while performing the Work. Contractor's employees, agents, and Subcontractors shall not perform any service for City while under the influence of alcohol or any controlled substance. Contractor, its employees, agents and Subcontractors shall not use, possess, distribute or sell illegal, illicit and/or prescribed controlled drugs or drug paraphernalia or misuse legitimate prescription drugs while on Site or performing the Work. Contractor, its employees, agents and Subcontractors shall not use, possess, distribute or sell alcoholic beverages while performing the Work or while on Site or performing the Work. Contractor shall remove any of its employees or Subcontractor employees from performing the Work or from the Site any time there is suspicion of alcohol and/or drug use, possession or impairment involving such employee and at any time an incident occurs where drug or alcohol use could have been a contributing factor. City has the right to require Contractor to remove employees or Subcontractor employees from performing the Work or from the Site any time cause exists to suspect alcohol or drug use. In such cases, Contractor's or Subcontractor's employees only may be considered for return to work after Contractor certifies, as a result of a for-cause test conducted immediately following a removal, said employee was in compliance with this Contract. Contractor shall not employ any individual, or shall not accept any Subcontractor employees, to perform the Work who either refuses to take or tests positive in any alcohol or drug test.
- 10.1.4 Contractor shall comply with all applicable federal, state and local drug and alcohol related laws and regulations (e.g., Department of Transportation regulations, Department of Defense Drug-free Work-free Workforce Policy, Drug-Free Workplace Act of 1988).
- 10.1.5 Both City and Contractor agree that these safety and health terms are of the highest importance and that a breach or violation of any of the terms of this **Section X** by Contractor or a Subcontractor shall be a material and substantial breach of this Contract. In the event that City shall determine that Contractor has breached or violated the terms of this Section, then City shall determine, immediately upon written notice to Contractor, whether the Work shall be suspended as a result thereof. If the Work is suspended, the Work shall not recommence until City is satisfied that the safety provisions hereof shall not be breached or violated thereafter. If City terminates the Contract as a result of such breach or violation, City and Contractor shall complete their obligations hereunder to one another in accordance with **Section 13.3** herein.
- 10.1.6 Nothing contained in this **Article X** shall be interpreted as creating or altering the legal duty of City to

Contractor or to Contractor's agents, employees, Subcontractors or third parties, or altering the status of Contractor as an independent contractor.

- 101.7 Notwithstanding either of the above provisions, or whether City exercises its rights set forth herein, City neither warrants nor represents to Contractor, Contractor's employees or agents, any Subcontractors or any other third party that Contractor's safety policy meets the requirements of any applicable law, code, rule or regulation, nor does City warrant that the proper enforcement of Contractor's policy shall insure that no accidents or injuries shall occur. In addition, any action by City under these provisions in no way diminishes any of Contractor's obligations under applicable law or the Contract Documents.

10.2 SAFETY OF PERSONS AND PROPERTY

- 102.1 Contractor shall take reasonable precautions for the safety of and shall provide reasonable protection to prevent damage, injury or loss to:
- 10.2.1.1 employees performing the Work and other persons who may be affected thereby;
 - 10.2.1.2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under the care, custody or control of Contractor or Contractor's Subcontractors or Sub-Subcontractors;
 - 10.2.1.3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of Construction; and
 - 10.2.1.4 the contents of a building or structure, when Contractor is working in, on or around an existing/operating City facility.
- 102.2 Contractor shall give notices and comply with applicable laws, ordinances, rules, regulations and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury or loss.
- 102.3 Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards, promulgating safety regulations and notifying City and users of adjacent sites and utilities.
- 102.4 When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for the execution of the Work, Contractor shall exercise extraordinary care and shall carry on such activities under the direct supervision of properly qualified personnel. Prior to the use of any explosives, Contractor shall submit a written blasting plan, shall obtain City's approval and shall comply with City's requirements for such use.
- 102.5 Contractor shall designate a responsible member of Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be Contractor's superintendent unless otherwise designated by Contractor in writing to City and Design Consultant.
- 102.6 Notwithstanding the delivery of a survey or other documents by City, Contractor shall perform all Work in such a manner so as to avoid damaging any utility lines, cables, pipes or pipelines on the property. Contractor acknowledges and accepts that the location of underground utilities (both public and private)

reflected on any City-provided Plans are not guaranteed and may not be completely accurate. Contractor shall locate and verify any and all utilities and associated service lines prior to beginning any Work. Contractor shall be responsible for and shall repair, at Contractor's own expense, any damage done to lines, cables, pipes and pipelines identified or not identified to Contractor.

10.3 EMERGENCIES

- 103.1 In an emergency affecting safety of persons or property, Contractor shall exercise its best efforts to act to prevent or minimize threatened damage, injury or loss. Additional compensation or extension of time claimed by Contractor on account of an emergency shall be determined, as provided in **Section 4.3** and **Article VII** herein.
- 103.2 If Contractor causes damage resulting in an issue of safety and/or security to public or private property, Contractor immediately shall repair any damage caused. If Contractor does not or shall not act immediately to repair the damage caused by Contractor to eliminate the resulting safety and/or security issue(s), City may act to repair the damage caused and deduct all costs associated with the repair from any money due Contractor.

10.4 PUBLIC CONVENIENCE AND SAFETY

- 104.1 Contractor shall place materials stored at the Project site and shall conduct the Work at all times in a manner that causes no greater obstruction to the public than is considered necessary by City. Sidewalks or streets shall not be obstructed, except by special permission of City. Materials excavated and construction materials or plants used in the performance of the Work shall be placed in a manner that does not endanger the Work or prevent free access to all fire hydrants, water mains and appurtenances, water valves, gas valves, manholes for the telephone, telegraph signal or electric conduits, wastewater mains and appurtenances and fire alarm or police call boxes in the vicinity.
- 104.2 City reserves the right to remedy any neglect on the part of Contractor, in regard to public convenience and safety, which may come to City's attention after twenty-four (24) hours-notice in writing to Contractor. In case of an emergency, City shall have the right to immediately remedy any neglect without notice. In either case, the cost of any work done by or for City to remedy Contractor's neglect shall be deducted by City from Contractor's Contract Sum. Contractor shall notify City and Design Consultant when any street is to be closed or obstructed. The notice shall, in the case of major thoroughfares or street upon which transit lines operate, be given at least forty-eight (48) hours in advance. City reserves the right to postpone and/or prohibit any closure or obstruction of any streets or thoroughfares, to the extent necessary for the safety and benefit of the traveling public. Contractor shall, when directed by City or Design Consultant, keep any street or streets in condition for unobstructed use by City departments. When Contractor is required to construct temporary bridges or make other arrangements for crossing over ditches or around structures, Contractor's responsibility for accidents shall include the roadway approaches as well as the crossing structures.
- 104.3 Contractor shall limit airborne dust and debris throughout the Project site and its duration. Contractor shall apply the necessary amounts of water or other appropriate substance required to maintain sufficient moisture content for dust control. For City horizontal projects, Contractor shall apply appropriate amounts of water or other appropriate substance to the base on streets under construction and on detours required to maintain sufficient moisture control in the surface layer for dust control.

10.5 PUBLIC UTILITIES AND OTHER PROPERTIES TO BE CHANGED. In case it is necessary for Contractor to change or move the property of City or of any telecommunications or public utility, such property shall not be touched, removed or interfered with until ordered to do so by City. City

reserves the right to grant any public or private utility personnel the authority to enter upon the Project site for the purpose of making such changes or repairs to their property that may become necessary during the performance of the Work. City reserves the right of entry upon the Project site at any time and for any purpose, including repairing or relaying sewer and water lines and appurtenances, repairing structures and for making other repairs, changes, or extensions to any of City's property. City's actions shall conform to Contractor's current and approved schedule for the performance of the Work, provided that proper notification of schedule requirements has been given to City by Contractor.

10.6 ARRANGEMENT AND CHARGE FOR WATER FURNISHED BY CITY/ELECTRICITY FOR THE PROJECT/WIRELESS ACCESS

- 1061 When Contractor desires to use City's water in connection with the Work, Contractor shall make complete and satisfactory arrangements with the Pflugerville Water Service Department and shall be responsible for the cost of the water Contractor uses. Where meters are required and used, the charge shall be at the regular established rate; where no meters are required and used, the charge shall be as prescribed by City ordinance, or where no ordinance applies, payment shall be based on estimates made by the representatives of the Pflugerville Water Service Department.
- 1062 Contractor shall make complete and satisfactory arrangements for electricity and metered electrical connections with any applicable retail electric provider, in the event that separately metered electrical connections are required for the Project. Contractor shall pay for all electricity used in the performance of the Work through separate metered electrical connections obtained by Contractor through a retail electric provider.
- 1063 If Contractor elects or is required by City to place and operate out of a construction trailer or office on the Project site, for which all related costs shall be borne by Contractor, Contractor shall provide for an electronic device to exchange data wirelessly via a local area computer network, to include high-speed internet connections (Wi-Fi access), for City personnel's use while on the Project site for the duration of the Project.

10.7 ENVIRONMENTAL COMPLIANCE

- 1071 Contractor and its Subcontractors are deemed to have made themselves familiar with and at all times shall comply with any and all applicable federal, state or local laws, rules, regulations, ordinances and rules of common law now in effect (including any amendments thereto), relating to the environment, Hazardous Substances or exposure to Hazardous Substances including, but not limited to, the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C.A. §§ 9601, et seq.; the Hazardous Materials Transportation Act, 49 U.S.C.A. §§ 1801, et seq.; the Resource Conservation and Recovery Act of 1976, 42 U.S.C.A. §§ 6901, et seq.; the Federal Water Pollution Control Act, 33 U.S.C.A §§ 1201, et seq.; the Toxic Substances Control Act, 15 U.S.C.A. §§ 2601, et seq.; the Clean Air Act, 42 U.S.C.A. §§ 7401, et seq.; the Safe Drinking Water Act, 42 U.S.C.A. §§ 3808, et seq., and any current judicial or administrative interpretation of these laws, rules, regulations, ordinances or rules of common law including, but not limited to, any judicial or administrative order, consent decree or judgment affecting the Project.
- 1072 In the event Contractor encounters on the Project Site materials reasonably believed to be a Hazardous Substance that have not been rendered harmless, and the removal of such materials is not a part of the scope of Work required under the Contract Documents, Contractor immediately shall stop Work in the affected area and immediately report in writing the facts of such encounter to City and Design Consultant. Work in the affected area shall not thereafter be resumed except by written order of City and written

consent of Contractor, unless and until the material is determined not to be a Hazardous Substance or the Hazardous Substance is remediated. Unless removal of such materials is a part of the scope of Work required under the Contract Documents, City shall remediate the Hazardous Substance with a separate contractor or through a Change Order with Contractor. If the Hazardous Substance exists in the affected area due to the fault or negligence of Contractor or any of its Subcontractors, Contractor shall be responsible for remediating the condition at the sole expense of Contractor. If applicable, such remediation shall be in accordance with Contractor's Spill Remediation Plan. An extension of the Contract Time for any delay in the progress schedule caused as a result of the discovery and remediation of a Hazardous Substance may be granted by City only if the Project critical path is affected and Contractor is not the source of the Hazardous Substance. Any request for an extension of the Contract Time related to the discovery and remediation of a Hazardous Substance is subject to the provisions of **Section 4.3** and **Article VIII** herein.

- 10.73 Contractor shall be responsible for identification, abatement, cleanup, control, removal, remediation and disposal of any Hazardous Substance brought into or onto the site by Contractor or any Subcontractor or Contractor's Supplier. Contractor shall obtain any and all permits necessary for the legal and proper handling, transportation and disposal of the Hazardous Substance and shall, prior to undertaking any abatement, cleanup, control, removal, remediation and/or disposal, notify City and Design Consultant so that they may observe the activities; provided, however, that it shall be Contractor's sole responsibility to comply with all applicable laws, rules, regulations or ordinances governing said activities.

10.8 ROAD CLOSURES AND DETOUR ROUTES. Contractor shall not begin construction of the Project or close any streets until adequate barricades and detour signs have been provided, erected and maintained in accordance with the detour route and details shown on the Project Plans. Contractor shall notify City forty-eight (48) hours in advance of closing any street to through traffic. Local traffic shall be permitted the use of streets under construction whenever feasible.

10.9 USE OF CITY STREETS. Contractor shall confine the movements of all steel-tracked equipment to the limits of the Project Site and any such equipment shall not be allowed use of City's streets unless being transported on pneumatic-tired vehicles. Any damage to City's streets caused by Contractor and/or Contractor's equipment, either outside the limits of the Project site or within the limits of the Project site but not within the limits of the current phase then being constructed, shall be repaired by Contractor at its own expense and as prescribed by City's Specifications and direction. If Contractor cannot or refuses to repair street damage caused by Contractor and/or Contractor's equipment, City may perform the repairs and all expenses incurred by City in performing the repairs shall be deducted from any money due or owed to Contractor.

10.10 MAINTENANCE OF TRAFFIC. In accordance with the approved traffic control plan and as specified in the Contract, Contractor shall:

- 10.10.1 keep existing roadways open to traffic or construct and maintain detours and temporary structures for safe public travel;
- 10.10.2 maintain the Work in passable condition, including proper drainage, to accommodate traffic;
- 10.10.3 provide and maintain temporary approaches and crossings of intersecting roadways in a safe and passable condition;
- 10.10.4 construct and maintain necessary access to adjoining property as shown in the Plans or as directed by City; and
- 10.10.5 furnish, install and maintain traffic control devices in accordance with the Contract.

- 10.10.6 The cost of maintaining traffic shall be subsidiary to the Project and shall not directly be paid for by City, unless otherwise stated in the Plans and Specifications. City shall notify Contractor if Contractor fails to meet the above traffic requirements. City may perform the work necessary for compliance, but any action by City shall not change the legal responsibilities of Contractor, as set forth in the Contract Documents. Any costs incurred by City for traffic maintenance shall be deducted from money due or owed to Contractor.

10.11 ABATEMENT AND MITIGATION OF EXCESSIVE OR UNNECESSARY CONSTRUCTION NOISE. Contractor shall ensure abatement and mitigation of excessive or unnecessary construction noise to the satisfaction of City and as prescribed by all applicable state and local laws.

10.12 INCIDENTAL WORK, CONNECTIONS, AND PASSAGEWAYS. Contractor shall perform all incidental Work necessary to complete and comply with this Contract including, but not limited to the following:

- 10.12.1 Contractor shall make and provide all suitable reconnections with existing improvements (generally excluding new connections with or relocation of utility services, unless specifically provided for otherwise in the Contract Documents) as are necessarily incidental to the proper completion of the Project;
- 10.12.2 Contractor shall provide passageways or leave open such thoroughfares in the Work Site as may be reasonably required by City; and
- 10.12.3 Contractor shall protect and guard same at its own risk and continuously shall maintain the Work Site in a clean, safe and workmanlike manner.

ARTICLE XI. INSURANCE AND BONDS

11.1 CONTRACTOR'S LIABILITY INSURANCE

- 11.1.1 Prior to the commencement of any work under this Contract, Contractor shall furnish copies of all required endorsements and completed Certificate(s) of Insurance to City's ODR or Department, which shall be clearly labeled "Package 1A Street Reconstruction Project" in the Description of Operations block of the Certificate. The Certificate(s) shall be completed by an agent and signed by a person authorized by that insurer to bind coverage on its behalf. City shall not accept a Memorandum of Insurance or Binder as proof of insurance. The Certificate(s) shall be signed by the Authorized Representative of the insurance carrier and shall include the agent's original signature and telephone number. The Certificate(s) shall be mailed, with copies of all applicable endorsements, directly from the insurer's authorized representative to City. City shall have no duty to pay or perform its obligations under this Contract until such Certificate(s) and endorsements have been received and approved by City's ODR or Department. No officer or employee of City, other than the City of Pflugerville's Risk Manager, shall have authority to waive any of these requirements.
- 11.1.2 City reserves the right to review the insurance requirements of this **Article XI** during the effective period of this Contract and to modify insurance coverages and limits when deemed necessary and prudent by the City of Pflugerville's Risk Manager based upon changes in statutory law, court decisions, or circumstances surrounding this Contract. In no instance will City allow modification whereby City may incur increased risk.
- 11.1.3 Contractor's financial integrity is of the utmost concern and interest to City; therefore, subject to Contractor's right to maintain reasonable deductibles in such amounts as are approved by City,

Contractor shall obtain and maintain in full force and effect, for the duration of this Contract and at Contractor's sole expense, insurance coverage written on an occurrence basis, unless otherwise indicated, by companies authorized to do business in the State of Texas and with an A.M Best's rating of no less than A- (VII), in the following types and for amounts not less than the amounts listed below:

<u>TYPE</u>	<u>AMOUNTS</u>
1. Workers' Compensation 2. Employers' Liability	Statutory \$1,000,000.00/\$1,000,000.00/ \$1,000,000.00
3. Commercial General Liability Insurance to include coverage for the following: a. Premises/Operations b. Products/Completed Operations c. Personal/Advertising Injury *d. Environmental Impairment/ Impact – sufficiently broad to cover disposal liability. *e. Explosion, Collapse, Underground	For <u>Bodily Injury</u> and <u>Property Damage</u> of: \$1,000,000.00 per occurrence; \$2,000,000.00 General Aggregate, or its equivalent in Umbrella or Excess Liability Coverage
4. Business Automobile Liability: a. Owned/leased vehicles b. Non-owned vehicles c. Hired Vehicles	<u>Combined Single Limit</u> for <u>Bodily Injury</u> and <u>Property Damage</u> of \$1,000,000.00 per occurrence
5. *Professional Liability (Claims-made basis) To be maintained and in effect for no less than two years subsequent to the completion of the professional service.	\$1,000,000.00 per claim, to pay on behalf of the insured all sums which the insured shall become legally obligated to pay as damages by reason of any act, malpractice, error, or omission in professional services.
6. *Builder's Risk	All Risk Policy written on an occurrence basis for 100% replacement cost during construction phase of any new or existing structure.
*if applicable	

11.14 Contractor agrees to require, by written contract, all Subcontractors providing goods or services pursuant to performance on the Project to obtain the same categories of insurance coverage required of Contractor herein and provide a Certificate of Insurance and endorsement that names Contractor and City as additional insureds. Policy limits of the coverages carried by Subcontractors shall be determined as a business decision of Contractor. Contractor shall provide City with said Certificate and endorsement prior to the commencement of any work by the Subcontractor. This Subcontractor insurance provision may be modified by the City of Pflugerville's Risk Manager, without subsequent Pflugerville City Council approval, when deemed necessary and prudent, based upon changes in statutory law, court decisions, or circumstances surrounding this Contract. Such insurance coverage modification may be enacted by letter signed by the City of Pflugerville's Risk Manager, which shall become a part of this Contract for all purposes.

11.15 As they apply to the limits required by City, City shall be entitled, upon request and without expense, to receive copies of all insurance policies, declaration pages and all required endorsements associated with this Work. Contractor shall be required to comply with any such requests and shall submit requested documents to City at the address provided below within ten (10) calendar days. Contractor shall pay any and all costs incurred resulting from provision of said documents to City.

City of Pflugerville
Attn: Engineering
Department; ODR:
Immanuel Road Improvements
Brad Limmi, Project Manager
15500 Sun Light Near Way #B, Bldg 6
Pflugerville, Texas 78660

11.16 Contractor agrees that with respect to the above required insurance, all insurance policies are to contain or be endorsed to contain the following provisions:

- Name City, its officers, officials, employees, volunteers, and elected representatives as additional insureds by endorsement, with respect to operations and activities of, or on behalf of, the named insured performing under this Contract with City, with the exception of the workers' compensation and professional liability policies;
- Provide for an endorsement reflecting the "other insurance" clause shall not apply to the City of Pflugerville where City is an additional insured shown on the policy;
- Workers' compensation, employers' liability, general liability and automobile liability policies will provide a waiver of subrogation in favor of City.
- Provide advance written notice directly to City, at the address cited above, of any suspension or non-renewal in coverage of Contractor's insurance policy/policies associated with this Work and not less than ten (10) calendar days in advance notice for Contractor's nonpayment of premium(s).

11.17 Within five (5) calendar days of a suspension, cancellation or non-renewal of insurance coverage associated with this Work, Contractor shall provide a replacement Certificate(s) of Insurance and applicable endorsement(s) to City. City shall have the option to suspend Contractor's performance should there be a lapse in coverage at any time during this Contract. Failure to provide and to maintain the required insurance shall constitute a material breach of this Contract.

11.18 In addition to any other remedies City may have upon Contractor's failure to provide and maintain any insurance and/or policy endorsements to the extent and within the time herein required, City shall have the right to order Contractor to stop work hereunder and/or withhold any payment(s) which become due

to Contractor hereunder until Contractor demonstrates compliance with the insurance requirements hereof.

- 11.19 Nothing contained herein shall be construed as limiting in any way the extent to which Contractor may be held responsible for payments of damages to persons or property resulting from Contractor's or its Subcontractors' performance of the Work covered under this Contract.
- 11.1.10 Contractor accepts and agrees Contractor's insurance shall be deemed primary and non-contributory, with respect to any insurance or self-insurance carried by City, for liability arising out of Contractor's operations under this Contract.
- 11.1.12 Contractor understands, accepts and agrees the insurance required of Contractor by this Contract is in addition to and separate from any other obligation contained in this Contract and no claim or action by or on behalf of City shall be limited to insurance coverage provided.
- 11.1.13 Contractor and any of Contractor's Subcontractors are responsible for any and all damage to their own equipment and/or property.
- 11.1.14 Without limiting any of the other obligations or liabilities of Contractor under the Contract Documents, Contractor shall purchase and maintain, during the term of the Contract and at Contractor's own expense, the minimum liability insurance coverage described below with insurance companies duly authorized or approved to do business in the State of Texas and otherwise satisfactory to City. Contractor also shall require each Subcontractor performing work under the Contract, at Subcontractor's own expense, to maintain levels of insurance necessary and appropriate for the Work performed during the term of the Contract, said levels of insurance comply with all applicable laws. Subcontractor's liability insurance shall name Contractor, City and Design Consultant as additional insureds by using endorsement CG 20 26 or broader. Certificates of insurance complying with the requirements prescribed in **Section 11.1.2** herein shall show the existence of each policy, together with copies of all policy endorsements showing City and Design Consultant as an additional insured, and shall be delivered to City before any Work is started. Contractor promptly shall furnish, upon the request of and without expense to City, a copy of each policy required, including all endorsements, which shall indicate:
 - 11.1.14.1 Workers' Compensation, with statutory limits, with the policy endorsed to provide a waiver of subrogation as to City; Employer's Liability Insurance of not less than \$1,000,000.00 for each accident, \$1,000,000.00 disease for each employee and \$1,000,000.00 disease policy limit;
 - 11.1.14.2 Commercial General Liability Insurance, Personal Injury Liability, Independent Contractor's Liability and Products and Completed Operations and Contractual Liability covering, but not limited to, the liability assumed under the indemnification provisions of this Contract, fully insuring Contractor's (and/or Subcontractor's) liability for injury to or death of City's employees and all third parties, and for damage to property of third parties, with a combined bodily injury (including death) and property damage minimum limit of \$1,000,000.00 per occurrence, \$2,000,000.00 annual aggregate. If coverage is written on a claims-made basis, coverage shall be continuous (by renewal or extended reporting period) for no less than sixty (60) months following completion of the contract and acceptance of work by City. Coverage, including any renewals, shall have the same retroactive date as the original policy applicable to the Project. City shall be named as additional insured by using endorsement CG 20 26 or broader. The general liability policy shall include coverage extended to apply to completed operations and XCU hazards. The Completed Operations coverage must be maintained for a minimum of one (1) year after Final Completion and acceptance of the Work, with evidence of same filed with City. The policy shall include an endorsement CG2503 amendment of limits (designated project

or premises) in order to extend the policy's limits specifically to the Project in question.

11.1.143 Business Automobile Liability Insurance, covering owned, hired and non-owned vehicles, with a combined bodily injury (including death) and property damage minimum limit of \$1,000,000 per occurrence. Such insurance shall include coverage for loading and unloading hazards.

11.1.144 Five (5) calendar days prior to a suspension, cancellation or non-renewal of any required line of insurance coverage, Contractor shall provide City a replacement certificate of insurance with all applicable endorsements included. If not so provided, City shall have the option to suspend Contractor.

11.1.15 If any insurance company providing insurance coverage(s) required under the Contract Documents for Contractor becomes insolvent or becomes the subject of any rehabilitation, conservatorship, liquidation or similar proceeding, Contractor immediately shall procure, upon first notice to Contractor or City of such occurrence and without cost to City, replacement insurance coverage before continuing the performance of the Work at the Project. Any failure to provide such replacement insurance coverage shall constitute a material breach of the Contract.

11.2 PROPERTY INSURANCE

11.2.1 As stated in **Section 11.1** Contractor shall obtain at its expense and maintain throughout the duration of the Project, All-Risk Builder's Risk Insurance, if the Project involves complete construction of a new building, or an All-Risk Installation Floater policy, if the Project involves materials and supplies needed for additions to, renovations or remodeling of an existing building. Coverage on either policy shall be All-Risk, including, but not limited to, Fire, Extended Coverage, Vandalism and Malicious Mischief, Flood (if located in a flood zone) and Theft, in an amount equal to one hundred percent (100%) of the insurable value of the Project for the Installation Floater policy, and one hundred percent (100%) of the replacement cost of the Project for the Builder's Risk policy. If an Installation Floater policy is provided, City shall be shown as a Joint Named Insured with respect to the Project. If a Builder's Risk policy is provided, the policy shall be written on a Completed Value Form, including materials delivered and labor performed for the Project. This policy shall be in the name of Contractor and naming City, Design Consultant and Subcontractors, as well as any Sub-Subcontractors, as additional insureds as their interests may appear. The policy shall have endorsements as follows:

11.2.1.1 This insurance shall be specific as to coverage and not contributing insurance with any permanent insurance maintained on the property.

11.2.1.2 Loss, if any, shall be adjusted with and made payable to Contractor or City and Contractor as trustee for the insureds as their interests may appear.

11.2.2 **BOILER AND MACHINERY INSURANCE.** If applicable, City shall purchase and maintain Boiler and Machinery Insurance required by the Contract Documents or by law, which specifically shall cover such insured objects during installation and until final acceptance by City. This insurance shall include the interests of City, Contractor, Subcontractors and Sub-Subcontractors in the Work, and City and Contractor shall be named insureds.

11.2.3 **LOSS OF USE INSURANCE.** City, at City's option, may purchase and maintain such insurance as shall insure City against loss of use of City's property due to fire or other hazards, however caused. City waives all rights of action against Contractor that it may now have or have in the future for loss or damage to City's property howsoever arising, including consequential losses due to fire or other hazards however caused.

- 1124 Contractor shall provide to Design Consultant for delivery to City a Certificate of Insurance evidencing all property insurance policies procured under this **Section 11.2** and all endorsements thereto, before any exposure to loss may occur.
- 1125 Partial occupancy or use in accordance with **Section 9.8** herein shall not commence until the insurance company/companies providing property insurance have consented to such partial occupancy or use by endorsement or otherwise. City and Contractor shall take reasonable steps to obtain consent of the insurance company/companies and shall take no action without mutual written consent with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.
- 1126 Contractor shall take all necessary precautions to ensure no damage shall result from operations to private or public property. All damages shall be repaired or replaced by Contractor at no additional cost to City.

11.3 PERFORMANCE BONDS AND PAYMENT BONDS

- 113.1 Subject to the provisions of **Section 11.3.2** herein, Contractor shall, with the execution and delivery of the Contract, furnish and file with City, in the amounts required in this **Article XI**, the Surety Bonds described in **Section 11.3.1.1** and **Section 11.3.1.2** herein, with said Surety Bonds in accordance with the provisions of Chapter 2253, Texas Government Code, as amended. Each Surety Bond shall be signed by Contractor, as the Principal, as well as by an established corporate surety bonding company as surety, meeting the requirements of **Section 11.3.3** herein and approved by City. The Surety Bonds shall be accompanied by an appropriate Power-of-Authority clearly establishing the extent and limitations of the authority of each signer to so sign and shall include:
- 113.1.1 **PERFORMANCE BOND.** A good and sufficient Performance Bond in an amount equal to one hundred percent (100%) of the total Contract Sum, guaranteeing the full and faithful execution of the Work and performance of the Contract in accordance with Plans, Specifications and all other Contract Documents, including any extensions thereof, for the protection of City. This Performance Bond shall also cover and ensure performance of the Contractor's warranty and guarantee obligations established under **Section 3.5** herein and as otherwise provided in the Contract Documents providing for the repair or remedy of all defects that are discovered or appear within a period of one (1) year from the date of Substantial or Final Completion or acceptance of the Work by City, as applicable, or lesser or longer periods as otherwise may be designated in the Contract Documents.
- 113.1.2 **PAYMENT BOND.** A good and sufficient Payment Bond in an amount equal to 100% of the total Contract Sum, guaranteeing the full and prompt payment of all claimants supplying labor or materials in the prosecution of the Work provided for in the Contract, and for the use and protection of each claimant.
- 1132 If the Contract Sum, including City-accepted Alternates and allowances, if any, is greater than \$100,000.00, a Payment Bond and a Performance Bond equaling one hundred percent (100%) of the Contract Sum are mandatory and shall be provided by Contractor. If the Contract Sum is greater than \$50,000 but less than or equal to \$100,000, only a Payment Bond equaling one hundred percent (100%) of the Contract amount is mandatory; provided, however, Contractor also may elect to furnish a Performance Bond in the same amount if Contractor so chooses. If the Contract Sum is less than or equal to \$25,000, Contractor may elect not to provide Performance and Payment Bonds; provided, in such event, no money shall be paid by City to Contractor until Final Completion of all Work. If Contractor elects to provide the required Performance Bond and Payment Bond, the Contract Sum shall be payable to Contractor through progress payments in accordance with these General Conditions.

1133 No surety shall be accepted by City that is in default, delinquent on any bonds or that is a party to any litigation against City. All bonds shall be made and executed on City's standard forms, shall be approved by City and shall be executed by not less than one (1) corporate surety that is authorized and admitted to do business in the State of Texas, is licensed by the State of Texas to issue surety bonds, is listed in the most current United States Department of the Treasury List of Acceptable Sureties and is otherwise acceptable to City. Each bond shall be executed by Contractor and the surety and shall specify that legal venue for enforcement of each bond exclusively shall lie in Travis County, Texas. Each surety shall designate an agent resident in Travis County, Texas to which any requisite statutory notices may be delivered and on which service of process may be had in matters arising out of the suretyship.

1134 The person or persons, partnership, company, firm, limited liability company, association, corporation or other business entity to whom the Contract is awarded shall, within ten (10) days after such award, sign the required Contract with City and provide the necessary surety bonds and evidence of insurance as required under the Contract Documents. No Contract shall be binding on City until:

- (1) it has been approved as to form by City's City Attorney;
- (2) it has been authorized by City Council and executed by City's City Manager (if required);
- (3) the Payment Bond and Performance Bond and evidence of the required insurance have been furnished to City by Contractor, as required by the Contract Documents; and
- (4) a fully executed Contract has been delivered to Contractor (if required).

1135 The failure of Contractor to execute the Contract (if required) and deliver the required Bonds and evidence of insurance within ten (10) days after the Contract is awarded, or as soon thereafter as City can assemble and deliver the Contract and by the time the City-scheduled Pre-Construction meeting is held, shall, at City's option, constitute a material breach of Contractor's bid proposal and City may rescind the Contract award and collect or retain the proceeds of the bid security. By reason of the uncertainty of the market prices for materials and labor and it being impracticable and difficult to determine accurately the amount of damages occurring to City by reason of Contractor's failure to execute the Contract within ten (10) days and deliver bonds and insurance by the City-scheduled Pre-Construction meeting, the filing of a bid proposal shall constitute an acceptance of this **Section 11.3.5**. In the event City should re-advertise for bids, the defaulting Contractor shall not be eligible to bid and the lowest responsible bid obtained in the re-advertisement shall be the bid referred to in this **Section 11.3**.

11.4 'UMBRELLA' LIABILITY INSURANCE. Contractor shall obtain, pay for and maintain Umbrella Liability Insurance during the Contract term, insuring Contractor for an amount of not less than \$5,000,000 per occurrence combined limit Bodily Injury (including death) and Property Damage, that follows form and applies in excess of the primary coverage required hereinabove. City and Design Consultant shall be named as additional insureds using endorsement CG 20 26 or broader. No aggregate shall be permitted for this type of coverage. The Umbrella Liability Insurance policy shall provide "drop down" coverage, where the underlying primary insurance coverage limits are insufficient or exhausted.

11.5 POLICY ENDORSEMENTS AND SPECIAL CONDITIONS

11.5.1 Each insurance policy to be furnished by Contractor shall address the following required provisions within the certificate of insurance, which shall be reflected in the body of the insurance contract and/or by endorsement to the policy:

11.5.1.1 City and Design Consultant shall be named as additional insureds on all liability coverages, using endorsement CG 20 26 or broader. When City employs a Construction Manager on the

Project, Contractor and Subcontractor(s) shall include the Construction Manager on all liability insurance policies to the same extent as City and Design Consultant are required to be named as additional insureds.

11.5.12 Within five (5) calendar days of a suspension, cancellation or non-renewal of any required line of insurance coverage, Contractor shall provide City a replacement certificate of insurance with all applicable endorsements included. City shall have the option to suspend Contractor's performance should there be a lapse in coverage at any time during the Contract.

11.5.13 The terms "Owner," "City" or "City of Pflugerville" shall include all authorities, boards, bureaus, commissions, divisions, departments and offices of City and the individual members, employees and agents thereof in their official capacities, while acting on behalf of City.

11.5.14 The policy phrase or clause "Other Insurance" shall not apply to City where City is an additional insured on the policy. The required insurance coverage furnished by Contractor shall be the primary insurance for all purposes for the Project, as well as the primary insurance for the additional insureds named in the required policies.

11.5.15 All provisions of the Contract Documents concerning liability, duty and standard of care, together with the indemnification provision, shall, to the maximum extent allowable in the insurance market, be underwritten with contractual liability coverage(s) sufficient to include such obligations with the applicable liability policies.

11.52 Concerning the insurance to be furnished by the Contractor, it is a condition precedent to acceptability that:

11.52.1 All policies must comply with the applicable requirements and special provisions of this **Article 11**.

11.52.2 Any policy evidenced by a Certificate of Insurance shall not be subject to limitations, conditions or restrictions deemed inconsistent with the intent of the insurance requirements set forth herein, and City's decision regarding whether any policy contains such provisions and contrary to this requirement shall be final.

11.52.3 All policies required are to be written through companies duly authorized and approved to transact that class of insurance in the State of Texas and that otherwise are acceptable to City.

11.53 Contractor agrees to the following special provisions:

11.53.1 Contractor hereby waives subrogation rights for loss or damage to the extent same are covered by insurance. Insurers shall have no right of recovery or subrogation against City, it being the intention that the insurance policies shall protect the Parties to the Contract and be primary coverage for all losses covered by the policies. This waiver of subrogation shall be included, by endorsement or otherwise, as a provision of all policies required under this **Article XI**.

11.53.2 Insurance companies issuing the insurance policies and Contractor shall have no recourse whatsoever against City for payment of any premiums or assessments for any deductibles, as all such premiums and assessments solely are the responsibility and risk of Contractor.

11.53.3 Approval, disapproval or failure to act by City, regarding any insurance supplied by Contractor or any Subcontractor(s), shall not relieve Contractor of any responsibility or liability for damage or accidents as set forth in the Contract Documents. The bankruptcy, insolvency or

denial of liability of or by Contractor's insurance company shall likewise not exonerate or relieve Contractor from liability.

11.53.4 City reserves the right to review the insurance requirements of this **Article XI** during the effective period of this Contract and to adjust insurance coverage and insurance limits when deemed necessary and prudent by City's Risk Management Division, based upon changes in statutory law, court decisions or the claims history of Contractor and Subcontractors. Contractor agrees to make any reasonable request for deletion, revision or modification of particular policy terms, conditions, limitations or exclusions, except where policy provisions are established by law or regulation binding upon either Party to this Contract or upon the underwriter of any such policy provisions. Upon request by City, Contractor shall exercise reasonable efforts to accomplish such changes in policy coverage.

11.53.5 No special payments shall be made for any insurance policies that Contractor and Subcontractors are required to carry. Except as provided in **Section 11.5.3.4** herein, all amounts payable regarding the insurance policies required under the Contract Documents are included in the Contract Sum.

11.53.6 Any insurance policies required under this **Article XI** may be written in combination with any of the other policies, where legally permitted, but none of the specified limits neither may be lowered or otherwise negatively impacted by doing so, nor may any of the requirements or special provisions of this **Article XI** be limited or circumvented by doing so.

ARTICLE XII. INSPECTING, UNCOVERING AND CORRECTING OF WORK

121 INSPECTING WORK. City and Design Consultant shall have authority to reject Work that does not conform to the Contract Documents. Whenever City or Design Consultant considers it necessary or advisable, City and/or Design Consultant shall have authority to require inspection or testing of the Work in accordance with this **Article XII**, whether or not such Work is fabricated, installed or completed.

122 UNCOVERING WORK

12.2.1 If a portion of the Work is covered, concealed and/or obstructed, contrary to City's or Design Consultant's requirements specifically expressed in the Contract Documents, it must be uncovered for City's or Design Consultant's inspection and properly be replaced at Contractor's expense without any change in the Contract Time or Sum.

12.2.2 If a portion of the Work has been covered, concealed and/or obstructed and Design Consultant or City has not inspected the Work prior to its being covered, concealed and/or obstructed, City and Design Consultant retain the right to inspect such Work and, when directed by City, Contractor shall uncover it. If said Work is found to be in accordance with the Contract Documents, the costs for uncovering and replacement shall, by appropriate Change Order, be paid by City. If such Work uncovered is found to not be in accordance with the Contract Documents, Contractor shall pay all costs associated with the uncovering, correction and replacement of the Work, unless the condition found was caused by City or City's separate contractor, in which event City shall be responsible for payment of actual costs incurred by Contractor.

123 CORRECTING WORK

12.3.1 Contractor promptly shall correct any Work rejected by City or Design Consultant as failing to conform to the requirements of the Contract Documents, whether inspected before or after Substantial

Completion and whether or not fabricated, installed or completed. Contractor shall bear costs of correcting such rejected Work, along with all costs for additional testing, inspections and compensation for Design Consultant's services and expenses made necessary thereby.

- 12.3.2 In addition to Contractor's warranty obligations, if any of the Work is found to be defective or nonconforming with the requirements of the Contract Documents, including, but not limited to these General Conditions, Contractor shall correct it promptly after receipt of written notice from City or Design Consultant to correct unless City previously has given Contractor a written acceptance or waiver of the defect or nonconformity. Contractor's obligation to correct defective or nonconforming Work remains in effect for:
- 12.3.2.1 one (1) year after the date of Substantial Completion of the Work or designated portion of the Work;
 - 12.3.2.2 one (1) year after the date for commencement of warranties established by agreement in connection with partial occupancy under **Section 9.8** hereto; or
 - 12.3.2.3 the stipulated duration of any applicable special warranty required by the Contract Documents.
- 12.3.3 The one (1) year period, described in **Section 12.3.2.1**, **Section 12.3.2.2** and **Section 12.3.2.3** herein, shall be extended, with respect to portions of the Work first performed after Substantial Completion, by the period of time between Substantial Completion and the actual completion of the Work.
- 12.3.4 The obligations of Contractor under **Sections 3.5 and 3.18** herein and this **Section 12.3** shall survive final acceptance of the Work and termination of this Contract. City shall give notice to Contractor promptly after discovery of a defective or nonconforming condition in the Work. The one (1) year period stated in this **Section 12.3** does not limit the ability of City to require Contractor to correct latent defects or nonconformities in the Work, which defects or nonconformities could not have been discovered through reasonable diligence by City or Design Consultant at the time the Work was performed or at the time of inspection for certification of Substantial Completion or Final Completion. The one (1) year period also does not relieve Contractor from liability for any defects or deficiencies in the Work that may be discovered after the expiration of the one (1) year correction period.
- 12.3.5 Contractor shall remove from the Project Site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by Contractor nor accepted by City.
- 12.3.6 If Contractor fails to correct any defective or nonconforming Work within what City deems a reasonable time after City or Design Consultant gives written notice of rejection to Contractor, City may correct the defective or nonconforming Work in accordance with this **Section 12.3**. If Contractor promptly does not proceed with correction of any defective or nonconforming Work within a reasonable time fixed by written notice from City or Design Consultant, City may remove or replace the defective or nonconforming Work and store the salvageable materials or equipment at Contractor's expense. If Contractor does not pay the costs of removal and storage within ten (10) calendar days after written notice by City or Design Consultant, City may, upon ten (10) additional calendar days written notice, sell the materials and equipment at auction or at private sale and shall account to Contractor for the proceeds, after deducting all costs and damages that should have been borne by Contractor to correct the defective work, including all compensation for Design Consultant's services and expenses made necessary as a result of the sale, removal and storage. If the proceeds of sale do not cover the costs that Contractor should have borne, the Contract Sum shall be reduced by the deficiency. If payments due to Contractor then or thereafter are not sufficient to cover the deficiency, Contractor shall pay the

difference to City.

- 12.3.7 Contractor shall bear the cost of correcting destroyed or damaged construction of City or City's separate contractors, whether the construction is completed or partially completed, caused by Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.
- 12.3.8 Nothing contained in this **Section 12.3** shall be construed to establish a period of limitation with respect to other obligations which Contractor might have under the Contract Documents. The establishment of the one (1) year time period, as described in **Section 12.3.2** relates only to the specific obligation of Contractor to correct the Work and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced or to the time within which proceedings may be commenced to establish Contractor's liability with respect to Contractor's obligations other than specifically to correct the Work.
- 12.3.9 Any Work repaired or replaced, pursuant to this **Article XII**, shall be subject to the provisions of **Article XII** to the same extent as Work originally performed or installed.
- 12.4 ACCEPTANCE OF NONCONFORMING WORK.** City may, in City's sole discretion, accept Work that is not in accordance with the requirements of the Contract Documents instead of requiring its removal and correction. Upon that occurrence, the Contract Sum shall be reduced as appropriate and equitable, as solely determined by City. Any adjustment shall be accomplished whether or not final payment has been made.

ARTICLE XIII. COMPLETION OF THE CONTRACT; TERMINATION; TEMPORARY SUSPENSION

- 13.1 FINAL COMPLETION OF CONTRACT.** The Contract shall be considered completed, except as provided in any warranty or maintenance stipulations, bond or by law, when all the Work has been finally completed, a final inspection is made by City and Design Consultant and final acceptance and final payment is made by City.
- 13.2 WARRANTY FULFILLMENT.** Prior to the expiration of the specified warranty period provided for in the Contract Documents, City or Design Consultant shall make a detailed inspection of the Work and shall advise Contractor and may advise Contractor's Surety of the items that require correction. City or Design Consultant shall make a subsequent inspection and, if the corrections have been properly performed, City shall issue a letter of release on the maintenance obligations to Contractor. If, for any reason, Contractor has not made the required corrections before the expiration of the warranty period, the warranty provisions as provided for in the Contract Documents shall remain in effect until the corrections have properly been performed and a letter of release from City to Contractor is issued.

13.3 TERMINATION BY CITY FOR CAUSE

- 13.3.1 Notwithstanding any other provision of these General Conditions, the Work or any portion of the Work may be terminated immediately by City for any good cause after giving seven (7) calendar days advance written notice and an opportunity to cure to Contractor, including but not limited to the following causes:
- 13.3.1.1 Failure or refusal of Contractor to start the Work within ten (10) calendar days after the date of the written Notice to Proceed is issued by City to Contractor to commence Work.

- 13.3.1.2 A reasonable belief of City or Design Consultant that the progress of the Work being made by Contractor is insufficient to complete the Work within the specified Contract Time.
- 13.3.1.3 Failure or refusal of Contractor to provide sufficient and proper equipment or construction forces properly to execute the Work in a timely manner.
- 13.3.1.4 A reasonable belief Contractor has abandoned the Work.
- 13.3.1.5 A reasonable belief Contractor has become insolvent, bankrupt, or otherwise is financially unable to carry on the Work.
- 13.3.1.6 Failure or refusal on the part of Contractor to observe any material requirements of the Contract Documents or to comply with any written orders given by City or Design Consultant, as provided for in the Contract Documents.
- 13.3.1.7 Failure or refusal of Contractor promptly to correct any defects in materials or workmanship, or defects of any nature, the correction of which has been directed to Contractor in writing by City or Design Consultant.
- 13.3.1.8 A reasonable belief by City collusion exists or has occurred for the purpose of illegally procuring the Contract or a Subcontractor, or that a fraud is being perpetrated on City in connection with the construction of Work under the Contract.
- 13.3.1.9 Repeated and flagrant violation of safe working procedures or other requirements of the Contract.

1332 When the Work or any portion of the Work is terminated for any of the causes itemized in **Section 13.3.1** herein, or for any other cause except termination for convenience pursuant to **Section 13.3.6** herein, Contractor shall, as of the date specified by City, immediately discontinue the Work or portion of the Work as City shall designate, whereupon the Surety shall, within fifteen (15) calendar days after the written Notice of Termination by City For Cause has been served upon Contractor and the Surety or its authorized agents, assume the obligations of Contractor for the Work or that portion of the Work which City has ordered Contractor to discontinue and Surety may:

- 13.3.2.1 perform the Work with forces employed by the surety;
- 13.3.2.2 with the written consent of City, tender a replacement Contractor to take over and perform the Work, in which event the Surety shall be responsible for and pay the amount of any costs required to be incurred or the completion of the Work that are in excess of the amount of funds remaining under the Contract as of the time of the termination; or
- 13.3.2.3 with the written consent of City, tender and pay to City in settlement the amount of money necessary to finish the balance of uncompleted Work under the Contract, correct existing defective or nonconforming work and compensate City for any other loss sustained as a result of Contractor's default.

In the event of Termination by City For Cause involving **Article 13.3.2.1** and/or **Article 13.3.2.2**, the Surety shall assume Contractor's place in all respects and the amount of funds remaining and unpaid under the Contract shall be paid by City for all Work performed by the Surety or the replacement contractor in accordance with the terms of the Contract Documents, subject to any rights of City to deduct any and all costs, damages (liquidated or actual) City incurred including, but not limited to, any and all additional fees and expenses of Design Consultant and any attorneys' fees City incurs as a result

of Contractor's default and subsequent termination.

- 1333** The balance of the Contract Sum remaining at the time of Contractor's default and subsequent termination shall become due and payable to the Surety as the Work progresses, subject to all of the terms, covenants and conditions of the Contract Documents. If the Surety does not, within the time specified in **Section 13.3.2** herein, exercise its obligation to assume the obligations of the Contract, or that portion of the Work which City has ordered Contractor to discontinue, then City shall have the power to complete the Work by contract or otherwise, as City may deem necessary and elect. Contractor agrees that City shall have the right to:
- (1) take possession of or use any or all of the materials, plant, tools, equipment, supplies and property of every kind, to be provided by Contractor for the purpose of the Work; and
 - (2) procure other tools, equipment, labor and materials for the completion of the Work at Contractor's expense; and
 - (3) charge to the account of Contractor the expenses of completion and labor, materials, tools, equipment, and incidental expenses.
- 1334** All expenses incurred by City to complete the Work shall be deducted by City out of the balance of the Contract Sum remaining unpaid to or unearned by Contractor. Contractor and the Surety shall be liable to City for any costs incurred in excess of the balance of the Contract Sum for the completion and correction of the Work, and for any other costs, damages, expenses (including, but not limited to, additional fees of Design Consultant and attorney's fees) and liquidated or actual damages incurred as a result of the termination.
- 1335** City shall not be required to obtain the lowest bid for the Work of completing the Contract, as described in **Section 13.3.3** herein, but the expenses to be deducted from the Contract Sum shall be the actual cost of such Work and the other damages, as provided in **Section 13.3.3** herein. In case City's costs and damages are less than the sum which would have been payable under the Contract if the Work had been completed by Contractor pursuant to the Contract, then City may pay Contractor (or the Surety, in the event of a complete Termination by City For Cause) the difference, provided that Contractor (or the Surety) shall not be entitled to any claim for damages or for loss of anticipated profits. In case such costs for completion and damages shall exceed the amount which would have been payable under the Contract if the Work had been completed by Contractor pursuant to the Contract, then Contractor and its Surety shall pay the amount of the excess to City immediately upon written notice from City to Contractor and/or the Surety for the excess amount owed. When only a particular part of the Work is being carried on by City, by contract or otherwise under the provisions of this Section, Contractor shall continue the remainder of the Work in conformity with the terms of the Contract and in such manner as not to hinder or interfere with the performance of workers employed and provided by City.
- 1336** **TERMINATION FOR CONVENIENCE.** The right to terminate this Contract for the convenience of City (including, but not limited to, non-appropriation of funding) expressly is retained by City. In the event of a termination for convenience by City, City shall, at least ten (10) calendar days in advance, deliver written notice of the termination for convenience to Contractor. Upon Contractor's receipt of such written notice, Contractor immediately shall cease the performance of the Work and shall take reasonable and appropriate action to secure and protect the Work then in place. Contractor shall then be paid by City, in accordance with the terms and provisions of the Contract Documents, an amount not to exceed the actual labor costs incurred, the actual cost of all materials installed and the actual cost of all materials stored at the Project site or away from the Project site, as approved in writing by City but not yet paid for and which cannot be returned, plus applicable authorized overhead, profit, and actual, reasonable and documented termination costs, if any, paid by Contractor in connection with the Work in place which is completed and in conformance with the Contract Documents up to the date of

termination for convenience, less all amounts previously paid for the Work. No amount ever shall be paid to Contractor for lost or anticipated profits on any part of the Work not performed.

13.4 TEMPORARY SUSPENSION OF THE WORK

134.1 The Work or any portion of the Work may temporarily be suspended by City, for a time period not to exceed ninety (90) calendar days, immediately upon written notice to Contractor for any reason, including, but not limited to:

13.4.1.1 the causes described in **Section 13.3.1.1** through **Section 13.3.1.9** herein;

13.4.1.2 under other provisions in the Contract Documents that require or permit temporary suspension of the Work;

13.4.1.3 situations where the Work is threatened by, contributes to or causes an immediate threat to public health, safety, or security; or

13.4.1.4 other unforeseen conditions or circumstances.

1342 Contractor immediately shall resume the temporarily suspended Work when ordered in writing to do so by City. City shall not, under any circumstances, be liable for any claim of Contractor arising from a temporary suspension due to a cause described in **Section 13.4.1** herein; provided, however, that in the case of a temporary suspension for any of the reasons described under **Section 13.4.1.2** through **Section 13.4.1.4** herein, where Contractor is not a contributing cause of the suspension or where the provision of the Contract Documents in question does not specifically provide that the suspension is at no cost to City, City shall make an equitable adjustment for the following items, provided that a Claim properly is made by Contractor under **Section 4.3** herein:

13.4.2.1 an equitable extension of the Contract Time, not to exceed the actual delay caused by the temporary suspension, as determined by City and Design Consultant;

13.4.2.2 an equitable adjustment to the Contract Sum for the actual, necessary and reasonable costs of properly protecting any Work finished or partially finished during the period of the temporary suspension; provided, however, that no payment of profit and/or authorized overhead shall be allowed on top of these costs; and

13.4.2.3 if it becomes necessary to move equipment from the Project Site and then return it to the Project Site when the Work is ordered to be resumed, an equitable adjustment to the Contract Sum for the actual, necessary and reasonable cost of these moves; provided, however, that no adjustment to the Contract Sum shall be due if said equipment is moved to another Project site of City.

ARTICLE XIV. MISCELLANEOUS PROVISIONS

14.1 GOVERNING LAW; COMPLIANCE WITH LAWS AND REGULATIONS

14.1.1 This Contract shall be governed by the laws and case decisions of the State of Texas, without regard to conflict of law or choice of law principles of Texas or of any other state.

14.1.2 This Contract is entered into subject to and controlled by the Charter and ordinances of the City of Pflugerville and all applicable laws, rules and regulations of the State of Texas and the Government of

the United States of America. Contractor shall, during the performance of the Work, comply with all applicable City of Pflugerville codes and ordinances, as amended, and all applicable State of Texas and Federal laws, rules and regulations, as amended.

14.2 SUCCESSORS AND ASSIGNS. City and Contractor respectively bind themselves, their partners, successors, assigns and legal representatives to the promises, covenants, terms, conditions and obligations contained in the Contract Documents. Contractor shall not assign, transfer or convey its interest or rights in the Contract, in part or as a whole, without the written consent of City. If Contractor attempts to make an assignment, transfer or conveyance without City's written consent, Contractor nevertheless shall remain legally responsible for all obligations under the Contract Documents. City shall not assign any portion of the Contract Sum due or to become due under this Contract without the written consent of Contractor, except where assignment is compelled by court order, other operation of law or the terms of these General Conditions.

14.3 WRITTEN NOTICE. Any notice, payment, statement or demand required or permitted to be given under this Contract by either Party to the other may be effected by personal delivery in writing or by facsimile transmission, email or by mail, postage prepaid, or by overnight delivery to an officer, management level employee or other designated representative of either Party. Mailed or email notices shall be addressed to the Parties at an address designated by each Party, but each Party may change its address by written notice in accordance with this section. Mailed notices shall be deemed received as of three (3) calendar days after mailing.

14.4 RIGHTS AND REMEDIES; NO WAIVER OF RIGHTS BY CITY

14.4.1 The duties and obligations imposed on Contractor by the Contract Documents and the rights and remedies available to City under the Contract Documents shall be in addition to, and not a limitation of, any duties, obligations, rights and remedies otherwise imposed or made available by law.

14.4.2 No action or failure to act by City shall constitute a waiver of a right afforded City under the Contract Documents, nor shall any action or failure to act by City constitute approval of or acquiescence in a breach of the Contract by Contractor, except as may be specifically agreed in writing by Change Order, Amendment or Supplemental Agreement.

14.5 INTEREST. City shall not be liable for interest on any progress or final payment to be made under the Contract Documents, except as may be provided by the applicable provisions of the Prompt Payment Act, Chapter 2251, Texas Government Code, as amended, subject to **Article IX** of these General Conditions.

14.6 INDEPENDENT MATERIALS TESTING AND INSPECTION

In some circumstances, City shall retain, independent of Contractor, the inspection services, the testing of construction materials engineering and the verification testing services necessary for acceptance of the Project by City. The professional services, duties and responsibilities of any independent Consultants shall be described in the agreements between City and those Consultants. The provision of inspection services by City shall be for Quality Assurance and shall not reduce or lessen Contractor's responsibility for the Work or its duty to establish and implement a thorough Quality Control Program to monitor the quality of construction and guard City against defects and deficiencies in the Work, as required herein. Contractor fully and solely is responsible for constructing the Project in strict accordance with the Construction Documents.

14.7 COMPLIANCE WITH CHAPTER 38 OF THE CITY'S CODE OF ORDINANCES.

Contractor acknowledges that this Contract is conditioned upon Contractor's compliance with Chapter 38, Sections 38.01 through 38.07 of the City's Code of Ordinances, all of which are incorporated herein by reference. Contractor hereby certifies that Contractor has fully read and understood the terms and conditions for eligibility to contract with the City pursuant to Chapter 38 of the City's Ordinances and by entering into this Contract hereby certifies that they are in compliance with these requirements.

14.8 VENUE. This Contract is performed in Travis County, Texas, and if legal action is necessary to enforce this Contract, exclusive venue shall lie in Travis County, Texas.

14.9 INDEPENDENT CONTRACTOR. In performing the Work under this Contract, the relationship between City and Contractor is and shall remain an independent contractor. Contractor shall exercise independent judgment in performing the Work and solely is responsible for setting working hours, scheduling and/or prioritizing the Work flow and determining the means and methods of performing the Work, subject only to the requirements of the Contract Documents. No term or provision of this Contract shall be construed as making Contractor an agent, servant or employee of City or making Contractor or any of Contractor's employees, agents or servants eligible for the fringe benefits, such as retirement, insurance and worker's compensation that the City provides to its employees.

14.10 TEXAS GOVERNMENT CODE. The City of Pflugerville may not enter into a contract with a company for goods and services unless the contract contains a written verification from the company that; (i) it does not Boycott Israel; and (ii) will not Boycott Israel during the term of the contract. (Texas Government Code Chapter 2270). By accepting this Contract, Contractor verifies and hereby certifies that it does not Boycott Israel and agrees that during the term of this Contract will not Boycott Israel as that term is defined in the Texas Government Code Section 808.001, as amended.

14.11 GIFTS TO PUBLIC SERVANTS

14.11.1 City may terminate this Contract immediately if Contractor has offered, conferred or agreed to confer any benefit on a City of Pflugerville employee or official that the employee or official is prohibited by law from accepting.

14.11.2 For purposes of this Article, "benefit" means anything reasonably regarded as pecuniary gain or pecuniary advantage, including benefit to any other person in whose welfare the beneficiary has a direct or substantial interest, but does not include a contribution or expenditure made and reported in accordance with law.

14.11.3 Notwithstanding any other legal remedies, City may require Contractor to remove any employee of Contractor, a Subcontractor or any employee of a Subcontractor from the Project who has violated the restrictions of this **Article XIV** or any similar State or Federal law and City may obtain reimbursement for any expenditures made to Contractor as a result of an improper offer, an agreement to confer or the conferring of a benefit to a City of Pflugerville employee or official.

ARTICLE XV. AUDIT

15.1 RIGHT TO AUDIT CONTRACTOR'S RECORDS. By execution of the Contract, Contractor grants City the right to audit, examine, inspect and/or copy, at City's election at all reasonable times during the term of this Contract and for a period of four (4) years following the completion or termination of the Work, all of Contractor's written and electronically stored records and billings relating to the performance of the Work under the Contract Documents. The audit, examination or inspection may be performed by a City designee, which may include its internal auditors or an outside representative engaged by City. Contractor agrees to retain its records for a minimum of four (4) years

following termination of the Contract, unless there is an ongoing dispute under the Contract, then, such retention period shall extend until final resolution of the dispute, with full access allowed to authorized representatives of City upon request, for purposes of evaluating compliance with this and other provisions of the Contract.

- 15.1.1 As used in these General Conditions, "Contractor written and electronically stored records" or "Contractor's records" shall include any and all information, materials and data of every kind and character generated as a result of the work under this Contract. Example of Contractor written and electronically stores records include, but are not limited to: accounting data and reports, billings, books, general ledgers, cost ledgers, invoices, production sheets, documents, correspondences, meeting notes, subscriptions, agreements, purchase orders, leases, contracts, commitments, arrangements, notes, daily diaries, reports, drawings, receipts, vouchers, memoranda, time sheets, payroll records, policies, procedures, Subcontractor agreements, Supplier agreements, rental equipment proposals, federal and state tax filings for any issue in question, along with any and all other agreements, sources of information and matters that may, in City's sole judgment, have any bearing on or pertain to any matters, rights, duties or obligations under or covered by any Contract Documents.
- 15.1.2 City agrees that it shall exercise the right to audit, examine or inspect Contractor's records only during regular business hours. Contractor agrees to allow City and/or City's designee access to all of the Contractor's Records, Contractor's facilities and current or former employees of Contractor, deemed necessary by City or its designee(s), to perform such audit, inspection or examination. Contractor also agrees to provide adequate and appropriate work space necessary for City or its designees to conduct such audits, inspections or examinations.
- 15.1.3 Contractor shall include this **Article XV** in any Subcontractor, supplier or vendor contract, for the benefit of the City.

ARTICLE XVI. ATTORNEY FEES

The Parties hereto expressly agree, in the event of litigation, the prevailing Party shall be entitled to payment of reasonable attorneys' fees and costs as may be recoverable, pursuant to the Texas Civil Practice and Remedies Code Chapter 38, Texas Local Government Code §271.153, the Prompt Payment Act, common law or any other provision of applicable federal, state or local law for payment of attorney's fees.

End of General Conditions. The remainder of this page left blank intentionally.

**SPECIAL CONDITIONS FOR CITY OF PFLUGERVILLE CIP CONSTRUCTION
CONTRACTS**

[Insert as Applicable]

(Remainder of this page intentionally left blank)

PREVAILING WAGE RATES DETERMINATION

The City of Pflugerville has adopted the prevailing wage rates for Travis County as determined by the United States Department of Labor in accordance with the Davis-Bacon Act and its subsequent amendments. The determination of prevailing wages is not to be construed to prohibit the payment of more than the rate named. Under no condition may any laborer, workman, or mechanic employed on this job be paid less than the minimum wage scale.

The contractor must comply with all applicable state and federal laws, including but not limited to, laws concerned with labor, equal employment opportunity, safety, and minimum wage. The contractor must post the applicable Prevailing Wage Rate Determination in a prominent and easily accessible place at the project site. To ensure that the contractor, and/or subcontractors are paying the posted specified rates to all classifications of workmen, mechanics and laborers, the City reserves the right to perform "spot labor interviews" and examine contractor payroll information.

Pursuant to Chapter 2258 of the Texas Government Code, the City will take notice of complaints of all violations of this chapter committed in the execution of the contract and withhold money forfeited or required to be withheld under Chapter 2258 from the payments to the contractor under the contract, except that the City may not withhold money from other than the final payment without a determination by the City that there was good cause to believe that the contractor has violated this chapter.

"General Decision Number: TX20250007 01/03/2025

Superseded General Decision Number: TX20240007

State: Texas

Construction Types: Heavy and Highway

Counties: Atascosa, Bandera, Bastrop, Bell, Bexar, Brazos, Burleson, Caldwell, Comal, Coryell, Guadalupe, Hays, Kendall, Lampasas, McLennan, Medina, Robertson, Travis, Williamson and Wilson Counties in Texas.

HEAVY (excluding tunnels and dams, not to be used for work on Sewage or Water Treatment Plants or Lift / Pump Stations in Bell, Coryell, McClennon and Williamson Counties) and HIGHWAY Construction Projects

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least \$17.75 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2025.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least \$13.30 per hour (or the applicable wage rate listed on this wage determination,

	if it is higher) for all hours spent performing on that contract in 2025.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at <http://www.dol.gov/whd/govcontracts>.

Modification Number	Publication Date
0	01/03/2025

SUTX2011-006 08/03/2011

	Rates	Fringes
CEMENT MASON/CONCRETE FINISHER (Paving and Structures).....	\$ 12.56	**
ELECTRICIAN.....	\$ 26.35	
FORM BUILDER/FORM SETTER Paving & Curb.....	\$ 12.94	**
Structures.....	\$ 12.87	**
LABORER Asphalt Raker.....	\$ 12.12	**
Flagger.....	\$ 9.45	**
Laborer, Common.....	\$ 10.50	**
Laborer, Utility.....	\$ 12.27	**
Pipelayer.....	\$ 12.79	**
Work Zone Barricade Servicer.....	\$ 11.85	**
PAINTER (Structures).....	\$ 18.34	
POWER EQUIPMENT OPERATOR: Agricultural Tractor.....	\$ 12.69	**
Asphalt Distributor.....	\$ 15.55	**
Asphalt Paving Machine.....	\$ 14.36	**
Boom Truck.....	\$ 18.36	

Broom or Sweeper.....	\$ 11.04	**
Concrete Pavement		
Finishing Machine.....	\$ 15.48	**
Crane, Hydraulic 80 tons		
or less.....	\$ 18.36	
Crane, Lattice Boom 80		
tons or less.....	\$ 15.87	**
Crane, Lattice Boom over		
80 tons.....	\$ 19.38	
Crawler Tractor.....	\$ 15.67	**
Directional Drilling		
Locator.....	\$ 11.67	**
Directional Drilling		
Operator.....	\$ 17.24	**
Excavator 50,000 lbs or		
Less.....	\$ 12.88	**
Excavator over 50,000 lbs...	\$ 17.71	**
Foundation Drill, Truck		
Mounted.....	\$ 16.93	**
Front End Loader, 3 CY or		
Less.....	\$ 13.04	**
Front End Loader, Over 3 CY.	\$ 13.21	**
Loader/Backhoe.....	\$ 14.12	**
Mechanic.....	\$ 17.10	**
Milling Machine.....	\$ 14.18	**
Motor Grader, Fine Grade....	\$ 18.51	
Motor Grader, Rough.....	\$ 14.63	**
Pavement Marking Machine....	\$ 19.17	
Reclaimer/Pulverizer.....	\$ 12.88	**
Roller, Asphalt.....	\$ 12.78	**
Roller, Other.....	\$ 10.50	**
Scraper.....	\$ 12.27	**
Spreader Box.....	\$ 14.04	**
Trenching Machine, Heavy....	\$ 18.48	

Servicer.....\$ 14.51 **

Steel Worker

Reinforcing.....	\$ 14.00	**
Structural.....	\$ 19.29	

TRAFFIC SIGNALIZATION:

Traffic Signal Installation

Traffic Signal/Light Pole		
Worker.....	\$ 16.00	**

TRUCK DRIVER

Lowboy-Float.....	\$ 15.66	**
Off Road Hauler.....	\$ 11.88	**
Single Axle.....	\$ 11.79	**

Single or Tandem Axle Dump
Truck.....\$ 11.68 **
Tandem Axle Tractor w/Semi
Trailer.....\$ 12.81 **

WELDER.....\$ 15.97 **

WELDERS - Receive rate prescribed for craft performing
operation to which welding is incidental.

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** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 (\$17.75) or 13658 (\$13.30). Please see the Note at the top of the wage determination for more information. Please also note that the minimum wage requirements of Executive Order 14026 are not currently being enforced as to any contract or subcontract to which the states of Texas, Louisiana, or Mississippi, including their agencies, are a party.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at <https://www.dol.gov/agencies/whd/government-contracts>.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

The body of each wage determination lists the classifications

and wage rates that have been found to be prevailing for the type(s) of construction and geographic area covered by the wage determination. The classifications are listed in alphabetical order under rate identifiers indicating whether the particular rate is a union rate (current union negotiated rate), a survey rate, a weighted union average rate, a state adopted rate, or a supplemental classification rate.

Union Rate Identifiers

A four-letter identifier beginning with characters other than ""SU"", ""UAVG"", ?SA?, or ?SC? denotes that a union rate was prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2024. PLUM is an identifier of the union whose collectively bargained rate prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2024 in the example, is the effective date of the most current negotiated rate.

Union prevailing wage rates are updated to reflect all changes over time that are reported to WHD in the rates in the collective bargaining agreement (CBA) governing the classification.

Union Average Rate Identifiers

The UAVG identifier indicates that no single rate prevailed for those classifications, but that 100% of the data reported for the classifications reflected union rates. EXAMPLE: UAVG-OH-0010 01/01/2024. UAVG indicates that the rate is a weighted union average rate. OH indicates the State of Ohio. The next number, 0010 in the example, is an internal number used in producing the wage determination. The date, 01/01/2024 in the example, indicates the date the wage determination was updated to reflect the most current union average rate.

A UAVG rate will be updated once a year, usually in January, to reflect a weighted average of the current rates in the collective bargaining agreements on which the rate is based.

Survey Rate Identifiers

The ""SU"" identifier indicates that either a single non-union rate prevailed (as defined in 29 CFR 1.2) for this classification in the survey or that the rate was derived by computing a weighted average rate based on all the rates

reported in the survey for that classification. As a weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SUFL2022-007 6/27/2024. SU indicates the rate is a single non-union prevailing rate or a weighted average of survey data for that classification. FL indicates the State of Florida. 2022 is the year of the survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 6/27/2024 in the example, indicates the survey completion date for the classifications and rates under that identifier.

?SU? wage rates typically remain in effect until a new survey is conducted. However, the Wage and Hour Division (WHD) has the discretion to update such rates under 29 CFR 1.6(c)(1).

State Adopted Rate Identifiers

The ""SA"" identifier indicates that the classifications and prevailing wage rates set by a state (or local) government were adopted under 29 C.F.R 1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 01/03/2024 in the example, reflects the date on which the classifications and rates under the ?SA? identifier took effect under state law in the state from which the rates were adopted.

WAGE DETERMINATION APPEALS PROCESS

1) Has there been an initial decision in the matter? This can be:

- a) a survey underlying a wage determination
- b) an existing published wage determination
- c) an initial WHD letter setting forth a position on a wage determination matter
- d) an initial conformance (additional classification and rate) determination

On survey related matters, initial contact, including requests for summaries of surveys, should be directed to the WHD Branch of Wage Surveys. Requests can be submitted via email to davisbaconinfo@dol.gov or by mail to:

Branch of Wage Surveys
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

Regarding any other wage determination matter such as conformance decisions, requests for initial decisions should be directed to the WHD Branch of Construction Wage Determinations. Requests can be submitted via email to BCWD-Office@dol.gov or by mail to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2) If an initial decision has been issued, then any interested party (those affected by the action) that disagrees with the decision can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Requests for review and reconsideration can be submitted via email to dba.reconsideration@dol.gov or by mail to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210.

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END OF GENERAL DECISION"

TECHNICAL SPECIFICATIONS

SECTION CIP1 – DEFINITION OF TERMS

CIP1.01

DEFINITIONS

- A. Wherever in these specifications or in other contract documents, the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:
1. CITY - The City of Pflugerville, party of the First Part.
 2. COUNCIL - The Pflugerville City Council.
 3. COUNTY - A political Subdivision of the State.
 4. ENGINEER- Representative of the City and/or “Design Consultant” as provided in the General Conditions for Pflugerville Capital Improvement Projects.
*ENGINEER - Representative of the Contractor or the Developer.
 5. INSPECTOR - The authorized representative of the City assigned to inspect any or all parts of the work and the materials to be used therein.
 6. CONTRACTOR - The individual, firm or corporation or any combination thereof, Party of the Second Part, with which the contract is made by the City, Developer or Public Cooperation.
 7. SUPERINTENDENT - The representative of the Contractor authorized to receive and fulfill instructions from the Engineer or representative of the City, and who shall supervise and direct the construction.
 8. PAVEMENT DESIGN MANUAL - Texas Department of Transportation manual outlining procedure to be followed in the design and control of asphaltic concrete and portland cement concrete mixes for structures and pavements.
 9. MANUAL OF TESTING PROCEDURES - Texas Department of Transportation Materials and Tests Division manual outlining testing methods and procedures.
 10. PLANS - The drawings approved by the City, or true reproductions thereof, which show the location, character, dimensions, and details of the work and which are a part of the contract. Plans and specifications to be prepared by a Professional Engineer registered in the State of Texas.
 11. SPECIFICATIONS - The directions, provisions and requirements contained herein or in the Special Provisions, supplemented by such “Special Provisions or Standards” as may be issued or made pertaining to the method and manner or performing the work or qualities of materials to be furnished. Where the phrases “or directed by the City”, “ordered by the City”, or “to the satisfaction of the City” occur, it is to be understood that the directions, orders, or instructions of which they relate are within the limitations of, and authorized by the contract. “Special Provisions” will cover work pertaining to a particular project included in the proposal but not covered by the specifications. Where reference is made to specifications of ASTM, AWWA, AASHTO or Bulletins and Manuals of the Texas Department of Transportation it shall be construed to mean the latest standard or tentative standard in effect on the date of the proposal.
 12. RIGHT OF WAY - The land provided for a highway or street, owned by the City of Pflugerville or the municipality in which the highway or street is in.
 13. ROADWAY - The portion of the highway or street within the limits of construction.
 14. ROADBED - The graded portion of the roadway between the intersection of top and side slopes upon which the base course, surface course, shoulders and median are constructed.
 15. SUBGRADE - That portion of the roadbed upon which the subbase, base, or pavement structure is to be placed.

16. BRIDGES - Structures of over 20-foot span measured from face to face of abutments, or in case of copings, from face to face of copings, and multiple span structures of over 20-foot length, measured between inside of end walls along the centerline of the roadbed.
17. CULVERTS - All drainage structures not defined as bridges.
18. TEMPORARY STRUCTURES - All temporary bridges and structures required to maintain traffic during the construction of the work.
19. SUBSTRUCTURE - That part of the structure below the bridge seats or below the springing lines of arches. Parapets, back walls and wing walls of abutments shall be considered as parts of the substructure.
20. SUPERSTRUCTURE - The part of the structure above the bridge seats or above the springing lines of arches.
21. THE WORK - The work shall include the furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract; or, if applicable, the Work as defined in the General Conditions for Pflugerville Capital Improvement Projects.
22. PROJECT - The specific section or sections of the highway or street together with all appurtenances and construction to be performed thereon under the contract; or, if applicable, the Project as defined in the General Conditions for Pflugerville Capital Improvement Projects.
23. ASTM - American Society for Testing Materials.
24. AASHTO - American Association of State Highway and Transportation Officials.
25. ANSI - American National Standards Institute.
26. API - American Petroleum Institute.
27. UL - Underwriters Laboratory, Inc.
28. SCREENS AND SIEVES - As defined by the ASTM.
29. HIGHWAY, STREET OR ROAD - A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way. Recommended usage in urban areas-highway or road.
30. ARTERIAL HIGHWAY OR STREET - A general term denoting a highway or street primarily for through traffic, usually on a continuous route.
31. MAJOR STREET OR MAJOR HIGHWAY - An arterial highway or street with intersections at grade and direct access to abutting property, and on which geometric design and traffic control measures are used to expedite the safe movement of through traffic.
32. THROUGH STREET OR THROUGH HIGHWAY - Every highway, street, or portion thereof at the entrance to which vehicular traffic from intersecting highways or streets is required by law to stop before entering or crossing the same and when stop signs are erected.
33. LOCAL STREET OR LOCAL ROAD - A street or road primarily for access to residence, business, or other abutting property.
34. COMPETITIVE SEALED PROPOSALS - A procurement method by which a governmental entity requests proposals, ranks the offerors, negotiates as prescribed, and then contracts with a general contractor for the construction, rehabilitation, alteration, or repair of a facility.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP2 - ABBREVIATIONS

CIP2.01

SCOPE

A. Whenever in these Contract Documents or Specifications the following abbreviations are used, the intent and meaning shall be interpreted as follows:

1.	AA	Aluminum Association
2.	AAMA	Architectural Aluminum Manufacturers' Association
3.	AASHTO	American Association of State Highway and Transportation Officials
4.	ACI	American Concrete Institute
5.	AFBMA	Anti-Friction Bearing Manufacturers' Association
6.	AGA	American Gas Association
7.	AGMA	American Gear Manufacturers' Association
8.	AISC	American Institute of Steel Construction
9.	AISI	American Iron and Steel Institute
10.	AITC	American Institute of Timber Construction
11.	AMCA	Air Moving and Conditioning Association
12.	ANSI	American National Standards Institute
13.	APA	American Plywood Association
14.	API	American Petroleum Institute
15.	AREA	American Railway Engineering Association
16.	ASAE	American Society of Agricultural Engineers
17.	ASCE	American Society of Civil Engineers
18.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
19.	ASME	American Society of Mechanical Engineers
20.	ASTM	American Society of Testing and Materials
21.	AWI	Architectural Woodwork Institute
22.	AWPA	American Wood Preservers' Association
23.	AWPB	American Wood Preservers' Bureau
24.	AWS	American Welding Society
25.	AWWA	American Water Works Association
26.	BHMA	Builders' Hardware Manufacturers' Association
27.	CBMA	Certified Ballast Manufacturers' Association
28.	CDA	Copper Development Association
29.	CISPI	Cast Iron Soil Pipe Institute
30.	CMAA	Crane Manufacturers' Association of America
31.	CRSI	Concrete Reinforcing Steel Institute
32.	Fed. Spec.	Federal Specifications

33.	HI	Hydraulic Institute
34.	HMI	Hoist Manufacturers' Institute
35.	ICBO	International Conference of Building Officials
36.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
37.	IPCEA	Insulated Power Cable Engineer's Association
38.	MMA	Monorail Manufacturers' Association
39.	NACE	National Association of Coatings Engineers
40.	NBMA	National Builders' Hardware Association
41.	NEC	National Electrical Code
42.	NEMA	National Electrical Manufacturers' Association
43.	NESC	National Electric Safety Code
44.	NFPA	National Fire Protection Association
45.	NLMA	National Lumber Manufacturers' Association
46.	NWMA	National Woodwork Manufacturers' Association
47.	OECI	Overhead Electrical Crane Institute
48.	OSHA	Occupational Safety and Health Act (both Federal & State)
49.	PS	Product Standards Sections - U.S. Department of Commerce
50.	RMA	Rubber Manufacturers' Association
51.	SAE	Society of Automotive Engineers
52.	SSPC	Steel Structures Painting Council
53.	TCA	Tile Council of America
54.	TxDOT	Texas Department of Transportation
55.	TEMA	Tubular Exchanger Manufacturers' Association
56.	UBC	Uniform Building Code
57.	UL	Underwriter's Laboratories, Inc.
58.	WWPA	Western Wood Products Association

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP3 – SUMMARY OF WORK

*** For Projects Contracted by the City of Pflugerville for Capital Improvement Projects ***

CIP3.01 SCOPE OF WORK

- A. This specification covers the requirements for constructing Package 1A Street Reconstruction Project as shown on the construction Plans and specified herein.
- B. The Work is located within the City of Pflugerville as shown on the Location Map included in the Plans.
- C. The Work includes, but is not necessarily limited to, the following:
 - 1. 16,235 linear feet pavement rehabilitation for Kay Lane, Mountain View Drive, Plumbago Drive, W. Custers Creek Bend, and 10th Street. Removal and replacement of 50+ curb ramps, 350 LF curbs and gutters, 1650 LF ribbon curbs, 300 SF valley gutters, 2300 SF driveways, and 1010 SF sidewalks

CIP3.02 WORK SEQUENCE

- A. Perform work in sequence as agreed upon at the pre-construction conference.

CIP3.03 PROGRESS OF THE WORK

- A. The Work shall be started within 10 days following the effective date of the Notice to Proceed, and the Work shall be executed with such progress as may be required to prevent any delay to the general completion of the project. The Work shall be executed at such times and in or on such parts of the project, and with such personnel, materials, and equipment to assure completion of the Work in the time established by the Agreement.
- B. If the Contractor for his convenience and at his own expense, should desire to carry on his work at night or outside regular hours, he shall submit a written approval request to the City and he shall allow ample time for satisfactory arrangements to be made for inspecting the work in progress. The Contractor shall pay the expenses for extra inspection required for work outside regular hours. Normal working hours for this purpose are Monday through Friday, 7:00 a.m. to 6:00 p.m. The Contractor shall light the different parts of the Project as required to comply with all applicable Federal and State regulations and with all applicable requirements of the City of Pflugerville.

CIP3.04 CONSTRUCTION SCHEDULE

- A. The Contractor shall, in accordance with the General Conditions, provide and submit to the City for approval, the Schedule for the project. A complete updated schedule shall be submitted with monthly pay requests. The Schedule shall account for all the work of the Contractor and his Subcontractors and suppliers. The Schedule shall fully comply with the requirements of the General Conditions.
- B. While the Contractor bears full responsibility for scheduling all phases and stages of the Work to ensure its successful prosecution and completion within the time specified in accordance with all provisions of these Specifications, the Contractor is specifically required to complete fully or complete such stages of work to enable his Subcontractors and suppliers to complete their work within the respective times specified.
- C. If the City determines that operations are falling behind schedule at any time during the construction period, the City may require the Contractor to add to his plant, equipment and/or construction forces, including increases in working hours, in such quantities as are required to bring operations back on schedule, in accordance with the General Conditions. Upon receipt of written communication from the City requiring such addition, the Contractor shall furnish same at no additional cost to the City.

PRECONSTRUCTION CONFERENCE

- A. A pre-construction conference shall be held as soon as possible after issuance of Notice of Award of Contract and before Work is started. The conference will be held at a location selected by the City. The conference will be attended by:
1. Contractor's Office Representative.
 2. Contractor's General Superintendent.
 3. Any subcontractors' or suppliers' representatives whom the Contractor may desire to invite or the City may request.
 4. Design Consultant's Representatives.
 5. City's Representatives.
 6. Such other individuals that the City may invite.
- B. Format may include, but not be limited to, the following subjects and others provided in the Contract Documents:
1. Verification of required bonds and insurance certifications.
 2. Liquidated damages.
 3. Shop drawing submittal and approval procedure.
 4. Chain of command, direction of correspondence, and coordinating responsibility between Contractors.
 5. Schedule of periodic job meetings for all involved.
 6. Introduction of the key project personnel.
 7. Equal opportunity requirements.
 8. Laboratory testing of material requirements.
 9. Inventory of material stored on site provisions.
 10. Progress estimate and payment procedure.
 11. Discussion of Contractor's Safety program.
 12. Scheduled plan for work requiring interruption of existing operations.
 13. Review of the construction Plans and Specifications.
 14. Discussion of Contractor's storage facilities for the Project.
- C. The City's Representative will preside at the conference, prepare the minutes of the meeting and distribute copies of same to all participants who so request by fully completing the attendance form to be circulated at the beginning of the conference.

CONSTRUCTION MEETINGS

- A. Periodic Construction meetings shall be held at intervals designated by the City, generally weekly to review the progress at the project, submittals, upcoming activities, pay requests, etc. The Contractor is expected to have at least the project Superintendent present for all meetings. Attendance at the meetings

shall not be directly paid for but shall be considered subsidiary to the items of the Contract.

- B. In the event the Contractor is 30 minutes late or more or fails to attend a Construction meeting without 48 hours prior notice, the Contractor shall be billed the time for the Design Consultant(s) to represent the City at \$150.00 per hour up to one (1) hour.

CIP3.07

COORDINATION WITH CITY'S OPERATIONS AND EXISTING FACILITIES

- A. Several parts of the proposed Work under this Contract may connect with or into existing facilities. The Contractor shall plan carefully the schedule of that portion of the Work which will affect the existing facilities. Such plans and schedules shall be subject to the approval of the City of Pflugerville.
- B. Work which requires shutdown or in any way impedes the operations of existing facilities shall be closely coordinated with the City of Pflugerville. A minimum of 48 hours written notice shall be given to the City of Pflugerville.
- C. Immediately after the award of a Contract for this Project, the Contractor shall outline and submit a scheduled plan for installation of the work, which requires interruption of operations.

CIP3.08

CONTRACTOR'S USE OF PREMISES

- A. Contractor shall limit the use of the premises for his/her work and coordinate use of the premises with the City to allow for:
 - 1. Work by other Contractors.
 - 2. Public use.
- B. Contractor shall assume full responsibility for security of all materials and equipment stored on the site.
- C. If directed by the City, move any stored items, which interfere with operations of the City, other contractors, or the public.
- D. Obtain and pay for use of additional storage or work areas at no additional cost to the City if needed to perform the Work.
- E. Contractor shall submit to the City for approval a plan of operations, designating proposed areas of the property to be used for his operations, material storage, equipment storage, employee's parking, offices and shops. The area shall affect minimal interference with the present operations.
- F. Any damage to existing facilities, including contamination, which may be caused by Contractor's personnel, callers, visitors, materials or equipment, shall be repaired or corrected at the sole expense of the Contractor.
- G. Any fence that is damaged or removed by the Contractor will be replaced at the Contractor's expense in like kind, and to the satisfaction of the City.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP4 – SITE CONDITIONS AND USE

CIP4.01 SCOPE OF WORK

- A. This specification covers the requirements for investigation and verification of site conditions for the Project, and also provides requirements for Site usage.

CIP4.02 SUBSURFACE INFORMATION

- A. No subsurface investigations have been made by the City unless otherwise indicated in the Contract Documents and being subject to the same. The Bidder / Contractor shall be responsible for any subsurface explorations and tests deemed necessary.
- B. No test borings have been made by the City to indicate subsurface materials unless otherwise indicated in the Contract Documents and being subject to the same.

CIP4.03 SITE INVESTIGATION AND REPRESENTATION

- A. The Bidder / Contractor acknowledges that Contractor has satisfied itself as to the nature and location of the Work; the general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river/stream stages, or similar physical conditions at the site; the conformation and conditions of the ground; the character of equipment and facilities needed preliminary to and during the prosecution of the Work and all other matters which can in any way affect the Work or the cost thereof under this Contract.
- B. The Contractor further acknowledges that Contractor has satisfied itself as to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site and from evaluating information derived from exploratory work, if any, that has been done by the City as presented in the geotechnical report, as well as from information presented herein as a part of these Contract Documents. Any failure by the Contractor to acquaint itself with all the available information will not relieve Contractor from responsibility for properly estimating the difficulty or cost of successfully performing the work. Neither the City nor the Engineer (which includes Design Consultant throughout these Technical Specifications if included within a City Capital Improvement Project Contract) assume responsibility for any conclusion or interpretation made by the Contractor on the basis of the information made available by the City or the Engineer, nor accept responsibility occasioned by any information so provided in excess of that established by the Contract Documents, if applicable.
- C. Existing ground profiles shown on the Plans were plotted from field surveys.

CIP4.04 RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

- A. Known utilities and structures adjacent to or encountered in the work are shown on the Plans. The locations shown are taken from existing records and the best information available from existing plans; however, it is expected that there may be some discrepancies and omissions in the locations and quantities of utilities and structures shown. Those shown are for the convenience of the Contractor only, and no responsibility is assumed by either the City or the Engineer for their accuracy or completeness.
- B. Neither the City nor its officers or agents shall be responsible to the Contractor for damages as a result of the Contractor's failure to protect utilities encountered in the work.
- C. The Contractor shall at all times provide unobstructed access to fire hydrants and structures as per Fire Code, underground conduit, manholes, and water or gas valve boxes.

- D. Where the Contractor's operations could cause damage which might result in considerable expense, loss, or inconvenience when his operations are adjacent to or near railway, telegraph, telephone, television, power, oil, gas, water, sewer, irrigation, or other systems, no operations shall be commenced until the Contractor has made all arrangements necessary for the protection of these utilities and services.
- E. The Contractor shall notify all utility offices that are affected by the construction operation at least 15 days in advance of commencing construction operations. The Contractor shall not expose any utility without first obtaining permission from the affected agency. Once permission has been granted, locate and, if necessary, expose and provide temporary support for all existing underground utilities in advance of operations.
- F. The Contractor shall be solely and directly responsible to the City and operators of such utility properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage that may result from the construction operations under this Contract.
- G. In the event of interruption to domestic water, sewer, storm drain, or other utility services as a result of accidental breakage due to construction operations, the Contractor shall promptly notify the proper authority and cooperate with said authority in restoration of service as promptly as possible and bear all costs of repair.
- H. The Contractor shall replace, at Contractor's own expense, any and all other existing utilities or structures removed or damaged during construction, unless otherwise provided for in these Contract Documents.
- I. Where existing utility lines or structures are so located as to physically conflict with permanent structures to be constructed under this Contract, the conflicting utility line or structure shall be permanently relocated.
- J. The Contractor shall give immediate notice to the Engineer, the City and the owner of the utility (where applicable) when a physical conflict is determined to exist.
 - 1. Contractor will not be charged contract time for delays caused by unanticipated conflicts.
 - 2. Contractor shall not charge the City of Pflugerville for lost time or down time for unanticipated conflicts.
- K. Where existing utility lines or structures are so located as to interfere with the Contractor's prosecution of the work, but do not physically conflict with completed manholes or other permanent structures to be constructed under this Contract, any modification, alteration, or relocation of interfering utility, either permanent or temporary, shall be accomplished at the expense of the Contractor.

CIP4.05

INTERFERING STRUCTURES

- A. Take necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground. An attempt has been made to show major structures on the Plans. While the information has been compiled from the best available sources, it's completeness and accuracy cannot be guaranteed, and it is presented as a guide to avoid known possible difficulties.
- B. Protect existing structures from damage, whether or not they lie within the right-of-way or the limits of the easements obtained by the City. Where existing structures must be removed to properly carry out the work, or are damaged during the Work, they shall be restored at the Contractor's own expense to at least their original condition and to the satisfaction of the Engineer.
- C. The Contractor may, with the approval of the Engineer and without additional compensation, remove and replace in a condition as good as or better than original, any small interfering structures such as fences and signposts that interfere with the Contractor's operations.

CIP4.06

FIELD RELOCATION

- A. During the progress of the Work, minor relocations of the Work may be necessary. Such relocations shall be made only by direction of the Engineer or the City. If existing structures are encountered that will prevent construction as shown, notify the Engineer before continuing with the Work in order that the Engineer may make such field revisions as necessary to avoid conflict with the existing structures. If the Contractor fails to notify the Engineer when an existing structure is encountered and proceeds with the Work despite this interference, he shall be responsible for any damage that may occur.

CIP4.07

LAND MONUMENTS

- A. The Contractor shall preserve or replace any existing Federal, State, County, City, and private land monuments encountered.
- B. Any damaged or destroyed monuments shall be replaced at the sole expense of the Contractor as designated by the City.

CIP4.08

USE OF SITE

- A. Contractor shall confine construction equipment, the storage of materials and equipment and the operations of workers to areas permitted by law, ordinances, permits or the requirements of the Contract Documents and shall not unreasonably encumber the premises with construction equipment or other materials or equipment.
- B. Contractor shall not load nor permit any part of any structure to be loaded in any manner that shall endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that shall endanger it.
- C. Contractor shall abide by all applicable rules and regulations of City with respect to conduct, including smoking, parking of vehicles, security regulations and entry into adjacent facilities owned by City.
- D. Contractor shall provide access to residents and businesses affected by the construction of this Project to the greatest extent possible, including providing temporary base and asphalt as needed.
- E. Contractor shall erect and maintain on Site a Project Bulletin Board, accessible to all Contractor and Subcontractor employees, upon which Contractor shall post and maintain, throughout the Project's duration, all employment and safety information required by law. Contractor further shall post complete Payment and Performance Bond information on the Project Bulletin Board, listing Contractor's bonding and insurance agencies/providers, to include agency contact names, address and telephone numbers.
- F. As applicable, City shall have appropriate Temporary Bench Marks (hereafter referred to as "TBM") and a baseline (for both horizontal and vertical projects, as applicable) established. As of the date of the Notice To Proceed, it is Contractor's responsibility to protect, preserve and reestablish (if required) the TBM and/or baseline. Construction staking and tolerances shall be in accordance with the "Manual of Practice for Land Surveying in the State of Texas Category 5".
- G. As applicable, Contractor shall layout its work from an established baseline and TBM indicated on the drawings and shall be responsible for all measurements in connection with the layout. Contractor shall furnish, at its own expense, all stakes, templates, platforms, equipment, tools, materials and labor required to layout any part of the work. Contractor shall provide cut sheets to City's inspector at minimum seven (7) calendar days prior to construction of street and drainage work. Contractor shall establish the necessary offsets, hubs and guards marked showing control designation and offsets for water, sewer or other utility Work, if present. Contractor shall provide cut sheets for improvements where Sewer profiles are provided for various phases of the project and cut sheets for Water profiles, if applicable. Contractor shall provide staking and preparation of cut sheets after receiving notice to proceed from City. If present, Contractor shall provide other utilities with cut sheets at minimum fifteen (15) calendar days prior to commence of water, sewer or other utility work. Contractor shall be responsible for maintaining and preserving a baseline and TBM indicated on the drawings for duration of construction. If such marks are destroyed, Contractor shall replace them at its own expense. At the end of construction of the Project, Contractor shall provide City a grade certificate prepared by a

Registered Professional Land Surveyor. This certificate shall state the infrastructure is constructed in accordance to the construction documents or as approved by City and the Engineer of Record, which is noted on the record plan set.

CIP 4.09

CUTTING AND PATCHING

- A. Contractor shall be responsible for all cutting, fitting or patching required to complete the Work or to make its parts fit together properly.
- B. Contractor shall not damage or endanger a portion of the Work or a fully or partially completed construction by either City or separate contractors by cutting, patching or otherwise altering such construction, or by excavation. Contractor shall not cut or otherwise alter such construction by City or a separate contractor except with written consent of City and, if City so designates, of such separate contractor and said consent shall not be unreasonably withheld. Contractor unreasonably shall not withhold from City or City's separate contractor Contractor's consent to cutting or otherwise altering the Work.
- C. Any part of the Work damaged by Contractor, either during installation or prior to Final Completion of the Work (or such earlier date established in accordance with the General Conditions), shall be repaired by Contractor to be equal in quality, appearance, serviceability and other respects to an undamaged item or part of the Work. Where this repair cannot fully be accomplished, a damaged item or part shall be replaced by Contractor.

CIP4.10

CLEANING UP

- A. During the progress of the Work, Contractor shall keep the Project Site and surrounding area including, but not limited to, creeks, drainage channels, easements and private property free from accumulations of waste materials, rubbish and other debris resulting from the Work. As applicable, Contractor shall clean, sweep, mop, brush and polish, as appropriate, the interior of the improvements and/or renovated areas including, but not limited to, any floors, carpeting, ducts, fixtures and ventilation units operated during construction, and shall clean exterior gutters, drainage, walkways, driveways and roofs of debris. If Contractor fails to clean up as provided in the Contract Documents, City may elect to do so and all costs incurred by City shall be paid by Contractor.
- B. Prior to Substantial Completion of the Work, Contractor shall remove all waste materials, rubbish and debris from and about the premises, as well as all tools, appliances, construction equipment and machinery and surplus materials, and shall leave the Project Site clean and ready for occupancy by City. As applicable, Contractor shall clean, sweep, mop, brush and polish, to City's satisfaction, the interior of the improvements and/or renovated areas including, but not limited to, any floors, carpeting, ducts, fixtures and ventilation units operated during construction, and shall clean exterior gutters, drainage, walkways, driveways and roofs of debris. Contractor shall restore to their original condition those portions of the Site not designated for alteration by the Contract Documents. If Contractor fails to clean up the premises as provided in the Contract Documents, City may elect to do so and all costs incurred by City shall be paid by Contractor.

CIP4.11

TEMPORARY STORM SEWER AND DRAIN CONNECTIONS.

- A. When existing storm sewers or drains have to be taken up or removed, Contractor shall, at its expense as part of the Work, provide and maintain temporary outlets and connections for all public and private storm sewers and drains. Contractor shall also provide for all storm sewage and drainage that shall be received from these storm drains and sewers. For this purpose, Contractor shall provide and maintain, at Contractor's own expense, adequate pumping facilities and temporary outlets or diversions. Contractor shall, at Contractor's own expense, construct such troughs, pipes or other structures that may be necessary and shall be prepared at all times to dispose of storm drainage and sewage received from these temporary connections until such time as the permanent connections are built and are in service. The existing storm sewers and connections shall be kept in service and maintained under the Contract, except where specified or ordered to be abandoned by Design Consultant. All storm water and sewage shall be disposed of in a satisfactory and lawful manner so that no nuisance is created and that the Work under construction shall be adequately protected.

CIP4.12

USE OF FIRE HYDRANTS.

- A. Contractor, Subcontractors and any other person working on the Project shall not open, turn off, interfere with, attach any pipe or hose to or connect anything with any fire hydrant, stop valve or stop cock, or tap any water main belonging to City, unless duly authorized in writing to do so by City.

CIP4.13

BARRICADES, LIGHTS AND WATCHMEN.

- A. If the Work is carried on, in or adjacent to any street, alley or public place, Contractor shall, at Contractor's own cost and expense, furnish, erect and maintain sufficient barricades, fences, lights and danger signals, provide sufficient watchmen and take such other precautionary measures as are necessary for the protection of persons or property and of the Work. All barricades shall be painted in a color that shall be visible at night and shall be illuminated by lights as required under the Contract Documents, or if none, under the City's Barricades Specifications. The term "lights," as used in this **Section 4.13**, shall mean flares, flashers or other illuminated devices. A sufficient number of barricades with adequate markings and directional devices also shall be erected to keep vehicles from being driven on or into any Work under construction. Contractor shall be held responsible for all damage to the Work due to failure of barricades, signs, lights and/or watchmen necessary to protect the Work. Whenever evidence is found of such damage, City or Design Consultant may order the damaged portion immediately removed and replaced by Contractor at Contractor's sole cost and expense. Contractor's responsibility for maintenance of barricades, signs, lights, and for providing watchmen, as required under this **Section 4.13**, shall not cease until the Project has been finally accepted by City.

CIP4.11

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP5 – CONTRACTOR USE OF PREMISES

CIP5.01 SCOPE OF WORK

- A. This specification covers the requirements for the Contractor's use of the premises for the Project.

CIP5.02 GENERAL

- A. Contractor shall limit his use of the premises, for work and for storage, to the areas designated on the Plans, or approved by the City.
- B. Contractor shall assume full responsibility for the protection and safekeeping of materials under this Contract stored on the site.
- C. Contractor shall move any stored materials, under Contractor's control, which interfere with operations of the City of Pflugerville.
- D. Contractor shall obtain and pay for the use of additional storage or work areas needed for operations.
- E. Water meters for construction shall not be issued to parties that are indebted to the City of Pflugerville.
- F. Any damage to existing facilities, including contamination, which may be caused by Contractor's personnel, callers, visitors, materials or equipment, shall be repaired or corrected at the sole expense of the Contractor.
- G. Any fence that is damaged or removed by the Contractor will be replaced at the Contractor's expense in like kind, and to the satisfaction of the Engineer and the City.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP6 – CONTROL OF WORK

CIP6.01 SCOPE OF WORK

- A. This specification covers the requirements for exercising control of work performed on the Project.

CIP6.02 AUTHORITY OF ENGINEER OR INSPECTOR

- A. The work will be done in accordance with the Contract, Plans and Specifications. The Engineer or Inspector will decide all questions which may arise as to the quality or acceptability of materials furnished and work performed and the interpretations of the Plans and Specifications. His decisions will be final, and he will have executive authority to enforce and make effective such decisions and orders.

CIP6.03 CONFORMITY WITH PLANS, SPECIFICATIONS AND SPECIAL PROVISIONS

- A. All work performed and all materials furnished shall be in reasonable close conformity with the lines, grades, cross sections, dimensions, details, gradations, physical and chemical characteristics of materials in accordance with tolerances shown on the Plans or indicated in the Specifications and Special Provisions. The limits establishing reasonable close conformity will be as defined in these items of the contract.
- B. In the event the City finds that the work performed or the materials used are not within reasonable close conformity with the Plans, Specifications and Special Provisions, the affected material or product shall be removed and replaced or otherwise satisfactorily corrected by and at the expense of the Contractor.
- C. Deviations from the Plans and approved working drawings as may be required will in all cases be determined by the City and authorized in writing. Before final acceptance of the project is issued by the City, the Contractor shall provide the City with a set of record drawings for the project certified by the Engineer of record.

CIP6.04 COORDINATION OF PLANS, SPECIFICATIONS AND SPECIAL PROVISIONS

- A. The Specifications, the accompanying Plans, Special Provisions, and Supplemental Agreements, are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be co-operative and to describe and provide for a complete work. In cases of disagreement, figured dimensions shall govern over scaled dimensions, the Plans shall govern over Specifications, and Special Provisions shall govern over both Specifications and Plans.

CIP6.05 AUTHORITY AND DUTIES OF INSPECTORS

- A. Inspectors will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or to any part of the work and to the preparation or Manufacturer of the materials to be used. Such inspection will not relieve the Contractor from any obligation to perform the work in accordance with the requirements of the Specifications. In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the work, the Inspector will have authority to reject materials or suspend work until the question at issue can be referred to and decided by the City. The Inspector will not be authorized to revoke, alter, enlarge, or release any requirement of these Specifications, nor to approve or accept any portion of work, nor to issue instruction contrary to the Plans and Specifications. He will in no case act as foreman or perform other duties for the Contractor nor interfere with the management of the work.

CIP6.06

PLANT

- A. The Contractor shall furnish plant and equipment which will be efficient, appropriate and large enough to secure a satisfactory quality of work and a rate of progress which will insure the completion of the work within the time stipulated in the Proposal. If at any time such plant appears to the Engineer to be inefficient, inappropriate or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, he may order the Contractor to increase the efficiency, change the character or increase the plant and equipment, and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of work and rate of progress required.

CIP6.07

PRIVATE LAND

- A. The Contractor shall not enter or occupy private land outside of easements, except by written permission of the respective landowner. The Contractor shall provide the City of Pflugerville a copy of any agreement reached with private landowners.

CIP6.08

PIPE LOCATIONS

- A. Pipelines shall be located substantially as indicated on the Plans, but the Engineer and the City reserve the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings are noted on the Plans, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

CIP6.09

OPEN EXCAVATIONS

- A. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons, and damage to property. The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access during construction shall be removed when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street, and requiring that the trench shall not remain open overnight. The Contractor shall take precautions, such as fences and barricades, to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles, which could be dangerous to the public, shall be well lighted at night. All trenches shall conform to the requirements of OSHA.

CIP6.10

TEST PITS

- A. Test pits for the purpose of locating underground pipelines or structures in advance of the construction shall be excavated and backfilled by the Contractor at the direction of the Engineer or the City. Test pits shall be backfilled immediately after their purpose has been satisfied and the surface restored and maintained in a manner satisfactory to the Engineer and the City.

CIP6.11

MAINTENANCE OF TRAFFIC

- A. Unless permission to close a street is received in writing from the proper authority, all excavated material shall be placed so that vehicular and pedestrian traffic may be maintained at all times. If the Contractor's operations cause traffic hazards, he shall repair the road surface, provide temporary ways, erect wheel guards or fences, or take other measures for safety satisfactory to the Engineer and the City.

- B. Detours around construction will be subject to the approval of the City and the Engineer. Where detours are permitted, the Contractor shall provide all necessary barricades and signs as required to divert the flow of traffic. While traffic is detoured, the Contractor shall expedite construction operations and periods when traffic is being detoured will be strictly controlled by the City.
- C. The Contractor shall take precautions to prevent injury to the public due to open trenches. Night watchmen may be required where special hazards exist, or police protection provided for traffic while work is in progress. The Contractor shall be fully responsible for damage or injuries whether or not police protection has been provided.

CIP6.12 BLASTING

- A. No blasting shall be allowed unless approved in writing by the City of Pflugerville.

CIP6.13 CARE AND PROTECTION OF PROPERTY

- A. The Contractor shall be responsible for the preservation of all public and private property, and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, such property shall be restored by the Contractor, at his expense, to a condition equal or better than existing before the damage was done, or he shall make good the damage in some other manner acceptable to the Engineer and the City.

CIP6.14 MAINTENANCE OF FLOW

- A. The Contractor shall, at his own cost, provide for the flow of sewers, drains and water courses interrupted during the progress of the work, and shall immediately cart away and remove all offensive matter. The entire procedure of maintaining existing flow shall be fully discussed with the Engineer and the City well in advance of the interruption of any flow.

CIP6.15 COOPERATION WITHIN THIS CONTRACT

- A. The Contractor shall cooperate with Subcontractors or trades, and shall assist in incorporating the work of other trades where necessary or required.
- B. Cutting and patching, drilling and fitting shall be carried out where required by the Contractor and his Subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer or the City.

CIP6.16 CLEANUP

- A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. The Contractor shall dispose of all rubbish resulting from the construction work and, at the conclusion of the work, he shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations, and shall leave the entire site of the work in a neat and orderly condition.

CIP6.17 FINAL INSPECTION

- A. Whenever the work provided for in, and contemplated under, the contract has been satisfactorily completed, the City will make the "Final Inspection". If the work is found to be satisfactory, the Contractor will be notified in writing of the acceptance of the same. The City will require a Certificate of Completion and Final Acceptance from the Inspector before any building, electric or plumbing permits will be issued or any City utilities provided. No such Certificate will be issued until all monuments have been set and record drawing reviewed by the Engineer of Record are provided to the City. If items are found in need of repair or completion, a final punch list will be generated and the items shall be completed by the Contractor. The City will inspect the punch list items one time following their completion. The cost for any subsequent inspections due to inadequate repair or completion of the punch list items shall be paid for by the Contractor or Developer at cost, but in no event will the cost be less than \$200.00 per inspection.

- B. Final acceptance of the Project or Development does not relieve the Contractor or Developer of the responsibility of insuring all work shown on the Plans has been completed. If any portion of the work is found at a later date to be inferior or incomplete, the Contractor or Developer shall replace or complete the work at no expense to the City in accordance with the City of Pflugerville General Conditions, if applicable.

CIP6.18

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP7 – CONTROL OF MATERIALS

CIP7.01 SCOPE OF WORK

- A. This specification covers the requirements for exercising control of materials used on the Project.

CIP7.02 SOURCES OF SUPPLY AND QUALITY OF MATERIALS

- A. The source of supply of each of the materials shall be approved by the City before any deliveries and at the option of the City, may be sampled and tested for determining compliance with the governing Specifications by the City before delivery begins. If it is found after trial that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, the Contractor shall furnish materials from other approved sources. Only materials conforming to the requirements of these Specifications and approved by the City shall be used in the work. All materials being used are subject to inspection or test at any time during their preparation or use. Any materials which have been tested and accepted at the source of supply may be subjected to a check test after delivery and all materials which, when retested, do not meet approval or have in any way become unfit for use shall not be used in the work.
- B. Throughout these Specifications where reference is made to ASTM, AASHTO or bulletins of the Texas Department of Transportation for the quality of materials or sampling and testing, the most current standard, tentative standard or bulletin issued prior to the date of the proposal shall govern.

CIP7.03 SAMPLES AND TEST

- A. All materials, before being incorporated in the work, shall be inspected, tested and approved by the City and any work in which materials are used without prior test and approval or written permission of the City may be ordered removed and replaced at the Contractor's expense. The Contractor shall be responsible for and pay for all charges of testing laboratories for services in conjunction with initial tests made on all imported materials to the project site including but not limited to embedment materials, fill materials, backfill materials, select material, crushed limestone base, sub-base, concrete, steel, wood forms, liquid asphalt, aggregate, water, cement, guard rail etc. Sampling and testing of all materials, on the project site will be coordinated by the Contractor and paid for by the City. The selection of the method of test shall be designated by the City. Where tests are required, other than those made in the laboratory, for the purpose of control in the manufacture of a construction item, the Contractor will be required to furnish such facilities and equipment as may be necessary to perform the tests and inspection and shall be responsible for calibration of all test equipment required. When requested, the Contractor shall furnish a complete written statement of the origin, composition, and/or manufacture of any or all materials that are to be used in the work. Testing of all materials and work shall conform to the Texas Department of Transportation "Manual of Testing Procedures" which outlines testing methods and procedures. Other Texas Department of Transportation Bulletins shall apply.

CIP7.04 PAYMENT

- A. No separate payment will be made for work performed under this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP8 – LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

CIP8.01 SCOPE OF WORK

- A. This specification covers the requirements for complying with all Federal, State, and local laws, ordinances, and regulations, which in any manner affect the conduct of the work on the Project.

CIP8.02 LAWS TO BE OBSERVED

- A. The Contractor shall make himself familiar with and at all times shall observe and comply with all Federal, State, and local laws, ordinances, and regulations which in any manner affect the conduct of the work and shall indemnify and save harmless the City and its representatives against any claim arising from the violation of any such law, ordinance, or regulation, whether by himself or by his employees.

CIP8.03 PERMITS, LICENSES AND TAXES

- A. The Contractor shall procure all permits and licenses, pay all charges, fee and taxes, and give all notices necessary and incident to the due and lawful prosecution of the work.

CIP8.04 RESTORATION OF SURFACES OPENED BY PERMIT

- A. The Contractor shall not allow any party to make an opening in the highway or street unless a duly authorized permit signed by the owner of the facility is presented. Until the acceptance of the work, the Contractor shall make all necessary repairs in the roadway where openings have been made by due authority.

CIP8.05 PUBLIC SAFETY AND CONVENIENCE

- A. The safety of the public and the convenience of traffic shall be regarded as of prime importance. Unless otherwise shown on the Plans or except as herein provided, all portions of the highway and street shall be kept open to traffic. It shall be the entire responsibility of the Contractor to provide for traffic along and across the highway and streets as well as for ingress and egress to private property all as specified herein, as shown on the Plans or as directed by the City.
- B. The Contractor shall plan and execute his operations in a manner that will cause the minimum interference with traffic. The Contractor shall secure the City's approval of his proposed plan of operation, sequence of work and methods of providing for the safe passage of traffic before it is placed into operation. If at any time during construction, the approved plan does not accomplish the intended purpose, due to weather or other conditions affecting the safe handling of traffic, the Contractor shall immediately make necessary changes in accordance with the latest version of the TMUTCD to correct the unsatisfactory conditions.
- C. If due to rains or other reasons, the shoulders, slopes and ditches become unsatisfactory for handling traffic, construction operations shall be suspended and the base course or surface area shall be opened to traffic. Where the Specifications require that traffic be carried over or along the proposed work, construction operations shall be so prosecuted and new material so kept that placement and spreading will allow the passage of traffic in comfort and safety.
- D. Where an Asphalt Surface Treatment is placed for the full width in an operation, traffic shall be carried on the shoulder slopes and ditches where appropriate. During the operation of placing asphalt and aggregate, the surface or pavement shall not be closed to traffic for a period of more than 45 minutes.

- E. During construction of proposed structures, unless otherwise shown on the Plans, the Contractor shall provide and maintain detours including temporary structures or crossovers of adequate structural design as may be required for the safety and convenience of the traffic.
- F. At night or otherwise, all equipment not in use shall be stored in such manner and such locations as not to interfere with the safe passage of traffic. The Contractor shall provide and maintain flagmen at such points and for such periods of time as may be required to provide for the safety and convenience of public travel and Contractor's personnel, and as directed by the City. Flagmen shall have a sense of responsibility for the safety of the public and the workers, adequate training in safe temporary traffic control practices, average intelligence, good physical condition, including sight, mobility, and hearing, mental alertness and the ability to react in an emergency, courteous but firm manner, and a neat appearance. When directing traffic, flagmen shall use the standard attire, flags and signals and follow the flagging procedure set forth in "Instructions to Flagmen" published by the Texas Department of Transportation.

CIP8.06

BARRICADES AND DANGER, WARNING AND DETOUR SIGNS

- A. The Contractor shall place and maintain in good condition, standard barricades and warning signs at each end of the project and at other locations therein as called for on the Plans or as called for in the Contractor's approved plan of operation. The signs shall be of standard design as shown on the Plans and in accordance with Texas Department of Transportation Standards.
- B. All barricades and signs remaining in place at night and all points of hazard to traffic shall be either retro-reflective with a material that has a smooth, sealed outer surface or illuminated by lights to show the same shape and similar color both day and night. Signs which refer to construction operations which do not apply after work has ended for the day, shall be moved to points out of the clear zone that are not visible to traffic until construction is resumed.
- C. The Contractor may provide special signs not covered by the Plans to protect the traveling public against special conditions or hazards, provided however, that such signs are first approved by the City.
- D. Upon completion of the work, all signs and evidences thereof shall be removed by the Contractor.

CIP8.07

PROJECT IDENTIFICATION SIGNAGE

- A. Project identification signage shall be in accordance with Section CIP14- PROJECT IDENTIFICATION SIGNAGE. This does not apply to private development Projects.

CIP8.08

USE OF EXPLOSIVES

- A. When the use of explosives is necessary for the prosecution of the work, the Contractor shall use the utmost care not to endanger life or property. All explosives shall be stored in a secure manner, and all storage places shall be marked clearly, "DANGEROUS - EXPLOSIVES". The method of storing and handling explosives and highly flammable materials shall conform with Federal and State laws and regulations. **The use of explosives must be approved in writing by the City prior to any use.**
- B. In advance of doing any blasting work, involving the use of electric blasting caps within 200 feet of any railroad track, the Contractor shall give at least 24 hours advance notice to the nearest Roadmaster, Section Foreman, Agent, Signal Maintainer or Telegraph Operator with the request that his Superintendent be advised immediately of the pending use of explosives.

CIP8.09

PROTECTION OF ADJOINING PROPERTY

- A. The Contractor shall take proper measures to protect the adjacent or adjoining property which might be damaged by any process of construction, and in case of any injury or damage resulting from any act or omission on the part of or on behalf of the Contractor, he shall restore at his own expense the damaged property to a condition equal or better than that existing before such injury or damage was done, or he shall make good such injury or damage in an acceptable manner.

CIP8.10

RESPONSIBILITY FOR DAMAGE CLAIMS

- A. The Contractor shall save harmless the City from all suits, actions or claims brought on account of any injuries or damages sustained by any person or property in consequence of any neglect in safeguarding the work by the Contractor, or from any claims or amounts arising or recovered under the "Workmen's Compensation Laws" or any other laws. He shall be responsible for all damage or injury to property of any character occurring during the prosecution of the work resulting from any act, omission, neglect, or misconduct on his part in the manner or method of executing the work; or from his failure to properly execute the work; or from defective work or materials. He shall not be released from such responsibility until all claims have been settled and suitable evidence to that effect furnished the Council.
- B. The Contractor's attention is directed to the fact that pipelines and other underground installations as may be shown on the Plans have been taken from the best available information. There may be other pipelines or installations. The Contractor shall save harmless the City from any and all suits or claims resulting from damage by his operations to any pipeline or underground installation.

CIP8.11

CONTRACTOR'S RESPONSIBILITY FOR WORK

- A. Until the final acceptance of the work by the City as evidenced in writing, it shall be under the charge and care of the Contractor. The Contractor shall rebuild and make good at his own expense all injuries and damages to the work occurring before its completion and acceptance. In case of suspension of work for any cause, the Contractor shall be responsible for the preservation of all materials. He shall provide suitable drainage of the roadway and shall erect temporary structures where required. The Contractor shall maintain the roadway in good and passable condition until final acceptance.
- B. Wherever, in the opinion of the City, any roadway or portion thereof is in suitable condition for travel, it shall be opened to traffic, as may be directed, and such opening shall not be held to be in any way the final acceptance of the roadway or any part of it or as a waiver of any of the provisions of the Contract. Where it is considered by the City to be in the public interest, any substantially completed roadway or portion thereof may be opened to traffic.

CIP8.12

PERSONAL LIABILITY OF PUBLIC OFFICIALS

- A. In carrying out the provisions of the contract or in exercising any power or authority granted thereunder, there shall be no liability upon the City or its authorized assistant, either personally or otherwise, as they are agents and representatives of the City.

CIP8.13

PROSECUTION OF WORK

- A. Prior to beginning construction operations, the Contractor shall submit to the City a chart or brief outlining the manner of prosecution of the work that he intends to follow in order to complete the Contract. Before any work is started on the project or development, a "Pre-Construction Conference", shall be held between the City, Contractor, Developer and any other interested parties.

CIP8.14

PAYMENT

- A. No separate payment shall be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP9 – ENVIRONMENTAL PROTECTION PROCEDURES

CIP9.01 SCOPE OF WORK

- A. This specification covers the requirements for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.
- B. The control of environmental pollution requires consideration of air, water and land, and involves management of noise and solid waste, as well as other pollutants.
- C. Schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. Provide erosion control measures such as diversion channels, sedimentation or filtration systems, berms, seeding, mulching or other special surface treatments as are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion control measures shall be in place in an area prior to any construction activity in that area. Specific requirements are specified in Section G6- SEDIMENTATION AND TEMPORARY EROSION CONTROL.
- D. These Specifications are intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.
- E. All phases of sedimentation and erosion control shall comply with and be subject to the approval of the Texas Commission on Environmental Quality, and U.S. EPA.

CIP9.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including descriptions of any special operations required, temporary roads and embankments, and all other pertinent data to illustrate conformance to the specification found within.

CIP9.03 APPLICABLE REGULATIONS

- A. Comply with all applicable Federal, State and local laws and regulations concerning environmental pollution control and abatement.

CIP9.04 NOTIFICATIONS

- A. The Engineer and/or City will notify the Contractor in writing of any non-compliance with the foregoing provisions or of any environmentally objectionable acts and corrective action to be taken. State or local agencies responsible for verification of certain aspects of the environmental protection requirements shall notify the Contractor in writing, through the Engineer, of any non-compliance with State or local requirements. The Contractor shall, after receipt of such notice from the Engineer or from the regulatory agency through the Engineer, immediately take corrective action. Such notice, when delivered to the Contractor or his/her authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the City may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it is later determined that the Contractor was in compliance.

CIP9.05

IMPLEMENTATION

- A. Prior to commencement of the work, the Contractor shall meet with the City to develop mutual understandings relative to compliance with this provision and administration of the environmental pollution control program. All environmental and pollution control features shall be in place prior to any construction.
- B. Remove temporary environmental control features, when approved by the Engineer, and incorporate permanent control features into the Project at the earliest practical time.

CIP9.06

PROTECTION OF WATERWAYS

- A. The Contractor shall observe the rules and regulations of the State of Texas and agencies of the U.S. Government prohibiting the pollution of any lake, stream, river, or wetland by the dumping of any refuse, rubbish, dredge material, or debris therein.
- B. Contractors are specifically cautioned that disposal of materials into any waters of the State must conform with the requirements of the Texas Commission on Environmental Quality, and an applicable permit from the U.S. Army Corps of Engineers.
- C. The Contractor shall be responsible for providing holding ponds or an approved method which will handle, carry through, or divert around his work all flows, including storm flows and flows created by construction activity, so as to prevent silting of waterways or flooding damage to the property or adjacent properties.
- D. The Contractor is responsible for researching the need for a U.S. EPA NPDES permit for the construction site. If one is required, the Contractor is responsible for obtaining the permit and for monitoring the site per the permit requirements until final completion.

CIP9.07

DISPOSAL OF EXCESS EXCAVATION AND OTHER WASTE MATERIALS

- A. Excess excavated material not required or suitable for backfill and other waste material must be disposed of at sites approved by the City and Engineer.
- B. Unacceptable disposal sites, include, but are not limited to, sites within a wetland or critical habitat and sites where disposal will have a detrimental effect on surface water or groundwater quality.
- C. The Contractor may make his own arrangements for disposal subject to submission of proof to the Engineer that the Owner(s) of the proposed site(s) has a valid fill permit issued by the appropriate governmental agency and submission of a haul route plan including a map of the proposed route(s).
- D. The Contractor shall provide watertight conveyance of any liquid, semi-liquid, or saturated solids which tend to bleed or leak during transport. No liquid loss from transported materials will be permitted whether being delivered to the construction site or being hauled away for disposal. Fluid materials hauled for disposal must be specifically acceptable at the selected disposal site.

CIP9.08

USE OF CHEMICALS

- A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification, must show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture or any other applicable regulatory agency. Use of all such chemicals and disposal of residues shall be in conformance with the Manufacturer's instructions.
- B. Any oil or other hydrocarbon spilled or dumped during construction must be excavated and completely removed from the site prior to final acceptance. Soil contaminated by the Contractor's operations shall become the property of the Contractor, who will bear all costs of testing and disposal.
- C. Before a Contractor commences work, the following steps shall be completed.

1. The City will inform the Contractor of his rights under the Texas Hazards Communication Act.
2. The City will provide a copy of the Chemical List giving the hazardous chemicals to which the Contractor, his employees and agents may be exposed to on the Project site.
3. The City will provide copies of all Material Safety Data Sheets (MSDS) to the Contractor for the hazardous chemicals, which he may be exposed to on the Project site.
4. The City will inform the Contractor of his obligation to inform his employees and agents of each of the above requirements.
5. The Contractor shall provide MSDS for all hazardous chemicals he may bring onto the project site that the City's employees may be exposed to.
6. The Contractor shall sign a Contractor Acknowledgement certifying that he/she has received the information provided by the City on hazardous chemicals and maintain the Acknowledgement with the original Contract.

CIP9.09

EROSION CONTROL

- A. Provide positive means of erosion control such as shallow ditches around construction to carry off surface water. Erosion control measures, such as siltation basins, silt fences, rock berms, hay check dams, mulching, jute netting and other equivalent techniques, shall be used as appropriate. Flow of surface water into excavated areas shall be prevented. Ditches around the construction area shall also be used to carry away water resulting from dewatering of excavated areas. At the completion of the work, ditches shall be backfilled and the ground surface restored to original condition.

CIP9.10

PROTECTION OF STREAMS

- A. Care shall be taken to prevent, or reduce to a minimum, any damage to any stream from pollution by debris, sediment or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, or that contains oils or sediments that will reduce the quality of the water in the stream, shall not be directly returned to the stream. Such waters will be diverted through a settling basin or filter before being directed into the streams.
- B. The Contractor shall not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water or any storm sewer. Water from dewatering operations shall be treated by filtration, settling basins, or other approved method to reduce the amount of sediment contained in the water to allowable levels.
- C. All preventative measures shall be taken to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with a Contingency Action Plan approved by the Texas Commission on Environmental Quality. Contractor shall submit two (2) copies of approved contingency plans to the Engineer.
- D. Water being flushed from structures or pipelines after disinfection, with a Cl_2 residue of 2 mg/l or greater, shall be treated with a dechlorination solution, in a method approved by the Engineer, prior to discharge.

PROTECTION OF LAND RESOURCES

- A. Land resources within the project boundaries and outside the limits of permanent work shall be restored to a condition, after completion of construction, that will appear to be natural and not detract from the appearance of the Project. Confine all construction activities to the appropriate areas shown on the Plans.
- B. Outside of areas requiring earthwork for the construction of the new facilities, the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.
- C. Where trees may possibly be defaced, bruised, injured, or otherwise damaged by the Contractor's equipment, dumping or other operations, protect such trees by placing boards, planks, or poles around them in accordance with Section S6- SEDIMENTATION AND TEMPORARY EROSION CONTROL. Monuments and markers shall be protected similarly before beginning operations near them.
- D. Any trees or other landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition. The Engineer or the City will decide what method of restoration shall be used and whether damaged trees shall be treated and healed or removed and disposed of.

All scars made on trees by equipment, construction operations, or by the removal of limbs larger than one (1) inch in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.

Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving in the opinion of the Engineer or the City, shall be immediately removed and replaced.

- E. The locations of the Contractor's storage, and other construction buildings, required temporarily in the performance of the work, shall be cleared portions of the job site or areas to be cleared as shown on the Plans and shall require written approval of the Engineer and shall not be within wetlands or floodplains. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings. Plans showing storage facilities shall be submitted for approval of the Engineer or the City.
- F. If the Contractor proposes to construct temporary roads or embankments and excavations for plant and/or work areas, he/she shall submit the following for approval at least 10 days prior to scheduled start of such temporary work.
 - 1. A layout of all temporary roads, excavations and embankments to be constructed within the work area.
 - 2. Details of temporary road construction.
 - 3. Plans and cross sections of proposed embankments and their foundations, including a description of proposed materials.
 - 4. A landscaping drawing showing the proposed restoration of the area. Removal of any trees and shrubs outside the limits of existing clearing area shall be indicated. The drawing shall also indicate location of required guard posts or barriers required to control vehicular traffic passing close to trees and shrubs to be maintained undamaged. The drawing shall provide for the obliteration of construction scars as such and shall provide for a natural appearing final condition of the area. Modification of the Contractor's approved drawings shall be made only

with the written approval of the Engineer. No unauthorized road construction, excavation or embankment construction including disposal areas will be permitted.

- G. Remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess waste materials, or any other vestiges of construction as directed by the Engineer or the City. It is anticipated that excavation, filling and plowing of roadways will be required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The disturbed areas shall be prepared and seeded as described in Section G7- LOAMING, HYDROSEEDING AND PERMANENT EROSION CONTROL, or as approved by the Engineer or the City.
- H. All debris and excess material will be disposed of outside wetland or floodplain areas in an environmentally sound manner.

CIP9.12

PROTECTION OF AIR QUALITY

- A. Burning. The use of burning at the project site for the disposal of refuse and debris will not be permitted.
- B. Dust Control. The Contractor will be required to maintain all excavations, embankment, subgrade, road bed, base course stockpiles, access roads, plant sites, waste areas, borrow areas, and all other work areas within or outside the project boundaries free from dust which could cause the standards for air pollution to be exceeded, and which would cause a hazard or nuisance to others.
- C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of petroleum products is prohibited. The use of chlorides may be permitted with approval from the Engineer or the City.
- D. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Engineer or the City.

CIP9.13

MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

- A. During the life of this Contract, the Contractor shall maintain all facilities constructed for pollution control as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

CIP9.14

NOISE CONTROL

- A. The Contractor shall make every effort to minimize noises caused by his/her operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with State and Federal regulations.

CIP9.15

PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP10 - SUBMITTALS

CIP10.01 SCOPE OF WORK

- A. This specification covers the requirements for submissions applicable to the following work-related submittals: Shop Drawings, Product Data, Samples, Mock Ups, Construction Photographs, and Construction or Submittal Schedules. Detailed submittal requirements will be specified in the technical specification sections.
- B. All submittals shall be clearly identified by reference to Specification Section, Paragraph, Drawing No. or Detail as applicable. Submittals shall be clear and legible and of sufficient size for sufficient presentation of data.

CIP10.02 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

A. Shop Drawings

- 1. Shop drawings as specified in individual work Sections include, but are not necessarily limited to, custom-prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shopwork manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the Work.
- 2. All shop drawings submitted by subcontractors for approval shall be sent directly to the Contractor for checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.
- 3. The Contractor shall check all subcontractor's shop drawings regarding measurements, size of members, materials, and details to satisfy himself that they conform to the intent of the Plans and Specifications. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors for correction before submission thereof.
- 4. All details on shop drawings submitted for approval shall show clearly the relation of the various parts to the main members and lines of the structure, and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the Plans before being submitted for approval.

B. Product Data

- 1. Product data as specified in individual Sections, include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the Manufacturer's product specification and installation instructions, availability of colors and patterns, Manufacturer's printed statements of compliance's and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing and printed product warranties, as applicable to the work.

C. Samples

- 1. Samples specified in individual Sections, include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols and units

of work to be used by the Engineer or the City for independent inspection and testing, as applicable to the work.

CIP10.03

CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:
1. Field measurements
 2. Field construction criteria
 3. Catalog numbers and similar data
 4. Conformance with the Specifications
- B. Each shop drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements." Shop drawings and product data sheets eleven by seventeen (11" x 17") and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Provide to the Resident Project Representative a copy of each submittal transmittal sheet for shop drawings, product data and samples at the time of submittal of said drawings, product data and samples to the Engineer or the City.
- C. The Contractor shall utilize a 10 character submittal identification numbering system in the following manner:
1. The first character shall be a D, S, P, M, or R, which represents Shop/Working Drawing and other Product Data (D), Sample (S), Preliminary Submittal (P), Operating/Maintenance Manual (M), or Request for Information (R).
 2. The next sequence shall be the applicable Specification Section Number.
 3. The next three (3) digits shall be the numbers 001 - 999 to sequentially number each initial separate item or drawing submitted under each specific Section number.
 4. The last character shall be a letter, A-Z, indicating the submission, or resubmission of the same Drawing (i.e. A=1st submission, B=2nd submission, C=3d submission, etc.). A typical submittal number would be as follows:

D-C2-008-B
D = Shop Drawing
C2 = Specification Section for Concrete for Structures C2
008 = The eighth initial submittal under this specification section
B = The second submission (first resubmission) of that particular shop drawing
- D. Notify the Engineer or the City in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.

- E. The review and approval of shop drawings, samples or product data by the Engineer or the City shall not relieve the Contractor from his/her responsibility with regard to the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer or the City will have no responsibility therefore.
- F. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk. The City will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
- G. Project work, materials, fabrication, and installation shall conform with approved shop drawings, applicable samples, and product data.

CIP10.04

SUBMISSION REQUIREMENTS

- A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other Contractor.
- B. Each submittal, appropriately coded, will be returned within 30 working days following receipt of submittal by the Engineer or the City.
- C. Number of submittals required:
 - 1. Shop Drawings as defined in Paragraph G10.02 A: Six (6) copies.
 - 2. Product Data as defined in Paragraph G10.02 B: Six (6) copies.
 - 3. Samples: Submit the number stated in the respective Specification Sections.
- D. Submittals shall contain:
 - 1. The date of submission and the dates of any previous submissions.
 - 2. The Project title and number.
 - 3. Contractor identification.
 - 4. The names of:
 - a. Contractor
 - b. Supplier
 - c. Manufacturer
 - 5. Identification of the product, with the specification section number, page and paragraph(s).
 - 6. Field dimensions, clearly identified as such.
 - 7. Relation to adjacent or critical features of the Work or materials.
 - 8. Applicable standards, such as ASTM or Federal Specification numbers.
 - 9. Identification of deviations from Contract Documents.
 - 10. Identification of revisions on re-submittals.
 - 11. Two (2) five-inch by three-inch (5"x3") blank space for Contractor and Engineer stamps.

REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES

- A. The review of shop drawings, data, and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed as:
1. Permitting any departure from the Contract requirements;
 2. Relieving the Contractor of responsibility for any errors, including details, dimensions, and materials; and/or
 3. Approving departures from details furnished by the Engineer or the City, except as otherwise provided herein.
- B. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.
- C. If the shop drawings, data or samples as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the City and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting an exception.
- D. Submittals will be returned to the Contractor under one of the following codes.

Code 1 "REVIEWED" is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.

Code 2 "PROVIDE AS NOTED". This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 "PROVIDE AS NOTED/CONFIRM". This combination of codes is assigned when a confirmation of the notations and comments IS required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.

Code 4 "PROVIDE AS NOTED/RESUBMIT". This combination of codes is assigned when notations and comments are extensive enough to require a re-submittal of the package. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This re-submittal is to address all comments, omissions and non-conforming items that were noted. Re-submittal is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the re-submittal.

Code 5 "NOT APPROVED" is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

Code 6 "COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the Contractor.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

- E. Re-submittals will be handled in the same manner as first submittals. On re-submittals the Contractor shall direct specific attention, in writing on the letter of transmittal and on resubmitted shop drawings by use of revision triangles or other similar methods, to revisions other than the corrections requested by the Engineer, on previous submissions. Any such revisions which are not clearly identified shall be made at the risk of the Contractor. The Contractor shall make corrections to any work done because of this type revision that is not in accordance to the Contract Documents as may be required by the Engineer.
- F. Partial submittals may not be reviewed. The Engineer will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor, and will be considered "Not Approved" until resubmitted. The Engineer may at his/her option provide a list or mark the submittal directing the Contractor to the areas that are incomplete.
- G. If the Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Contractor shall give written notice thereof to the Engineer at least seven (7) working days prior to release for manufacture.
- H. When the shop drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

CIP10.06 DISTRIBUTION

- A. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by the Engineer. Number of copies shall be as directed by the Engineer but shall not exceed six (6).

CIP10.07 MOCK UPS

- A. Mock Up units as specified in individual Sections include, but are not necessarily limited to, complete units of the standard of acceptance for that type of work to be used on the Project. Remove at the completion of the Work or when directed.

CIP10.08 GENERAL PROCEDURES FOR SUBMITTALS

- A. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work sections, of the Specifications, so that the installation will not be delayed by processing times including disapproval and re-submittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. No extension of time will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the Work.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP11 – TRENCH SAFETY REQUIREMENTS

CIP11.01 SCOPE OF WORK

- A. This specification covers the requirements to plan, design, construct, install, maintain, monitor, modify as necessary, and remove upon completion, a Trench Safety System as specified herein.
- B. The requirements of this Section apply to all trenches which equal or exceed a depth of five (5) feet, measured from the ground surface at the highest side of the trench to the trench bottom.
- C. All applicable and non-conflicting portions of Section G4- TRENCHING, BACKFILLING AND COMPACTION apply as appropriate.

CIP11.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, but not less than 10 calendar days prior to execution of any trench excavation operations, the Contractor shall submit a site specific Trench Safety System Conformance Affidavit stating that operations will be conducted in full conformance with the OSHA Standards.
 - 1. The Conformance Letter shall also describe the Trench Safety System techniques proposed to be used on the Project.
 - 2. Specific references to the applicable OSHA Standards sections shall be included for each technique to be used.
- B. The Trench Safety System Plan shall be in writing, site specific and sufficiently detailed and clear to be understandable and usable by all personnel who will be executing, supervising and witnessing the trenching operations. A copy of the Trench Safety System Plan shall be available at the site of trenching operations at all times.
- C. If borings and/or detailed geotechnical analyses are required to develop the Trench Safety System Plan, they shall be executed by the Contractor at his cost.
- D. For trenches having depths greater than the various limits given in the OSHA Standards (8, 12 or 20 feet, depending on the techniques used), a site specific protective system shall be designed by a Registered Professional Engineer, registered in the State of Texas experienced in soil mechanics and structural design. The design shall be signed, sealed and dated by the Professional Engineer, and it shall identify those specific locations where the design is applicable.

CIP11.03 GENERAL

- A. All materials and products incorporated into the Trench Safety System shall be suitable for their intended uses; shall meet all design criteria and parameters used by the Trench Safety System designer; and shall meet all applicable requirements of OSHA Standards.

CIP11.04 METHODS OF PROVIDING FOR TRENCH SAFETY

- A. Protective systems referenced in this Section shall be as defined and described in 29 CFR 1962.652, "Requirements for Protective Systems."

- B. It is the duty, responsibility and prerogative of the Contractor to determine the specific applicability of a proposed Trench Safety System for each field condition encountered on the Project. Contractor specifically holds the City, Engineer, and any of their designated representatives harmless in any actions resulting from the failure or inadequacy of the Trench Safety System used to complete the Project.
- C. Unless otherwise noted on the drawings or excluded below, Sloping/Benching, Trench Shielding with trench boxes, and/or Sheeting/Shoring/Bracing protective systems may be used on this Project.
- D. Restrictions on the use of the various protective systems for this Project are as follows:
 - 1. Sloping or Benching. Allowed with prior approval from the City.
 - 2. Trench Shields/Boxes. No restrictions.
 - 3. Sheeting/Shoring/Bracing. No restrictions.

CIP11.05

INSPECTION DUTIES OF CONTRACTOR

- A. Provide a Competent Person, as defined in the OSHA Standards, to make frequent inspections of the trenching operations and the Trench Safety System in full conformance with the OSHA Standards.
- B. If evidence of a possible cave-in or landslide is apparent, all work in the trench shall immediately cease and not be resumed until all necessary precautions have been taken to safeguard personnel entering the trench.
- C. In an emergency situation, which may threaten or affect the safety or welfare of any persons or properties, the Contractor shall act at his discretion to prevent possible damage, injury or loss. Any additional compensation or time extension claimed for such actions shall be considered in view of the cause of the emergency and in accordance with the General Conditions.

CIP11.06

MEASUREMENT AND PAYMENT

- A. Payment for the Trench Safety Plan shall be on a Lump Sum price basis, the Lump Sum price being as given in the Bid Proposal.
- B. Payment for the Trench Safety Plan Implementation shall be on a unit price basis, the unit price being as given in the Bid Proposal, and the unit of measure being linear feet of trench and/or square foot of bore pit or structure, without regard to whether specific trench safety precautions are required or used for the trench reach being measured.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP12 – TESTING OF PIPELINES AND MANHOLES

CIP12.01 SCOPE OF WORK

- A. This specification covers the requirements to perform ex-filtration testing and deflection testing of gravity pipelines and to perform pressure and leakage testing of pressure pipelines.

CIP12.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including a description of the deflection test procedure for flexible pipe greater than 27-inches in diameter, video inspection of gravity wastewater lines, and all other pertinent data to illustrate conformance to the specification found within.

CIP12.03 GENERAL

- A. The entire length of the installed gravity line and the force main shall be field tested for water tightness. Gravity wastewater lines shall be video taped by camera.
- B. Hydrostatic pressure and leakage tests shall be made on all pressure pipelines carrying wastewater or water.
- C. All labor and equipment, including, but not limited to test pump with regulated by-pass meters and gauges required for conducting pipeline tests, shall be furnished by the Contractor. The Contractor shall furnish equipment and necessary piping as required to transport water used in testing from source to test location.
- D. Time and sequence of testing shall be scheduled by the Contractor, subject to observation and approval by the City. The Contractor shall provide adequate labor, tools and equipment to operate valves and to locate and repair any leaks discovered during the initial filling of the pipeline prior to actual testing or during the course of the tests.

CIP12.04 CLEANING

- A. At the conclusion of the work, thoroughly clean all pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered the pipes during the construction period. Debris cleaned from the lines shall be removed from the low end of the pipeline. If after this cleaning, obstructions remain, they shall be removed. After the pipelines are cleaned and if the groundwater level is above the pipe or following a heavy rain, the Engineer will examine the pipes for leaks. If any defective pipes or joints are discovered, they shall be repaired, and/or replaced by the Contractor at his expense.

CIP12.05 TEST PROCEDURES FOR GRAVITY PIPELINES AND MANHOLES

- A. Scope: After sewers and manholes have been installed and backfilled, subject newly laid gravity lines and manholes to a leakage test. Contractor to furnish all labor, materials, tools and equipment to test lines. Take such precautions as required to prevent damage to lines and appurtenances being tested. Repair any damage resulting from test at Contractor's expense. Conduct test in presence of Engineer or designated City Representative.
- B. Test Procedures for Leakage Test of Gravity Sewer: Contractor, at his option, may test lines by hydrostatic or low pressure air test as specified below. However, the Engineer may direct a specific test be performed in specified areas of the Project.

C. Infiltration or Exfiltration Test (for Gravity Sewer)

1. Preparation: Seal ends of line section being tested with water tight plugs, equipped with pipe riser inserted and braced in the inlet of the manholes. Fill section with water 24-hours prior to start of test. Fill slowly from downstream manhole in test section so that no air is trapped in the line. Leave outlets of stacks and service lines exposed and unplugged until after exfiltration test has been made. Outlets terminating below level of test water surface to be temporarily extended upward by installing additional lengths of pipe. After completion of satisfactory test, remove lengths of pipe added for test.
2. Duration of Test: Test for 24-hours. Minimum head of either two (2) feet measured above the crown, inside pipe at upper end of section or four (4) feet measured above trench water table, whichever is higher, so that a net positive of two (2) feet TCEQ is used for testing.
3. Allowable Leakage: Allowable leakage or exfiltration in any individual section under construction shall not exceed 10 gallons per inch of inside diameter per mile of pipe per 24 hours.

D. Low Pressure Air Test

1. Preparation: Clean pipe to be tested by propelling snug fitting inflated rubber ball through the pipe with water or by use of water jet cleaning equipment. After manhole to manhole reach of pipe has been backfilled and cleaned, pneumatic plugs shall be placed in the line at each manhole and inflated to 25 psig. Add air slowly to the section under test until the internal pressure of 4.0 psig is obtained. Allow at least two (2) minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

2. Duration of Test and Allowable Leakage

Decrease pressure to 3.5 psig and start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding times are indicated in seconds and shall be computed by the following equation:

$$T = (0.085 \times D \times K) / Q$$

T = time for pressure to drop 1.0 pound per square inch gauge in seconds

K = $0.000419 \times D \times L$, but not less than 1.0

D = average inside diameter in inches

L = length of line of same pipe size being tested, in feet

Q = rate of loss assume 0.0015 cubic feet per minute per square foot internal surface shall be used

Since K value of less than 1.0 shall not be used, there are minimum times for each pipe diameter as outlined below:

Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length
(inches)	(seconds)	(feet)	(seconds)
6	340	398	0.855(L)
8	454	298	1.520(L)
10	567	239	2.374(L)
12	680	199	3.419(L)
15	850	159	5.342(L)
18	1020	133	7.693(L)
21	1190	114	10.471(L)
24	1360	100	13.676(L)

Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length
27	1530	88	17.309(L)
30	1700	80	21.369(L)
33	1870	72	25.856(L)
36	2040	66	30.771(L)

The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration as outlined above or until failure. Lines with a 27-inch average inside diameter and larger may be air tested at each joint. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing. The pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum time allowable for the pressure to drop from 3.5 psi gauge to 2.5 psi gauge shall be 10 seconds.

E. Test Procedures for Hydrostatic Test for Manholes

1. Manholes shall be tested for leakage separately and independently of the wastewater lines by hydrostatic exfiltration testing, or other methods acceptable to the City. If a manhole fails a leakage test, the manhole must be made water tight and retested. The maximum leakage for hydrostatic testing shall be 0.025 gallon per vertical foot per hour. Alternative test methods must ensure compliance with the above allowable leakage. Hydrostatic exfiltration testing shall be performed as follows: all wastewater lines coming into the manhole shall be sealed with an internal pipe plug, then the manhole shall be filled with water and maintained full for at least one (1) hour. For concrete manholes a wetting period of 24-hours may be used prior to testing in order to allow saturation of the concrete.

F. Test Procedures for Vacuum Testing Manholes

1. In lieu of the hydrostatic exfiltration test, manholes may be tested by vacuum. Manholes tested by vacuum shall be performed by the Contractor in compliance with these specifications.
2. Manholes shall be tested after installation of all connections (existing and/or proposed) in place. All lift holes shall be plugged with an approved non-shrink grout and all drop connections and gas sealing connections shall be installed prior to testing. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond the drop-connections, gas sealing connections, etc. The test head shall be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. A vacuum of 10-inches of mercury shall be drawn, and the vacuum pump shall be turned off. With the valve closed, the level of vacuum shall be read after the required test time as shown in the following table. If the drop in the level is less than one (1) inch of mercury (final vacuum of nine (9) inches of mercury), the manhole will have passed the vacuum test. The required test time shall be three (3) minutes.
3. Manholes which have a final vacuum of nine (9) inches of mercury after the time indicated will be accepted. If there has been no pressure loss during the first 23-seconds the test may be stopped and the manhole will be accepted. Any manhole which fails the vacuum test as described above shall be repaired with an approved non-shrink grout or other material acceptable to the Engineer and the City based on the material from which the manhole is constructed. The manhole shall be retested as described above until a successful test is made.

G. Exfiltration Test

1. Preparation: Seal ends of manhole being tested with watertight plugs. Fill manhole 24-hours prior to start of test. Manholes to be filled to top of manhole cone section.
2. Duration of Test: The test shall be performed for a 24-hour duration.
3. Allowable Leakage: No leakage is allowed. The water elevation shall be the same at beginning and end of test period.

H. Deflection Testing

1. Deflection tests shall be performed on all flexible pipes. For pipes with inside diameters less than 27-inches, a rigid mandrel shall be used to measure deflection. For pipelines with an inside diameter of 27-inches and greater, the Contractor shall submit to the Engineer the proposed method, with which shall provide a precision of $\pm$ two tenths of one percent (0.2%) deflection, for review and approval by the Texas Natural Resource Conservation Commission. The test shall be conducted after final backfill has been in place at least 30 days in the presence of a representative of the City's Utilities Department. No pipe shall exceed a deflection of five percent (5%). If a pipe should fail to pass the deflection test, the problem shall be corrected and a second test shall be conducted after the final backfill has been in place an additional 30 days. Test shall be performed without mechanical pulling devices.
 2. Mandrel Sizing: The rigid mandrel shall have an outside diameter (O.D.) equal to 95% of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter of the pipe minus two minimum wall thickness for O.D. controlled pipe and the average inside diameter for the I.D. Controlled pipe, all dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
 3. Mandrel Design: The rigid mandrel shall be constructed of a metal or rigid plastic material that can withstand 200 psi without being deformed. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75% of the inside diameter of the pipe. A proving ring shall be provided and used for each size mandrel in use.
 4. Method Options: Adjustable or flexible mandrels are prohibited. A television inspection is not a substitute for the deflection test. A deflectometer may be approved provided the Contractor notifies the Engineer in a timely manner and submits adequate information for the Engineer to submit to the Texas Natural Resource Conservation Commission for review and approval. Mandrels with removable legs or runners may also be approved provided the Contractor notifies the Engineer in a timely manner and submits adequate information for the Engineer to submit to the Texas Natural Resource Conservation Commission for review and approval.
- I. Repairs of Lines: Remove and replace or make approved corrective repairs to any section of line or manhole which has leakage that exceeds above amounts. Repair any individual leaks that may appear whether or not overall section meets leakage requirements. Individual leaks will ordinarily be revealed by looking through sewer with a light while groundwater level is over sewer, during water tamping operations or immediately after water leakage is emptied from sewer.
- J. Retest: Sewers and/or manholes failing to meet requirements of leakage test will, after repair by Contractor, be tested again for leakage. No sewer or manhole will be accepted until leakage is less than allowable amount.

K. Video Inspection

1. The use of a television camera for inspection prior to placing the sewer in service will be required. Video inspection is at the cost of the Contractor, and copies of the videotapes will be presented to the City prior to final acceptance. Two (2) copies of the videotapes shall be submitted to the City along with a letter of concurrence from the Project Engineer acknowledging that all newly constructed sewer within the project has been videotaped and that he/she has reviewed the videotape and has not found any deficiencies in the videotaped sewer.
2. Post construction video of the gravity wastewater lines will be evaluated on a case-by-case basis for acceptance. Preparation for video taping of wastewater line shall be as follows:
 - a. Flush and clean the gravity wastewater line prior to video taping.
 - b. The videotape shall display the station, in accordance with the Plans and Standards, and counter on the screen. Manhole numbers and stations shall correspond to the contract documents.
 - c. If debris is evident in the line during the video, the line will be flushed and cleaned to allow a clean video.
 - d. All manholes will be identified at the beginning and end of the video corresponding to contract documents with upstream and downstream ends identified.

L. Golf Ball Test

1. During the video inspection, water shall be flowed into the pipe to permit meaningful observations. Any pipe settlement which causes excessive ponding of water in the pipe shall be cause for rejection. Excessive ponding shall be defined as a golf ball (1-5/8" dia.) submerged at any point along the line.

CIP12.06 TEST PROCEDURES FOR PRESSURE PIPELINES

A. General

1. After the pipe has been laid and backfilled and the backfill has been otherwise consolidated, all newly laid pipe, or any valved section thereof, shall be subjected to the hydrostatic pressure specified below for that particular type of pipe. The duration of the hydrostatic test shall be at least two (2) hours. Unless otherwise specified or noted on the Plans. All meters, fixtures, devices or appliances which are connected to the pipeline system and which might be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped during the testing procedures.
2. Each valved (capped or plugged) section of pipe shall be filled slowly with water and all air shall be expelled. If permanent air vents are not located at all high points, the Contractor shall install, at his own expense, corporation or blow-off cocks at such points so that air can be expelled as filling takes place. After verification that all air has been expelled, the cocks shall be closed and the pipe kept filled until tested. All exposed pipe, fittings, valves, hydrants and joints shall be examined while under test pressure and all visible leaks shall be stopped. Any cracked or defective pipe, fittings, valves or hydrants discovered during testing shall be removed and replaced by the Contractor. Replacement shall be with sound material and the test shall be repeated until satisfactory to the City.

- B. Special Requirements: Where any section of pipeline is provided with concrete reaction blocking, the hydrostatic pressure shall not be made until at least five (5) days have elapsed after installation of the blocking. However, if high-early-strength cement is used in the concrete, two (2) days shall have elapsed prior to testing.
- C. Leakage Test: A Leakage Test will be conducted on each valved section over the entire Project. The leakage test shall be at 150 psi for at least four (4) hours.
- D. Allowable Leakage

1. The allowable hydrostatic leakage rate shall be based on the following formula:

$$L = \frac{SD \sqrt{P}}{133,200}$$

L = testing allowance in gallons per hour

S = length of pipe tested in feet

D = nominal diameter of the pipe in inches

P = average test pressure during the hydrostatic test in pounds per square inch (gauge)

Table 6A
Hydrostatic testing allowance per 1,000 ft of pipeline* - *gph*[†]

Avg. Test Pressure <i>psi</i>	Nominal Pipe Diameter – in.																	
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
450	.48	.64	.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60	9.56	10.19
400	.45	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11	9.01	9.61
350	.42	.56	.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58	8.43	8.99
300	.39	.52	.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02	7.80	8.32
275	.37	.50	.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72	7.47	7.97
250	.36	.47	.71	.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41	7.12	7.60
225	.34	.45	.68	.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03	6.76	7.21
200	.32	.43	.64	.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73	6.37	6.80
175	.30	.40	.59	.80	.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36	5.96	6.36
150	.28	.37	.55	.74	.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97	5.52	5.88
125	.25	.34	.50	.67	.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53	5.04	5.37
100	.23	.30	.45	.60	.75	.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05	4.50	4.80

* If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the testing allowance for each size.

[†] Calculated on the basis of Eq. 1.

- a. These formulas are based on a testing allowance of 11.65 gpd/mi/in. (1.079 L/d/km/mm) of nominal diameter at a pressure of 150 psi (1,034 kPa).
- b. 5.2.1.6.1 Testing allowance at various pressures is shown in Tables 6A and 6B.
- c. 5.2.1.6.2 When testing against closed metal-seated valves, an additional testing allowance per closed valve of 0.0078 gal/h/in. (1.2 mL/h/mm) of nominal valve size shall be allowed.
- d. 5.2.1.6.3 When hydrants are in the test section, the test shall be made against the main valve in the hydrant.

- e. 5.2.1.7 Acceptance of installation. Acceptance shall be determined on the basis of testing allowance. If any test of laid pipe discloses a testing allowance greater than that specified in Sec. 5.2.1.6, repairs or replacements shall be accomplished in accordance with the specifications.
 - f. 5.2.1.7.1 All visible leaks are to be repaired regardless of the allowance used for testing.
- 2. If such testing discloses leakage in excess of this specified allowable, the Contractor, at his expense, shall locate and correct all defects in the pipeline until the leakage is within the specified allowance. All known leaks, regardless of this test, shall be repaired.
- E. Pressure Test: After satisfactorily completing the leakage test, each valved section over the entire project, shall be tested at 200 psi for a sufficient period (approximately 10 min) to discover all leaking or defective materials and/or workmanship.
- F. Disinfecting Water Mains: The Contractor shall disinfect all water mains before the new facilities are placed into service. Disinfection must be performed in accordance with AWWA C651, latest revision and water samples must be submitted to a laboratory approved by the Texas Department of Health. Sample must be collected by the Contractor or his representative in the presence of the City or his representative. The Contractor shall be responsible for delivering the samples to an approved laboratory for testing. Sample results must indicate the facility is free of microbiological contamination before it is placed into service. It shall be the Contractor's responsibility to obtain a current copy of AWWA C651 to determine the correct forms of chlorine for disinfection, the basic disinfection procedure, preventive and corrective measures during construction, methods of chlorination, final flushing procedures, procedures for bacteriological tests, procedures for re-disinfection and disinfection procedures when cutting into existing mains. The Contractor, at its expense, will supply the concentrated chlorine disinfecting material, the City's personnel will supervise and direct the overall sterilization procedure. The Contractor, at his own expense, shall provide all other equipment, supplies and necessary labor to perform the sterilization under general supervision by the City.
- G. General
 - 1. All valves shall be arranged to prevent the strong disinfecting dosage from flowing back into the existing water supply piping. The new pipeline shall then be completely filled with disinfecting solution by feeding the concentrated chlorine and approved water from the existing system uniformly into the new piping in such proportions that every part of the line has a minimum concentration of chlorine as prescribed in AWWA C651.
 - 2. Unless otherwise identified, all quantities called for herein refer to measurements by the testing procedures in the current edition of "Standard Methods of Examination of Water and Wastewater". The chlorine concentration of each step in the sterilization procedure shall be verified by chlorine residual determinations. This disinfecting solution shall be retained in the piping for at least twenty-four (24) hours, and all valves, hydrants, etc., shall be operated to disinfect all their parts. After this retention period, the water shall contain no less than the chlorine residual prescribed in AWWA C651 throughout the treated section of the pipeline.
 - 3. This heavily chlorinated water shall then be carefully flushed from the line until the chlorine concentration is not higher than the residual generally prevailing in the existing distribution system, or approximately 1.0 parts per million. Proper planning and appropriate preparations to handle, dilute and dispose of this strong chlorine solution without causing injury or damage to the public, the water system, the environment must be approved by the City before flushing of the line may begin, and the flushing shall be witnessed by an authorized representative of the City.

H. Bacteriological Testing

1. After final flushing of the strong disinfecting solution, water samples from the line shall be tested for bacteriological quality, at the Contractor's expense, and must be found free of coliform organisms before the pipeline may be placed in service. One (1) test sample shall be drawn from the end of the main and additional samples collected at intervals of not more than one-thousand (1,000) feet along the pipeline. A minimum of three (3) samples must be collected.
2. The Contractor, at his own expense, shall install sufficient sampling taps at proper locations along the pipeline. Each sampling tap shall consist of a standard corporation cock installed in the line and extended with a copper tubing gooseneck assembly. After samples have been collected, the gooseneck assembly shall be removed and retained for future use.
3. Samples for bacteriological analysis shall be collected only from suitable taps, in sterile bottles. Collection of the test samples shall be made in the presence of City personnel. If the initial disinfection fails to produce acceptable sample tests, the disinfection procedure shall be repeated (without extra compensation) until satisfactory test results have been obtained, before the piping may be placed in service.

CIP12.07 FINAL ACCEPTANCE

- A. No pipe installation will be accepted until all known leaks have been repaired whether or not leakage is within allowable limits. Locating and repairing of leaks shall be performed by the Contractor at no additional cost to the City.
- B. The City will certify that all required pressure and leakage tests have been successfully completed before the pipeline is accepted.

CIP12.08 PAYMENT

- A. No separate payment will be made for work completed in accordance with this specification, and the cost thereof will be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP13 – SUMMARY OF TESTING (MISCELLANEOUS)

CIP13.01 SCOPE OF WORK

- A. This specification covers the requirements to perform testing of various work items for this Project.

CIP13.02 SUBMITTALS

- A. Within 30 days after the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature and all other pertinent data to illustrate conformance to the specification found within.

CIP13.03 TESTING FOR ROADS

Testing for roads shall be in accordance with Table 13-1.

Table 13-1

Item	Test Method	Passing Criteria	Comments
Hot Mix Asphaltic Concrete (HMAC)	Tex-200-F	See SD1.06 A	Sieve Analysis of Fine and Coarse Aggregate
	Tex-207-F	94.5%-97.5%Lab Density; 91.0%-96.0%In-PlaceField Density	Determining Density of Compacted Bituminous Mixtures
	Tex-210-F	See SD 1.06 B	Determining Asphalt Content of Bituminous Mixtures by Extraction
	Tex-227-F		Max. Specific Gravity of Bituminous Mixtures
	Tex-208-F	Min 35	Stability
Trench Backfill	Applicable Tex Testing Method	See Section G4.05	Minimum of one test every 250 linear feet of trench length for each lift.
Embankment	Tex-114-E	See Section SD3.06	Test every 2,000 SY of roadbed surface
Flexible Base	Tex-107-E, Part II Tex-411-A Tex-110-E	2% shrinkage	Bar Linear Shrinkage
	Tex-113-E	100% Density	Magnesium Soundness
	Tex-115-E		Sieve Analysis
	Tex-116-E	40 Max.	Moisture Density
	Tex-117-E	45 psi @ 0 psi lateral & 175 psi @ 15 psi lateral	Roadway Density
		Max. increase ≤ 20	Wet Ball Mill
	Tex-460-A	Plasticity Index ≤ 10	Triaxial Test (Part I or II)
	Tex-106-E	Liquid Limit ≤ 35	Particle Count (Part I)
	Tex-104-E	$\pm 2\%$ Optimum	Plasticity Index
	Tex-103-E		Liquid Limit
			Moisture Content

Table 13-1, cont.

Item	Test Method	Passing Criteria	Comments
Striping	Tex-828-B	10 or more stripes visible (day) 6 or more stripes visible (night) 0.060-inches minimum thickness for edgeline markings	Glass Beads: If criteria is not met, check Tex-828-B for scheduling replacement of striping.
	Tex-854-B	0.090-inches minimum thickness for stop bars, legends, symbols, gore and centerline/no passing barrier line markings 0.180-inches maximum thickness for all markings	The average of the readings across each sample must be equal to or above the specified minimum thickness. No reading should be more than 10-mils below the specified minimum thickness.

CIP13.04 TESTING FOR WATER/WASTEWATER

Testing for water/wastewater shall be in accordance with Table 13-2.

Table 13-2

Item	Test Method	Passing Criteria	Comments
Valves, Hydrants and Appurtenances	Manufacturer's Recommendations	Manufacturer's Recommendations	Functional field test of each valve, including actuators and valve control equipment.
Water and Wastewater Lines			As described in Section CIP 12: Testing of Pipelines

CIP13.05 TESTING FOR CONCRETE

Testing for concrete shall be in accordance with Table 13-3. Two (2) samples shall be tested for each truck load.

Table 13-3

Item	Test Method	Passing Criteria	Comments
Asphalt Board	Tex-524-C	Deflection from horizontal $<1:3\frac{1}{2}$	
Concrete Slump	Tex-415-A		See Table 13-4 for Slump
Compressive Strength	Tex-418-A		See Table 4 in Section C-2
Flexural Strength	Tex-448-A		See Table 4 in Section C-2
Coarse Aggregate	Tex-413-A Tex-410-A Tex-411-A	0.25% by weight clay lumps 1.00% by weight shale 5.00% by weight laminated and/or friable particles 40% wear 12% loss Sodium Sulfate 18% loss Magnesium Sulfate	See Table 13-5 for Gradation Soundness Test

Table 13-3, cont.

Fine Aggregate	Tex-612-J	60% by weight acid insoluble residue subject to direct traffic. Color shall not be darker than Organic Color No. 3 (Gardner No. 11)	Color Test
	Tex-408-A		
	Tex-401-F Tex-203-F Tex-402-A	Not less than 80 Between 2.3 & 3.1 for Non-Class K Between 2.6 & 2.8 for Class K	See Table 13-6 for Gradation Sand Equivalent Fineness Modulus
Membrane Curing	Tex-219-F	2% loss for 24-hour test 4% loss for 72-hour test	Water Retention Test

Table 13-4

Concrete Designation	Slump	Maximum Slump
1. All drill shaft	6	7
2. Uncased drill shafts, thin walled sections (<9") and pre-stressed concrete members	4	5
3. Slabs, caps, columns, piers, wall sections over 9", etc.	3	4
4. Underwater or seal concrete	6	7
5. Riprap, curb, gutter and other miscellaneous concrete.	As specified by City.	

Table 13-5

Aggregate Grade No.	Nominal Size (in)	Amount Retained (%)								
		2 1/2 in	2 in	1 1/2 in	1 in	3/4 in	1/2 in	3/8 in	No 4	No 8
1	2	0	0-20	15-50		60-80			95-100	
2 (467)*	1 1/2			0-5		30-65		70-90	95-100	
3	1 1/2			0-5		10-40	40-75		95-100	
4 (57)*	1				0-5		40-75		90-100	95-100
5 (67)*	1/4					0-10		45-80	90-100	95-100
6 (7)*	1/2							30-60	85-100	95-100
7	3/8							5-30	75-100	
8	3/8							0-5	35-80	90-100

Table 13-6

Aggregate Grade No.	Amount Retained (%)							
	3/8 in	No 4	No 8	No 16	No 30	No 50	No 100	No 200
1	0	0-5	0-20	15-50	35-75	65-90	90-100	97-100

CIP13.06

PAYMENT

- A. No separate payment will be made for work completed in accordance with this specification, and the cost thereof will be included in the appropriate items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP14 – PROJECT CLOSEOUT

CIP14.01 SCOPE OF WORK

- A. This specification covers the administrative and procedural requirements for Project closeout, including but not limited to:
 - 1. Closeout procedures.
 - 2. Final cleaning.
 - 3. Adjusting.
 - 4. Project record documents.
 - 5. Spare parts and maintenance materials.

CIP14.02 RECORD DOCUMENTS

- A. Maintain on site, one (1) set of the following documents; actual revisions to the Work shall be recorded in these documents:
 - 1. Contract Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other Modifications to the Contract.
 - 5. Reviewed shop drawings, product data, and samples.
- B. Store Record Documents separate from documents used for construction.
- C. Record information concurrent with construction progress.
- D. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and Modifications.
- E. Contract Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured depths of foundations in relation to finish floor datum.
 - 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 4. Field changes of dimension and detail.
 - 5. Details not on original Contract Drawings.

- F. Submit documents to City with claim for final Application or Payment. Retention monies will not be released until complete record documents have been submitted.

CIP14.03

CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's and/or City's inspection.
- B. Provide submittals to the City that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- D. Submit three (3) sets of as-built drawings in digital and hard copy format.
- E. Reserved.

CIP14.04

FINAL CLEANING

- A. At the completion of work and immediately prior to final inspection, cleaning of the entire project shall be accomplished according to the following provisions:
 - 1. The Contractor shall thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. The cleaning shall leave the structures and site in a complete and finished condition to the satisfaction of the City.
 - 2. All Subcontractors shall similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.
 - 3. The Contractor shall remove all temporary structures and all debris, including all dirt, sand, gravel, rubbish and waste material.
 - 4. Should the Contractor not remove rubbish or debris, or not clean the buildings and site as specified above, the City reserves the right to have the cleaning done at the expense of the Contractor.
- B. Use only cleaning materials recommended by manufacturer of surface to be cleaned.
- C. Use cleaning materials only on surfaces recommended by cleaning material manufacturers.
- D. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.
- E. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.
- F. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.
- G. Replace air-handling filters if units were operated during construction.
- H. Vacuum clean all interior spaces, including inside cabinets. Broom clean paved surfaces, mow any areas planted with grass which are in excess of two (2) inches high, and rake clean other surfaces of grounds.

- I. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.
- J. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly-painted surfaces.

CIP14.05 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

CIP14.06 FINAL INSPECTION

- A. After final cleaning and restoration and upon written notice from the Contractor that the work is completed, the Engineer and/or City will make a preliminary inspection, with the Contractor present. Upon completion of this preliminary inspection, the Engineer and/or City will notify the Contractor, in writing, of any particulars in which this inspection reveals that the work is defective or incomplete.
- B. Upon receiving written notice from the Engineer and/or City, the Contractor shall immediately undertake the work required to remedy deficiencies and complete the work to the satisfaction of the City.
- C. When the Contractor has corrected or completed the items as listed in the Engineer's/ City's written notice, he/she shall inform the City in writing, that the required work has been completed. Upon receipt of this notice, the Engineer and/or City and the Contractor, will make the final inspection of the Project.
- D. Should the Engineer and/or City find all work satisfactory at the time of his inspection, the Contractor will be allowed to make application for final payment in accordance with the provisions of the Standard Form of Agreement. Should the Engineer and/or City still find deficiencies in the work, the Engineer and/or City will inform the Contractor of the deficiencies and will deny the Contractor's request for final payment until such time as the Contractor has satisfactorily completed the required work. Additional inspections of deficiencies shall be paid for by the Contractor at City's cost, but in no event will the cost be less than \$200.00 per inspection.

CIP14.07 ACCESSORY ITEMS

- A. The Contractor shall provide to the City, upon acceptance of the equipment, all special accessories required to place each item of equipment in full operation. These special accessory items include, but are not limited to, the specified spare parts, adequate oil and grease as required for the first lubrication of the equipment, initial fill-up of all chemical tanks and fuel tanks, light bulbs, fuses, hydrant wrenches, valve wrenches, valve keys, handwheels, and other expendable items as required for initial start-up and operation of all equipment.

CIP14.08 GUARANTEES, BONDS, AND AFFIDAVITS

- A. No application for final payment will be accepted until all guarantees, bonds, certificates, licenses, and affidavits required for work or equipment as specified in the Contract Documents are satisfactorily filed with the Engineer.

CIP14.09 RELEASE OF LIENS OR CLAIMS

- A. No application for final payment will be accepted until satisfactory evidence of release of liens has been submitted to the City as required by the Standard Form of Agreement.

CIP14.10

FINAL PAYMENT

- A. Final payment will be made to the Contractor in accordance with the General Conditions. Final payment and release of retention monies will not be made until the Contractor has submitted three (3) sets of as-built plans (digital and hard copy) to the City for the Project.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP15 – PROJECT IDENTIFICATION SIGNAGE

CIP15.01 SCOPE OF WORK

- A. This specification covers the requirements for furnishing, fabricating and erecting Project Signs on Capital Improvement Projects (C.I.P.) and for project identification at other construction sites, when required on the Plans or by the City.

CIP15.02 MATERIALS

- A. Sign Face: The sign face shall be manufactured on standard exterior waterproof plywood sheets or other suitable material approved by the Engineer or the City. Unless indicated otherwise on the Plans, the thickness of the plywood sheet shall be a minimum of $\frac{3}{4}$ -inches.
- B. Posts: Plastic post, of the size indicated on the Plans, shall be pressure treated with pentachlorophenol.
- C. Paint: Exterior oil base paint shall be used and colors shall be as indicated on the Plans.
- D. Signs for Capital Improvements Projects: City seals shall be provided by the City.

CIP15.03 INSTALLATION

- A. The signs shall be erected at each major entrance to the project for maximum public identification and exposure. At locations where construction is confined to an adequate area defined by the City, the installed sign size shall be four-feet by eight-feet (4'x8'). At locations where roadway construction is in progress, such as a street paving or construction of a sidewalk, the sign shall be two-feet by three-feet (2'x3'). The signs shall be posted on portable wood frames or stanchions and will be located in the proximity of the work area as construction progresses. All lumber shall be painted with two (2) coats of paint as indicated on the Plans.
- B. In special cases, the size of the sign may be changed to meet special requirements, but general proportions shall be maintained.
- C. It shall be the responsibility of the Contractor to maintain and relocate signs, if necessary, during the progression of the project. Care shall be exercised to assure that placement of the signs does not interfere with or cause sight obstruction to vehicular and pedestrian traffic.
- D. The Contractor may install, at his own expense, company signs to identify the Contractor, Developer, etc. Signs are to be securely attached to the posts at locations indicated on the Plans and shall not be larger than 18-inches by 36-inches.

CIP15.04 PAYMENT

- A. No separate payment will be made for work performed in accordance with this section of the specifications, and the cost thereof shall be included in the proper items of the Proposal and Bid Schedule.

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP16 – RESERVED

END OF SECTION

TECHNICAL SPECIFICATIONS

SECTION CIP17 – INSPECTION OF PROJECTS

CIP17.01 INSPECTION

- A. All Projects, whether by a private development or the City of Pflugerville shall be inspected by the City or a designated representative of the City.
- B. The time that the City of Pflugerville or its designated representative will be available for inspection is from 8:00 AM to Noon and 1:00 PM to 5:00 PM on working days. Working days shall be defined as Monday through Friday excluding all holidays observed by the City of Pflugerville. All inspections shall be scheduled with the City a minimum of two (2) working days prior to the inspection.
- C. If the Contractor, for his convenience and at his own expense, should desire to carry on his work at night or outside regular hours, he shall submit a written approval request, in accordance with **Section 3.1.4** of the General Conditions, to the City and, if authorized, he shall allow ample time for satisfactory arrangements to be made for inspecting the Work in progress. The Contractor shall also pay the expenses for extra inspection required for work outside regular hours at City's actual cost, but in no event a rate of less than \$50.00/hour. Normal working hours are work hours occurring during the Work Week as defined in **Section 3.1.4** of the General Conditions. The Contractor shall light the different parts of the Project as required to comply with all applicable Federal and State regulations and with all applicable requirements of the City of Pflugerville.

CIP17.02 AUTHORITY AND DUTIES OF INSPECTORS

- A. Inspectors will be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or to any part of the Work and to the preparation or Manufacturer of the materials to be used. Such inspection will not relieve the Contractor from any obligation to perform the Work in accordance with the requirements of the Specifications. In case of any dispute arising between the Contractor and the Inspector as to materials furnished or the manner of performing the Work, the Inspector will have authority to reject materials or suspend work until the question at issue can be referred to and decided by the City. The Inspector will not be authorized to revoke, alter, enlarge, or release any requirement of these Specifications, nor to approve or accept any portion of the Work, nor to issue instruction contrary to the Plans and Specifications. He will in no case act as foreman or perform other duties for the Contractor nor interfere with the management of the Work.

END OF SECTION

SERIES 100 - EARTHWORK

ITEM NO. 101S - PREPARING RIGHT OF WAY

101S.1 - Description

This item shall govern the preparation of the right of way for construction operations by removal and disposal of all obstructions from the right of way and from designated easements, where removal of such obstructions is not otherwise indicated as a separate pay item.

Such obstructions shall be considered to include, but not be limited to, remains of houses not completely removed by others, foundations, floor slabs, concrete, brick, lumber, plaster, cisterns, water wells, septic tanks and drain fields, basements; abandoned utility pipes, conduits, underground service station tanks, fences, retaining walls, outhouses, shacks and all other debris.

This item shall also include, but not be limited to, the removal of trees, stumps, roots, bushes, shrubs, curb and gutter, driveways, paved parking areas, miscellaneous stone, brick, sidewalks, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron, and all rubbish and debris whether above or below ground. Care should be taken to identify and protect existing infrastructure.

101S.2 - Submittals

Not used.

101S.3 - Construction Methods

Prior to commencement of this work, all required erosion controls and tree protection measures indicated in the City of Pflugerville Engineering Design Manual and Construction Standards, the City of Pflugerville Tree Technical Manual: Standards & Specifications, the City of Pflugerville Erosion and Sedimentation Control Notes, and/or as indicated on the Drawings shall be in place. The existing utilities shall be located and protected as specified in the City of Pflugerville Engineering Design Manual and Construction Standards and/or as specified on the Drawings.

After the construction permit has been issued and prior to beginning construction, the owner or his representative shall schedule a pre-construction conference between the City Engineer or designated representative, Contractor(s), Travis County (if in the ETJ), other utility companies, and any other affected parties. The City Engineer or designated representative shall be contacted to set up the meeting at least 3 business days prior to the proposed meeting time (512-990-6300) and after receiving both the required number of signed plans and the SWP3.

The contractor shall coordinate with local utility service requirements and comply with their instructions. A permit shall be required when utility adjustments are to be made in preparation for construction in the right-of-way. The contractor shall verify all depths and locations of existing utilities prior to beginning construction. Any discrepancies with the construction plans found in the field shall be brought to the attention of the City Engineer or designated representative immediately. The Design Engineer shall be responsible for revising the plans as appropriate and submitting a revision to the City Engineer or designated representative. Use One call utility System: Dial 1-800-344-8377, 48 hours BEFORE you dig. For City of Pflugerville water and wastewater utility locates, call 512-990-6400.

Conduct right of way preparation/site-clearing operations to ensure minimum interference with roads, streets, walks and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

Areas within the construction limits shall be cleared of all obstructions, abandoned structures, and other items as defined above. Protect existing property and easement corners and pins. In the event that property or easement corners or pins are moved, disturbed or destroyed, the Contractor shall replace them at his own expense. They shall be replaced by a Registered Professional Land Surveyor registered in the State of Texas. All vegetation, except trees or shrubs indicated for preservation, shall also be removed. Trees and shrubs, which are scheduled for preservation, shall be carefully trimmed as directed and shall be protected from scarring, barking or other injuries during construction operations in accordance with the City of Pflugerville Tree Technical Manual: Standards & Specifications. All exposed cuts over 2 inches in diameter, exposed ends of pruned limbs or scarred bark shall be treated with an approved asphalt material within 24 hours of the pruning or injury.

Construction equipment shall not be operated, nor construction materials stockpiled under the canopies of trees, unless otherwise indicated on the Drawings and/or specified in the Contract Documents. Excavation or embankment materials shall not be placed within the drip line of trees until tree wells are constructed.

Culverts, storm sewers, manholes and inlets shall be removed in proper sequence for maintenance of traffic and drainage.

Unless otherwise indicated on the Drawings and/or Contract Documents, all underground obstructions, stumps and roots shall be removed to the following depths:

1. In areas to receive 6 inches or more embankment, a minimum of 12 inches below natural ground.
2. In areas to receive less than 6 inches of embankment, a minimum of 18 inches below the lower elevation of embankment, structure or excavation.
3. In areas to be excavated a minimum of 18 inches below the lower elevation of the embankment, structure or excavation.
4. In all other areas, a minimum of 12 inches below natural ground.

Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc. shall be backfilled with select embankment material and compacted by approved methods.

When a utility in service conflicts with the construction, it shall be modified as specified in the City of Pflugerville Engineering Design Manual & Construction Standards and/or as specified on the Drawings.

Where an abandoned underground piped utility is found, it shall be cut and plugged with 6 inches of concrete (in accordance with Specification Item 403, "Concrete for Structures") brick and mortar (in accordance with Specification Item 506, "Manholes") or a precast stopper grouted in place.

Material to be removed will be designated as salvageable or non-salvageable by the City Engineer or designated representative prior to removal from the construction site by the Contractor in a manner satisfactory to the City Engineer or designated representative. Unless otherwise provided, all materials as described above shall become the property of the Contractor and removed from the site and disposed of at a permitted disposal site. All material, which is located within the public right of way and is declared by the City Engineer or designated representative as salvageable, will remain the property of the City of Pflugerville and will be stored at the site or loaded on city trucks as directed by the City Engineer or

designated representative. All non-salvageable materials and debris shall become the property of the Contractor and shall be removed from the site and deposited at a permitted disposal site.

Restore all damaged work to condition existing prior to start of work.

101S.4 - Measurement

The preparation of right of way for new construction, when included in the contract as a pay item, will be measured by the acre (hectare: 1 hectare equals 2.471 acres), 100-foot stations or lump sum, regardless of the width of the right of way.

Measurement for payment will be made only on areas indicated and classified as "Preparing Right of Way".

101S.5 - Payment

The work and material presented herein will not be paid for directly but shall be included in the unit price bid for the item of construction in which this item is used unless specified as a separate pay item in the contract bid form. When included for payment, it shall be paid for at the contract bid price for "Preparing Right of Way." This price shall include full compensation for work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under one of the following:

Pay Item No. 101S-A:	Preparing Right of Way - Roadway	Per Acre.
Pay Item No. 101S-B:	Preparing Right of Way - Development	Per 100-foot Station.
Pay Item No. 101S-C:	Preparing Right of Way -	Per Lump Sum.

END

ITEM NO. 402S - CONTROLLED LOW STRENGTH MATERIAL

402S.1 - Description

This item governs Controlled Low Strength Material (CLSM) used for trench backfill and for filling abandoned culverts, pipes, other enclosures, and for other uses as indicated on the drawings, Standard Details or as approved by the Engineer or designated representative. CLSM is a low strength, self-compacting, flowable, cementitious material used in lieu of soil backfill. It is intentionally prepared at low strength to allow for future removal using conventional excavation equipment.

The CLSM shall be composed of Portland Cement (PC) or fly ash, or both, filler aggregate and water. The CLSM, specified for use in filling abandoned culverts, pipes, or other enclosures, shall contain a settlement compensator, in addition to the other ingredients, to minimize settlement of the CLSM within the enclosure.

Normal Set CLSM shall be specified whenever the material will remain uncovered or will not be subjected to traffic or other loads within 24 hours after placement. Fast Set CLSM shall be specified whenever the material will be covered, subjected to traffic or other loads within 24 hours, or needed to expedite construction.

CLSM can be used for permanent subgrade repairs below the base layer but shall not be used for permanent pavement repairs. For temporary traffic applications, a minimum 2-inch cap composed of Hot Mix-Cold Laid Asphaltic Concrete Pavement (TxDOT Standard Specification Item 334) shall be placed on the CLSM.

402S.2 - Submittals

The submittal requirements of this specification item include:

1. A mix design submittal including the results of unconfined compressive strength tests, air entrainment (if applicable), flow consistency, hardened unit weight, and timed Ball Drop and corresponding Penetrometer tests.
2. Certifications and test results for the cement fly ash, and admixtures.
3. Particle-size gradation and specific gravity tests on the filler aggregate.

402S.3 - Materials

A. Cement.

PC shall conform to ASTM C 150, Type I (General Purpose).

PC manufactured in a cement kiln fueled by hazardous waste shall be considered as an approved product if the production facility is authorized to operate under regulation of the Texas Commission on Environmental Quality (TCEQ) and the U.S. Environmental Protection Agency (EPA). Supplier shall provide current TCEQ and EPA authorizations to operate the facility.

B. Fly Ash

Fly ash shall conform to the requirements of Standard Specification Item No. 405, "Concrete Admixtures" and TxDOT Specification Item 437.

C. Filler Aggregate.

Filler aggregate shall consist of sand, stone screenings, pavement milling cuttings or other granular material that is compatible with the other mixture components. The filler aggregate shall be fine enough to stay in suspension to the extent required for proper flow without segregation, and, in the case of filling of enclosures, for minimal settlement. Filler aggregate shall have a Plasticity Index (TxDOT Test Method Tex-106-E) less than 15 and shall conform to the following gradation:

Sieve Designation	US	Percent Passing
	No. 200	0—10

D. Mixing Water.

Mixing water shall conform to the requirements of Standard Specification Item No. 403, "Concrete for Structures".

E. Settlement Compensator

An air entraining admixture with a higher than usual dosage, which meets the requirements of Standard Specification Item No. 405, "Concrete Admixtures", shall be used as a settlement compensator. The settlement compensator may be introduced to the CLSM at the job site by placement of prepackaged admixture in capsules or bags in the mixing drum in accordance with the admixture manufacturer's recommendations.

402S.4 - Mix Design

The proportioning of CLSM shall be the responsibility of the Contractor. The Contractor shall furnish a mix design conforming to the requirements herein, for review and approval by the Engineer or designated representative. The mix design shall be prepared by a qualified commercial laboratory and then reviewed and signed by a registered Professional Engineer licensed in the State of Texas.

The Mix Design submittal must include:

- A. Test results for unconfined compressive strength, air entrainment (if applicable), flow consistency, hardened unit weight, and timed Ball Drop (ASTM C-360) and corresponding Penetrometer tests (with a concrete pocket penetrometer),
- B. Certifications and test results for the cement, fly ash, and admixtures, and
- C. Results of particle-size gradation and specific gravity tests on the filler aggregate. The submittal shall include Penetrometer tests performed every thirty minutes until the Ball Drop test shows a 2-inch indentation, as well as the predicted Penetrometer reading that corresponds to a 3-inch Ball Drop indentation. Particle-size gradation shall be determined using a series of sieves that gives no fewer than five uniformly spaced points for graphing the entire range of particle sizes larger than a No. 200 sieve.

The Contractor shall perform the work required to substantiate the design at no cost to the City, including all testing. Approved mix designs shall be valid for one year, provided there are no changes in the type, source, or characteristics of the materials during that year.

At the end of one year, the mix design may be submitted for renewal, provided that:

1. field tests of the CLSM during the year have been satisfactory,
2. there have been no changes in type or source of the materials of the mix, and
3. the characteristics of the materials have not changed significantly since the original submittal.

The Contractor shall also submit certifications and test results for the cement, fly ash and admixtures, and particle-size gradation and specific gravity test results for the filler aggregate. The Contractor shall compare results of tests made on the filler aggregate at the end of the year to the results of tests reported in the original submittal. Gradation changes less than ten percent in percent passing any sieve and specific gravity changes less than five percent shall not be considered significant.

402S.5 - Strength

The CLSM mix designs shall meet the unconfined compressive strength requirements outlined in the table below. The compression tests shall be conducted in accordance with TxDOT Method Tex-418-A, using approved unbonded caps on specimens with 4-inch diameter and 8-inch height [or 3-inch diameter by 6-inch high specimens if a smaller capacity loading device gives more accurate results].

Unconfined Compressive Strength, psi		
Age	Normal Set CLSM	Fast Set CLSM
3 hours	—	35 minimum
24 hours	35 minimum	—
28 days	300 maximum	300 maximum

402S.6 - Flow Consistency

Flow consistency shall be established in tests involving the use of a 6-inch length by 3-inch diameter open-ended straight tubing made of steel, plastic or other non-absorbent material that is non-reactive with cement or fly ash. The tube shall be placed with one end on a horizontal flat surface and held in a vertical position. The tube shall then be filled to the top with CLSM. The top surface shall be struck off with a suitable straight edge and any spillage shall be removed from the base of the tube. Within five seconds thereafter the tube shall be raised carefully, using a steady upward lift with no lateral or torsional motion. The entire test, from the start of filling until removal of the tube, shall be completed within 1½ minutes without interruption.

After removal of the tube, the spread of the CLSM shall be measured immediately along two diameters that are perpendicular to one another. The average of those two measurements is defined as the flow

consistency of the mix. The flow consistency of the CLSM shall be considered satisfactory if a circular-type spread of the mix occurs without segregation and a flow consistency (average diameter of spread) of 8 inches or more is achieved.

402S.7 - Air Entrainment

Air entraining admixture shall be added as a settlement compensator, whenever the CLSM will be used to fill an enclosure (Section 402S.1). The dosage shall be sufficient to result in an air content of 15 to 25 percent (as determined by TxDOT Method Tex-416-A) at the time of placement of the CLSM.

402S.8 - Field Strength Tests

Ball Drop or Penetrometer tests shall be used to determine, when the CLSM has developed sufficient strength to be covered or subjected to traffic or other loads as approved by the Engineer or designated representative.

The Ball Drop test shall be performed according to the latest version of ASTM C-360. An indentation diameter of 3 inches or less, and the absence of a sheen or any visible surface water in the indentation area shall indicate that the CLSM has achieved the desired strength. Because trench width and depth may affect the test results, the Contractor may perform this test on a control sample of CLSM in a 2-foot square by 6-inch deep container.

Penetrometer tests using a hand-held, spring reaction-type device commonly called a concrete pocket penetrometer, shall be performed on the surface of the CLAMS. A Penetrometer reading, equal to or greater than the value established in the mix design (Section 402S.4) for a Ball Drop test indentation of 3-inches, shall indicate that the CLSM has achieved the desired strength.

402S.9 - Construction Methods

A. General

The height of free fall placement of the CLSM shall not exceed 4 feet. Since CLSM is considered to be self-compacting, a vibrator shall not be allowed. The CLSM shall not be covered with any overlying materials or subjected to traffic or other loads until the Ball Drop test or the Penetrometer test shows acceptable results (Section 402S.8) or until the CLSM has been in place a minimum of 24 hours for Normal Set CLSM and a minimum of 3 hours for Fast Set CLSM. Curing of the CLSM will not be required.

B. Utility Line Backfill

After the utility pipe has been placed and the proper bedding material placed in accordance with the details on the drawings, the trench may be immediately backfilled with the CLSM to the subgrade level shown on the drawings, Standard Details 1100S-6B & D, 430S-4 "Concrete Backfill Under Curb and Gutter" or as directed by the Engineer or designated representative.

C. Culvert Backfill

Care shall be taken to prevent movement of the structure. If the pipe or structure moves either horizontally or vertically, the CLSM and the structure shall be immediately removed, and the pipe or structure re-laid to proper line and grade.

D. Other Backfill

CLSM may be used for backfill material in lieu of soil as shown on the drawings, Standard Details or as approved by the Engineer or designated representative.

E. Filling Abandoned Culverts, Pipe, or other Enclosures

The CLSM shall be placed in a manner that allows all air or water, or both, to be displaced readily as the CLSM fills the enclosure.

402S.10 - Acceptance Testing During Construction

The Engineer or designated representative may perform flow consistency, air entrainment, and unconfined compressive strength tests to determine if the CLSM meets the specification requirements. The number and frequency of acceptance tests will be determined by the Engineer or designated representative.

402S.11 - Measurement and Payment

The work and materials presented herein will generally not be paid for directly but shall be included in the unit price bid for the item of construction in which this item is used.

When specified in the contract bid form as a separate pay item, the item will be paid for at the contract unit bid price(s) for "Controlled Low Strength Material". The bid prices shall include full compensation for all Work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the Work.

Payment will be made under the following:

Pay Item No. 402S-A:	Controlled Low Strength Material	Per Cubic Yard

END

ITEM NO. 403S - CONCRETE FOR STRUCTURES

403S.1 - Description

This item shall govern quality, storage, handling, proportioning and mixing of materials for hydraulic cement concrete construction of buildings, bridges, culverts, slabs, prestressed concrete and incidental appurtenances.

403S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall submit electronically the following submittal requirements as applicable:

- a. Technical literature including type of concrete and mix design option(s) of the class of concrete required on the project,
- b. The supplier of the concrete mix design(s) and type of mixing equipment,
- c. Type of admixtures to be used with the concrete mixes,
- d. Description of curing method used, and
- e. Manufacturer of precast structures

403S.3 - Materials

Concrete shall be composed of Portland cement, water, aggregates (fine and coarse), and admixtures if desired or required, proportioned and mixed as hereinafter to achieve specified results.

A. Cementitious Materials

Hydraulic cement shall conform to ASTM C 150, Type I (General Purpose), Type II (General Purpose with Moderate Sulfate Resistance) and Type III (High Early Strength). Type I shall be used when none is specified or indicated on the drawings. Type I and Type III cements shall not be used when Type II cement is specified or indicated on the drawings. Type III cement may be used in lieu of a Type I cement, when the anticipated air temperature for the succeeding 12 hours will not exceed 60°F (15.6°C). A Type III cement shall only be used in precast concrete or when otherwise specified or allowed. All cement shall be of the same type and from the same source for a monolithic placement.

Unless otherwise specified, the cementitious material content shall be limited to no more than 700 lbs. per cubic yard. When supplementary cementing materials are used, cement is defined as "cement plus supplementary cementing material." Supplementary cementing materials include fly ash (DMS-4610), ultra-fine fly ash (DMS-4610), ground granulated blast furnace slag grade 100 or 120 (DMS-4620), silica fume (DMS-4630) and metakaolin (DMS-4635).

Class C flyash shall not be used in sulfate-resistant concrete.

Hydraulic cement manufactured in a cement kiln fueled by hazardous waste shall be considered as an approved equivalent product if the production facility is authorized to operate under regulation of the Texas Commission on Environmental Quality (TCEQ) and the U.S. Environmental Protection Agency (EPA). Supplier shall provide current TCEQ and EPA authorizations to operate the facility.

When sulfate-resistant concrete is required for a project, mix design options 1, 2, 3 or 4 presented in Section 403S.8, "Mix Design Options" shall be used to develop appropriate mix design utilizing Type I/II, II, V, IP or IS cement.

B. Mixing Water

Water for use in concrete and for curing shall be potable water free of oils, acids, organic matter or other deleterious substances and shall not contain more than 1,000 parts per million of chlorides as Cl or sulfates as SO₄.

Water from the City of Pflugerville will not require testing. Contractor may request approval of water from other sources. Contractor shall arrange for samples to be taken from the source and tested at the Contractor's expense. When water from other sources is proposed, test reports shall be provided that indicates compliance with Table 1 before use.

Table 1: Chemical Limits for Mix Water		
Contaminant	Test Method	Maximum Concentration (ppm)
Chloride (CL) Prestressed concrete Bridge decks & superstructure All other concrete	ASTM D-512	500 500 1,000
Sulfate (SO ₄)	ASTM D-516	1,000
Alkalies (NA ₂ O + 0.658 K ₂ O)	ASTM D-4191 & D-4192	600
Total Solids	AASHTO T-26	50,000

Water that has an adverse effect on the air-entraining agent or any other chemical admixture or on strength or time of set of the concrete shall not be used. Water used in white Portland Cement (PC) concrete shall be free from iron and other impurities, which may cause staining, or discoloration.

C. Coarse Aggregate

Coarse aggregate shall consist of durable particles of crushed or uncrushed gravel, crushed blast furnace slag, crushed stone or combinations thereof; free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material either free or as an adherent coating. When white hydraulic cement is specified, the coarse aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout.

The coarse aggregate from each source shall not contain more than 0.25 percent by weight of clay lumps, nor more than 1.0 percent by weight of shale nor more than 5 percent by weight of laminated and/or friable particles when tested in accordance with TxDOT Test Method Tex-413-A. The coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with TxDOT Test Method Tex-410-A.

Unless otherwise indicated on the drawings, the coarse aggregate from each source shall be subjected to 5 cycles of the soundness test conforming to TxDOT Test Method Tex-411-A. The loss shall not be greater than 12 percent when sodium sulfate is used or 18 percent when magnesium sulfate is used. A satisfactory record under similar conditions of service and exposure will be considered in the evaluation of material failing to meet these requirements.

Coarse aggregate shall be washed. The Loss by Decantation (TxDOT Test Method Tex-406-A), plus allowable weight of clay lumps, shall not exceed 1 percent or the value indicated on the drawings or in the project manual, whichever is less. If material finer than the # 200 sieve is definitely established to be dust or fracture of aggregates made primarily from crushing of stone, essentially free from clay or shale as established by Part III of TxDOT Test Method Tex-406-A, the percent may be increased to 1.5. When crushed limestone coarse aggregate is used in concrete pavements, the decant may exceed 1% but not more than 3% if the material finer than the #200 sieve is determined to be at least 67% calcium carbonate in accordance with TxDOT Test Method Tex-406-A, Part III.

The coarse aggregate factor may not be more than 0.82; however, when voids in the coarse aggregate exceed 48 percent of the total rodded volume, the coarse aggregate factor shall not exceed 0.85. The coarse aggregate factor may not be less than 0.68 except for a Class I machine extruded mix that shall not have a coarse aggregate factor lower than 0.61.

When exposed aggregate surfaces are required, the coarse aggregate shall consist of particles with at least 40 percent crushed faces. Uncrushed gravel, polished aggregates and clear resilient coatings are not acceptable for exposed aggregate finishes.

When tested by approved methods, the coarse aggregate including combinations of aggregates when used, shall conform to the grading requirements shown in Table 2.

Table 2: Coarse Aggregate Gradation Chart (Percent Passing)										
Grade	Nom. Size	2½"	2"	1½"	1"	¾"	½"	⅜"	No. 4	No. 8
1	2"	100	80-100	50-85		20-40			0-5	
2 (467)*	1½"		100	95-100		35-70		10-30	0-5	
3	1"		100	95-100		60-90	25-60		0-5	
4 (57)*	1"			100	95-100		25-60		0-10	0-5
5 (67)*	¾"				100	90-100		20-55	0-10	0-5
6 (7)*	½"					100	90-100	40-70	0-15	0-5
7	⅜"						100	70-95	0-25	
8	⅜"						100	95-100	20-65	0-10

Notes:

1. Recycled crushed concrete fine aggregate shall be limited to a maximum of 20% of the fine aggregate.
2. The use of recycled crushed hydraulic cement concrete as a coarse aggregate shall be limited to Concrete Classes A, B and D (see Table 5).

D. Fine Aggregate

Fine aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. When white hydraulic cement is specified, the fine aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5 percent by weight of clay lumps in accordance with Tex-413-A. When subjected to color test for organic impurities per TxDOT Test Method Tex-408-A, it shall not show a color darker than standard.

Unless indicated otherwise on the drawings the acid insoluble residue of fine aggregate used in slab concrete subject to direct traffic shall not be less than 60 percent by weight (mass) when tested conforming to TxDOT Test Method Tex-612-J.

Unless indicated otherwise on the Drawings, fine aggregate shall be blended, when necessary, to meet the acid insoluble residue requirement.

When blending the following equation shall be used:

$$\text{Acid Insoluble (\%)} = \{(A1)(P1) + (A2)(P2)\} / 100$$

Where:

A1 = acid insoluble (%) of aggregate 1,

A2 = acid insoluble (%) of aggregate 2,

P1 = % by weight of A1 of the fine aggregate blend, and

P2 = % by weight of A2 of the fine aggregate blend.

When tested in accordance with TxDOT Test Method Tex-401-A, the fine aggregate, including mineral filler and combinations of aggregates, when used, shall conform to the grading requirements shown in Table 3.

Table 3: Fine Aggregate Gradation Chart ¹ (Grade 1 - Percent Passing)							
3/8	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
100	95-100	80-100	50-85	25-65	10-35	0-10	0-32

Notes:

1. Recycled crushed concrete fine aggregate shall be limited to a maximum of 20% of the fine aggregate.
2. The use of recycled crushed hydraulic cement concrete as a fine aggregate shall be limited to Concrete Classes A, B and D (see Table 5).
3. 6 to 35 when sand equivalent value is greater than 85.
4. 0 to 6 for manufactured sand.

Fine aggregate will be subjected to Sand Equivalent Test per TxDOT Test Method Tex-203-F. Sand Equivalent shall not be less than 80 nor less than otherwise indicated on the drawings, whichever is greater.

The fineness modulus will be determined by adding the percentages by weight retained on sieve Nos. 4, 8, 16, 30, 50 and 100 and dividing the sum of the six sieves by 100. For all classes of concrete except K (see Table 5), the fineness modulus shall be between 2.30 and 3.10. For Class K concrete, the fineness modulus shall be between 2.6 and 2.8, unless indicated otherwise on the Drawings.

E. Mineral Filler

Mineral filler shall consist of stone dust, clean crushed sand or other approved inert material. When tested in accordance with TxDOT Test Method Tex-401-A, it shall conform to the following gradation:

Passing the No. 30 Sieve	100 percent
Passing the No. 200 Sieve	65 to 100 percent

F. Mortar and Grout

Unless otherwise specified, indicated on the drawings or approved by the City Engineer or designated representative mortar and grout shall consist of 1 part cement, 2 parts finely graded sand and enough water to make the mixture plastic. When required to prevent color difference, white cement shall be added to produce color required. When required by the City Engineer or designated representative, approved latex adhesive may be added to the mortar. Mortar shall be provided with a consistency such that the mortar can be easily handled and spread by trowel. Grout shall be provided of a consistency that will flow into and completely fill all voids.

G. Admixtures

All chemical admixtures including water reducing, plasticizers and air entrainment shall conform to TxDOT DMS-4640, "Chemical Admixtures for Concrete". Calcium chloride-based admixtures shall not be approved. Unless otherwise noted, air-entraining, retarding and water reducing admixtures may be used in all concrete. Admixtures shall be included in the prequalified concrete admixtures list maintained by TxDOT's Construction Division (latest edition). High-range water-reducing admixtures

(TxDOT Type F or G) and accelerating admixtures (TxDOT Type C or E) shall not be used in bridge deck concrete.

H. Air Entrainment

Unless indicated otherwise on the drawings, all concrete classes with the exception of Class B shall be air entrained in accordance with Table 8. If the air content is more than 1½ percentage points below or 3 percentage points above the required air, the load of concrete will be rejected. If the air content is more than 1½ but less than 3 percentage points above the required air, the concrete may be accepted based on strength test results.

403S.4 - Storage of Materials

A. Cement, Supplementary Cementing Materials and Mineral Filler

All cement, supplementary cementing materials and mineral filler shall be stored in separate and well ventilated, weatherproof buildings or approved bins, which will protect the material from dampness or absorption of moisture. Storage facilities shall be easily accessible, and each shipment of packaged cement shall be kept separated to provide for identification and inspection. The City Engineer or designated representative may permit small quantities of sacked cement to be stored in the open for a maximum of 48 hours on a raised platform and under waterproof covering.

B. Aggregates

The method of handling and storing concrete aggregates shall prevent contamination with foreign materials. If the aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and shall be level. Aggregates shall be stockpiled in sizes to facilitate blending. If the aggregate is not stockpiled on a hard, non-contaminant base, the bottom 6-inch layer of the stockpile shall not be used without recleaning the aggregate.

When conditions require the use of 2 or more grades of coarse aggregates, separate stockpiles shall be maintained to prevent intermixing. Where space is limited, stockpiles shall be separated by walls or other appropriate barriers.

Aggregate shall be stockpiled and protected from the weather a minimum of 24 hours prior to use to minimize free moisture content. When stockpiles are too large to protect from the weather, accurate and continuous means acceptable to the City Engineer or designated representative shall be provided to monitor aggregate temperature and moisture. Aggregates shall be stockpiled and handled such that segregation and contamination are minimized.

The stockpiles shall be sprinkled to control moisture and temperature as necessary. A reasonably uniform moisture content shall be maintained in aggregate stockpiles.

C. Admixtures

Admixtures shall be stored in accordance with manufacturer's recommendations and shall be protected against freezing.

D. Hot Weather Concrete Mixes

Ice may be used during hot weather concrete placement (Section 13 of Standard Specification Item No. 410S, "Concrete Structures") to lower the concrete temperature; however, the Contractor shall

furnish a mix design acceptable to the City Engineer or designated representative for class of concrete specified. The addition of ice shall not exceed 50% of the total mix water weight.

403S.5 - Measurement of Materials

Water shall be accurately metered. Fine and coarse aggregates, mineral filler, bulk cement and fly ash shall be weighed separately. Allowances shall be made in the water volume and aggregate weights during batching for moisture content of aggregates and admixtures. Volumetric and weight measuring devices shall be acceptable to the City Engineer or designated representative. Measurement of materials in non-volumetric and volumetric mixers shall conform TxDOT Specification Item 421, "Hydraulic Cement Concrete".

Batch weighing of sacked cement is not required; however, bags, individually and entire shipments, may not vary by more than 3 percent from the specified weight of 94 pounds per bag. The average bag weight of a shipment shall be determined by weighing 50 bags taken at random.

403S.6 - Mix Design

The Contractor shall furnish a mix design acceptable to the City Engineer or designated representative for the class of concrete required in accordance with Table 5. The mix shall be designed by a qualified commercial laboratory and/or concrete technician and signed/sealed by a registered Professional Engineer, licensed in the state of Texas to conform with requirements contained herein, to ACI 211.1 or TxDOT Bulletin C-11 (and supplements thereto). The maximum water-to-cementitious material ratio identified in Table 5 for specific classes of concrete shall not be exceeded.

A higher-strength class of concrete with equal or lower water-to-cementitious-material ratio may be substituted for the specified class of concrete.

The mix design shall be over-designed in accordance with Table 5 in order to account for production variability and to ensure minimum compressive strength requirements are met.

Allowable mix design options are presented in Section 403S.8.

The Contractor shall perform, at the Contractor's expense, the work required to substantiate the design, including testing of strength specimens. Complete concrete design data shall be submitted to the City Engineer or designated representative for approval. The mix design will be valid for a period of one (1) year provided that there are no changes to the component materials. In lieu of the above mix design, the Contractor may accept a design furnished by the City. However, this will not relieve him of providing concrete meeting the requirements of these specifications.

It shall also be the responsibility of the contractor to determine and measure the batch quantity of each ingredient, including all water, so that the mix conforms to these specifications and any other requirements shown on the Drawings.

When there are changes in aggregates or in type, brand or source of cement, supplementary cementing material or chemical admixtures, the mix shall be evaluated as a new mix design. A change in vendor does not necessarily constitute a change in materials or source. When only the brand or source of cement is changed and there is a prior record of satisfactory performance of the cement with the ingredients, the submittal of new trial batches may be waived by the City Engineer or designated representative.

At the end of one (1) year, a previously approved mix may be resubmitted for approval if it can be shown that no substantial change in the component materials has occurred and that test results confirming the adequacy of the mix designs have been acquired during the previous year. The resubmittal analysis must be reviewed, signed and sealed by a registered Professional Engineer, licensed in the state of Texas. This resubmittal shall include a reanalysis of specific gravity, absorption, fineness modulus, sand equivalent, soundness, wear and unit weights of the aggregates. Provided that the fineness modulus did not deviate by more than 0.20 or that the re-proportioned total mixing water, aggregate and cement (or cement plus fly ash) are within 1, 2, and 3 percent, respectively, of pre-approved quantities, a one-year extension on the approval of the mix may be granted by the City Engineer or designated representative. Updated cement, fly ash, and admixture certifications shall accompany the resubmittal.

Approved admixtures that are included in the prequalified concrete admixtures list maintained by TxDOT's Construction Division may be used with all classes of concrete at the option of the Contractor provided that specific requirements of the governing concrete structure specification are met. Water reducing and retarding agents shall be required for hot weather, large mass, and continuous slab placements. Air entraining agents may be used in all mixes but must be used in the classes indicated on Table 5. Unless approved by the City Engineer or designated representative, mix designs shall not exceed air contents for extreme exposure conditions as recommended by ACI 211.1 for the various aggregate grades.

403S.7 - Consistency and Quality of Concrete

Concrete shall be uniform, workable, cohesive, possess satisfactory finishing qualities and of stiffest consistency that can be placed and vibrated into a homogeneous mass within slump requirements specified in Table 4 without the development of segregation or honeycombing. No concrete will be permitted with a slump in excess of the maximums shown unless water-reducing admixtures have been previously approved. Concrete that exceeds the maximum acceptable placement slump at time of delivery will be rejected. Slump values shall be conducted in accordance with TxDOT Test Method Tex-415-A.

Consistency and quality of concrete should allow efficient placement and completion of finishing operations before initial set. Re-tempering (i.e. addition of water and reworking concrete after initial set) shall not be allowed. When field conditions are such that additional moisture is needed for final concrete surface finishing operation, the required water shall be applied to surface by fog spray only and shall be held to a minimum. Excessive bleeding shall be avoided and in no case will it be permissible to expedite finishing and drying by sprinkling the surface with cement powder.

Table 4: Slump Requirements		
Type of Construction	Slump ¹, inches	
	Maximum	Minimum
Cased Drilled Shafts	4	3
Reinforced Foundation Caissons and Footings	3	1
Reinforced Footings and Substructure Walls	3	1
Uncased Drilled Shafts	6	5
Thin-walled Sections; 9 inches or less	6½	4
Prestressed Concrete Members	6½	4
Precast Drainage Structures	6	4

Wall Sections over 9 inches	5	3
Reinforced Building Slabs, Beams, Columns and Walls	4	1
Bridge Decks	4	2
Pavements, Fixed-form	6½	4
Table 4 (continued): Slump Requirements		
	Slump ¹, inches	
Type of Construction	Maximum	Minimum
Pavements, Slip-form	3	1½
Sidewalks, Driveways and Slabs on Ground	4	2
Curb & Gutter, Hand-vibrated	3	1
Curb & Gutter, Hand-tamped or spaded	4	2
Curb & Gutter, Slip-form/extrusion machine	2	1/2
Heavy Mass Construction	2	1
High Strength Concrete	4	3
Riprap and Other Miscellaneous Concrete	6	1
Under Water or Seal Concrete	8½	6

Notes:

1. Slump values when a high range water reducer (HRWR) is not used.
2. When a high range water reducer (HRWR) is used, maximum acceptable placement slump will be 9 in.

During progress of the work, the City Engineer or designated representative shall cast test cylinders as a check on compressive strength of concrete actually placed. The City Engineer or designated representative may also perform slump tests, entrained air tests and temperature checks to ensure compliance with specifications.

Proportioning of all material components shall be checked prior to discharging. Excluding mortar material for pre-coating of the mixer drum [see section 403S.8.B] and adjustment for moisture content of admixtures and aggregates, material components shall fall within the range of + 1% for water, + 2% for aggregates, + 3% for cement, + 2% for fly ash and within manufacturer recommended dosage rates for admixtures except that air entrainment shall be within + 1½ percentage points of the mix design requirements.

Unless otherwise specified or indicated on the drawings, concrete mix temperature shall not exceed 90°F except in mixes with high range water reducers where a maximum mix temperature of 100°F will be allowed. Cooling an otherwise acceptable mix by addition of water or ice during agitation will not be allowed.

Test cylinders will be required for small placements such as manholes, inlets, culverts, wing walls, etc. The City Engineer or designated representative may vary the number of tests to a minimum of 1 for each 25 cubic yards placed over a several-day period.

Test cylinders shall be required for each monolithic placement of bridge decks or superstructures, top slabs of direct traffic culverts, cased drilled shafts, structural beams and as otherwise directed by the City Engineer or designated representative for design strength confirmation or early form removal. Test cylinders made for early form removal or for consideration of use of structure will be at Contractor's expense, except when required by the City Engineer or designated representative.

A strength test shall be defined as the average breaking strength of 2 cylinders. A minimum of four test cylinders shall be prepared; two each to be tested at 7 and 28 days. Specimens will be tested conforming to TxDOT Test Method Tex-418-A. If required strength or consistency of class of concrete being produced cannot be secured with minimum cementitious material specified or without exceeding maximum water/cementitious material ratio, Contractor will be required to furnish different aggregates, use a water reducing agent, an air entraining agent or increase the cement content in order to provide concrete meeting these specifications.

Slump tests will be performed in accordance with TxDOT Test Method Tex-415-A. Entrained air tests will be performed in accordance with TxDOT Test Method Tex-416-A.

Test specimens shall be cured using the same methods and under the same conditions as the concrete represented. Design strength cylinders shall be cured conforming to TxDOT Bulletin C-11 (and supplements thereto).

When control of concrete quality is by 28-day compressive tests, job control testing will be by 7-day compressive strength tests. The minimum strength requirement for seven (7) day test will be 70 percent of the specified minimum 28-day compressive strength. If the required 7-day strength is not secured with the quantity of cement specified in Table 4, changes in the mix design shall be made and resubmitted for approval. For an occasional failure of the seven-day compressive test, the concrete may be tested at 28 days for final evaluation.

Concrete Classification	Sacks of Cement per CY	Min. Compressive Strength (28^f c) 28 Day (psi)	Min. Beam Strength 7 Day	Max. Water/Cement Ratio (gal/sack)	Coarse Aggregate No.⁵
A ⁷	5.0	3000	425 390 ³	6.5	1-2-3-4-8 ^{1,4}
B	4.5	2500	300	8	2-3-4-5-6-7
C ^{6,7}	6.0	3600	510	6	1-2-3-4-5
D	3.0	1500	215	11	2-3-4-5-6-7
E	6.0	3000	425	6	2-3-4-5
S ⁷	6.5	4000	570 525 ³	5	2-3-4-5
P	5.0	N/A	555 ²	6.25	2-3
DC	8.75	5500	720	3.6	6

CO	7.0	4600	640	4.5	6
SS	7.0	3600	510	5.5	3-4-5

Notes:

1. Grade 8 aggregate for use in extended coarse and extruded curbs, unless a larger size is approved by the City Engineer or designated representative.
2. Minimum running average of concrete pavement.
3. When Type II or Type I / II cement is used.
4. Unless otherwise permitted by the City Engineer, Grade I coarse aggregate may only be used in massive foundations with 4-inch minimum clear spacing between reinforcing steel bars
5. Grade 1 coarse aggregate grading shall not be used in drilled shafts.
6. Structural concrete classes.
7. When Type II cement is used in Class C, S or A concrete, the 7-day compressive strength requirement will be 2310 psi for Class C, 2570 psi for Class S and 1925 psi for Class A minimum.

Table 6: Over Design Required to Meet Compressive Strength Requirements ¹					
Number Of Tests ^{2,3}	Standard Deviation, psi				
	300	400	500	600	700
15	470	620	850	1,120	1,390
20	430	580	760	1,010	1,260
30 or more	400	530	670	900	1,130

Notes:

1. When designing the mix, add the tabulated amounts to the minimum design strength in Table 5. Maximum water-cement or water-cementitious ratio by weight
2. Number of tests of a concrete mixture used to estimate the standard deviation of a concrete production facility. Test of another mix within 1,000 psi of the specified strength may be used.
3. If less than 15 prior tests are available, the overdesign should be 1,000 psi for specified strength less than 3,000 psi, 1,200 psi for specified strengths from 3,000 to 5,000 psi and 1,400 psi for specified strengths greater than 5,000 psi.

Table 7: Expected Usage of Concrete Classes	
Class	General Usage
A	Drilled shafts, culverts (except top of slab of direct traffic culverts), inlets, manholes, headwalls, approach slabs, curb, gutter, curb & gutter, concrete retards, sidewalks, driveways, backup walls and anchors
B	Riprap, small roadside signs and anchors
C ⁵	Drilled shafts, bridge substructure, bridge railing, culverts (except top slab of direct traffic culverts), headwalls, wing walls, approach slabs, and cast-in-place concrete traffic barrier
Table 7 (Continued): Expected Usage of Concrete Classes	
Class	General Usage
D	Riprap
E	Seal concrete
S	Bridge slab, top slab of direct traffic culvert, bridge sub-structure
P	Concrete pavement
DC	Dense concrete overlay
CO	Concrete overlay
SS	Slurry displacement shafts, underwater drill shafts

Table 8: Air Entrainment ¹		
Nominal Maximum Aggregate Size, In.	% Air Entrainment ²	
	Moderate Exposure	Severe Exposure
3/8 - Grades 7 & 8	6	7½
1/2 - Grades 6	5½	7
3/4 - Grades 5	5	6
1 - Grades 4	4½	6
1½ - Grades 2 & 3	4½	5½
2 - Grades 2	4	5

Notes:

1. For specified concrete strengths above 5,000 psi a reduction of 1 percentage point is allowed.
2. Grade 8 aggregate for use in extended course and extruded curbs, unless a larger size is approved by the City Engineer or designated representative.

403S.8 - Mix Design Options

For the structural concretes identified in Table 5 (Class C) and any other class of concrete designed using more than 520 lbs. of cementitious material per cubic yard, one of the mix design options presented below shall be used.

For the non-structural concretes identified in Table 5 (Classes A, B, D, E, S, P, DC, CO and SS) and any other class of concrete designed using less than 520 lbs. of cementitious material per cubic yard, one of the mix design options presented below will be used, except that Class C fly ash may be used instead of Class F fly ash for Options 1, 3 and 4 unless a sulfate-resistant concrete is required.

- A. Option 1: Twenty (20) to thirty-five (35) percent of the cement may be replaced with Class F fly ash.
- B. Option 2: Thirty-five (35) to fifty (50) percent of the cement may be replaced with ground granulated blast-furnace slag.
- C. Option 3: Thirty-five (35) to fifty (50) percent of the cement may be replaced with a combination of Class F fly ash, ground granulated blast-furnace slag or silica fume. The combination may not include more than thirty-five (35) percent fly ash and no more than ten (10) percent silica fume.
- D. Option 4: Type IP or Type IS will be used and up to ten (10) percent of the cement may be replaced with Class F fly ash, ground granulated blast-furnace slag or silica fume.
- E. Option 5: Thirty-five (35) to fifty (50) percent of the cement may be replaced with a combination of Class C fly ash and at least six (6) percent of silica fume, ultra-fine fly ash or metakaolin. The combination may not include more than thirty-five (35) percent fly ash and no more than ten (10) percent silica fume.
- F. Option 6: A lithium nitrate admixture will be added at a minimum dosage of 0.55 gal. of thirty (30) percent lithium nitrate solution per pound of alkalis present in the hydraulic cement.
- G. Option 7: When hydraulic cement only is used in the design, the total alkali contribution from the cement in the concrete does not exceed 4.0 lbs. per cubic yard, when calculated as follows:

$$\text{alkali (lbs. per CY)} = .01 (\text{lbs cement/CY}) (\% \text{ Na}_2\text{O equivalent in cement})$$

where (% Na₂O equivalent in cement) is assumed to be the maximum cement alkali content reported on the cement mill certificate.

- H. Option 8: When there are deviations from Options 1 through 7, the following shall be performed:
 1. Conduct tests on both coarse and fine aggregate separately in accordance with ASTM C-1260, using 440 g of the proposed cementitious in the same proportions of hydraulic cement to supplementary cementing material to be used in the mix.

2. Prior to use of the mix, a certified test report signed and sealed by a Professional Engineer, licensed in the state of Texas shall be submitted that demonstrates that ASTM C 1260 test results for each aggregate do not exceed 0.10 percent expansion.

403S.9 - Mixing and Mixing Equipment

All equipment, tools and machinery used for hauling materials and performing any part of the work shall be maintained in such condition to insure completion of the work without excessive delays for repairs and replacement. Mixing shall be done in a mixer of approved type and size that will produce uniform distribution of material throughout the mass and shall be capable of producing concrete meeting requirements of ASTM C 94, Ready-mixed concrete and these specifications. Mixing equipment shall be capable of producing sufficient concrete to provide required quantities. Entire contents of the drum shall be discharged before any materials are placed therein for a succeeding batch. Improperly mixed concrete shall not be placed in a structure. For all mixers an adequate water supply and an accurate method of measuring the water shall be provided.

The concrete shall be mixed in quantities required for immediate use. Re-tempering of concrete will not be permitted unless concrete is delivered in a truck-mixer.

In threatening weather, which may result in conditions that will adversely affect quality of the concrete to be placed, the City Engineer or designated representative may order postponement of the work. Where work has been started and changes in weather conditions require protective measures, the Contractor shall furnish adequate shelter to protect the concrete against damage from rainfall, or freezing temperatures. If necessary to continue operations during rainfall, the Contractor shall also provide protective coverings for the material stock piles. Aggregate stockpiles need to be covered only to the extent necessary to control the moisture conditions in the aggregates to adequately control the consistency of the concrete.

The mixer may be batched by either volumetric or weight sensing equipment and shall be equipped with a suitable timing device that will lock the discharging mechanism and signal when specified time of mixing has elapsed.

A. Proportioning and Mixing Equipment

For all miscellaneous concrete placements, a mobile, continuous, volumetric mixer or a volumetric or weight batch mixer of the rotating paddle type may be used.

When approved by the City Engineer or designated representative in writing or when specified for use in other items, these mixers may be used for other types of concrete construction, including structural concrete, if the number of mixers furnished will supply the amount of concrete required for the particular operation in question.

These mixers shall be designed to receive all the concrete ingredients, including admixtures, required by the mix design in a continuous uniform rate and mix them to the required consistency before discharging.

For continuous volumetric mixers, the materials delivered during a revolution of the driving mechanism or in a selected interval, will be considered a batch and the proportion of each ingredient will be calculated in the same manner as for a batch type plant.

Mixing time shall conform to recommendations of manufacturer of mixer unless otherwise directed by the City Engineer or designated representative.

B. Ready-mixed Concrete

Use of ready-mixed concrete will be permitted provided the batching plant and mixer trucks meet quality requirements specified herein. When ready-mixed concrete is used, additional mortar (1 sack cement, 3 parts sand and sufficient water) shall be added to each batch to coat the mixer drum. Ready-mixed concrete, batching plant and mixer truck operation shall include the following:

1. A ticket system will be used that includes a copy for the Inspector. Ticket will have machine stamped time/date of concrete batch, a mix design designation, weight of cement, fly ash, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on ticket may be cause for rejection of concrete.
2. Sufficient trucks will be available to support continuous placements. The Contractor will satisfy the City Engineer or designated representative that adequate standby trucks are available to support monolithic concrete placement requirements.
3. A portion of mixing water required by the mix design to produce the specified slump may be withheld and added at the job site, but only with permission of the City Engineer or designated representative and under the Inspector's observation. When water is added under these conditions, the concrete batch will be thoroughly mixed before any slump or strength samples are taken. Additional cement shall not be added at the job site to otherwise unacceptable mixes.
4. A metal plate(s) shall be attached in a prominent place on each truck mixer plainly showing the various uses for which it was designed. The data shall include the drum's speed of rotation for mixing and for agitating and the capacity for complete mixing and/or agitating only. A copy of the manufacturer's design, showing dimensions of blades, shall be available for inspection at the plant at all times. Accumulations of hardened concrete shall be removed to the satisfaction of the City Engineer or designated representative.
5. The loading of the transit mixers shall not exceed capacity as shown on the manufacturer's plate attached to the mixer or 63 percent of the drum volume, whichever is the lesser volume. The loading of transit mixers to the extent of causing spill-out en route to delivery will not be acceptable. Consistent spillage will be cause for disqualification of a supplier.
6. Excess concrete remaining in the drum after delivery and wash water after delivery shall not be dumped on the project site unless approval of the dump location is first secured from the City Engineer or designated representative.

C. Volumetric Batching

Use of volumetric batched concrete will be permitted provided the batching and continuous mixing operations conform to ASTM C 685, "Concrete Made By Volumetric Batching and Continuous Mixing." This type concrete shall be made from materials continuously batched by volume, mixed in a continuous mixer and delivered to the site in a freshly mixed and unhardened state. Tests and criteria for batching accuracy and mixing efficiency shall be as specified in ASTM C 685.

1. A ticket system will be used that includes a copy for the Inspector. The ticket will have machine stamped time/date of concrete batch, a mix design designation, weight of cement, fly ash, sand and aggregates; exact nomenclature and written quantities of admixtures and water. Any item missing or incomplete on ticket may be cause for rejection of concrete.
2. Each batching or mixing unit, or both, shall carry in a prominent place a metal plate or plates on which are plainly marked the gross volume of the unit in terms of mixed concrete, discharge speed and the weight-calibrated constant of the machine in terms of a revolution counter or other output indicator. The mixer shall produce a thoroughly mixed and uniform concrete.
3. The batcher-mixer unit shall contain in separate compartments all the necessary ingredients needed for the manufacture of concrete. The unit shall be equipped with calibrated proportioning devices to vary the mix proportions and it shall produce concrete as required by the Work and ASTM C 685.

D. Truck-mixed Concrete

The concrete shall be mixed in a truck mixer from 70 to 100 revolutions at the mixing speed designated by the manufacturer that will produce a uniform concrete mix. The concrete shall be delivered to the project in a thoroughly mixed and uniform mass and shall be discharged with a satisfactory degree of uniformity. Additional mixing at the job site, at the mixing speed designated by the manufacturer, may be allowed by the City Engineer or designated representative as long as the concrete is discharged before the drum has revolved a total of 300 revolutions after the introduction of the mixing water to the cement and the aggregates.

Re-tempering or adding concrete chemical admixtures is only permitted at the job site when concrete is delivered in a truck mixer. Water shall not be added after introduction of mixing water at the batch plant except on arrival at the job site with approval of the City Engineer or designated representative, in order to adjust the slump of the concrete. When this water is added, the mix design water-cementitious-material ratio shall not be exceeded. The drum or blades shall be turned at least 30 additional revolutions at mixing speed to ensure thorough and uniform mixing of the concrete. Water or chemical admixtures shall not be added to the batch after any concrete has been discharged.

When the concrete contains silica fume, mixing times and batching operations shall be adjusted as necessary to ensure that the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix shall be verified in trial batches.

E. Hand-mixed Concrete

Hand mixing of concrete may be permitted for small placements or in case of an emergency and then only on authorization of the City Engineer or designated representative. Hand-mixed batches shall not exceed a 4 cubic foot batch in volume. Material volume ratios shall not be leaner than 1 part cement, 2 parts large aggregate, 1 part fine aggregate and enough water to produce a consistent mix with a slump not to exceed 4 inches. Admixtures shall not be used unless specifically approved by the City Engineer or designated representative.

403S.10 - Excavation, Placing of Concrete, Finishing, Curing and Backfill

Excavation, placing of concrete, finishing, curing and backfill shall conform to Standard Specification Item No. 401S, "Structural Excavation and Backfill", Standard Specification Item No. 410S, "Concrete Structures" and Standard Specification Item No. 411S, "Surface Finishes for Concrete".

A. Placing Concrete in Cold Weather

Concrete may be placed when the atmospheric temperature is not less than 35°F. Concrete shall not be placed in contact with any material coated with frost or having a temperature less than 32°F.

403S.11 - Measurement

Where measurement of concrete for a structure is not provided by another governing pay item, measurement shall be made under this specification in accordance with the following.

The quantities of concrete of the various classifications which constitute the completed and accepted structure or structures in place will be measured by the cubic yard, each, square yard, or linear foot as indicated in the Contract Documents. Measurement will be as follows:

A. General

1. Measurement based on dimensions shall be for the completed structure as measured in place. However, field-measured dimensions shall not exceed those indicated on the drawings or as may have been directed by the City Engineer or designated representative in writing.
2. No deductions shall be made for chamfers less than 2 inches in depth, embedded portions of structural steel, reinforcing steel, nuts, bolts, conduits less than 5 inches in diameter, pre/post tensioning tendons, keys, water stops, weep holes and expansion joints 2 inches or less in width.
3. No measurement shall be made for concrete keys between adjoining beams or prestressed concrete planks.
4. No measurement shall be made for fill concrete between the ends or adjoining prestressed concrete planks/box beams at bent caps or between the ends of prestressed concrete planks/box beams and abutment end walls.
5. No measurement shall be made for inlet and junction box invert concrete.
6. No measurement shall be made for any additional concrete required above the normal slab thickness for camber or crown.

B. Plan Quantity. For those items measured for plan quantity payment, adequate calculations have been made. If no adjustment is required by Article 403S.11, additional measurements or calculations will not be required or made.

C. Measured in Place. For those items not measured for Plan Quantity payment, measurement will be made in place, subject to the requirements of Article 403S.10.A.1 above.

403S.12 - Payment

The work performed and materials furnished as prescribed by this item and measured in accordance with the applicable provisions of "Measurement" above will be paid for as follows.

The quantity to be paid for will be that quantity indicated in the contract documents and/or shown on the drawings, regardless of errors in calculations, except as may be modified by the following.

Plan Quantities will be adjusted:

- A. When a complete structure element has been erroneously included or omitted from the drawings, the quantity shown on the drawings for that element will be added to or deducted from the plan quantity and included for payment. A complete structure element will be the smallest portion of a total structure for which a quantity is included on the drawings. Quantities revised in this manner will not be subject to the provisions of the "General Conditions", Article 11.
- B. When the plan quantity for a complete structure element is in error by 5 percent or more, a recalculation will be made, and the corrected quantity included for payment. Quantities revised in this manner will not be subject to the provisions of the "General Conditions", Article 11.
- C. When quantities are revised by a change in design, the "plan quantity" will be increased or decreased by the amount involved in the design change. Quantities revised in this manner will be subject to the provisions of the "General Conditions", Article 11.

The party to the contract requesting the adjustment shall present to the other, a copy of the description and location, together with calculations of the quantity for the structure element involved. When this quantity is certified correct by the City Engineer or designated representative, it will become the revised plan quantity.

Payment for increased or decreased costs due to a change in design on those items measured as "Cubic Yard", "Each", "Square Foot", "Square Yard" or "Linear Foot" will be determined by Change Order. Quantities revised in this manner will be subject to the provisions of the "General Conditions", Article 11.

The unit prices bid for the various classes of concrete shown shall include full compensation for furnishing, hauling, and mixing all concrete material; placing, finishing and curing all concrete; all grouting, pointing and finishing; furnishing and placing drains; furnishing and placing metal flashing strips; furnishing and placing expansion joint material required by this item; and for all forms and false work, labor, tools, equipment and incidentals necessary to complete the work.

Pay Item No. 403S-CY:	(Structure or Structural Component)	Per Cubic Yard.
Pay Item No. 403S-EA:	(Structure or Structural Component)	Per Each.
Pay Item No. 403S-SY:	(Structure or Structural Component)	Per Square Yard.
Pay Item No. 403S-LF:	(Structure or Structural Component)	Per Lineal Foot.

END

ITEM NO. 406S - REINFORCING STEEL

406S.1 - Description

This item shall govern furnishing and placement of reinforcing steel, deformed and smooth, of the size and quantity indicated on the drawings and in accordance with these specifications.

406S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall electronically submit the following submittal requirements:

- A. Evidence that the steel reinforcement producer is included on the TxDOT list of approved producing mills
- B. Listing of the size, grade, type and quantity of reinforcing steel proposed for the project.
- C. If welding of reinforcing steel is proposed, evidence that carbon equivalent (CE) of the proposed steel is at least 0.55% with a report of chemical analysis showing the percentages of elements necessary to establish CE
- D. If epoxy coated steel is proposed, evidence that the steel reinforcement producer is included on the TxDOT list of approved epoxy coating applicators
- E. If epoxy coated steel is proposed, written certification that the epoxy-coated reinforcing steel meets the requirements of this Item with a copy of the manufacturer's control tests.
- F. When mechanical splices are proposed, the types of couplers proposed for use.

406S.3 - Materials

A. Approved Mills

Prior to furnishing reinforcing steel, the producing mills must be included on the list of approved producing mills that is maintained by the Construction Division of the State of Texas Department of Transportation

B. Deformed Bars and Wire Reinforcement

Unless indicated otherwise on the drawings, Bar reinforcement shall be Grade 60 and deformed. Reinforcing steel must conform to one of the following:

ASTM A615/615M, Grades 40 or 60 (300 or 420)

ASTM A996/996M, Type A, Grades 40 or 60 (300 or 420)

ASTM A996/996M, Type R, Grade 60 (420), permitted in concrete pavement only (furnished as straight bars only without bends. Bend tests are not required.)

ASTM A706/706M

In cases where the provisions of this item are in conflict with the provisions of the ASTM Designation to which reference is made, the provisions of this item shall govern.

The nominal size, area and weight of reinforcing steel bars covered by these specifications are as follows:

Bar Size Number 1/8 ins	Nominal Diameter, inches	Nominal Area, Sq. ins.	Weight/Linear Foot Lbs.
2	0.250	0.05	0.167
3	0.375	0.11	0.376
4	0.500	0.20	0.668
5	0.625	0.31	1.043
6	0.750	0.44	1.502
7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313
14	1.693	2.25	7.65
18	2.257	4.00	13.60

Smooth, round bars shall be designated by size number through a No. 4. Smooth bars above No. 4 shall be designated by diameter in inches.

C. Smooth Bar and Spiral Reinforcement

Smooth bars and dowels for concrete pavement must have a minimum yield strength of 60 ksi and meet ASTM A615/615M. Smooth bars that are greater in diameter than a No. 4 designation shall conform to ASTM A615 or meet the physical requirements of ASTM A36.

Spiral reinforcement shall be either smooth or deformed bars or wire of the minimum size or gauge indicated on the drawings. Bars for spiral reinforcement shall comply with ASTM A615 Grade 40(300), ASTM A996, Type A, Grade 40 (300); or ASTM A675, Grade 80(550), meeting dimensional requirements of ASTM A615. Smooth wire shall comply with ASTM A82, and deformed wire shall comply with ASTM A496.

D. Weldable Reinforcing Steel

Reinforcing steel to be welded must comply with ASTM A706 or have a carbon equivalent (CE) of at most 0.55%. A report of chemical analysis showing the percentages of elements necessary to establish CE is required for reinforcing steel that does not meet ASTM A706 to be structurally welded. No tack welding will be allowed. All welding shall conform to the requirements of AWS D1.1/D1.1M.

Carbon Equivalent (CE) shall be calculated as follows:

$$CE = \%C + 1.67*(\% Mn) + .025*(\% Cu) + .05*(\% Ni) + .01*(\%Cr) - .02*(\%Mo) - .1*(\%V)$$

Where C is carbon,

Mn is manganese

Cu is copper

Ni is nickel

Cr is chromium

Mo is molybdenum, and

V is vanadium.

The requirements above do not apply to the following miscellaneous welding applications:

Splicing reinforcing steel to extend bars in the bottom of a drilled shaft;

Attaching chairs to the reinforcing steel cage of a drilled shaft;

Armor joints and their supports;

Screed rail and form hanger supports where permitted on steel units;

Reinforcing steel to R-bars for lateral stability between prestressed beams, spirals, or bands of reinforcing bars in drilled shaft cages;

Permanent bridge deck forms;

Steel added in railing when slip-form construction is used; and

Other similar miscellaneous members that have no load carrying capacity in the completed structure.

E. Welded Wire Fabric

Wire shall conform to the requirements of the Standard Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement, ASTM A82 or A 496. Wire fabric, when used as reinforcement, shall conform to ASTM A185 or A497.

When wire is ordered by size numbers, the following relation between size number, diameter in inches and area shall apply unless otherwise indicated on the drawings:

Size, W Number 1/100 in ²	Nominal Diameter inch	Nominal Area, sq. inches
31	0.628	0.310
30	0.618	0.300
28	0.597	0.280
26	0.575	0.260
24	0.553	0.240
22	0.529	0.220
20	0.505	0.200
18	0.479	0.180
16	0.451	0.160
14	0.422	0.140
12	0.391	0.120
10	0.357	0.100
8	0.319	0.080
7	0.299	0.070
6	0.276	0.060
5.5	0.265	0.055
5	0.252	0.050
4.5	0.239	0.045
4	0.226	0.040
3.5	0.211	0.035

Size, W Number 1/100 in ²	Nominal Diameter inch	Nominal Area, sq. inches
3	0.195	0.030
2.5	0.178	0.025
2	0.160	0.020
1.5	0.138	0.015
1.2	0.124	0.012
1	0.113	0.010
0.5	0.080	0.005

Where deformed wire is required, the size number shall be preceded by D and for smooth wire the prefix W shall be shown.

Welded wire fabric shall be designated as follows: 6 x 12 - W16 x W8, which indicates a 6 in longitudinal wire spacing and 12-in transverse wire spacing with smooth No. 16 (103) wire longitudinally and smooth no. 8 (52) wire transversely.

F. Epoxy Coating

Epoxy coating shall be required as indicated on the drawings. Prior to furnishing epoxy-coated reinforcing steel, the epoxy applicator must be included on the list of approved applicators that is maintained by the Construction Division of the State of Texas Department of Transportation.

The reinforcing steel shall be epoxy coated in accordance with the following.

Epoxy Coating Requirements for Reinforcing Steel

Material	Specification
Bar	ASTM A775 or A934
Wire or Fabric	ASTM A884 Class A or B
Mechanical Coupler	As indicated on the drawings
Hardware	As indicated on the drawings

The epoxy coating material and coating repair material shall comply with TxDOT's DMS-8130, "Epoxy Powder Coating for Reinforcing Steel". The applicator shall not patch more than 1/4 inch total length in any foot at the applicator's plant.

The epoxy-coated reinforcing steel shall be sampled and tested in accordance with TxDOT Test Method Tex-739-I, "Sampling and Testing Epoxy Coated Reinforcing Steel".

The identification of all reinforcing steel shall be maintained throughout the epoxy coating and fabrication and until delivery to the project site.

Written certification that the epoxy-coated reinforcing steel meets the requirements of this Item shall be provided along with a copy of the manufacturer's control tests.

G. Mechanical Couplers

When mechanical splices in reinforcing steel bars are indicated on the drawings, the following types of couplers may be used:

Sleeve-filler

Sleeve-threaded

Sleeve-swaged, or

Sleeve-wedge.

H. Chairs and Supports

Chairs and Supports shall be steel, precast mortar or concrete blocks cast in molds meeting the approval of the Engineer or designated representative of sufficient strength to position the reinforcement as indicated on the drawings when supporting the dead load of the reinforcement, the weight of the workers placing concrete and the weight of the concrete bearing on the steel. Chairs shall be plastic coated when indicated on the drawings.

Chair Types and Applicable Uses	
Structural or Architectural Elements (columns, beams, walls, slabs) exposed to weather, not subjected to sand blasting, water blasting or grinding.	Galvanized steel or steel chairs with plastic coated feet.
Structural or Architectural Elements exposed to weather and subject to sand blasting, water blasting or grinding.	Stainless steel chairs.
Structural or Architectural Elements not exposed to weather or corrosive conditions.	Uncoated steel chairs

Chair Types and Applicable Uses	
Slabs and grade beams cast on grade.	Steel chairs with a base with 9 inch ² minimum area or sufficient area to prevent the chair from sinking into fill or subgrade. Precast mortar or concrete blocks meeting

406S.4 - Bending

The reinforcement shall be bent cold, true to the shapes indicated on the drawings. Bending shall preferably be done in the shop. Irregularities in bending shall be cause for rejection. Improperly fabricated, damaged or broken bars shall be replaced at no additional expense to the City. Damaged or broken bars embedded in a previous concrete placement shall be repaired using a method approved by the Engineer or designated representative.

Unless otherwise indicated on the drawings, the inside diameter of bar bends, in terms of the nominal bar diameter (d), shall be as follows:

Bends of 90 degrees and greater in stirrups, ties and other secondary bars that enclose another bar in the bend.

Bar Number in 1/8 inches	Diameter
3, 4, 5	4d
6, 7, 8	6d

All bends in main bars and in secondary bars not covered above.

Bar Number in 1/8 inches	Diameter
3 thru 8	6d
9, 10, 11	8d
14, 18	10d

406S.5 - Tolerances

Fabricating tolerances for bars shall not be greater than shown on Standard (Detail) 406S-1 "Reinforced Steel Tolerances".

406S.6 - Storing

Steel reinforcement shall be stored above the surface of the ground upon platforms, skids or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel indicated on the drawings.

406S.7 - Splices

Splicing of bars, except when indicated on the drawings or specified herein, will not be permitted without written approval of the Engineer or designated representative. No substitution of bars will be allowed without the approval of the Engineer or designated representative. Any splicing of substituted bars shall conform to the requirements in the Table below.

Splices not indicated on the drawings will be permitted in slabs not more than 15 inches in thickness, columns, walls and parapets.

Splices will not be permitted in bars 30 feet or less in plan length unless otherwise approved. For bars exceeding 30 feet in plan length, the distance center to center of splices shall not be less than 30 feet minus 1 splice length, with no more than 1 individual bar length less than 10 feet. Splices not indicated on the drawings, but permitted hereby, shall conform to the Table below. The specified concrete cover shall be maintained at such splices and the bars placed in contact and securely tied together.

Minimum Lap Requirements		
Bar Number in 1/8 inches	Uncoated Lap Length	Coated Lap Length
3	1 foot 4 inches	2 foot 0 inches
4	1 foot 9 inches	2 foot 8 inches
5	2 foot 2 inches	3 feet 3 inches
6	2 foot 7 inches	3 feet 11 inches
7	3 feet 5 inches	5 feet 2 inches
No. 8	4 feet 6 inches	6 feet 9 inches

No. 9	5 feet 8 inches	8 feet 6 inches
No. 10	7 feet 3 inches	10 feet 11 inches
No. 11	8 feet 11 inches	13 feet 5 inches

Spiral steel shall be lapped a minimum of 1 turn. Bar No. 14 and No. 18 may not be lapped.

Welded wire fabric shall be spliced using a lap length that includes an overlap of at least 2 cross wires plus 2 inches on each sheet or roll.

Splices using bars that develop equivalent strength and are lapped in accordance with the table above are permitted.

Welding of reinforcing bars may be used only where indicated on the drawings or as permitted herein. All welding operations, processes, equipment, materials, quality of work and inspection shall conform to the requirements indicated on the drawings. All splices shall be of such dimension and character as to develop the full strength of the bar being spliced.

End preparation for butt-welding reinforcing bars shall be done in the field, except Bar No. 6 and larger shall be done in the shop. Delivered bars shall be of sufficient length to permit this practice.

For box culvert extensions with less than 1 foot of fill, the existing longitudinal bars shall have a lap with the new bars as shown in the table above. For box culvert extensions with more than 1 foot of fill, a minimum lap of 12 inches will be required.

Unless otherwise indicated on the drawings, dowel bars transferring tensile stresses shall have a minimum embedment equal to the minimum lap requirements shown in the table above. Shear transfer dowels shall have a minimum embedment of 12 inches.

406S.8 - Placement

Reinforcement shall be placed as near as possible in the position indicated on the drawings. Unless otherwise indicated on the drawings, dimensions shown for reinforcement are to the centers of the bars. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch. Cover of concrete to the nearest surface of steel shall be as follows:

	Minimum Cover, Inches
(a) Concrete cast against and permanently exposed to earth	3
(b) Concrete exposed to earth or weather:	
Bar No. 6 (19) through No. 18 bars (57)	2
Bar No. 5 (16), W31 (W200) or D31 (D200) wire and smaller	1½

	Minimum Cover, Inches
(c) Concrete not exposed to weather or in contact with ground:	
Slabs, walls, joists:	
Bar No. 14 (43) and 18 (57)	1½
Bar No. 11 (36) and smaller	1
Beams, columns:	
Primary reinforcement, ties, stirrups, spirals	1 ½
Shells, folded plate members:	
Bar No. 6 (19) and larger	1
Bar No. 5 (16), W31 (W200) or D31 (D200) wire, and smaller	1

Vertical stirrups shall always pass around the main tension members and be attached securely thereto.

The reinforcing steel shall be located accurately in the forms and held firmly in place before and during concrete placement by means of bar supports that are adequate in strength and number to prevent displacement and to keep the steel at the required distance from the form surface. Bars shall be supported by means of approved galvanized metal spacers, metal spacers with plastic coated tips, stainless steel spacers, plastic spacers or approved precast mortar or concrete blocks when supports are in contact with removable or stay-in-place forms. Bright basic bar supports shall be used to support reinforcing steel placed in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade shall be approved.

For bar supports with plastic tips, the plastic protection must be at least 3/32 in thick and extend upward on the wire to a point at least 1/2 in above the formwork.

For approval of plastic spacers on a project, representative samples of the plastic shall show no visible indications of deterioration after immersion in a 5 percent solution of sodium hydroxide for 120 hours.

All accessories such as tie wires, bar chairs, supports, or clips used with epoxy-coated reinforcement shall be of steel, fully coated with epoxy or plastic. When approved by the Engineer or designated representative, plastic supports may also be used with epoxy-coated reinforcement.

All reinforcing steel shall be tied at all intersections, except that where spacing is less than 1 foot in each direction, alternate intersections only need be tied. For reinforcing steel cages for other structural members, the steel shall be tied at enough intersections to provide a rigid cage of steel. Mats of wire fabric shall overlap each other 1 full space as a minimum to maintain a uniform strength and shall be tied at the ends and edges.

Where prefabricated deformed wire mats are specified or if the Contractor requests, welded wire fabric may be substituted for a comparable area of steel reinforcing bar plan, subject to the approval of the Engineer or designated representative.

Mortar or concrete blocks shall be cast to uniform dimensions with adequate bearing area. A suitable tie wire shall be provided in each block, to be used for anchoring to the steel. Except in unusual cases and when specifically authorized by the Engineer, the size of the surface to be placed adjacent to the forms shall not exceed 2½ inches square or the equivalent thereof in cases where circular or rectangular areas are provided. Blocks shall be cast accurately to the thickness required and the surface to be placed adjacent to the forms shall be a true plane, free of surface imperfections. The blocks shall be cured by covering them with wet burlap or mats for a period of 72 hours. Mortar for blocks should contain approximately 1 part hydraulic cement to three parts sand. Concrete for blocks should contain 850 pounds of hydraulic cement per cubic yard of concrete.

Individual bar supports shall be placed in rows at 4-ft maximum spacing in each direction. Continuous type bar supports shall be placed at 4-ft maximum spacing. Continuous bar supports shall be used with permanent metal deck forms.

The exposure of the ends of longitudinals, stirrups and spacers used to position the reinforcement in concrete pipe and in precast box culverts or storm drains is not a cause for rejection.

Reinforcing steel for bridge slabs, top slabs of direct traffic culverts, and top slabs of prestressed box beams at all intersections, except tie only alternate intersections where spacing is less than 1 ft in each direction.

For steel reinforcing cages for other structural members, reinforcement shall be supported and tied in such a manner that a sufficiently rigid cage of steel is provided. Fasten mats of wire fabric securely at the ends and edges. If the cage is not adequately supported to resist settlement or floating upward of the steel, overturning of truss bars or movement in any direction during concrete placement, permission to continue concrete placement will be withheld until corrective measures are taken. Sufficient measurements shall be made during concrete placement to ensure compliance with the above.

No concrete shall be deposited until the Engineer or designated representative has reviewed the placement of the reinforcing steel and all mortar, mud, dirt, etc., shall be cleaned from the reinforcement, forms, workers' boots and tools. Do not place concrete until authorized by the Engineer or designated representative.

406S.9 - Handling, Placement and Repair of Epoxy-coated Reinforcement Steel

A. Handling

Systems for handling coated reinforcement with padded contact areas shall be provided. Handling bands shall be padded to prevent damage to the coating. Bundles of coated reinforcement shall be lifted with a strongback, spreader bar, multiple supports or a platform bridge. The bundled reinforcement shall be carefully transported and stored on protective cribbing. The coated reinforcement should not be dropped or drug during handling.

B. Construction Methods

Coated reinforcement shall not be flame-cut but shall be sawn or shear-cut only when approved. Cut ends shall be coated as specified in Section C, "Repair of Coating".

Coated reinforcement steel shall not be welded or mechanically coupled except where specifically indicated on the drawings. When welding or coupling is indicated on the drawing, the epoxy coating shall be removed at least 6 in beyond the weld limits before welding and 2 in beyond the limits of the mechanical coupler before assembly. After the welding or coupling operation is completed the steel shall be cleaned of oil, grease, moisture, dirt, welding contamination (slag or acid residue) and rust to a near-white finish. The existing epoxy coating shall be examined for damage and any damaged or loose epoxy shall be removed to expose sound epoxy coating.

After cleaning the coated steel, the splice area shall be coated with epoxy repair material to a thickness of 7 to 17 mils after curing. A second application of the repair material shall be applied to the bar and coupler interface to ensure complete sealing of the joint.

C. Repair of Coating

The material used for coating repair shall comply with the requirements of this Item and ASTM D3963/D3963M, "Specification for Fabrication and Jobsite Handling of Epoxy-coated Reinforcing Steel Bars". Repairs shall be made in accordance with procedures recommended by the manufacturer of the epoxy coating powder. For areas to be patched, a minimum coating thickness as required for the original coating shall be applied. All visible damage to the coating shall be repaired.

Sawed and sheared ends, cuts, breaks and other damage shall be promptly repaired before additional oxidation occurs. The areas to be repaired shall be cleaned to ensure that they free from surface contaminants. Repairs shall be made in the shop or in the field as required.

406S.10 - Measurement

The measurement of quantities of reinforcement furnished and placed will be based on the calculated weight of the steel actually placed as indicated on the drawings, with no allowance made for added bar lengths for splices requested by the Contractor nor for extra steel used when bars larger than those indicated on the drawings are used or for a higher grade of steel that is substituted with the permission of the Engineer or designated representative. Tie wires and supporting devices will not be included in the calculated weights. The calculated weight of bar reinforcement will be determined using the theoretical bar weight set forth in this item.

Measurement required by a change in design will be computed as described above for the actual steel required to complete the work.

406S.11 - Payment

This item shall be paid for at the contract unit price bid per pound of "Reinforcing Steel". The unit bid price shall include full compensation for all work specified herein including furnishing, bending, fabricating, welding and placing reinforcement, for all clips, blocks, metal spacers, ties, chairs, wire or other materials used for fastening reinforcement in place and for all tools, labor, equipment and incidentals necessary to complete the work.

Reinforcing steel will generally not be paid for directly but shall be included in the unit price bid for the items of construction in which the reinforcing steel is used.

When specified in the contract bid form as a separate pay item, this item shall be paid for at the contract unit price bid per pound of "Reinforcing Steel". The unit bid price shall include full compensation for all work specified herein including furnishing, bending, fabricating, welding and placing reinforcement, for all

clips, blocks, metal spacers, ties, chairs, wire or other materials used for fastening reinforcement in place and for all tools, labor, equipment and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 406S-RC:	Reinforcing Steel	Per Pound.
Pay Item No. 406S-ERC:	Epoxy-Coated Reinforcing Steel	Per Pound.

END

ITEM NO. 407S - FIBROUS CONCRETE

407S.1 - Description

This item shall govern furnishing and placing of concrete reinforced with fibers in accordance with this specification item and with details as shown on the Drawings.

Fibrous concrete shall only be used with permission of the City Engineer on City projects and within the City right-of-way.

407S.2 - Submittal Requirements

The submittal requirements of this specification item include:

- A. Concrete Type, Supplier and Design.
- B. Fiber Type, Supplier and product properties.
- C. Proposed proportioning of material, including adjustment for slump requirements.
- D. Fiber documentation of compliance with applicable building codes, this specification item, and ASTM C 1116/C 1116 M-08.

407S.3 - Materials

A. Concrete

All concrete shall conform to the requirements of Standard Specification Item Number 403S, "Concrete for Structures".

The concrete shall be Class A concrete unless otherwise shown on the drawings or indicated otherwise in the Pay item of this document.

Since the slump of a fiber-reinforced concrete is less than the slump of an otherwise identical concrete without fiber and since the magnitude of difference depends upon the amount and type of fibers, trial mixtures representing the amount and type of fibers to be used for the work shall be prepared and tested to insure that the specified slump requirements are met.

B. Reinforcement

Reinforcement shall be in accordance with ASTM C 1116/C 1116 M-08. Fibers shall conform to section 4.1.2 Type 2 Glass Fiber-Reinforced Concrete, or 4.1.3 Type 3 Synthetic Fiber-Reinforced Concrete, or 4.1.4 Natural Fiber-Reinforced Concrete. Unless otherwise shown on the drawings, each cubic yard of concrete shall contain no less than 1½ pounds of fibers. The fibers shall be added to the concrete mix at the time the mix is batched.

Reinforcement shall be 100% virgin polypropylene fibrillated fibers specially manufactured for use as concrete reinforcement and meeting the requirements of ASTM C-1116 (Fiber-Reinforced Concrete and Shotcrete). The fibrous material shall not contain reprocessed olefin. Each container of fibrous material shall bear the manufacturer's name and/or trademark and the net weight of fibrous material in the package.

The fiber manufacturer shall provide documentation of a minimum of 5 year performance history of the fiber and confirm compliance with applicable building codes, this specification item and ASTM C-1116.

The specific gravity of the fibrous material shall be 0.91 plus or minus .05. The tensile strength shall be 80 to 110 ksi. The lengths of the fibrous material shall be 1/2, 3/4, 1½ and 2 inches in length.

Unless otherwise shown on the drawings, each cubic yard of concrete shall contain no less than 1½ pounds of fibrous material. The fibrous material shall be added to the concrete mix at the time the mix is batched.

407S.4 - Excavation, Placing of Concrete, Finishing, Curing and Backfill

All excavation, placing of concrete, finishing, curing and backfilling shall be in accordance with Standard Specification Item Number 401S, "Structural Excavation and Backfill", and Standard Specification Item Number 410S, "Concrete Structures".

407S.5 - Measurement

The quantities of concrete of the various classes which constitute the completed and accepted work in place will be measured per cubic yard, square foot or linear foot as indicated in the Project Manual. Measurement will be as follows:

- A. Plan Quantity. For those items measured for plan quantity payment, adequate calculations have been made. No additional measurements or calculations will be made.
- B. Measured in Place. For those items not measured for Plan Quantity payment, measurement will be made in place. However, field measured dimensions shall not exceed those indicated on the drawings or as may have been directed by the Engineer or designated representative in writing.

407S.6 - Payment

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit bid price for Fibrous Concrete of the class specified. The unit bid price shall include full compensation for furnishing, hauling and mixing all materials; placing, finishing and curing all concrete; and for all forms, labor, tools, equipment and incidentals necessary to complete the work.

Pay Item No. 407S-CY:	Fibrous Concrete, (Class _____)	Per Cubic Yard.
Pay Item No. 407S-SF:	Fibrous Concrete, (Class _____)	Per Square Foot.
Pay Item No. 407S-LF	Fibrous Concrete, (Class _____)	Per Lineal Foot

END

ITEM NO. 408S - CONCRETE JOINT MATERIALS

408S.1 - Description

This item shall govern the furnishing and placing of all longitudinal, transverse contraction and expansion joint material in concrete work as herein specified in the various items of these specifications as indicated or as directed by the Engineer or designated representative.

408S.2 - Submittals

The submittal requirements of this specification item include:

- A. Type and manufacturer of all joint materials proposed for use.
- B. Technical data indicating that proposed products meet the requirements specified herein.

408S.3 - Materials

(1) Preformed Asphalt Board

Preformed asphalt board formed from cane or other suitable fibers of a cellular nature securely bound together and uniformly impregnated with a suitable asphaltic binder and meeting the requirements of the Standard Specifications for Preformed Expansion Joint Filler for Concrete (Bituminous Type), ASTM D 994.

(2) Preformed Nonbituminous Fiber Material

Preformed nonbituminous fiber material shall meet the requirements of the Standard Specifications for the Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM D 1751, except that the requirements pertaining to bitumen content, density and water absorption shall be voided.

(3) Joint Sealer (Concrete Pavement)

This material shall be a one part low modulus silicone especially designed to cure at ambient temperatures by reacting with moisture in the air and shall have the following properties:

As Supplied	
Color	Gray
Flow, MIL-2-8802D Sec. 4.8.4	0.2 maximum
Working Time, minutes	10Tack-Free Time at 77°F 2F Min.
MIL-2-8802D Sec.4.8.7	60
Cure time, at 77°F, days	7-14

As Supplied	
Full Adhesion, days	14-21
As Cured—after 7 days at 77°F and 40% RH	
Elongation, percent minimum	1200
Durometer Hardness, Shore A, points ASTM 2240	15
Joint Movement Capability, percent	+100/-50
Tensile Strength, maximum elongation, psi	100
Peel Strength, psi	25

The joint sealer shall adhere to the sides of the concrete joint or crack and shall be an effective seal against infiltration of water and incompressibles. The material shall not crack or break when exposed to low temperature.

(5) Backer Rod

Backer Rod shall be expanded closed cell polyethylene foam compatible with sealant. No bond or reaction shall occur between rod and sealant. Backer Rod shall be of sufficient width to be in compression after placement and shall be used with joint sealer.

(6) Joint Sealing Material

Joint Sealing Material for other than pavement use may be a two-component, synthetic polymer or cold-pourable, self-leveling type meeting the following requirements:

The material shall adhere to the sides of the concrete joint or crack and shall form an effective seal against infiltration of water and incompressibles. The material shall not crack or break when exposed to low temperatures. Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles. It shall cure sufficiently at an average temperature of 77°F 3°F so as not to pick up under wheels of traffic in a maximum of 3 hours.

Performance Requirements:

When tested in accordance with Test Method Tex-525-C, the joint sealing material shall meet the above curing times and the requirements as follows:

It shall be of such consistency that it can be mixed and poured or mixed and extruded into joints at temperatures above 60°F.

Penetration 77°F, 150 gm. Cone, 5 sec., max.-cm	0.90
Bond and Extension 75%, 0F, 5 cycles:	
Dry Concrete Blocks	Pass
Wet Concrete Blocks	Pass
Steel Blocks (Primed if specified by manufacturer)	Pass
Flow at 200 °F	None
Water content % by weight, max.	5.0
Resilience:	
Original sample min. % (cured)	50
Oven-aged at 158°F min. %	50
For Class 1-a material only, Cold Flow (10 minute)	None

(7) Rebonded Recycled Tire Rubber

This material consists of granular particles of rubber, made by grinding automobile and truck tires, securely bound together by a synthetic resin or plastic binder. The filler must be molded into sheets of the required dimensions, which meet the testing requirements of both ASTM D 1751 and ASTM D 1752, except that the requirements for asphalt content and expansion are waived. The density of the material must be at least 30 lb/ft³.

408S.4 - Construction Methods

The Contractor shall install "Concrete Joint Materials" which will function as a compatible system. Joint sealer shall not be placed where a bond breaker is present.

Asphalt or other materials used shall extend the full depth of the concrete and shall be perpendicular to the exposed face. All joints shall be shaped to conform to the contour of the finished section in which they are installed. All material shall be a minimum of 1/2 inch thick or as indicated. Materials shall be anchored to the adjacent concrete to permanently hold them in place. Joint sealer shall be installed in accordance with the manufacturer's recommendations.

The material used for curb and gutter expansion joints filler shall conform to any of the above, except when placed adjacent to concrete pavement, the joint material shall match the pavement joint material.

408S.5 - Measurement and Payment

No additional compensation will be made for materials, equipment or labor required by this item, but shall be included in the unit price bid for the item of construction in which this item is used.

END

ITEM NO. 409S - MEMBRANE CURING

409S.1 - Description

This item shall govern curing concrete pavement, concrete base, pavement, curbs, gutters, retards, sidewalks, driveways, medians, islands, concrete riprap, cement stabilized riprap, concrete structures and other concrete as indicated by applying an impervious liquid membrane forming material.

409S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall electronically submit the following submittal requirements:

- A. Type and manufacturer for all membrane curing materials proposed.
- B. Proposed curing procedures.

409S.3 - Material

The liquid forming membrane curing compound shall comply with the "Standard Specification for Liquid Membrane-forming Compounds for Curing Concrete", ASTM C 309, Type 1-D clear or translucent, with fugitive dye or Type 2 white pigmented. The material shall have a minimum flash point of 80°F when tested by the "Pensky-Martin Closed Cup Tester", ASTM D 93.

It shall be of such consistency that it can be satisfactorily applied as a fine mist through an atomizing nozzle by means of approved pressure spraying equipment at atmospheric temperatures above 40°F.

It shall be of such nature that it will not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete or its components. Type 1 compound shall contain a fugitive dye that will be distinctly visible not less than 4 hours nor more than 7 days after application.

Type 2 compound shall not settle out excessively or cake in the container and shall be capable of being mixed to a uniform consistency by moderate stirring and shall exhibit a daylight reflectance of not less than 60 percent of that of magnesium oxide when tested as indicated.

The compound shall produce a firm, continuous, uniform moisture impermeable film, free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. When applied to the damp concrete surface at the rate of coverage indicated, the compound shall dry to the touch in not more than 4 hours and shall not be tacky or track off concrete after 12 hours.

It shall adhere to horizontal and vertical surfaces in a tenacious film and shall not run off or show an appreciable sag, disintegrate, check, peel or crack during the required curing period.

Under traffic, the compound shall not pick up or peel and shall gradually disintegrate from the surface.

The compound shall be delivered to the job only in the manufacturer's original containers, which shall be clearly labeled with the manufacturer's name, the trade name of the material and a batch number or symbol with which test samples may be correlated.

The water retention test shall be in accordance with the following:

Percentage loss shall be defined as the water lost after the application of the curing material was applied. The permissible percentage moisture loss (at the rate of coverage specified herein) shall not exceed the following:

24 hours after application	2 percent
72 hours after application	4 percent

409S.4 - Construction Methods

The membrane curing compound shall be applied after the surface finishing has been completed and immediately after the free surface moisture has disappeared. The surface shall be sealed with a single uniform coating of the specified type of curing compound applied at the rate of coverage recommended by the manufacturer and directed by the Engineer or designated representative, but not less than 1 gallon per 180 square feet of area. The Contractor shall provide satisfactory means and facilities to properly control and check the rate of application of the compound.

The compounds shall not be applied before the surface has become dry but shall be applied just after free moisture has disappeared.

The compound shall be thoroughly agitated during its use and shall be applied by means of approved mechanical power pressure sprayers for street and bridge applications. The sprayers used to apply the membrane to concrete exposed surfaces shall travel at a uniform speed along the forms and be mechanically driven. The equipment shall be of such design that it will insure uniform and even application of the membrane material. The sprayers shall be equipped with satisfactory atomizing nozzles. On small miscellaneous items or on interim bridge deck curing will the Contractor be permitted to use hand-powered spray equipment. For all spraying equipment, the Contractor shall provide facilities to prevent the loss of the compound between the nozzle and the concrete surface during the spraying operations.

At locations where the coating shows discontinuities, pinholes or other defects or if rain falls on the newly coated surface before the film has dried sufficiently to resist damage, an additional coat of the compound shall be applied immediately at the same rate of coverage specified herein.

To ensure proper coverage, the Engineer or designated representative shall inspect all treated areas after application of the compound for the period of time designated in the specification for curing, either for membrane curing or for other methods. Dry areas are identifiable because of the lighter color of dry concrete as compared to damp concrete. All suspected areas shall be tested by placing a few drops of water on the suspected areas. If the water stands in rounded beads or small pools which can be blown along the surface of the concrete without wetting the surface, the water impervious film is present. If the water wets the surface of the concrete as determined by obvious darkening of the surface or by visible soaking into the surface, no water-impervious film is present. Should the foregoing test indicate that any area during the curing period is not protected by the required water-impervious film an additional coat or coats of the compound shall be applied immediately and the rate of application of the membrane compound shall be increased until all areas are uniformly covered by the required water-impervious film.

The compounds shall not be applied to a dry surface and if the surface of the concrete has become dry, it shall be thoroughly moistened prior to the application of the membrane by fogging or mist application. Sprinkling or coarse spraying will not be allowed.

When temperatures are such as to warrant protection against freezing, curing by this method shall be supplemented with an approved insulating material capable of protecting the concrete for the specified curing period.

If at any time there is reason to believe that this method of curing is unsatisfactory or is detrimental to the work, the Contractor, when notified, shall immediately cease the use of this method and shall change to curing by one of the other methods specified under this contract.

Curing compounds shall be compatible with the adhesion of toppings or overlays where curing has been applied to the concrete base surface in order to assure adequate bond.

When forms are stripped before the 4 minimum curing days have passed, curing shall continue by an approved method.

409S.5 - Measurement and Payment

Membrane curing will not be measured for payment. The work and materials prescribed herein will not be paid for directly but shall be included in the unit price bid for the item of construction in which these materials are used.

END

ITEM NO. 410S - CONCRETE STRUCTURES

410S.1 - Description

This item shall govern the construction of all types of structures involving the use of structural concrete, except where the requirements are waived or revised by other governing specifications.

All concrete structures shall be constructed in accordance with the design requirements and details indicated on the drawings, in conformity with the pertinent provisions of the items contracted for, the incidental items referred to and in conformity with the requirements herein.

410S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall submit electronically the following submittal requirements as applicable:

- a. Appropriate mix designs for class of concrete for each type of structure or unit;
- b. Appropriate mortar and grout mix designs;
- c. Product name, description, technical information and supplier of any acrylic-polymer latex admixture;
- d. Type, supplier and certified test results for expansion joint materials;
- e. Type of waterstop and confirmation that the product conforms to TxDOT DMS-6160;
- f. Type and manufacturer of proposed evaporation retardant and confirmation that it meets the requirements of test results for TxDOT DMS-4650;
- g. Type and manufacturer of proposed chemical admixtures and confirmation that it meets the requirements of test results for TxDOT DMS-4640;
- h. Type and manufacturer of proposed curing admixtures and confirmation that it meets the requirements of test results for TxDOT DMS-4640;
- i. Type and manufacturer of proposed chemical admixtures and confirmation that it meets the requirements of test results for TxDOT DMS-4640;
- j. Type and manufacturer of proposed epoxy and/or adhesives and confirmation that it meets the requirements of test results for TxDOT DMS-6100;
- k. Reinforcing steel shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".
- l. Contractors formwork plan for placing and consolidating concrete around wall penetrations and at locations designated as having congested reinforcing steel.

410S.3 - Materials

A. Concrete

Concrete shall conform to Item No. 403S, "Concrete for Structures".

The class of concrete for each type of structure or unit shall be as indicated on the drawings or by pertinent governing specifications.

B. Grout or Mortar

When required or shown on the drawings, mortar and grout consisting of 1 part hydraulic cement and 2 parts sand with sufficient water to provide the desired consistency shall be provided. Mortar shall be provided with a consistency that can be handled easily and spread by a trowel. Grout shall be provided with a consistency that will flow into and completely fill all voids.

C. Latex

When required an acrylic-polymer latex admixture (acrylic resin emulsion in accordance with TxDOT DMS-4640, "Chemical Admixtures for Concrete") suitable for producing polymer-modified concrete or mortar shall be provided. The latex shall not be allowed to freeze.

The following information shall be submitted for latex:

- a. Name and information of company contact personnel,
- b. Product name and polymer description, and

The latex shall meet the following requirements.

Table 1: LATEX ADDITIVE REQUIREMENTS	
Property	Value
Total Solids, minimum, percent	47
PH	9.0 to 11.0
Brookfield viscosity (# 1 spindle @ 10 rpm), mPas, maximum	60
Butadiene Content, percent	30 to 40
Freeze-thaw stability, 2 cycles. maximum	0.1

Specification targets and production tolerances shall also be provided for the following properties.

1. viscosity (including test method and temperature reference),
2. percent solids,
3. pH,
4. specific gravity, and
5. styrene/butadiene ratio.

D. Reinforcing Steel

Reinforcing steel shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".

E. Expansion Joint Material

Joints and devices to provide for expansion and contraction shall be constructed as indicated herein or in the Drawings. The expansion joint material shall conform to the requirements of TxDOT DMS-6310, "Joint Sealants and Fillers".

1. Preformed Fiber Sheets

Unless otherwise indicated on the drawings preformed bituminous fiber material shall be provided. The preformed fiber material shall be 1/2 inch or conform to the dimensions indicated on the drawings. Preformed fiber sheets shall be one of the following unless otherwise noted on the drawings:

- a. "Preformed Bituminous Fiber Material" shall meet the requirements of the Standard Specifications for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction, ASTM Designation: D1751.
- b. "Preformed Non-Bituminous Fiber Material": shall meet the requirements of the Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction ASTM Designation: D1751, except that the requirements pertaining to bitumen content, density and water absorption shall be voided.

2. Joint Sealing Material

Unless otherwise indicated on the drawings, the sealer shall be synthetic polymer Sikaflex, iCSL or approved equivalent.

3. Timber Boards

Timber boards shall be made from redwood or cypress and must be free from sapwood, knots, clustered bird's eye, checks and splits. When oven dried at 230°F to a constant weight, the density of the board shall be between 20 and 35 lbs. per cubic foot.

4. Asphalt Board

Asphalt Board shall consist of two liners of 0.016 inches asphalt impregnated paper, filler with a mastic mixture of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat and sufficiently rigid to permit installation. When tested in accordance with Test Method Tex-524-C, the asphalt board shall not deflect from the horizontal more than one (1) inch in three and one half (3 ½) inches.

5. Rebonded Neoprene Filler Sheet

Rebonded neoprene filler shall consist of ground closed cell neoprene particles, rebonded and molded into sheets of uniform thickness of the dimensions indicated on the drawings. These sheets shall meet the requirements of ASTM D-1752, Type I.

The manufacturer shall furnish the City Engineer or designated representative with certified test results as to the compliance with the above requirements.

F. Waterstop

Unless otherwise indicated on the drawings, rubber waterstops or Polyvinyl Chloride (PVC) waterstops that conform to TxDOT DMS-6160, "Waterstops, Nylon Reinforced Neoprene Sheet, and Elastomeric Pads" shall be provided.

G. Evaporation Retardants

Evaporation retardants shall conform to the requirements of TxDOT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants". The evaporation retardant must be a commercially available monomolecular film compound. The evaporation retardant shall have no adverse effect on the cement hydration process or the concrete and shall reduce surface moisture evaporation from the concrete when performing concrete operations in direct sun, wind, high temperatures, or low relative humidity. The producer of the evaporation retardant shall certify that it meets these specified requirements.

H. Curing Materials

1. Liquid Membrane Forming compounds

Liquid Membrane Forming compounds shall conform to the requirements of TxDOT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants". The compound shall be applied to damp concrete as a fine mist through atomizing nozzles at a wet film thickness of 8 to 9 mils. The liquid membrane-forming compound must not react deleteriously with concrete or its components. It must produce a firm, continuous, uniform moisture-impermeable film that is free of pinholes, cracks, or other film defects. It must also exhibit satisfactory adhesion.

The consistency must be such that the compound can be applied satisfactorily by conventional or airless spray at atmospheric and material temperatures above 40°F without thinning. When applied at the manufacturer's recommended thickness, not less than 8 mils wet, to vertical surfaces of damp concrete, the compound must not run off or appreciably sag. The liquid membrane-forming compound must not disintegrate, check, peel, or crack during the required curing period. It must not peel or pick up under traffic and must disappear from the surface of the cured concrete by gradual disintegration.

2. Cotton Mats

Cotton mats shall consist of a filling material of cotton "bat" or "bats" [at least 12 oz. Per square yard] completely covered with unsized cloth [at least 6 oz. Per square yard stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 in., or tuft both longitudinally and transversely at intervals less than 3 in.

The cotton mats shall be free from tears and in good general condition. A flap at least 6 in. wide with two (2) thicknesses of the covering that extends along one side of the mat shall be provided.

3. Polyethylene Sheeting

The polyethylene sheeting shall be at least 4 mils thick and free from visible defects. Clear or opaque white sheeting shall be provided when the ambient temperature during curing exceeds 60°F or when applicable to control temperature during mass pours.

4. Burlap-Polyethylene Mats

The burlap-polyethylene mats shall be made from burlap impregnated on 1 side with a film of opaque white-pigmented polyethylene, free from visible defects. The laminated mats shall have at least 1 layer of an impervious material such as polyethylene, vinyl plastic, or other acceptable material (either as a solid sheet or impregnated into another fabric) and shall be free of visible defects.

I. Chemical Admixtures

Chemical admixtures including water reducing, plasticizers and air entrainment shall conform to TxDOT DMS-4640, "Chemical Admixtures for Concrete" Calcium chloride shall not be used. Admixtures shall be included in the prequalified concrete admixtures list maintained by TxDOT's Construction Division.

J. City of Pflugerville Survey Monuments

The Public Works Department may furnish permanent survey monuments to be cast in concrete as indicated on the drawings or as directed by the City Engineer or designated representative.

K. Epoxy

Unless indicated otherwise on the drawings, epoxy materials shall conform to TxDOT DMS-6100, "Epoxy and Adhesives".

410S.4 - General Requirements

Before starting work, the Contractor shall inform the City Engineer or designated representative fully of the construction methods the Contractor proposes to use, the adequacy of which shall be subject to the review by the City Engineer or designated representative. The Contractor shall notify the City Engineer or designated representative 2 days before placing concrete in any unit of the structure to permit for the inspection of forms, reinforcing steel placement, and other preparations. Concrete shall not be placed in any unit prior to the completion of formwork and placement of reinforcement therein. Drawings for forms and falsework for piers and superstructure spans over 20 feet long, bracing systems for girders when the overhang exceeds 3 ft. 6 in. and for all bridge widening details shall be submitted to the City Engineer or designated representative for review, if requested. Similar drawings shall be submitted for other units of the structure, if requested by the City Engineer or designated representative. The drawings shall be prepared on standard 22-inch by 36-inch sheets and shall show all essential details of the proposed forms, falsework and bracing to permit a structural analysis. Four sets of such drawings will be required.

Concrete mixing, placing and finishing shall be done in daylight hours unless adequate provisions are made to light the entire site of all operations.

Concurrence on the part of the City Engineer or designated representative in any proposed construction methods, approval of equipment or of form and falsework drawings does not relieve the Contractor of the responsibility for the safety or correctness of the Contractor's methods, adequacy of equipment or from carrying out the work in full accordance with the contract.

Unless otherwise indicated on the drawings, the requirements in the succeeding paragraphs shall govern the time sequence in which construction operations may be carried on and for the opening of completed structures to traffic:

- a. Superstructure members, forms, falsework or erection equipment shall not be placed on the substructure before the concrete therein has attained a 3000 psi compressive strength.
- b. Storage of materials on completed portions of a structure will not be permitted until all curing requirements for those particular portions have been met.
- c. No forms shall be erected on concrete footings supported by piling or drilled shafts until the concrete therein has attained a minimum compressive strength of 2500 psi. Such work may begin on spread footings after the therein has aged at least 2 curing days. Concrete may be placed as soon as the forms and reinforcing steel are approved by the City Engineer or designated representative.
- d. The support of tie beam and/or forms by falsework placed on previously placed tie beams is permissible provided such beams have attained 3000 psi compressive strength, curing requirements are completed and the beams are properly supported to eliminate stresses not provided for in the design.
- e. Bridges and direct traffic culverts shall not be opened to construction traffic or to the traveling public until authorized by the City Engineer or designated representative in accordance with the following:
- f. Authorization may be given after the last slab concrete has been in place at least 14 days for light construction traffic not to exceed a 3/4-ton vehicle. Authorization to place embankments to allow normal construction traffic and when necessary to the traveling public, may be given after the last slab concrete has been in place 30 days or when the minimum compressive strength (f_c') has reached the 28 day strength conforming to Item No. 403S, "Concrete for Structures" or as indicated on the drawings.

410S.5 - Drains

Weep holes and roadway drains shall be installed and constructed as indicated on the drawings.

410S.6 - Expansion Joints

Joints and devices shall be used to provide for expansion and contraction of concrete slabs and shall be constructed as indicated on the drawings.

The bearing area under the expansion ends of concrete slabs and slab and girder spans shall be given a steel trowel finish and finished to the exact grades required on the drawings. The material used to separate expansion surfaces shall be as indicated on the drawings and placed so that concrete or mortar cannot be subsequently worked around or under it. The bridging of concrete or mortar around expansion joint material in bearings and expansion joints shall be prevented.

Concrete adjacent to armor joints and finger joints shall be placed carefully to avoid defective anchorage and porous or honeycombed concrete in such areas.

All open joints and joints to be filled with expansion joint material shall be constructed using forms adaptable to loosening or early removal. To avoid expansion or contraction damage to the adjacent concrete, these forms shall be loosened as soon as possible after final concrete set to permit free movement of the span without requiring full form removal.

Preformed fiber joint material or other material indicated shall be used in the vertical joints of the roadway slab, curb, median or sidewalk. The top 1-inch thereof shall be filled with joint sealing material, as specified herein. The sealer shall be installed in accordance with Standard Specification Item No. 413S, "Cleaning and/or Sealing Joints and Cracks (PC Concrete)" and the manufacturer's recommendations.

Prior to placing the sealing material, the vertical faces of the joint shall be cleaned of all laitance by sandblasting or by mechanical routing. Cracked or spalled edges shall be repaired. The joint shall be blown clean of all foreign material and sealed.

Where preformed fiber joint material is used, it shall be anchored to the concrete on one side of the joint by light wire or nails to prevent the material from falling out.

Finished joints shall conform to the drawing details with the concrete sections completely separated by the specified opening or joint material.

Soon after form removal and where necessary after surface finishing, all projecting concrete shall be removed along exposed edges to secure full effectiveness of the expansion joints.

410S.7 - Construction Joints

The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. The term monolithic placement shall be interpreted to mean that the manner and sequence of concrete placing shall not create construction joints.

Construction joints shall be of the type and at the locations indicated on the drawings. Additional joints will not be permitted without written authorization from the City Engineer or designated representative and when authorized, shall have details equivalent to those indicated for joints in similar locations.

Unless otherwise provided, construction joints shall be square and normal to the forms. Bulkheads shall be provided in the forms for all joints, except when horizontal. All vertical construction joints shall be chamfered. All horizontal construction joints shall be routed or grooved.

Construction joints requiring the use of joint sealing material shall be as indicated on the drawings or as directed by the City Engineer or designated representative. The material will be indicated on the drawings without reference to joint type.

A concrete placement terminating at a horizontal construction joint shall have the top surface roughened thoroughly as soon as practicable after initial set is attained. The surfaces at bulkheads shall be roughened as soon as the forms are removed.

The hardened concrete surface shall be thoroughly cleaned of all loose material, laitance, dirt or foreign matter and saturated with water so it is moist when placing fresh concrete against it. Remove all free water and moisten the surface before concrete or bonding grout is placed against it. Forms shall be drawn tight against the existing concrete and the joint surface flushed with grout just prior to placing the fresh concrete.

The joint surface shall be coated with bonding mortar, grout, epoxy or other material as indicated on the drawings or other items. A Type V epoxy shall be provided in accordance with TxDOT DMS-6100, "Epoxy and Adhesives" for bonding fresh concrete to hardened concrete. The epoxy shall be placed on a clean dry surface and the fresh concrete shall be placed while the epoxy is still tacky. Bonding mortar or grout shall be placed on a surface that is saturated surface dry and the concrete shall be placed before

the bonding mortar or grout dries. Other bonding agents shall be placed in accordance with the manufacturer's recommendations.

410S.8 - Foundation and Substructure

Excavation for foundations and substructure shall conform to Standard Specification Item No. 401S, "Structural Excavation and Backfill".

Concrete for foundation seals, unless otherwise indicated on the drawings, shall be Class C Concrete with a coarse aggregate grade of 2, 3, 4 or 5 and placed in accordance with the requirements herein. The top of the completed seal shall not vary from plan grade or the grade established by the City Engineer or designated representative.

Where a concrete seal is indicated on the Drawings, the design will be based on the normal water elevation as indicated on the Drawings. If the foundation concrete can be placed in the dry at the time of construction, the seal will not be required. If additional seal is necessary for the conditions existing during the time of construction, its thickness shall be increased as deemed necessary by the Contractor and at the Contractor's expense. If the conditions existing at the time of construction require a seal for placing the foundation concrete in the dry and none is indicated on the Drawings, the Contractor shall place an adequate seal at the Contractor's expense.

The seal shall be allowed to set for at least 36 hours before the caisson or cofferdam is dewatered, after which the top of the seal shall be cleaned of all laitance or other soft material and all high spots exceeding the above limitation shall be cut off and removed.

410S.9 - Falsework

The Contractor is totally responsible for all falsework. The Contractor shall design and construct it to safely carry the maximum anticipated loads and to provide the necessary rigidity. Details of falsework construction shall be subject to review by the City Engineer or designated representative, but City's review shall in no way relieve the Contractor of responsibility of the adequacy and safety of the falsework design.

All timber used in falsework centering shall be sound, in good condition and free from defects which will impair its strength. When wedges are used to adjust falsework to desired elevations, they shall be used in pairs to insure even bearing.

Sills or grillages shall be large enough to support the superimposed load without settlement and unless founded on solid rock, shale or other hard materials, precautions shall be taken to prevent yielding of the supporting material.

Falsework, which cannot be founded on a satisfactory spread footing, shall be placed on piling driven to a bearing capacity sufficient to support the superimposed load without settlement. The safe bearing capacity of piling shall be determined by test loads or by such other methods that may be required or acceptable to the City Engineer or designated representative.

In general, each falsework bent shall be capped transversely by a member of proper size. A short cap section forming a T-head may be substituted to permit the removal of portions of the forms without disturbing the falsework. Caps shall be securely fastened to each pile or column in the bent and set at the proper elevation to produce, in conjunction with the use of approved wedges or jacks, permanent camber indicated on the Drawings, plus a construction camber covering allowance for deformation of the forms

and falsework. The use of wedges to compensate for incorrectly cut bearing surfaces will not be permitted. Each falsework bent shall be securely braced to provide the stiffness required with the bracing securely fastened to each pile or column it crosses.

In setting falsework for arches, allowances shall be made for settlement of falsework, deflection of the arch and permanent camber. Provision shall be made by suitable wedges, sand jacks or other acceptable devices for the controlled lowering of falsework when the arch is swung. Falsework may be required to be placed on jacks to provide for settlement correction during concrete placement.

When the falsework is no longer required, it shall be removed. Falsework piling shall be pulled or cut off not less than 2 feet below finished ground level. Falsework and piling in a stream, lake or bay shall be completely removed to a point specified by the City Engineer or designated representative to prevent any obstruction to the waterway.

410S.10 - Forms

Forms for precast prestressed concrete members and for prestressed piling shall be constructed conforming to Item No. 424S, "Pre-stressed Concrete Planks".

A. General

Except where otherwise indicated on the drawings, forms may be of either timber or metal.

Forms for round columns exposed to view shall be of steel, except that other materials will be allowed with written permission of the City Engineer or designated representative.

Forming plans shall be submitted for approval by the City Engineer or designated representative. Forms shall be designed for the pressure exerted by a liquid weighing 150 pounds per cubic foot. The rate of placing the concrete shall be taken into consideration in determining the depth of the equivalent liquid. For job-fabricated forms an additional live load of 50 pounds per square foot shall be allowed on horizontal surfaces. The maximum unit stresses shall not exceed 125 percent of the allowable stresses used by the City Engineer or designated representative for the design of structures.

Formwork for wall and/or column pours equal or exceeding 8 feet shall be designed in accordance with ACI 347, "Guide to Formwork for Concrete" and sealed by a Registered Civil Engineer Licensed in the State of Texas, who is experienced in formwork design.

Commercially produced structural units used in formwork shall not exceed the manufacturer's maximum allowable working load for moment, shear or end reaction. The maximum working load shall include a live load of 35 pounds per square foot of horizontal form surface and sufficient details and data shall be submitted for use in checking formwork details for approval.

Forms shall be practically mortar-tight, rigidly braced and strong enough to prevent bulging between supports and maintained to the proper line and grade during concrete placement. Forms shall be maintained in a manner that will prevent warping and shrinkage.

Deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram shall be taken into account in the setting of slab forms.

All forms and footing areas shall be cleaned of any extraneous matter before placing concrete.

Permission to place concrete will not be given until all of such work is complete to the satisfaction of the City Engineer or designated representative.

If, at any stage of the work, the forms show signs of bulging or sagging, the portion of the concrete causing such condition shall be removed immediately, if necessary and the forms shall be reset and securely braced against further movement.

B. Timber Forms

Lumber for forms shall be properly seasoned, of good quality and free from imperfections, which would affect its strength or impair the finished surface of the concrete. The lumber used for facing or sheathing shall be finished on at least 1 side and 2 edges and shall be sized to uniform thickness.

Form or form lumber that will be reused shall be maintained clean and in good condition. Lumber that is split, warped, bulged, or marred or that has defects that will produce inferior forms shall not be used but shall be removed from the work.

Form lining will be required for all formed surfaces, except for the inside of culvert barrels, inlets, manholes and box girders, the bottom of bridge decks between beams or girders, surfaces that are subsequently covered by backfill material or are completely enclosed and any surface formed by a single finished board. Lining will not be required when plywood forms are used.

Form lining shall be of an approved type such as Masonite or plywood. Thin membrane sheeting such as polyethylene sheets shall not be used for form lining.

Forms may be constructed of plywood not less than 3/4 inch in thickness, with no form lining required. The grain of the face plies on plywood forms shall be placed parallel to the span between the supporting studs or joists.

Plywood used for forming surfaces, which remain exposed, shall be equal to that specified as B-B Plyform Class I or Class II Exterior of the U.S. Department of Commerce Voluntary Product Standard, PS 1.

Studs and joists shall be spaced so that the facing form material remains in true alignment under the imposed loads.

Wales shall be spaced close enough to hold forms securely to the designated lines and scabbed at least 4 feet on each side of joints to provide continuity. A row of wales shall be placed near the bottom of each placement.

Facing material shall be placed with parallel and square joints and securely fastened to supporting studs.

Forms for surfaces receiving only an ordinary finish and exposed to view shall be placed with the form panels symmetrical, i.e., long dimensions set in the same direction. Horizontal joints shall be continuous.

Molding specified for chamfer strips or other uses shall be made of materials of a grade that will not split when nailed and which can be maintained to a true line without warping. Wood molding shall be mill cut and dressed on all faces. Unless indicated otherwise on the drawings, forms shall be filleted at all sharp corners and edges with triangular chamfer strips measuring 3/4 inch on the sides.

Forms for railings and ornamental work shall be constructed to standards equivalent to first class millwork. All moldings, panel work and bevel strips shall be straight and true with neatly mitered joints designed so the finish work is true, sharp and clean cut. All forms shall be constructed to permit their removal without marring or damaging the concrete. The forms may be given a slight draft to permit ease of removal.

Metal form ties of an approved type or a satisfactory substitute shall be used to hold forms in place and shall be of a type that permits ease of removal of the metal as hereinafter specified.

All metal appliances used inside of forms for alignment purposes shall be removed to a depth of at least 1/2 inch from the concrete surface. They shall be made so the metal may be removed without undue chipping or spalling and when removed, shall leave a smooth opening in the concrete surface. Burning off of rods, bolts or ties will not be permitted.

Any wire ties used shall be cut back at least 1/2 inch from the face of the concrete and properly patched.

Devices holding metal ties in place shall be capable of developing the strength of the tie and adjustable to allow for proper alignment.

Metal and wooden spreaders, which are separate from the forms, shall be removed entirely as the concrete is being placed.

Adequate clean-out openings shall be provided for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

Prior to placing concrete, the facing of all forms shall be treated with oil or other bond breaking coating of such composition that it will not discolor or otherwise injuriously affect the concrete surface. Care shall be exercised to prevent coating of the reinforcing steel.

C. Metal Forms

The foregoing requirements for timber forms as regards design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse and wetting shall also apply to metal forms, except that these will not require lining, unless specifically indicated on the drawings.

The thickness of form metal shall be as required to maintain the true shape without warping or bulging. All bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms, which do not present a smooth surface or line up properly, shall not be used. Metal shall be kept free from rust, grease or other foreign materials.

D. Form Supports for Overhang Slabs

Form supports which transmit a horizontal force to a steel girder or beam or to a prestressed concrete beam will be permitted, but shall not be used unless a structural analysis has been made of the effect on the girder or beam and approval is granted by the City Engineer or designated representative.

In normal or skewed spans with standard overhangs not exceeding 3 feet, 1 ½ inches, beam bracing as shown in the drawings shall be used.

Spans in which the overhang width exceeds 3 feet, 1½ inches will require additional support for the outside beams to resist torsion. Details of the Contractor's proposed method of providing additional support shall be included with the slab forming plans submitted to the City Engineer or designated representative for review and approval.

Holes in steel members for support of overhang brackets may be punched or drilled full size or may be torch cut to 1/4 inch under size and reamed full size. In no case shall the holes be burned full size. The hole shall be left open unless indicated to be filled with a button head bolt. They shall never be filled by welding.

410S.11 - Placing Reinforcement

Reinforcement in concrete structures shall be placed carefully and accurately and rigidly supported as provided in Standard Specification Item No. 406S, "Reinforcing Steel". Reinforcing steel supports shall not be welded to I-beams or girders or stirrups of prestressed concrete beams.

410S.12 - Placing Concrete

A. General

Concrete shall not be placed when impending weather conditions would impair the quality of the finished work. If conditions of wind, humidity and temperature are such that concrete cannot be placed without the potential for shrinkage cracking, the concrete should be placed in early morning, at night or on a schedule with more favorable weather. When mixing, placing and finishing concrete is scheduled during non-daylight hours; the entire placement site should be illuminated to the satisfaction of the City Engineer or designated representative.

If changes in weather conditions require protective measures after work starts, adequate shelter shall be provided to protect the concrete against damage from rainfall or from freezing temperatures as outlined in this Item. Operations during rainfall shall only be continued if approved by the City Engineer or designated representative. Aggregate stockpiles shall be covered to the extent necessary to control the moisture conditions in the aggregates.

Slab concrete shall be mixed in a plant located off the structure. Carting or wheeling concrete batches over completed slabs will not be permitted until they have aged at least 4 full curing days or timber planking placed on top of the slab for the carts to traverse along. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

Exposed concrete surfaces, while still plastic, shall be stamped with an impression having the Contractor's name, the month and year. The stamp shall be of an approved design.

At least 1 day of curing shall be allowed after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.

The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and when permitted, shall be limited to quantities and distribution that will not induce excessive stresses.

B. Preparation of Surfaces

All forms, prestressed concrete panels, T-beams and concrete box beams on which concrete will be placed shall be thoroughly wetted before the placement of concrete. Puddles of excess water shall be removed before placing the concrete. The various surfaces shall be in a moist, saturated surface dry condition when concrete is placed on or against them.

The subgrade or foundation shall be moist before placing concrete for bridge approach slabs or other concrete placed on grade. If dry the subgrade shall be lightly sprinkled.

C. Placing Temperature

The minimum temperature of all concrete at the time of placement shall not be less than 50°F. The maximum temperature of any concrete, unless otherwise indicated on the drawings, shall not exceed 95°F when placed. The maximum temperature of cast-in-place concrete in bridge superstructures, diaphragms, parapets, concrete portions of railing, curbs and sidewalks and direct traffic box culverts shall not exceed 85°F when placed. Other portions of structures, when indicated on the drawings, shall require the temperature control specified.

For continuous placement of the deck on continuous steel units, the initial set of the concrete shall be retarded sufficiently to ensure that it remains plastic in not less than 3 spans immediately preceding the one being placed. For simple spans, retardation shall be required only if necessary to complete finishing operations.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finishing, the required water shall be applied to the surface by fog spray only and shall be held to a minimum amount. Fog spray for this purpose may be applied with hand operated fogging equipment.

The height of free fall of concrete shall be limited to 5 feet to prevent segregation.

D. Transporting Time

The maximum time interval between the addition of cement to the batch and the placing of concrete in the forms shall not exceed the following:

Table 2: Allowable Transportation Times			
Air or Concrete Temperature whichever is higher	Maximum Time w/o Retarder	Maximum Time with Retarder	
		*Specific Applications	All others
Non-agitated Concrete			
35°F to 79°F	45 minutes	45 minutes	45 minutes
Over 80°F	30 minutes	45 minutes	45 minutes
Agitated Concrete			

90°F or above	45 minutes	75 minutes	105 minutes
75°F to 89°F	60 minutes	90 minutes	120 minutes
35°F to 74°F	90 minutes	120 minutes	150 minutes

* Specific applications include Bridge decks, cased drilled shafts and slabs of direct traffic culverts

The use of an approved retarding agent in the concrete will permit the extension of each of the above temperature-time maximums by 30 minutes for bridge decks, top slabs of direct traffic culverts and cased drilled shafts and 1 hour for all other concrete except that the maximum time shall not exceed 45 minutes for non-agitated concrete.

E. Handling and Placing

The Contractor shall give the City Engineer or designated representative 2 days' notice before placing concrete in any unit of the structure to permit the review of forms, reinforcing steel placement and other preparations. Concrete shall not be placed in any unit prior to the completion of formwork and placement of reinforcement therein.

The sequence for placing concrete shall be as indicated on the drawings or as required herein. The placing shall be regulated so the pressures caused by the plastic concrete shall not exceed the loads used in the form design.

The method of handling, placing and consolidation of concrete shall be capable of maintaining the rate of placement approved by the City Engineer, minimize segregation and displacement of the reinforcement and produce a uniformly dense and compact mass. Concrete shall not have a free fall of more than 5 feet, except in the case of drilled shafts, thin wall sections such as in culverts, or as allowed by other Items. Any hardened concrete spatter ahead of the plastic concrete shall be removed.

Each part of the forms shall be filled by depositing concrete as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point and running or working it along the forms will not be allowed.

Concrete shall be deposited in the forms in layers of suitable depth but not more than 36 inches in thickness, unless otherwise directed by the City Engineer or designated representative.

Cold joints in a monolithic placement shall be avoided. The sequence of successive layers or adjacent portions of concrete shall be such that they can be vibrated into a homogeneous mass with the previously placed concrete without a cold joint. Not more than 1 hour (1 ½ hours if a normal dosage of retarding admixture is used) shall elapse between adjacent or successive placements of concrete. Unauthorized construction joints shall be avoided by placing all concrete between the authorized joints in one continuous operation.

An approved retarding agent shall be used to control stress cracks and/or authorized cold joints in mass placements where differential settlement and/or setting time may induce stress cracking, such as on false work, in deep girder stems, etc.

Openings in forms shall be provided, if needed, for the removal of laitance or foreign matter of any kind.

All forms shall be wetted thoroughly before the concrete is placed therein.

F. Consolidation

All concrete shall be well consolidated, and the mortar flushed to the form surfaces by continuous working with immersion type vibrators. Vibrators which operate by attachment to forms or reinforcement will not be permitted, except on steel forms. At least 1 standby vibrator shall be provided for emergency use in addition to the ones required for placement. For lightweight concrete, vibrators of the high frequency type, which produce a minimum of 7000 impulses per minute, will be required.

The concrete shall be vibrated immediately after deposition. Prior to the beginning of work, a systematic spacing of the points of vibration shall be established to insure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures and into the corners and angles of the forms. Immersion type vibrators shall be inserted vertically, at points 18 to 30 inches apart and slowly withdrawn. The vibrator may only be inserted in a sloping or horizontal position in shallow slabs. The entire depth of each lift shall be vibrated, allowing the vibrator to penetrate several inches into the preceding lift. The vibrator shall not be used to move the concrete to other locations. In addition, the vibrator shall not be dragged through the concrete. Concrete along construction joints shall be thoroughly consolidated by operating the vibrator along and close to but not against the joint surface. The vibration shall continue until thorough consolidation and complete embedment of reinforcement and fixtures is produced, but not long enough to cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

G. Finishing

From the time of initial strike off until final finish is completed and required interim curing is in place, the unformed surfaces of slab concrete in bridge decks and top slab of direct traffic culverts and concrete slabs, shall be kept damp, not wet, to offset the effects of rapid evaporation of mixing water from the concrete due to wind, temperature, low humidity or combinations thereof. Fogging equipment capable of applying water in the form of a fine fog mist, not a spray, will be required. Fogging will be applied at the times and in the manner directed by the City Engineer or designated representative.

Fogging equipment may be either water pumped under high pressure or a combination of air and water, either system in combination with a proper atomizing nozzle. The equipment shall be sufficiently portable for use in the direction of any prevailing winds. The equipment shall be adapted for intermittent use to prevent excessive wetting of the surfaces.

Upon completion of the final finish, interim curing will be required for slab concrete in bridge decks and top slabs of direct traffic culverts as follows:

- a. Required water curing shall begin as soon as it can be done without damaging the concrete finish.
- b. Unless otherwise indicated on the Drawings, Type 1-D membrane curing compound (resin base only) shall be applied to the slab surface.

H. Installation of Dowels and Anchor Bolts

Dowels and anchor bolts shall be installed by casting them in place or by grouting with grout, epoxy, or epoxy mortar unless indicated otherwise on the drawings.

Holes for grouting shall be formed or drilled. Holes for anchor bolts shall be drilled to accommodate the bolt embedment required on the drawings. Holes for dowels shall be made at least 12 in. deep unless indicated otherwise on the drawings. When grout or epoxy mortar is specified the diameter of the hole shall be at least twice the dowel or bolt diameter but shall not exceed the dowel or bolt diameter plus 1 ½ in. When epoxy is specified the hole diameter should be 1/16 to 1/4 in. greater than the dowel or bolt diameter.

Holes for anchor bolts in piers, abutments, bents or pedestals may be drilled or formed by the insertion of oiled wooden plugs or metal sleeves in the plastic concrete. Formed holes shall be large enough to permit horizontal adjustments of the bolts. The bolts shall be carefully set in mortar. In lieu of the above, anchor bolts may be set to exact locations when the concrete is placed.

The holes shall be thoroughly cleaned of all loose material, oil, grease or other bond-breaking substance and blow them clean with filtered compressed air. When an epoxy type material is used the holes shall be in a surface dry condition. When hydraulic cement grout is used the holes shall be in a surface moist condition. The void space between the hole and the dowel or bolt shall be completely filled with grouting material. The requirements for cleaning outlined in the product specification for prepackaged systems shall be followed exactly.

The following should be used as a guide in selection of an appropriate grout, mortar, epoxy or epoxy grout.

Table 3: Guide for Selection of Epoxy, Epoxy Mortar, Grout and Epoxy Grout	
Material Type	Recommendation
Epoxy, Epoxy Mortar or other prepackaged Mortar	As Approved
Cast-in-place or Grouted system	1 part hydraulic cement, 2 parts sand and sufficient water for desired consistency
Neat Epoxy	Type III epoxy per TxDOT DMS-6100, "Epoxies and Adhesives"
Epoxy Grout	Type III epoxy per TxDOT DMS-6100, "Epoxies and Adhesives" Provide grout, epoxy or epoxy mortar as the binding agent unless otherwise indicated on the drawings

410S.13 - Placing Concrete in Cold Weather

A. General

The Contractor is responsible for the protection of concrete placed under any and all weather conditions and is responsible for producing concrete equal in quality to that placed under normal

conditions. Permission given by the City Engineer or designated representative to allow placement of the concrete during cold weather does not relieve the Contractor of the responsibility for producing concrete equal in quality to that placed under normal conditions. Concrete placed under adverse weather conditions that proves to be unsatisfactory shall be removed and replaced at Contractor' expense.

B. Cast-in-Place Concrete

Concrete may be placed when the ambient temperature is not less than 35°F in the shade and rising or above 40°F. Concrete shall not be placed when the ambient temperature in the shade is below 40°F and falling unless approved by the City Engineer or designated representative. Concrete shall not be placed in contact with any material coated with frost or having a temperature less than 32°F.

Aggregates shall be free from ice, frost and frozen lumps. When required, in order to produce the minimum specified concrete temperature; the aggregate and/or the water shall be heated uniformly, in accordance with the following:

The water temperature shall not exceed 180°F and/or the aggregate temperature shall not exceed 150°F. The heating apparatus shall heat the mass of aggregate uniformly. The temperature of the mixture of aggregates and water shall be between 50°F and 85°F before introduction of the cement.

All concrete shall be effectively protected as follows:

1. The temperature of slab concrete of all unformed surfaces shall be maintained at 50°F or above for a period of 72 hours from time of placement and above 40°F for an additional 72 hours.
2. The temperature at the surface of all concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, bottom of slabs and other similar forms shall be maintained at 40°F or above for a period of 72 hours from time of placement.
3. The temperature of all concrete, including the bottom slabs of culverts placed on or in the ground, shall be maintained above 32°F for a period of 72 hours from time of placement.

Protection shall consist of providing additional covering, insulated forms or other means and if necessary, supplementing such covering with artificial heating. Avoid applying heat directly to concrete surfaces. Curing shall be provided during this period until all requirements for curing have been satisfied.

When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand ready for use before permission is granted to begin placement.

Sufficient extra test specimens will be made and cured with the placement to ascertain the condition of the concrete as placed prior to form removal and acceptance.

C. Precast Concrete

A fabricating plant for precast products which has adequate protection from cold weather in the form of permanent or portable framework and covering, which protects the concrete when placed the forms and is equipped with approved steam curing facilities may place concrete under any low temperature conditions provided:

1. The framework and covering are placed, and heat is provided for the concrete and the forms within 1 hour after the concrete is placed. This shall not be construed to be 1 hour after the last concrete is placed, but that no concrete shall remain unprotected longer than 1 hour.
2. Steam heat shall keep the air surrounding the concrete between 50°F and 85°F for a minimum of 3 hours prior to beginning the temperature rise, which is required for steam curing.

410S.14 - Placing Concrete in Hot Weather

When the temperature of the air is above 85°F, an approved retarding agent will be required in all exposed concrete, concrete used in superstructures, top slabs of direct traffic culverts and all cased drilled shafts regardless of temperatures. Concrete mix temperatures shall not exceed 90°F except for mixes that include high range water reducers where a maximum mix temperature of 100°F will be allowed.

If the concrete mix temperature is expected to exceed 90°F (or 100°F in mixes with high range water reducers) ice may be utilized to lower the concrete mix temperature. Ice may be added to the concrete mix as a portion by weight of the mix water. However, the addition of ice shall not exceed 50% of the total mix water weight.

When weather conditions are such that the addition of ice at 50% of the mix water is not sufficient to reduce the concrete mix temperature to an acceptable temperature, concrete work shall not be allowed.

When ice is to be used in hot weather concrete placement, the Contractor shall furnish a mix design (Section 4.4 of Standard Specification Item 360S, "Concrete Pavement" and Section 6 of Standard Specification Item No. 403S, "Concrete for Structures") acceptable to the City Engineer or designated representative for class of concrete specified on the drawings.

410S.15 - Placing Concrete in Water

Concrete shall be deposited in water only when indicated on the drawings or with written permission of the City Engineer or designated representative. The forms, cofferdams or caissons shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping will not be permitted during the concrete placing nor until it has set for at least 36 hours.

The concrete shall be placed with a tremie, pump or other approved method and shall not be permitted to fall freely through the water nor shall it be disturbed after it has been placed. Its surface shall be kept approximately level during placement.

The tremie shall be supported or the pump operated so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow. The lower end of the tremie or pump hose shall be submerged in the concrete at all times.

The placing operations shall be continuous until the work is complete.

For concrete to be placed under water, the concrete mix shall be designed in accordance with Standard Specification Item No. 403S, "Concrete For Structures" with a minimum cement content of 650 lb. Per cubic yard. An anti-wash admixture may be included in the mix design as necessary to produce a satisfactory finished product.

410S.16 - Placing Concrete in Box Culverts

In general, construction joints will be permitted only where indicated on the drawings.

Where the top slab and walls are placed monolithically in culverts more than 4 feet in clear height, an interval of not less than 1 nor more than 2 hours shall elapse before placing the top slab to allow for settlement and shrinkage in the concrete wall.

The base slab shall be trowel finished accurately at the proper time to provide a smooth uniform surface. Top slabs, which carry traffic, shall be finished as specified for roadway slabs in "Finish of Roadway Slabs", below. Top slabs of fill type culverts shall be given a reasonably smooth float finish.

410S.17 - Placing Concrete in Foundations and Substructure

Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the City Engineer or designated representative and permission has been given to proceed.

Placing of concrete footings upon seal courses will be permitted after the caissons or cofferdams are free from water and the seal course cleaned. Any necessary pumping or bailing during the concrete placement shall be done from a suitable sump located outside the forms.

All temporary wales or braces inside cofferdams or caissons shall be constructed or adjusted as the work proceeds to prevent unauthorized construction joints in footings or shafts.

When footings can be placed in a dry excavation without the use of cofferdams or caissons, forms may be omitted if desired by the Contractor and approved by the City Engineer or designated representative and the entire excavation filled with concrete to the elevation of the top of footing.

Concrete in columns shall be placed monolithically unless otherwise indicated on the drawings. Columns and caps and/or tie beams supported thereon may be placed in the same operation or separately. To allow for settlement and shrinkage of the column concrete, it shall be placed on the lower level of the cap or tie beam and placement delayed for not less than 1 hour nor more than 2 before proceeding with the cap or tie beam placement.

410S.18 - Treatment and Finishing of Horizontal Surfaces Except Bridge Slabs

All unformed upper surfaces shall be struck off to grade and finished. The use of mortar topping for surfaces under this classification will not be permitted.

After the concrete has been struck off, the surface shall be floated with a suitable float. Bridge sidewalks shall be given a wood float or broom finish or may be striped with a brush as specified by the City Engineer or designated representative.

The tops of caps and piers between bearing areas shall be sloped slightly from the center toward the edge and the tops of abutments and transition bents sloped from the back wall to the edge, as directed by the City Engineer or designated representative, so that water will drain from the surface. The concrete shall be given a smooth trowel finish. Bearing areas for steel units shall be constructed in such a manner to have a full and even bearing upon the concrete. When the concrete is placed below grade, bearing areas may be raised to grade on beds of Portland cement mortar consisting of 1 part cement, 2 parts sand and a minimum amount of water.

Bearing seat buildups or pedestals for concrete units shall be cast integrally with the cap or with a construction joint. The construction joint area under the bearing shall have the surface roughened thoroughly as soon as practical after initial set is obtained. The bearing seat buildups shall be placed using a latex based grout, an epoxy grout, or an approved proprietary bearing mortar, mixed in accordance with the manufacturer's recommendation. Pedestals shall be placed using Class C concrete, reinforced as indicated on the drawings.

The bearing area under the expansion end of concrete slabs and slab and girder spans shall be given a steel-trowel finish to the exact grades required on the drawings. Bearing areas under elastomeric bearing pads or nonreinforced bearing seat buildups shall be given a textured wood float finish. The bearing area shall not vary from a level plane more than 1/16 in. in all directions.

410S.19 - Placing Survey Monuments

The Contractor shall obtain City Survey Monuments, for a fee of 10 dollars, from the Department of Public Works, Construction Inspection Division. Monuments shall be embedded in freshly poured concrete at locations indicated on the drawings and accessible to survey equipment at the completion of the project. The monuments shall be installed flush with the adjacent concrete.

410S.20 - Curing Concrete

The Contractor shall inform the City Engineer or designated representative fully of the methods and procedures proposed for curing, shall provide the proper equipment and material in adequate amounts and shall have the proposed method, equipment and material approved by the City Engineer or designated representative prior to placing concrete.

Inadequate curing and/or facilities therefore shall be cause for the City Engineer or designated representative to notify the Contractor, in writing, that the work is unsatisfactory, and the concrete will have to be removed and replaced.

All concrete shall be cured for a period of 4 curing days except as noted herein. A curing day is a calendar day when the temperature, taken in the shade away from artificial heat is above 50°F for at least 19 hours or on colder days if the temperature of all surfaces of the concrete is maintained above 40°F for the entire 24 hours. The required curing shall begin when all concrete has attained its initial set. TxDOT's Tex-440-A, "Initial Time-of-Set of Fresh Concrete" may be used to establish when the concrete has attained its initial set.

Table 4: Exceptions to 4-Day Curing		
Description	Type of Cement	Required Curing Days
Upper Surfaces of Bridge Slabs, Top Slabs of Direct Traffic Culverts and Concrete Overlays	I or II	8
	II or I/II	10
	All types with supplementary cementing materials	10
Concrete Piling buildups		6

For upper surfaces of bridge slabs, bridge support slabs, median and sidewalk slabs and culvert top slabs constructed using Class S Concrete (Standard Specification Item No. 403S, "Concrete for Structures") interim curing using a Type 1-D curing compound shall be applied as soon as possible after application of the evaporation retardant and after the water sheen has disappeared, but no more than 45 minutes after application of the evaporation retardant. Membrane interim curing shall be applied using a work bridge or other approved apparatus to ensure a uniform application. Final curing with water cure in accordance with this section shall start as soon as possible without damaging the surface finish. Water curing shall be maintained for the duration noted in the table above. Polyethylene sheeting, burlap-polyethylene blankets, laminated mats or insulating curing mats shall be placed in direct contact with the slab when the ambient temperature is expected to drop below 40°F during the first 72 hours of the curing period. The curing materials will be weighed down with dry mats to maintain direct contact with the concrete and to provide insulation against cold weather. Supplemental heating or insulation may be required in cold and wet weather if the insulating cotton mats become wet or if the concrete temperature drops below the specified curing temperature. Application of heat directly to concrete surfaces shall be avoided.

For the top surface of any concrete unit upon which concrete is to be placed and bonded at a later date (i.e. stub walls, risers, etc.), only water-cure in accordance with this Section shall be used.

All other concrete shall be cured as specified in pertinent Items.

The following methods are permitted for curing concrete subject to the restrictions of this Item:

A. Form Curing

When forms are left in intimate contact with the concrete, other curing methods will not be required except for exposed surfaces and for cold weather protection.

When forms are stripped before the 4-day minimum curing time has elapsed, curing shall continue by an approved method.

B. Water Curing

All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. The water used for curing shall meet the requirements for concrete mixing water as indicated in Item No. 403S, "Concrete for Structures". Seawater will not be permitted. Water, which stains or leaves an unsightly residue, shall not be used.

1. Wet Mats

Wet cotton mats placed in direct contact with the slab shall be maintained for the required curing time. If needed damp burlap blankets made from 9-ounce stock may be placed on the damp concrete surface for temporary protection prior to the application of the cotton mats, which may be placed dry and wetted down after placement.

The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible. The surfaces of the concrete shall be kept wet for the required curing time. Surfaces, which cannot be cured by contact, shall be enclosed with mats, anchored positively to the forms or to the ground, so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.

2. Water Spray

This method shall consist of overlapping sprays or sprinklers that keep all unformed surfaces continuously wet.

3. Ponding

This method requires the covering of the surfaces with a minimum of 2 inches of clean granular material, kept wet at all times or a minimum of 1 inch depth of water. Satisfactory provisions shall be made to provide a dam to retain the water or saturated granular material.

C. Membrane Curing

Unless otherwise indicated on the drawings, either Type 1-D or Type 2 membrane curing compound may be used where permitted except that Type 1-D (Resin Base Only) will be permitted for slab concrete in bridge decks and top slabs of direct traffic culverts and all other surfaces that require a higher grade of surface finish. For substructure concrete, only one Type of curing compound will be permitted on any one structure.

TABLE 5				
STRUCTURE UNIT DESCRIPTION	REQUIRED		PERMITTED	
	Water for Complete Curing	Membrane for Interim Curing	Water for Complete Curing	Membrane for Complete Curing
1. Upper surfaces of Bridge Roadway, Median and Side walk Slabs, Top Slabs of Direct Traffic, and Culverts.	X	X (resin base)		
2. Top Surface of any Concrete Unit upon which Concrete is to be placed and bonded at a later interval (Stub Walls, Risers, etc.). Other Super-structure Concrete (curbs, wing- walls, Parapet Walls, etc.).	X		*X	*X
3. Top Surface of Precast and/or Pre-stressed Piling.	X	X		
4. All Substructure Concrete Culverts. Box Sewers, Inlets, Manholes, Retaining Walls, Riprap.			*X	*X

* Polyethylene Sheeting, Burlap-Polyethylene Mats or Laminated Mats in close intimate contact with the concrete surfaces, will be considered equivalent to water or membrane curing for items under 4.

The membrane curing shall be applied just after free moisture has disappeared in a single, uniform coating at the rate of coverage recommended by the manufacturer and as approved by the City Engineer or designated representative, but not less than 1 gallon per 180 square feet of area. Tests for acceptance shall be at this specified rate.

Membrane curing shall not be applied to dry surfaces but shall be applied just after free moisture has disappeared. Formed surfaces and surfaces which have given a first rub shall be dampened and shall be moist at the time of application of the membrane.

When membrane is used for complete curing, the film shall remain unbroken for the minimum curing period specified. Membrane, which is damaged, shall be corrected immediately by reapplication of membrane. Polyethylene sheeting, burlap-polyethylene mats or laminated mats in close intimate contact with the concrete surfaces, will be considered equivalent to membrane curing. Unless otherwise indicated on the drawing, the choice of membrane type shall be at the option of the Contractor, except that the City Engineer or designated representative may require the same curing method for like portions of a single structure.

410S.21 - Removal of Forms and Falsework

Unless otherwise indicated on the drawing, forms for vertical surfaces may be removed when the concrete has aged 12 hours after initial set, provided it can be done without damage to the concrete. Forms for mass concrete placements shall be maintained in place for 4-days following concrete placement. Mass placements are defined as concrete placements with a least dimension greater than equal to 5 ft., or those designated as such on the drawings.

Forms for inside curb faces may be removed in approximately 3 hours provided it can be done without damage to the curb.

Unless indicated otherwise on the drawings weight supporting forms and falsework spanning more than 1 ft. for structures, bridge components and culvert slabs shall remain in place until the concrete has attained a minimum compressive strength of 2500 psi. Forms for other structural components may be removed as specified by the City Engineer or designated representative.

Inside forms (walls and top slabs) for inlets, box culverts and sewers may be removed after the concrete has attained a minimum compressive strength of 1800 psi, provided an overhead support system, approved by the City Engineer or designated representative, is used to transfer the weight of the top slab to the walls of the box culvert or sewer before the support provided by the forms is removed.

If all test cylinders made for the purpose of form removal have been broken without attaining the required strength, forms shall remain in place for a total of 14 curing days.

The above provisions relative to form removal shall apply only to forms or parts thereof which are constructed to permit removal without disturbing forms or falsework required to be left in place for a longer period on other portions of the structure.

Remove all metal appliances used inside forms for alignment shall be removed to a depth of at least 1/2 in. from the concrete surface. The appliances shall be manufactured to allow the removal without undue chipping or spalling of the concrete, and so that it leaves a smooth opening in the concrete surface when removed. Rods, bolts and ties shall not be burned-off.

Backfilling against walls of Type I or Type II cement shall not take place for a minimum of 7 days. Backfilling against walls of Type III cement shall not take place until the cylinder compressive strength has reached 3000 psi or the wall has cured for 5 days.

All forms and falsework shall be removed unless indicated otherwise on the drawings.

410S.22 - Defective Work

Any defective work discovered after the forms have been removed shall be repaired as soon as possible in accordance with "Finishing Exposed Surfaces", below.

If the surface of the concrete is bulged, uneven or shows excess honeycombing or form marks, which in the opinion of the City Engineer or designated representative, cannot be repaired satisfactorily, the entire section shall be removed and replaced at the expense of the Contractor.

410S.23 - Finishing Exposed Surfaces

A. Ordinary Surface Finish

An Ordinary Surface Finish shall be applied to all concrete surfaces either as a final finish or preparatory to a higher grade or class of finish. Higher grades and classes of finish shall conform to Item No. 411S, "Surface Finishes for Concrete". Where neither a grade or class of finish is specified, an Ordinary Surface Finish only, will be required.

Ordinary Surface Finish shall be provided as follows:

1. After form removal, all porous, honeycombed areas and spalled areas shall be corrected by chipping away all loose or broken material to sound concrete.
2. Feathered edges shall be eliminated by saw-cutting and chipping spalled areas to a depth at least 1/2 in. deep perpendicular to the surface. Shallow cavities shall be repaired using a latex adhesive grout, cement mortar or epoxy grout approved by the City Engineer or designated representative. If judged repairable by the City Engineer or designated representative, large defective areas shall be corrected using concrete or other material approved by the City Engineer or designated representative.
3. Holes and spalls caused by removal of form ties, etc., shall be cleaned and filled with latex adhesive grout, cement mortar or epoxy grout approved by the City Engineer or designated representative. Only the holes shall be filled. The patch shall not be blended with the surrounding concrete. On surfaces to receive a rub finish in accordance with Standard Specification Item No. 411S, "Surface Finishes for Concrete" the exposed parts of metal chairs shall be chipped out to a depth of 1/2 inch and the surface repaired.
4. All fins, runs, drips or mortar that will be exposed shall be removed from surfaces. Form marks and chamfer edges shall be smoothed by grinding and/or dry rubbing.
5. Grease, oil, dirt, curing compound, etc., shall be removed from surfaces requiring a higher grade of finish. Discolorations resulting from spillage or splashing of asphalt, paint or other similar material shall be removed.

6. Repairs shall be dense, well bonded and properly cured and when made on surfaces, which remain exposed and do not require a higher finish, shall be finished to blend with the surrounding concrete.

Unless otherwise indicated on the drawings Ordinary Surface Finish shall be the final finish for the following exposed surfaces:

1. inside and top of inlets,
2. inside and top of manholes,
3. inside of sewer appurtenances,
4. inside of culvert barrels,
5. bottom of bridge decks between beams or girders,
6. vertical and bottom surfaces of interior concrete beams or girders.

B. Rubbed Finish

In general, the following areas shall require a rubbed finish and shall receive a first and second rubbing:

1. The top, exterior and roadway facia of curbs and parapet walls.
2. All concrete surfaces of railing.
3. The exterior vertical facia of slab spans, rigid frames, arches and box girders.
4. The outside and bottom surfaces of facia beams or girders (except precast concrete beams).
5. The underside of overhanging slabs to the point of juncture of the supporting beams.
6. All vertical surfaces of piers, columns, bent caps, abutments, wing walls and retaining walls which are exposed to view after all backfill and embankments is placed.
7. Exposed formed surfaces of inlet and outlet structures on culverts, transition structures, headwalls and inlets.
8. Such other surfaces specified elsewhere to receive a rubbed finish and such additional surfaces required by the City Engineer or designated representative to receive a rubbed finish.

After removal of forms and as soon as the mortar used in pointing has set sufficiently, surfaces to be rubbed shall be wet with a brush and given a first surface rubbing with a medium coarse carborundum stone. This rubbing shall be done before the concrete has cured more than 48 hours.

The second rubbing shall present a cleaned uniform appearance free from drip marks and discoloration. It shall be given with a No.30 carborundum stone or an abrasive of equal quality.

If the Contractor elects to use epoxy paint in lieu of the second rubbings the Contractor may do so upon approval of the City Engineer or designated representative.

C. Special Surface Finishes

Striated, exposed aggregate and other special surface finishes shall conform to Standard Specification Item No. 411S, "Surface Finishes for Concrete" and/or with the requirements indicated on the drawings.

410S.24 - Measurement and Payment

No direct measurement or payment will be made for the work to be done or the equipment to be furnished under this item but shall be included in the unit price bid for the item of construction in which this item is used.

END

ITEM NO. 430S - PC CONCRETE CURB AND GUTTER

430S.1 - Description

This item shall govern Portland Cement (PC) concrete curb, PC concrete curb and gutter with reinforcing steel or PC concrete laydown curb as required, that is constructed in accordance with this specification on an approved subgrade and base in conformity with Standard Detail Series 430S and the lines, grades, section indicated on the Drawings or as established by the Engineer or designated representative.

430S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall electronically submit the following submittal requirements:

- A. Class A PC concrete mix design,
- B. Type of Installation (i.e. PC Concrete Curb and Gutter or PC Concrete Curb or PC Concrete Laydown Curb) and construction details (i.e. base, reinforcing steel, joints, curing membrane),
- C. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.

430S.3 - Materials

A. Concrete

The PC concrete shall conform to Class A Concrete, Section 403S.7 (Table 4) of Standard Specification Item No. 403S, "Concrete for Structures" or Sections 360S.4 and 360S.6 of Standard Specification Item No. 360S, "Concrete Pavement" when curb and gutter is to be constructed integral with the pavement.

B. Reinforcing Steel

Reinforcing steel shall conform to Standard Specification Item No. 406S, "Reinforcing Steel."

C. Expansion Joint Materials

Expansion joint materials shall conform to Standard Specification Item No. 408S, "Concrete Joint Materials."

D. Membrane Curing Compound

Membrane curing compound shall conform to Standard Specification Item No. 409S, "Membrane Curing."

E. Flexible Base

Aggregate shall conform to Standard Specification Item No. 210S, "Flexible Base".

430S.4 - Construction Methods

A. Subgrade and Base Preparation

Subgrade for curb and gutter shall be excavated and prepared to depth and width requirements indicated on the Drawings, including a minimum of 12 inches behind the curb, unless a greater width is indicated on the Drawings. The subgrade shall be shaped to the line, grades, cross section and dimensions indicated on the Drawings. A minimum of 4 inches (unless a greater or different base is indicated on the Drawings) of flexible base shall be spread, wetted and thoroughly compacted under curb and gutter as specified in Standard Specification Item No. 210S, "Flexible Base". If dry, the base shall be sprinkled lightly with water before PC concrete is deposited thereon.

B. C & G Forms

Forms shall be of metal, well-seasoned wood or other approved material. The length of the forms shall be a minimum of 10 feet. Flexible or curved forms shall be used for curves of 100-foot radius or less. Wood forms for straight sections shall be not less than 2 inches in thickness. Forms shall be a section, that is satisfactory to the Engineer or designated representative, of the depth required and clean, straight, free from warp and, if required, oiled with a light form oil. All forms shall be securely staked to line and grade and maintained in a true position during the placement of PC concrete.

C. Reinforcing Steel

The reinforcing steel, if required, shall be placed as shown on the typical section of the Drawings. Care shall be exercised to keep all steel in its proper location during PC concrete placement.

D. Joints

Joints shall be of the type and spacing shown on the Drawings. Expansion joint material, 3/4 inch in thickness, shall be provided at intervals not to exceed 40 feet and shall extend the full width and depth of the PC concrete. Weakened plane joints shall be made 3/4 inch deep at 10-foot intervals. All joint headers shall be braced perpendicular and at right angles to the curb.

Two round smooth dowel bars, 1/2 inch in diameter and 24 inches in length, shall be installed at each expansion joint. 16 inches of one end of each dowel shall be thoroughly coated with hot oil, asphalt or red lead, so that it will not bond to the concrete. The dowels shall be installed with a dowel sleeve on the coated end as indicated on the Drawings or equivalent method as directed by the Engineer or designated representative.

E. PC Concrete Placement and Form Removal

Concrete shall be placed in the forms and properly consolidated. Within 1 hour after PC concrete placement, a thin coating, that is no more than 1/2 inch nor less than 1/4 inch thick of finish mortar, composed of 1 part Portland Cement to 2 parts fine aggregate, shall be worked into the exposed faces of the curb and gutter by means of a "mule". After the PC concrete has become sufficiently set, the exposed edges shall be rounded by the use of an edging tool to the radii indicated on Standard Detail 432S-1 "Sidewalk". The entire exposed surface of the curb and gutter shall be floated to a uniform smooth surface, and then finished with a camel hairbrush to a gritty texture. The forms shall remain in place a minimum of 24 hours unless approved otherwise by the Engineer or designated representative.

After removal of the forms, any minor honeycombed surfaces shall be plastered with a mortar mix as described above. Excessively honeycombed curb and gutter, as determined by the Engineer or designated representative, shall be completely removed and replaced when directed.

F. Curing

Immediately after finishing the curb, concrete shall be protected by a membrane curing conforming to Standard Specification Item No. 409S, "Membrane Curing."

After a minimum of 3 days curing and before placement of the final lift of the base course, the curb shall be backfilled to the full height of the PC concrete, tamped and sloped as directed by the Engineer or designated representative. The upper 4 inches of backfill shall be of clean topsoil that conforms to Standard Specification Item No. 130S, "Borrow" and is free of stones and debris.

G. Seeding in Turf Areas

When turf is to be established, preparation of the seedbed shall conform to Item No. 604S, "Seeding for Erosion Control".

430S.5 - Measurement

Accepted work as prescribed by this item will be measured by the lineal foot of PC concrete curb and gutter, PC concrete curb and/or PC concrete laydown curb, complete in place.

430S.6 - Payment

The work performed as prescribed by this item will be paid for at the unit bid price per lineal foot for "PC Concrete Curb and Gutter" or PC Concrete Curb. The price shall include full compensation for all work as set forth and described under payment Method A and/or B.

A. Method A (Pay Item No. 430S-A)

This payment method shall include all the work performed for "PC Concrete Curb and Gutter" complete, at the unit bid price. The unit bid price shall include full compensation for excavation, preparation of the subgrade, furnishing and placing all concrete and base material, reinforcing steel, dowels, expansion joint material, curing material, backfill and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

B. Method B (Pay Item No. 430S-B)

This payment method includes all the work performed for "PC Concrete Curb and Gutter", complete, at the unit bid price. The unit bid price shall include full compensation for fine grading, furnishing and placing concrete and reinforcing steel, dowels, expansion joint material, curing material, backfill and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

C. Method C (Pay Item No. 430S-C)

This payment method includes all the work performed for " PC Concrete Curb" complete, at the unit bid price. The unit bid price shall include full compensation for excavation, furnishing and placing all concrete and base material, reinforcing steel, dowels, expansion joint material, curing material,

backfill and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

D. Method D (Pay Item No. 430S-D)

This payment method includes all the work performed for "PC Concrete Curb" complete, at the unit bid price. The unit bid price shall include full compensation for fine grading, furnishing and placing concrete and reinforcing steel, dowels, expansion joint material, curing material, backfill and for other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

E. Method E (Pay Item No. 430S-E)

This payment method shall include all the work performed for "PC Concrete Laydown Curb" complete, at the unit bid price. The unit bid price shall include full compensation for excavation, preparation of the subgrade, furnishing and placing all concrete and base material, reinforcing steel, dowels, expansion joint material, curing material, backfill and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

F. Method F (Pay Item No. 430S-F)

This payment method includes all the work performed for "PC Concrete Laydown Curb" complete, at the unit bid price. The unit bid price shall include full compensation for fine grading, furnishing and placing concrete and reinforcing steel, dowels, expansion joint material, curing material, backfill and for other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under one of the following:

Pay Item No. 430S-A:	PC Concrete Curb and Gutter (Excavation)	Per Lineal Foot.
Pay Item No. 430S-B:	PC Concrete Curb and Gutter (Fine Grading)	Per Lineal Foot.
Pay Item No. 430S-C:	PC Concrete Curb (Excavation)	Per Lineal Foot.
Pay Item No. 430S-D:	PC Concrete Curb (Fine Grading)	Per Lineal Foot.
Pay Item No. 430S-E:	PC Concrete Laydown Curb (Excavation)	Per Lineal Foot.
Pay Item No. 430S-F:	PC Concrete Laydown Curb (Fine Grading)	Per Lineal Foot.

END

ITEM NO. 431S - MACHINE LAID PORTLAND CEMENT CONCRETE CURB AND GUTTER

431S.1 - Description

This item shall govern Portland cement (PC) concrete curb and gutter and reinforcing steel dowels, constructed in accordance with this specification on an approved base in conformity with the lines, grades, sections and Standard Detail Series 430S and indicated on the Drawings or as established by the Engineer or designated representative.

431S.2 - Submittals

The submittal requirements of this specification item include:

- A. Class I PC concrete mix design,
- B. Type of Installation (i.e. PC Concrete Curb and Gutter or PC Concrete Curb) and construction details (i.e. base, reinforcing steel, joints, curing membrane),
- C. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.

431S.3 - Materials

A. PC Concrete

The PC Concrete shall conform to Class I Concrete, Section 403S.7 (Table 4) of Standard Specification Item No. 403S, "Concrete for Structures."

B. Reinforcing Steel

Reinforcing steel shall conform to Standard Specification Item No. 406S, "Reinforcing Steel."

C. Expansion Joint Materials

Preformed expansion joint materials shall conform to Standard Specification Item No. 408S, "Concrete Joint Materials."

D. Membrane Curing Compound

Membrane curing compound shall conform to Standard Specification Item No. 409S, "Membrane Curing."

E. Flexible Base

Flexible base material shall conform to Standard Specification Item No. 210S, "Flexible Base."

F. Stabilized Base

A stabilized base identified as a Type A or B shall conform to the requirements of Standard Specification Item 340S, "Hot Mix Asphaltic Concrete Pavement."

431S.4 - Construction Methods

A. Subgrade and Base Preparation

Subgrade for curb and gutter shall be excavated and prepared to depth and width requirements indicated on the Drawings, including a minimum of 12 inches behind the curb, unless a greater width is indicated on the Drawings. The subgrade shall be shaped to the line, grade, cross section and dimensions indicated on Standard Detail 432S-1 "Sidewalk" or the Drawings. A minimum thickness of 4 inches of flexible base (Standard Specification Item No. 210S "Flexible Base") or stabilized base shall be placed, spread, wetted (flexible base only) and thoroughly compacted. If dry, the flexible base shall be sprinkled lightly with water before PC concrete is deposited thereon.

B. PC Concrete Curb and Gutter Extrusion

The PC concrete curb shall be laid by a curb extrusion machine approved by the Engineer or designated representative. The line for top of curb shall be maintained from a guideline or guide rails, set by the Contractor. Curb outline shall strictly conform to the details indicated on the Drawings. The forming tube of the extrusion machine shall be readily adjustable vertically during the forward motion of the machine, to provide required variable height of curb necessary to conform to the established grade line. If a guideline is used, a pointer or gage shall be attached to the machine in such a manner that a comparison can be made between the curb and the guideline in order to provide a continual check on the curb grade. Other methods may be used if approved in writing by the Engineer or designated representative.

C. PC Concrete Placement and Finish

The PC concrete shall be fed into the machine in such a manner and at such consistency that the finished curb will present a well-compacted mass with a surface free from voids and honeycomb and true to established shape, line and grade.

Any additional surface finishing indicated on the Drawings and/or required by the Engineer or designated representative shall be performed immediately after placement. Weakened plane joints shall be cut to a depth of 3/4 inch at 10-foot intervals or as directed by the Engineer or designated representative.

Whenever the curb end abuts a PC concrete structure a 3/4-inch pre-molded expansion joint conforming to the curb section shall be placed between the 2 concrete surfaces.

Whenever extrusion is suspended long enough to produce a cold joint, 1/2-inch smooth dowel bars, 24 inches long, shall be embedded 12 inches into the completed curb, 1/4 curb height from top and bottom. The end of the curb at the point of suspension of extrusion shall be cut back until all remaining PC concrete is of a dense, well-compacted nature.

Any addition of concrete to the extruded curb is to be applied and finished before the extruded curb has achieved its initial set. The final finish shall have a gritty surface approved by the Engineer or designated representative.

D. Reinforcing Steel

The reinforcing steel, if required by Standard 432S-1 "Sidewalk" or shown on approved plans, shall be placed as shown on the typical section of the Drawings. Care shall be exercised to keep all steel in its proper location during PC concrete placement.

E. Joints

Joints shall be of the type and spacing shown on the Drawings. Expansion joint material, 3/4 inch in thickness, shall be provided at intervals not to exceed 40 feet and shall extend the full width and depth of the PC concrete. Weakened plane joints shall be made 3/4 inch deep at 10-foot intervals. All joint headers shall be braced perpendicular and at right angles to the curb.

Two round smooth dowel bars, 1/2 inch in diameter and 24 inches in length, shall be installed at each expansion joint. Sixteen inches of one end of each dowel shall be thoroughly coated with hot oil, asphalt or red lead, so that it will not bond to the concrete. The dowels shall be installed with a dowel sleeve on the coated end as indicated on the Drawings or equivalent method as directed by the Engineer or designated representative.

F. Curing

When finishing operations are completed the curb shall be cured conforming to Standard Specification Item No. 409S, "Membrane Curing."

When the curb has cured a minimum of 3 days and prior to placement of the final lift of base course, it shall be backfilled to the full height of the PC concrete, tamped and sloped to drain as directed by the Engineer or designated representative.

In turf areas, the upper 4 inches of backfill shall be of clean topsoil, that conforms to Standard Specification Item No. 130S, "Borrow" and shall be free of stones and debris.

G. Seeding in Turf Areas

When turf is to be established, the preparation of the seedbed shall conform to Standard Specification Item No. 604S, "Seeding for Erosion Control".

431S.5 - Measurement

Machine Laid PC Concrete Curbs will be measured by the lineal foot of completed and accepted curb, complete in place.

431S.6 - Payment

The work performed as prescribed by this item will be paid for at the unit bid price per lineal foot for "Machine Laid PC Concrete Curb and Gutter". The unit bid price shall include full compensation for all work as set forth and described under payment Method A, B or C below.

A. Method A: With Excavation (Pay Item No. 431S-A)

This payment method includes all the work performed for "Machine Laid PC Concrete Curb and Gutter", complete, at the unit bid price. The unit bid price shall include full compensation for excavation, preparation of the subgrade, furnishing and placing all base material, reinforcing steel, dowels, expansion joint materials, curing material, backfill and all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

B. Method B: With Fine Grading (Pay Item No. 431S-B)

This payment method includes all the work performed for "Machine Laid PC Concrete Curb and Gutter", complete, at the unit bid price. The unit bid price shall include full compensation for fine

grading, furnishing and placing reinforcing steel, dowels, expansion joint material, curing material, backfill and for all other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

- C. Method C: Included in the unit price bid for this specification Incidental Work (Pay Item No. 431S-C)

This method includes all the work performed as incidental work relating to "Machine Laid PC Concrete Curb and Gutter" as may be detailed and noted on the Drawings or included and described in the "Special Provisions" of the Standard Contract Documents.

Payment will be made under one of the following:

Pay Item No. 431S-A:	Machine Laid Curb and Gutter (Excavation)	Per Lineal Foot.
Pay Item No. 431S-B:	Machine Laid Curb and Gutter (Fine Grading)	Per Lineal Foot.
Pay Item No. 431S-C:	Machine Laid Curb and Gutter (Incidental Work)	Per Lineal Foot.

END

ITEM NO. 432S - PORTLAND CEMENT CONCRETE SIDEWALKS

432S.1 - Description

This item shall govern the construction of Portland Cement (PC) concrete sidewalks (Standard Detail No. 432S-10 "Mailbox Placement Detail"), as herein specified, on an approved subgrade and in conformance with the lines, grades and details indicated on the Drawings or as established by the Engineer or designated representative.

432S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall electronically submit the following submittal requirements:

- A. Class A PC concrete mix design,
- B. Type of Installation (i.e. Type I, Type II, etc.) and construction details (i.e. cushion layer, base, reinforcing steel, joints, curing membrane),
- C. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding,
- D. Number, manufacturer, model, construction, finish and installation details of streetscape appurtenances of bicycle racks, benches, chairs, trash receptacles, streetlights, tree wells and above grade tree planters [for sidewalks, 12 feet or wider].

432S.3 - Materials

A. PC Concrete

PC concrete shall be Class A conforming to Specification Item No. 403S, "Concrete for Structures" or Specification Item No. 407S, "Fibrous Concrete."

B. Reinforcement

Reinforcement shall conform to Specification Item No. 406S, "Reinforcing Steel" or Specification Item No. 407S, "Fibrous Concrete."

C. Expansion Joint Materials

Expansion joint materials shall conform to Specification Item No. 408S, "Concrete Joint Materials."

D. Membrane Curing Compound

Membrane curing compound shall conform to Specification Item No. 409S, "Membrane Curing."

432S.4 - Construction Methods

The subgrade shall be excavated in accordance with Specification Item No. 111S, "Excavation," prepared in accordance with Specification Item No. 201S, "Subgrade Preparation," shaped to the lines, grades and cross section as indicated on the Drawings or as directed by the Engineer or designated representative and thoroughly compacted in accordance with Specification Item No. 201S "Subgrade Preparation". A granular cushion of a minimum thickness of 2 inches but maximum thickness of 5 inches, composed of

crusher screenings, gravel and sand, crushed rock or coarse sand, shall be spread, wetted thoroughly, tamped and leveled. The granular cushion shall be moist at the time the PC concrete is placed.

If the subgrade is undercut by more than 4 inches or the elevation of the natural ground is more than 4 inches below "top of subgrade," then a necessary backfill/embankment layer of an approved material shall be placed and compacted with a mechanical tamper. Hand tamping will not be permitted.

Where the subgrade is rock or gravel, 70% of which is rock; the 2-inch cushion need not be used. The Engineer or designated representative will determine if the subgrade meets the above requirements.

Sidewalk forms shall be constructed of metal or well-seasoned wood not less than 2 inches in thickness, with a section satisfactory to the Engineer or designated representative. The forms shall be clean, straight, and free from warp with a depth equal to the thickness of the finished work. All forms shall be securely staked to line and grade and maintained in a true position during the deposition of PC concrete. Before PC concrete is placed, the forms shall be thoroughly oiled with a light form oil.

Expansion joint material $\frac{3}{4}$ -inch thick, shall be provided where the new construction abuts an existing structure, sidewalk or driveway. Similar expansion material shall be placed around all obstructions protruding through the sidewalk. The expansion joint material shall be placed vertically and shall extend the full depth of the PC concrete. Maximum spacing of expansion joints shall be 40 feet as indicated on the Drawings or as directed by the Engineer or designated representative. Weakened plane joints shall be spaced at 5 feet on center. Normal dimensions of the weakened plane joints shall be $\frac{1}{4}$ inch wide and $\frac{3}{4}$ inch deep. All joints shall be constructed perpendicular (90 degrees) to the centerline of walk and shall match any previously placed concrete joints. For sidewalks with widths exceeding 6 feet longitudinal weakened-plane tooled joints shall be provided as indicated on the Drawings or as directed by the Engineer or designated representative.

Reinforcement for sidewalks shall consist either of polypropylene fibrillated fibers (only when approved by the City Engineer) or 6" x 6" x W1.4 x W1.4 welded wire fabric or one layer #3 (10M) reinforcing bars, placed no more than 18 inches on center both directions. All reinforcement shall be accurately placed at slab mid-depth, equidistant from the top and bottom of the PC concrete and held firmly in place by means of bar supports of adequate strength and number that will prevent displacement and keep the steel at its proper position during the placement of the PC concrete. **In no instance shall the steel be placed directly on the subgrade or sand cushion layer.**

Prior to placement of the concrete, the reinforcement installation shall be inspected by the Engineer or designated representative to ensure conformance with the drawings, specifications and this item. In addition, care shall be exercised to keep all steel in its proper position during placement of the PC concrete. If during placement of the concrete, the reinforcement is observed to lose bar support, float upward or move in any direction, the placement shall be stopped until corrective action is taken.

Splices in wire fabric shall overlap sufficiently to allow two pairs of transverse wires to be tied together and no splice of less than 6 inches will be permitted. Splices in the #3 (10M) bars shall have a minimum lap of 12 inches.

Where driveways cross sidewalks, additional reinforcing shall be placed in the sidewalk as indicated on the Drawings.

PC concrete sidewalk ramps shall be formed to produce a finished surface with detectable warnings (Standard Detail 432S-2A "Detectable Warning Paver") in accordance with the requirements of the American Disabilities Act and Texas Accessibility Standards (TAS), including Sections 4.29.2 and

A4.29.2. The PC concrete sidewalk ramps shall be constructed in accordance with appropriate City of Pflugerville Standard Details (Standard Details 432S-3 "Type 1 Curb Ramps-Full Intersection", 432S-3A "Type 1 Curb Ramps- T Intersection" through 432S-3H "Type 1 Ramps Within PC/PT of Curb and Gutter", 432S-5 "Type 1 Sidewalk Curb Ramp", 432S-5A "Type 1 Sidewalk Curb Ramp With Left Flare", 432S-5B Type 1B Sidewalk Curb Ramp", etc.).

Detectable warning for the ramps shall consist of raised truncated domes with a diameter of nominal 0.9 inch, a height of nominal 0.2 inch and center-to-center spacing of nominal 2.35 inches and shall contrast visually with adjoining surfaces, either light on dark or dark-on-light. The material used to provide contrast shall be an integral part of the walking surface.

When indicated on the Drawings or as directed by the Engineer or designated representative, the construction of the sidewalk ramp shall include the installation of interlocking concrete paving units (Standard Specification Item No. 480S, "Concrete Paver Units for Sidewalks and Streetscape Requirements"). The concrete paving units shall be constructed in accordance with Standard Specification Item No. 485S, "Concrete Paving Units for Sidewalk Ramps" and appropriate City of Pflugerville Standard Details (Standard Details 432S-2A "Detectable Warning Paver", 432S-3 "Type 1 Curb Ramps-Full Intersection", 432S-3A "Type 1 Curb Ramps- T Intersection" through 432S-3H "Type 1 Ramps Within PC/PT of Curb and Gutter", 432S-5 "Type 1 Sidewalk Curb Ramp", 432S-5A "Type 1 Sidewalk Curb Ramp With Left Flare" and 432S-5B Type 1B Sidewalk Curb Ramp",

At the proper time after finishing, the surface shall be protected by a membrane, compound curing agent or by wetted cotton or burlap mats, conforming to Item No. 409S, "Membrane Curing." The sides of the PC concrete shall be cured in the forms. If the forms are removed during the curing process, the curing shall be continued by the placement of fill against the exposed concrete edges or by other procedures conforming to Item No. 410S, "Concrete Structures." The top 4 inches of fill shall be clean topsoil conforming to Item No. 604S, "Seeding for Erosion Control."

Existing sidewalk that is scheduled for removal and replacement shall be removed and the underlying material shaped to the lines, grades and cross section as indicated in the drawings or as directed by the Engineer or designated representative. The removal and/or relocation of obstructions, including but not limited to signs, trash cans and benches on concrete pads, abandoned manholes, sprinkler control valves and landscaping, shall be performed, as indicated on the drawings, in a manner acceptable to the Engineer or designated representative. Removal and/or relocation of obstructions will be considered incidental work to this item and will not be paid for directly.

Existing PVC pipe drains in and behind curb shall be removed and replaced as required in new sidewalk and/or curb and gutter. In areas of proposed sidewalk construction, where curb and gutter is to remain in place, existing PVC pipe shall be cut far enough behind the back of curb to allow sufficient room for joint fittings to connect to new or salvaged PVC pipe.

The Contractor shall be responsible for removing and replacing mailboxes that are located in the construction area, while assuring that mail delivery will not be interrupted as a result of the construction activities. Mailboxes shall not be laid on the ground.

All necessary excavation, filling and grading of the slopes adjacent to the completed concrete sidewalks will be considered incidental work pertaining to this item and will not be paid for directly. The adjacent excavation and grading of the slopes shall be done in a manner acceptable to the Engineer or designated representative.

432S.5 - Streetscape Furniture Installation Requirements

A. General

Bicycle racks, benches and chairs, trash receptacles, tree wells and above grade tree wells and planters shall only be installed in sidewalks that are 12 feet or wider. When installation is indicated on the Drawings or directed by the Engineer or designated representative, these items shall be permanently installed as indicated in; 432S-7A "New Trees Planted within Sidewalk 12' or Greater – Clay Soils" and 432S-7F "Tree Well Without Grate". Above grade tree wells shall be installed in conformance with Standard Detail 432S-7E "Tree Well With Seat", while above grade tree planters shall be installed in conformance with Standard Detail Nos. 432S-7D "Above Grade Tree Planters."

B. Location Requirements

1. Benches.

Benches shall be placed either perpendicular to the curb with the center of the bench on line with trees and light poles and facing toward the building entry, or parallel to the building and within 6" (150 mm) of the building wall, facing out to the street.

2. Bike Racks.

Bike racks are to be placed perpendicular to the curb with the centerline of the rack on line with trees and light poles.

3. Trash Receptacles.

Trash receptacles shall either be placed along the curb, with the center line of the receptacle on line with the trees and light poles, or shall be located at the building entry in alignment with the structural bay system of the building. If located at the entry there shall be no more than 1 foot clearance between the receptacle and the building wall.

432S.6 - Pedestrian Railing

When a pedestrian railing installation is required along sidewalks for pedestrian protection as indicated on the Drawings or directed by the Engineer or designated representative, this type of pedestrian railing shall be permanently installed in conformance with one of the following designated Standard Details: 707S-1 "Pedestrian Rail", 707S-2 "Pedestrian ADA Handrail Option 1", 707S-3 "Pedestrian ADA Handrail on Curb-Option 2" or 707S-4 "Pedestrian ADA Handrail on Sidewalk Option 3".

When a pedestrian railing installation is required along portions of sidewalks identified as 'ramps' for ADA accessibility purposes as indicated on the Drawings or directed by the Engineer or designated representative, this type of pedestrian railing shall be permanently installed in conformance with one of the following designated Standard Details: 707S-2 "Pedestrian ADA Handrail Option 1", 707S-3 "Pedestrian ADA Handrail on Curb-Option 2" or 707S-4 "Pedestrian ADA Handrail on Sidewalk Option 3".

432S.7 - Measurement

Accepted work performed as prescribed by this item will be measured by the square foot of surface area of "Concrete Sidewalk."

Accepted work performed as prescribed by "Sidewalk Ramps" will be measured per each for the type of ramp indicated on the Drawings.

Accepted work performed as prescribed by "Streetscape Appurtenances" will be measured per each for the type of appurtenance indicated on the drawings.

Accepted work performed as prescribed by "Pedestrian Railing" will be measured per lineal foot of the type of railing indicated on the Drawings.

432S.8 - Payment

The work performed as prescribed by this item for concrete sidewalk will be paid for at the unit bid price per square foot for "Concrete Sidewalk" and/or "Sidewalks Reconstruction"; per each for "Concrete Sidewalk Ramps" and "Streetscape Appurtenances" or per lineal foot for "Pedestrian Railing".

The unit bid price for new sidewalk shall include full compensation for excavating and/or removal and/or relocating obstructions, vegetating adjacent areas disturbed by sidewalk construction, preparing the subgrade; for furnishing and placing all materials including cushion material, all reinforcement, bar supports, joints, expansion joint materials, and for any other materials, manipulations, labor, tools, equipment, finishing, curing and incidentals necessary to complete the work.

The unit bid price for sidewalk reconstruction shall include full compensation for excavating and/or removal of existing sidewalk and other obstructions, relocating obstructions, replacing PVC drain pipe, re-vegetating adjacent areas disturbed by sidewalk construction, preparing the subgrade; for furnishing and placing all materials including cushion material, all reinforcement, bar supports, joints, expansion joint materials, and for any other materials, manipulations, labor, tools, equipment, finishing, curing and incidentals necessary to complete the work.

The unit bid price for ramps shall include full compensation for preparing the subgrade when not included as a separate item; for furnishing and placing all materials, manipulation, labor, tools, equipment and incidentals necessary to complete the work. All necessary excavation, filling and grading of the slopes adjacent to the completed concrete paver units will be included in the unit price bid for the item of construction in which this item is used, unless included as a separate pay item in the Contract bid form.

The unit bid price for streetscape appurtenances shall include full compensation for the individual item (i.e. bench, chair, bicycle rack, trash receptacle, street light or above grade tree planter), as well as the removal of existing sidewalk, preparation of footings, furnishing and placing all materials, manipulation and finishing, labor, tools, equipment and incidentals necessary to complete the work.

The unit bid price for pedestrian railing shall include full compensation for the complete installation of the specific pedestrian railing including but not limited to preparation of footings or curb, furnishing and placing all materials, manipulation and finishing, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under one of the following:

New Sidewalks		
Pay Item 432S-A:	New PC Concrete Sidewalks, (Thickness ____)	Per Square Foot.
Sidewalks Reconstruction		
Pay Item 432S-R:	Reconstruct Concrete Sidewalks to ____ thickness, including removal of existing sidewalk	Per Square Foot.

Ramps		
Pay Item 432S-RP-1:	PC Sidewalk Curb Ramp with Pavers (Type I)	Per Each.
Pay Item 432S-RP-1A:	PC Sidewalk Curb Ramp with Pavers (Type IA)	Per Each.
Pay Item 432S-RP-1B:	PC Sidewalk Curb Ramp with Pavers (Type IB)	Per Each.
Streetscape Appurtenances		
Pay Item 432S-SAC-1:	Streetscape Bench (_____ inches in length)	Per Each.
Pay Item 432S-SAC-2:	Streetscape Chair	Per Each.
Pay Item 432S-SAC-3:	Streetscape Bicycle Rack	Per Each.
Pay Item 432S-SAC-4:	Streetscape Trash Receptacle	Per Each.
Pay Item 432S-SAC-5:	Streetscape Street Light	Per Each.
Pay Item 432S-SAC-7C:	Streetscape Tree Well for Concrete Sidewalks	Per Each.
Pay Item 432S-SAC-7D:	Streetscape Above Grade Tree Planters	Per Each.
Pay Item 432S-SAC-7E:	Streetscape Tree Well with Seat	Per Each.
Pay Item 432S-SAC-7F:	Streetscape Tree Well without Grate	Per Each.
Pay Item 432S-SAC-7G:	Streetscape Above Grade Galvanized Steel Tree Planters	Per Each.
Pesdestrian Railing		
Pay Item 432S-PRC-1:	Pedestrian Railing (Standard 707S-1)	Per LF.
Pay Item 432S-PRC-2:	Pedestrian ADA Railing - Option 1 (Standard 707S-2)	Per LF.
Pay Item 432S-PRC-3:	Pedestrian ADA Railing - Option 2 (Standard 707S-3)	Per LF.
Pay Item 432S-PRC-4:	Pedestrian ADA Railing - Option 3 (Standard 707S-4)	Per LF.

END

ITEM NO. 433S - PC CONCRETE DRIVEWAYS

433S.1 - Description

This item shall govern construction of Portland Cement (PC) concrete driveways, as herein specified, on an approved subgrade, in conformity with the lines, grades and cross section indicated on the Drawings, identified in Standard Detail Series 433S, or as established by the Engineer or designated representative.

433S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall electronically submit the following submittal requirements:

- A. Class A and/or Item 360S "Concrete Pavement",
- B. Type of Installation (i.e. Type I, Flared Type I, Type II, etc.) and construction details (i.e. cushion layer, base, reinforcing steel, joints, curing membrane),
- C. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.

433S.3 - Materials

A. Concrete

The PC Concrete for a Type I driveway (Standards 433S-1 and 433S-1A) shall conform to Class A, Section 403S.7 (Table 4) of Standard Specification Item No. 403S, "Concrete for Structures." The PC Concrete for a Type II driveway (Standard 433S-2 "Type II Driveway") shall conform to a normal concrete mix design for concrete pavement, Section 360S.5(A) of Standard Specification Item No. 360S, "Concrete Pavement".

B. Reinforcing Steel

Reinforcing steel and welded wire fabric shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".

C. Expansion Joint Materials

Expansion joint materials shall conform to Standard Specification Item No. 408S, "Concrete Joint Materials."

D. Membrane Curing Compound

Membrane curing compound shall conform to Standard Specification Item No. 409S, "Membrane Curing."

E. Cushion Layer

The Cushion layer shall consist of crusher screenings, gravel or coarse sand.

433S.4 - Construction Methods

All forms and forming, placement of reinforcement, placement of concrete, form removal, finishing and curing shall conform to Standard Specification Item No. 410S, "Concrete Structures".

A. Subgrade Preparation

The subgrade shall be excavated, prepared and shaped to the lines, grades and cross sections indicated on the Drawings or as directed by the Engineer or designated representative. The subgrade shall be thoroughly compacted in accordance with Standard Specification Item No. 201S, "Subgrade Preparation". A 2-inch minimum compacted thickness cushion shall be spread, wetted thoroughly, tamped and leveled. The cushion shall be moist at the time the PC concrete is placed.

If the subgrade is undercut or natural ground is located below the top of subgrade, the necessary backfill material shall conform to Standard Specification Item 130S, "Borrow" and shall be compacted with a mechanical tamper. Hand tamping will not be permitted.

Where the subgrade material consists of gravel or includes 70 percent of rock, the 2-inch cushion layer may not be required. The Engineer or designated representative will determine if the subgrade meets the above requirements.

B. Forms

Forms shall be of metal, well-seasoned wood or other approved material of a section satisfactory to the Engineer or designated representative. Wood forms shall not be less than 2 inches nominal thickness for straight runs and 1-inch nominal thickness for curved runs. Forms shall be a section satisfactory to the Engineer or designated representative and clean, straight, free from warp and of a depth equal to the thickness of the finished work.

All forms shall be securely staked to line and grade and maintained in a true position during the placement of PC concrete.

C. Joints

Joints shall be of the type and spacing shown on the Drawings. Expansion joint material, 3/4 inch thick, shall be provided where the new construction abuts the existing sidewalks or driveways or as directed by the Engineer or designated representative. The expansion joint material shall be placed vertically and shall extend the full depth of the PC concrete. Similar expansion material shall be placed around all obstructions protruding through the driveway. Weakened plane joints shall be located on 10-foot centers or as directed by the Engineer or designated representative. Normal dimensions of the weakened plane groove joints shall be 1/4-inch wide and 3/4-inch deep.

D. Reinforcement

Reinforcement for Type I driveways shall consist of 1 layer of 6 x 6 by W 1.4 x W 1.4 wire fabric or No. 3 bars placed not more than 18 inches on center, both directions. Reinforcement for Type II driveways shall consist of 1 layer of No. 4 bars placed no more than 18 inches on center, both directions.

All reinforcements shall be accurately placed equidistant from the top and bottom of the PC concrete slab and held firmly in place by means of bar supports of adequate strength and number that will prevent displacement and keep the steel at its proper position. In no instance shall the steel be placed directly on the subgrade or sand cushion layer.

Prior to placement of the concrete, the reinforcement installation shall be inspected by the Engineer or designated representative to ensure conformance with the drawings, specifications and this item. In addition, care shall be exercised to keep all steel in its proper position during the placement of PC

concrete. If during placement of the concrete, the reinforcement is observed to lose bar support, float upward or move in any direction, the placement shall be stopped until corrective action is taken.

Splices in wire fabric shall overlap sufficiently to allow two pairs of transverse wires to be tied together and no splice of less than 6 inches will be permitted. Splices in the No. 3 and No. 4 bars shall have a minimum lap of 12 inches.

E. PC Concrete Placement and Finishing

The PC concrete shall be placed in the forms and spaced, tamped and thoroughly compacted until it entirely covers the surface and has a monolithic finish. The top surface shall be floated and troweled to a uniform smooth surface, then finished with a broom or wood float to a gritty texture unless otherwise indicated on the Drawings. The outer edges and joints shall be rounded with approved tools to a 1/4-inch radius. Care shall be exercised to prevent loss of dummy joints or rounded edges when applying the broom finish.

F. Curing

At the proper time after finishing, the surface shall be protected by a membrane compound curing agent in conformance with Standard Specification Item No. 409S, "Membrane Curing" or by wetting cotton or burlap mats. Either method shall be subject to approval by the Engineer or designated representative.

Traffic shall be barricaded from using the driveway for a minimum of 4 days after initial placing and may be opened to traffic only with approval of the Engineer or designated representative.

G. Incidental Work

All necessary excavation, filling and grading of the slopes, adjacent to the completed PCC driveways, will be considered incidental work pertaining to this item and will not be paid for directly.

The adjacent excavation and grading of the slopes shall be done with topsoil conforming to Standard Specification Item No. 130S, "Borrow". When turf is to be established, the preparation of the seedbed shall conform to Standard Specification Item No. 604S, "Seeding for Erosion Control", in a manner acceptable to the Engineer or designated representative.

433S.5 - Measurement

Accepted work performed as prescribed by this item will be measured by the square foot of surface area of the specific type of PC concrete driveway.

433S.6 - Payment

The work performed as prescribed by this item will be paid for at the unit bid price per square foot for "Concrete Driveways." The unit bid price shall include full compensation for preparation of the subgrade; furnishing and placing all materials, including cushion layer, all reinforcing steel, bar supports and expansion joint materials; and any other materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Pay Item No. 433S-A:	Type I PC Concrete Driveway	Per Square Foot.
Pay Item No. 433S-B:	Flared Type I PC Concrete Driveway	Per Square Foot.
Pay Item No. 433S-C:	Type II PC Concrete Driveway	Per Square Foot.

END

ITEM NO. 503S - FRAMES, GRATES, RINGS AND COVERS

503S.1 - Description

This item shall govern furnishing and installation of frames, grates, rings and covers for inlets, manholes and other structures indicated on the Drawings.

503S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall electronically submit the submittal requirements for approval. The submittal requirements of this specification item include manufacturer, model number, description, painting requirements and characteristics of grade rings with a notarized certificate indicating compliance with ASTM C478, as well as manhole frames, grates and covers with a notarized certificate indicating compliance with ASTM A48, Class 30, and the nuts and bolts required for the completion of work.

503S.3 - Materials

The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation in the Work is the kind and quality that satisfies the specified functions and quality. The City of Pflugerville Standard Products Lists (SPLs) form a part of these Specifications. Contractors may, when appropriate, elect to use products from the SPLs; however, submittal to the City Engineer or designated representative is still required. If the Contractor elects to use any materials from these lists, each product shall be completely and clearly identified by its corresponding SPL number when making the product submittal.

The purpose of the SPLs is to expedite the review by the City Engineer or designated representative of Contractor product submittals. The SPL's should not be interpreted as being a pre-approved list of products necessarily meeting the requirements for a given construction Project. Items contained in the SPL cannot be substituted for items that are shown on the Drawings, called for in the specifications, or specified in the Bidding Requirements, Contract Forms and Conditions of Contract, unless approved by the City Engineer or designated representative in conjunction with the Water and Wastewater Utility Standard Products Committee. The Standard Product List current at the time of plan approval will govern.

A. Welded

Steel Welded steel grates and frames shall conform to the number; size, dimensions and details indicated on the Drawings and shall be welded into an assembly in accordance with those details. Steel shall conform to the requirements of ASTM A 36/A 36M, "Specification for Structural Steel".

B. Castings

Castings shall be of good quality, strong, tough, even grained cast iron, smooth, free from scales, lumps, blisters, sand or blowholes or other defects of any kind. Surfaces of the castings shall be free from burnt on sand and shall be reasonably smooth. Runners, risers, fins and other cast on pieces shall be removed from the castings and such areas ground smooth. Bearing surfaces between manhole rings and covers or grates and frames shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact. Pairs of machined castings shall be matchmarked to facilitate subsequent identification at installation with the exception of water and wastewater manhole and valve castings. These manhole and valve castings shall be

fabricated with such draft, tolerances, bolt hole spacing, etc., that all rings and covers of a particular type or class are interchangeable and match-marking will not be required.

Cast iron castings shall conform to ASTM A48, "Specification for Gray Iron Castings", Class 30B or higher and shall conform to the City of Pflugerville Standard Product List Items 24 Inch Manhole Cover Casting Sets and 32 Inch Manhole Cover Casting Sets.

Ductile Iron castings shall conform to ASTM A 536, "Specification for Ductile Iron Castings". Grade 60-40-18 (415-275-125) shall conform to the City of Pflugerville Standard Product List Items "32 Inch Manhole Cover Casting Sets".

C. Manhole Cover Grade Rings

Grade rings, which are used for raising standard manhole covers, shall be those models listed City of Pflugerville Standard Products List item Manhole Grade Rings, HDPE.

D. Nuts and Bolts

Nuts and bolts shall be hex head 5/8 " × 2.5" #11 National Coarse Thread, Type 316 stainless steel. For bolted manhole covers, a thin film of an approved "Anti-freeze" compound, approved by the City Engineer or designated representative, shall be applied to all bolts.

E. Mortar

Unless otherwise specified or approved by the City Engineer or designated representative, the mortar for bedding castings shall consist of one (1) part Portland Cement (PC) and three (3) parts sand and sufficient water to provide the desired consistency. The gradation of the fine aggregate shall meet the requirements for Grade No. 1, Item No. 403, "Concrete for Structures".

503S.4 - Construction Methods

Frames, grates, grade rings and covers shall be constructed of the specified materials in accordance with the details indicated on the Drawings or in the City of Pflugerville Standard Details and Standard Products List. The Frames, grates, grade rings and covers shall be placed carefully to the lines or grades indicated on the Drawings or as directed by the City Engineer or designated representative.

All welding shall conform to the requirements of the ANSI/AWS Structural Welding Code D1.1.

Painting of gray iron castings will not be required, except when used in conjunction with structural steel shapes.

503S.5 - Measurement and Payment

Frames, grates, rings and covers will not be measured and payment for furnishing all materials, tools, equipment, labor and incidentals to complete the Work will be included in the Bid Items which constitute the complete structures.

END

ITEM NO. 504S - ADJUSTING STRUCTURES

504S.1 - Description

This item shall govern the removal and replacement of surfacing, furnishing of materials, adjusting and/or repositioning existing structures, valve boxes, pull boxes, survey monument boxes and water meters in accordance with these specifications to the locations or elevations indicated on the Drawings or as directed by the City Engineer or designated representative. This item shall also govern any pumping, bailing and drainage required to complete the Work and Standard Specification Item No. 509S, "Excavation Safety Systems" for trench walls when indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text the inch-pound units are given preference followed by SI units shown within parentheses

504S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall electronically submit the following submittal requirements:

1. Aggregate type, gradations and physical characteristics for the Portland Cement (PC) concrete mix.
2. Proposed proportioning of materials for the mortar mix.
3. Type structures and proposed adjustment technique (lowering, raising, lateral displacement).
4. Type structure, repair technique and materials to be furnished. Type of mixing plant and associated equipment including chart indicating the calibration of each cold bin.

504S.3 - Materials

Materials required shall conform to the details indicated on the Drawings.

1. PC Concrete. The PC Concrete shall be Class A conforming to Standard Specification Item No. 403, "Concrete for Structures".
2. Mortar Unless otherwise specified or approved by the City Engineer or designated representative, the mortar for bedding castings shall consist of one (1) part PC and three (3) parts sand, by volume based on dry materials. Sufficient water will be added to provide the desired consistency. The gradation of the fine aggregate shall meet the requirements for "Fine Aggregate" as given in Standard Specification Item No. 403, "Concrete for Structures".

504S.4 - Construction Methods

All adjustments shall be completed prior to the placement of the final surface.

Pull box and valve box components scheduled for reuse shall be carefully removed and the contact areas shall be cleaned of all mortar, concrete, grease and sealing compounds. Any items broken in the process of removal and cleaning shall be replaced in kind by the Contractor at its own expense.

If the adjustment involves slight lowering or raising a valve box or survey monument box, the outside shell of a slip or screw casing shall be excavated to its full length and adjusted to the proposed grade. Pipe castings shall be excavated to the depth required to cut from or weld a section to the casing as may be needed to adjust the ring to the proposed elevation. The ring shall be welded to the casing prior to pouring concrete around the casing.

If the adjustment involves a vertical (lowering or raising) or a horizontal reassignment of a water meter and the property owner's cut off valve, this work shall be completed in accordance with Standard Installation Details included in the City of Pflugerville Standard Details Series (501S-1 "Encasement Detail with Casing Spacers", 504S-3 "Gas Valve Casing Adjustment", etc.).

After the adjustments have been completed and cured, structures within the paved area shall be paved as indicated on the Drawings.

504S.5 - Measurement

The work performed and materials furnished as prescribed by this item as indicated shall be measured per each.

504S.6 - Payment

The work performed, materials furnished and measures as provided above, will be paid by the unit bid price per each. The price shall include full compensation for furnishing all materials, handling, placing, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under one of the following:

Pay Item No. 504S-1WM:	Adjusting Water Meters	Per Each
Pay Item No. 504S-1RM:	Repositioning & Adjusting Water Meters	Per Each
Pay Item No. 504S-3G:	Adjusting Gas Valve Boxes to Grade	Per Each
Pay Item No. 504S-3S:	Adjusting Survey Monument Boxes to Grade	Per Each
Pay Item No. 504S-3W:	Adjusting Water Valve Boxes to Grade	Per Each
Pay Item No. 504S-4PB:	Adjusting Pull Boxes to Grade	Per Each

END

ITEM NO. 505S - CONCRETE ENCASEMENT AND ENCASEMENT PIPE

505S.1 - Description

This item shall govern the furnishing of materials and the methods of constructing a Portland Cement (PC) concrete encasement or encasement pipe in a trench.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

505S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall electronically submit the following submittal requirements:

1. Type of pipe, spacers and end plugs, construction methods and sequence,
2. Aggregate types, gradations and physical characteristics for the PC concrete mix,
3. Proposed proportioning of materials for the mortar mix.

505S.3 - Materials

A. PC Concrete

The PC concrete shall conform to Class D Concrete, Item No. 403, "Concrete for Structures."

B. Carrier Pipe

Carrier pipe shall conform to Standard Specification Item No. 510, "Pipe" and shall be size, type materials, thickness and class indicated on the Drawings, unless otherwise specified.

C. Grout

Grout shall consist of not less than 6 sacks of PC per cubic yard and clean washed sand mixed with water. The grout shall have a consistency such that the grout will flow into and completely fill all voids. If allowed by the City Engineer or designated representative, an air entraining admixture may be added to facilitate placement.

505S.4 - Construction Methods

When indicated on the Drawings or acceptable to the City Engineer or designated representative, a concrete encasement shall be placed to protect the pipe. Pipe or bedding shall not be placed where:

- A. the top of the pipe would have less than 30 inches of cover from finish grade,
- B. the ground water invades the trench, or
- C. the trench bottom is of unstable material.

If either of these conditions is encountered, the City Engineer or designated representative shall be notified and may direct the Contractor to:

- A. encase the pipe with concrete,
- B. change pipe material, or
- C. use a higher strength class of pipe.

Concrete encasement shall extend from 6 inches below to 6 inches above the outer projections of the pipe over the entire width of the trench in accordance with the City Engineer of Pflugerville Standard Detail 501S-1, "Encasement Detail with Casing Spacers."

The ends of the encasement pipe shall be bulkheaded (Standard Specification Item No. 507S "Bulkheads") with concrete blocks or stones, dry-stacked without mortar, sufficient to prevent the intrusion of trench backfill material into the encasement, but fitted loosely enough to facilitate the escape of water from the encasement should carrier pipe leakage or failure occur.

505S.5 - Measurement

Concrete encasement will be measured by the lineal foot, for size of pipe being encased, complete in place. The measurement will be made between ends of the encasement, along the central axis as installed.

Encasement pipe installed by open cut will be measured by size of encasement installed, complete in place. The measurement will be made between the ends of the pipe, along the central axis as installed.

505S.6 - Payment

Work performed and materials furnished as prescribed by this item will be included in a unit price bid item from Standard Specification Item No. 510, "Pipe" unless included as a separate pay item in the contract. When included for payment, it shall be measured as provided under "Measurement" and will be paid at the unit bid price per lineal foot for "Concrete Encasement" or "Encasement Pipe" of the size indicated on the Drawings. The unit bid price shall include full compensation for furnishing all materials, pipe for all preparation, hauling, installation and for all labor, tools, equipment and incidentals necessary to complete the work, including bench excavation and disposal of surplus material.

Payment, when included as a contract Pay Item, will be made under one of the following:

Pay Item No. 505S-A:	Concrete Encasement for _____ Dia. Pipe	Per Lineal Foot.
Pay Item No. 505S-B:	Encasement Pipe _____ Dia., Type _____ ,	Per Lineal Foot.

END

ITEM NO. 506 - MANHOLES

506.1 - Description

This item governs construction of pre-cast and cast-in-place wastewater manholes, storm water manholes, storm water junction boxes and cast-in-place wastewater junction boxes, complete in place, including excavation, installation, backfilling and surface restoration; required items including rings, covers, coatings, and appurtenances; and incidental work such as pumping and drainage necessary to complete the work. Contractor-performed acceptance testing is required for wastewater manholes.

506.2 - Project Submittals

A. Products and Materials

Within 14 days prior to the commencement of related work, the Contractor shall electronically submit the necessary submittal requirements. All materials shall be new and unused. Material's quality, manufacturing process and finished selections are subject to the inspection and approval of the City Engineer or their designated representative. Inspection may be made at the place of manufacture, at the worksite following delivery, or both. Material will be examined for compliance with ASTM specifications, the City Engineer of Pflugerville Specifications and approved Manufacturer's drawings. Additional inspection criteria shall include appearance, dimensions, blisters, cracks and soundness. Materials shall be rejected for failure to meet any Specification requirement. Rejection may occur at the place of manufacture, the work site or following installation. Rejected materials shall be marked, removed from the work site immediately and replaced by the Contractor at no cost to the City Engineer.

Should the Contractor need to interrupt flow of the existing wastewater system, the Contractor shall submit electronically to the City Engineer or designated representative, for approval, a detailed written plan of all method of flow diversion and maintenance 14 days in advance of flow interruption.

For the abandonment of existing manholes, Contractors shall submit for approval technical product literature including backfill material (source, gradation and type), select backfill material (source, gradation, plasticity index and type), flexible base (binding material, additives, source, gradation and type), equipment and all other pertinent data to illustrate conformance to the specification found within.

The City of Pflugerville Standard Products List is considered a part of the Specifications for the Work. The Contractor shall use products from the SPLs for all water and wastewater construction unless alternative products are shown on the Drawings; called for in the specifications; or specified in the Bidding Requirements, Contract Forms and Conditions of the Contract.

The products included in the Standard Products Lists current at the time of plan approval shall govern; unless a specific product or products on the lists have subsequently been removed from those SPLs because of quality or performance issues. Products and materials that are not covered by SPLs shall meet the requirements in the contract documents.

Submittals for the products and materials covered by this specification shall include manufacturer catalog sheets, technical data sheets, shop drawings, product or material test results, requirements listed below, and any other information needed to adequately describe the product or material. For products covered by SPLs, the submittal shall include a copy of the applicable SPL with the proposed product identified. An SPL by itself is not considered an adequate submittal.

Like items of materials/equipment shall be the end products on a single Manufacturer in order to provide standardization in appearance, operation, maintenance, spare parts and Manufacturer's services.

The submittal requirements of this specification item include:

1. For pre-cast manholes and junction boxes: six (6) copies of shop drawings for each structure showing, at a minimum, the Project and Contractor's name: manufacturer's name and plant location; applicable specifications; list of materials (such as adjusting rings, boots, gaskets, and pre-cast sections) by type and quantity; elevation view showing diameter or size, ring and cover size and elevation, ring type (bolted or unbolted, flared top or flared bottom) wall thickness, elevations of transitions from large diameter sections to smaller diameter sections, base width and thickness, total depth, size of openings, reinforcement, and length of each pre-cast section; concrete mix design; concrete test cylinder reports; structure identification number and station location; pipe line identification; pipe material and size; pipe flowline elevations; plan view showing azimuthal orientation (based on 360 degrees clockwise) of the pipes relative to the outflow pipe; technical data sheets covering pipe-to-manhole or pipe-to-junction box connectors, and gaskets
2. For cast-in-place manholes and junction boxes: formwork drawings sealed by a registered Professional Engineer licensed in the State of Texas with documented experience in formwork design for wall pours that exceed 4 feet in height and slabs that are not ground supported
3. For hydraulic cement concrete; mix components and proportions, material sources, materials test results
4. For mortar: mix components and proportions, material sources, materials test results
5. For non-shrink grout: technical data sheet indicating ASTM type and containing instructions on surface preparation, mixing, placing, and curing procedures
6. For wastewater manhole coatings and linings: technical data sheets that include instructions on surface preparation, mixing, placing, and curing procedures

B. Acceptance Test Records

Submittal of acceptance test records is required for wastewater manholes and shall include as a minimum the following items:

1. Name of the manhole manufacturer
2. Interior surface coating type and application method
3. Model and manufacturer of vacuum tester
4. Date tested/date re-tested
5. Indication of whether test passed or failed, and statement of corrective action taken if test failed
6. Test Method Used
7. Location/station of manhole
8. Type of base: Precast/cast-in-place
9. Type of repairs made to the joints
10. The test records shall also be included as part of the Project records turned in with the acceptance package.

506.3 - Materials

A. Concrete

All cast-in-place concrete shall conform to City of Pflugerville Standard Specification Item No. 403S, "Concrete for Structures." Cast in place concrete shall be Class A or as specified on the Drawings. Concrete used in precast concrete manhole base sections, riser sections and appurtenances shall conform to the requirements of Texas Department of Transportation Item 421 "Hydraulic Cement Concrete" and ASTM C478. Concrete for backfill of over-excavated areas shall be City of Pflugerville Class A (City of Pflugerville Standard Specification Item 403S, "Concrete For Structures") or Controlled Low Strength Material (City of Pflugerville Standard Specification Item 402S) as indicated on the Drawings.

B. Mortar

Mortar shall be composed of one part Portland Cement (PC), one part masonry cement (or 1/4 part hydrated lime), and sand equal to 2½ to 3 times the sum of the volumes of the cements and lime used. The sand shall meet the requirements for "Fine Aggregate" as given in Standard Specification Item No. 403S "Concrete For Structures." Mortar shall not be used for any purpose on the inside of wastewater manholes.

C. Grout

Grout shall be the non-shrink type conforming to ASTM C 1107, Packaged, Dry, Hydraulic Cement Grout and conform with the City of Pflugerville SPL Item "Packaged Non-Shrink Grout Mix.". Grout shall be used as packaged, with the mixed ingredients requiring only the addition of water. Preparation, mixing, placing, finishing and curing shall be performed in accordance with the manufacturer's recommendation.

D. Reinforcement

The reinforcing steel shall conform to the requirements of Standard Specification Item No. 406S, "Reinforcing Steel." Secondary, non-structural steel in cast-in-place stormwater manholes may be replaced by collated fibrillated polypropylene fibers, if approved by the City Engineer or designated representative.

E. Rings and Covers

Rings and covers shall conform to the requirements of City of Pflugerville Standard Specification Item No. 503S, "Frames, Grates, Rings and Covers." Manhole covers shall be in accordance with the City of Pflugerville Standard Detail 511-AW-01 "Typical Gate Valve".

1. Replacement Rings and Covers, 24 in Diameter Lids

This ring and cover shall be used for the replacement of broken rings and covers, minor manhole adjustment, or as otherwise directed by the City Engineer or designated representative.

2. Rings and Covers, 32 in. Diameter Lids

This ring and cover shall be used for all new manhole construction, except as otherwise directed by the City Engineer or designated representative.

F. Bulkheads

Bulkheads shall meet the requirements of City of Pflugerville Standard Specification Item No. 507S "Bulkheads."

G. Precast Base Sections, Riser Sections, Flat-top Slabs and Cones

Precast concrete base sections, riser sections, flat-top slabs, and cones shall conform to the requirements of ASTM C 478. Manhole diameter shall be as shown on the Drawings, but not less than the diameter of the largest connecting pipe plus 2 feet. The width of the invert shall be specifically sized for the connecting pipes. Inverts shall be "U" shaped channels. The channel depth at the point where a pipe connects to the manhole wall, for pipes 24 inches in diameter and smaller, shall be a minimum of three fourths of the diameter of the pipe, with the top of the channel being a smooth transition between the inlet and outlet pipe connection points. For manholes connecting to pipes larger than 24 inches in diameter, the channel depth at the point where a pipe connects to the manhole wall shall be at least equal to the full pipe diameter. Changes in flow direction in the inverts of manholes shall be made by constructing smooth, long-radius sweeps to minimize splashing, turbulence, and eddies. The manhole invert grade shall 1) be a continuation of the inlet and outlet pipe grades carried through to the centerline of the manhole, or 2) have a minimum slope of 2.5 percent between the inlet and outlet pipe inverts, or 3) have a minimum difference of 0.10 feet between the inlet and outlet pipe inverts, whichever provides the maximum difference in invert elevation between the inlet and outlet pipes. In all cases, the bottom(s) of the channel(s) shall provide a smooth transition between the inlet and outlet pipes. Where wastewater lines enter a manhole above the flowline of the outlet, the invert shall be filleted to prevent splashing and solids deposition.

Precast concrete base sections, riser sections, transition top sections, flat slab tops and grade rings shall meet the following requirements:

1. Bottom slab thickness shall be 12 inches.
2. Top section shall be flat slab with a minimum clear opening of 32 & 7/8-inch diameter.
3. Base, riser and transition top sections shall have tongue and groove joints.
4. Sections shall be cured by an approved method.
5. Precast concrete sections shall be shipped after concrete has attained 3,000 psi compressive strength.
6. Design precast concrete base, riser, transition top, flat slab top and grade ring for a minimum HS-20 loading plus earth load.
7. Mark date of Manufacturer, name and trademark of Manufacturer on the inside of each precast section.
8. Provide integrally cast knock-out panels in precast concrete manhole sections at locations with sizes shown on Drawings. Knock-out panels shall have no steel reinforcing.
9. Precast concrete sections shall have lifting lugs or holes in each precast section for proper handling. Through-wall holes for lifting will not be permitted.

Joints for wastewater base sections, riser sections and cones shall conform to the requirements of ASTM C478, C76 and C443. Additionally, joint dimensions for 48-inch inside diameter wastewater

manhole sections and cones shall comply with City of Pflugerville Standard Detail 506S-13, "Wedge Seal Joint Detail, Precast Manhole Section." Joint dimensions for wastewater manhole sections and cones shall comply with City of Pflugerville Standard Detail 506S-12, "O-Ring Joint Detail Precast Manhole Section." Precast bases for 48 inch inside diameter manholes shall have pre-formed inverts.

H. Precast Junction Boxes

Precast junction boxes shall be allowed only where indicated on the Drawings or acceptable to the City Engineer or designated representative.

I. Pipe-to-Manhole and Pipe-to-Junction-Box Connectors

Resilient connectors, ring waterstops, and seals at connections of wastewater pipes to pre-cast and cast-in-place manholes and junction boxes shall be watertight, flexible, resilient and non-corrosive, conforming to ASTM C 923. Metallic mechanical devices for securing the connectors, ring waterstops, and seals in place shall be Type 304 stainless steel. The pipe may be connected to the manhole in the following ways:

1. Flexible Sleeve – Integrally cast sleeve in precast manhole section or install sleeve in a formed or cored opening. Fasten pipe to sleeve with stainless steel clamp(s). Coat stainless steel clamp(s) with bituminous material to protect from corrosion. Flexible sleeve shall be Lock Joint Flexible Manhole Sleeve, Kor-N-Seal connector, PSX Press-Seal Gasket or approved equivalent.
2. Compression Gasket – Integrally cast compression gasket in precast manhole section. Insert pipe into compression gasket. Compression gaskets shall be A-lok or approved equivalent.

J. Precast Flat-Slab Transition/Junction Box Lids

Precast slab transitions and lids shall be designed to safely resist pressures resulting from loads which might result from any combination of forces imposed by an HS-20 loading plus earth load as defined by the American Association of State Highway and Transportation Officials (AASHTO). The joints of precast slab transitions and of lids for wastewater applications shall conform to the requirements of ASTM C443.

K. Precast Grade Rings

Rings shall be reinforced Class A concrete

1. Precast Grade Rings, 24 ½ inches Inside Diameter

This adjustment ring shall be used only for adjusting existing manholes with 24 inch diameter lids and for Wastewater Access Device. Inside to outside diameter dimension of ring shall be 6 inches with a thickness of 3 inches to 6 inches.

2. Precast Grade Rings, 35 inches Inside Diameter

This adjustment ring shall be used for all new manhole construction with 32 inch diameter lids. Inside to outside diameter dimension of ring shall be 6 inches with a thickness of 2 inches to 6 inches.

L. High Density Polyethylene Grade Rings

Plastic grade (adjusting) rings shall be injection molded from high density polyethylene identified according to ASTM D4976. Reprocessable and recyclable ethylene plastic materials are allowed. Manufacturers of HDPE adjusting rings shall be listed in the SPL item "Manhole Grade Rings, HDPE."

M. Controlled Low Strength Material

Controlled low strength material (CLSM) shall meet Standard Specification Item 402S, Controlled Low Strength Material.

N. Cement Stabilized Sand

Cement stabilized sand for bedding or backfilling shall contain 2 bags of PC per cubic yard. The sand shall meet the requirements for "Fine Aggregate" in Standard Specification Item 403S, Concrete for Structures.

O. Waterproofing Joint Materials

O-rings and wedge seals for the joints of all wastewater manholes, and for stormwater manholes when indicated on the Drawings, shall conform to the requirements of ASTM C443. Cold applied preformed plastic gaskets for stormwater manholes shall be as specified in City of Pflugerville Standard Specification Item No. 510, "Pipe." Plastic seals wrapped around manholes at joints, and hydrophilic waterstops installed in joints, shall be listed in the SPL as item "Manhole Seals." PVC waterstops installed in joints and waterproofing compounds applied to the exterior surfaces of manholes and junction boxes shall be as specified in the Contract Documents. Completed joint shall withstand 15 psi internal water pressure without leakage or displacement of the gasket or sealant.

P. Interior Surface Coatings for Wastewater Manholes

Interior surface coatings for wastewater manholes shall be coated with a minimum 80 mils Raven Lining System, Sewpercoat, ARC Concrete Coating System, or approved equivalent, as designated in writing by the City Engineer or designated representative, or as included in the SPL as item "Cementitious Lining for Wastewater Manholes," which lists acceptable products, uses and applicators.

Q. Structural Lining Systems for Wastewater Manholes

Structural lining systems for wastewater manholes shall be either: as specified on the Drawings, as designated in writing by the City Engineer or designated representative, or as included in the SPL as item "Organic Lining for Wastewater Manholes" which lists acceptable products, uses and applicators.

506.4 - Construction

A. General

A minimum horizontal separation of 12 inches shall be maintained between adjacent pipes inside and outside a manhole or junction box. Pipe ends within the base section or junction box walls shall not be relied upon to support overlying manhole dead and live load weights. All wastewater branch connections to new or existing mains shall be made at manholes, with the branch pipe crown

installed at an elevation no lower than the elevation of the effluent pipe crown. Changes in flow direction in the inverts shall be made by constructing smooth, long-radius sweeps to minimize splashing, turbulence, and eddies. Where wastewater lines enter the manhole up to 24 inches above the flowline of the outlet, the invert shall be sloped upward in a U-shaped channel three-fourths of the diameter of the incoming pipe to receive the flow, thus preventing splashing or solids deposition. A drop pipe shall be provided for a wastewater pipe entering a manhole whenever the invert cannot be constructed to prevent splashing and solids deposition. Construction of extensions to existing systems shall require placement of bulkheads at locations indicated or directed by the City Engineer or designated representative.

Unless otherwise indicated on the Drawings, stormwater and wastewater manholes shall have eccentric cones. Wastewater manholes shall be in accordance with the City of Pflugerville Standard Detail 506S-6. Cast-in-place wastewater junction boxes shall be allowed only where indicated on the Drawings or where accepted by the City Engineer or designated representative.

Manholes shall be constructed such that all work is protected against flooding and flotation.

B. Foundation Support

Manholes shall be constructed to the dimensions shown on the Drawings and as specified herein. Manholes shall be founded at the established elevations on a bed of screened gravel 8 inches in depth unless otherwise indicated on the Drawings. The manhole base shall be set so that a maximum grade adjustment of 8 inches is required to bring the manhole frame and cover to final grade. Unstable subgrade shall be over-excavated a minimum of 12 inches and replaced with a material acceptable to the City Engineer or designated representative. A pipe section with a prefabricated tee manhole and half the length of the adjoining pipe sections on each side shall be founded on a minimum of 6-inch thick layer of unreinforced Class A concrete (City of Pflugerville Standard Specification Item No. 403S, "Concrete For Structures"). The cast-in-place concrete cradle shall be placed against undisturbed trench walls up to the pipe's springline.

C. Precast Concrete Manhole Sections

Set precast concrete barrel sections plumb with a 1/4 inch maximum out of plumb tolerance allowed. Allow joints to set for 14 hours before backfilling unless a shorter period is specifically approved by the City Engineer or designated representative. Backfill carefully and evenly around manhole sections.

Plug holes in the concrete barrel sections required for handling with a non-shrink grout or non-shrink grout in combination with concrete plugs. Finish flush on the inside.

Core holes in precast sections to accommodate pipes prior to setting manhole sections in place to prevent jarring which may loosen mortar joints.

D. Cast-in-Place Concrete

Structural concrete work shall conform to Standard Specification Item No. 410S, Concrete Structures". Forms shall be used for all slabs that are not ground supported and for all vertical surfaces above the foundation level. Formwork shall be designed according to American Concrete Institute ACI 347, Guide to Formwork for Concrete. Outside forms on vertical surfaces may be omitted where concrete can be cast against the surrounding earthen material that can be trimmed to a smooth vertical face.

E. Manhole Bases

Pre-cast bases shall conform to requirements in 506.3.H.

Cast-in-place bases shall have a minimum thickness of 12 inches at the invert flowline. The widths of all manhole inverts shall be specifically sized for the connecting pipes. Inverts shall be "U" shaped channels. The channel depth at the point where a pipe connects to the manhole wall, for pipes 24 inches in diameter and smaller, shall be a minimum of three-fourths of the pipe diameter, with the top of the channel being a smooth transition between the inlet and outlet pipe connection points. For manholes connecting to pipes greater than 24 inches in diameter, the channel depth at the point where a pipe connects to the manhole wall shall be equal to the full pipe diameter. The manhole invert grade shall 1) be a continuation of the inlet and outlet pipe grades carried through to the centerline of the manhole, or 2) have a minimum slope of 2.5 percent between the inlet and outlet pipe inverts, or 3) have a minimum difference of 0.10 feet between the inlet and outlet pipe inverts, whichever provides the maximum difference in invert elevation between the inlet and outlet pipes. In all cases, the bottom(s) of the channel(s) shall provide a smooth transition between the inlet and outlet pipes. Changes in flow direction in the inverts of manholes shall be made by constructing smooth, large-radius sweeps to prevent splashing, turbulence, and eddies. The lowermost riser section may be set in the PC concrete, while still plastic, after which the base shall be cured a minimum of 24 hours prior to proceeding with construction of the manhole up to 12 feet in depth. The base shall be cured an additional 24 hours prior to continuing construction above the 12-foot level.

Wastewater manholes having cast-in-place bases may be constructed over existing wastewater pipes and the top half of the pipe removed to facilitate invert construction, except where the existing pipe is PVC, in which case, the entire pipe shall be removed from inside the manhole. The manhole floor shall rise outwardly from the springline elevation of the pipe, approximately one inch for each 12 inches of run (8 percent slope). The floors of stormwater manholes, also, shall rise outwardly from the springline elevation of the pipe, approximately one inch for each 12 inches of run (8 percent slope).

Wastewater manholes with lines larger than 18 inches shall require pre-cast bases; manholes constructed over in-service mains however, may be built on cast-in-place bases if the flow cannot be interrupted.

F. Pipe Connections to Manholes and Junction Boxes

Wastewater pipe connections to manholes and junction boxes shall be flexible sleeves or compression gaskets acceptable to the City Engineer or designated representative, as specified in Section 506.3.J herein. The Connectors shall conform to the requirements of ASTM C-923. Any voids in the annular space between the pipe and boot connector or ring waterstop and the inside of the manhole wall shall be filled with non-shrink grout to prevent solids collection.

G. Pipe Connections to Existing Manholes and Junction Boxes

Wastewater pipe connections to existing manholes and junction boxes shall be made by removing the wall section by coring or alternative method approved by the City Engineer or designated representative; installing flexible sleeves or compression gaskets acceptable to the City or designated representative and conforming to the requirements of ASTM C-923; filling any voids in the annular space between the pipe and boot connector or ring waterstop and the inside of the

manhole or junction box wall with non-shrink grout; rebuilding the invert to conform to Section 506S.4.D; rehabilitating the interior walls with structural lining material listed as SPL Item "Structural Lining for Wastewater Manholes" and coating the interior of the manhole with material listed as SPL Item "Organic Lining for Wastewater Manholes."

H. Waterproofing

PVC waterstops, hydrophilic waterstops, joint wrapping, and waterproofing compounds shall be installed as specified. Material wrapped around manholes at joints shall be listed as SPL Item "Manhole Seals" regardless of whether installation of the material is required by the Contract for waterproofing or is volunteered by the Contractor for ensuring acceptance of the manhole joints.

I. Backfilling

Backfilling of manholes shall conform to the density requirements of City of Pflugerville Standard Specification Item No. 510 "Pipe". Backfilling operations shall be performed carefully and evenly around manhole sections. Manhole construction in roadways may be staged to facilitate pavement base construction. Manholes constructed to interim elevations to facilitate interim construction shall be covered with steel plates. Steel plates on wastewater manholes shall be set in mortar to minimize inflow of storm water runoff. Manholes shall be completed to finish elevation prior to placement of the roadway's finish surface except on pavement reconstruction projects, where castings may be adjusted after paving is completed. The excavation for completion of manhole construction shall be backfilled in accordance with the City of Pflugerville Standard Detail 1100S-2, "Flexible Base with Asphalt Surface Trench Repair – Existing Pavement."

J. Height Adjustment of Manholes

1. General

All adjustments shall be completed prior to the placement of the final roadway surface except on pavement reconstruction projects, where castings may be adjusted after paving is completed. Brick shall not be used in making height adjustments to wastewater manholes. Mortar shall not be used for any purpose on the inside of wastewater manholes.

All materials shall be new and unused.

If the adjustment involves lowering the top of a manhole, a sufficient depth of pre-cast concrete rings or shall be removed to permit reconstruction. If there are brick courses, the brick shall be removed in its entirety. Existing mortar shall be cleaned from the top surface remaining in place and the manhole rebuilt to the required elevation using precast concrete or HDPE grade rings. The manhole ring and cover shall then be installed with the top surface conforming to the proposed grade.

If the adjustment involves raising the elevation of the top of the manhole in accordance with "Minor Manhole Height Adjustment," the top of the concrete ring shall be cleaned and built up vertically to the new elevation, using new concrete rings and the ring and cover installed with the top surface conforming to the proposed grade.

After rings and covers are set to grade, the inside and outside of the precast concrete grade rings shall be wiped with non-shrink grout to form a durable surface and water-tight joints. The

grouted surface shall be smooth and even with the manhole cone or riser section. Grout shall not be placed when the atmospheric temperature is at or below 40°F. If a sudden drop in temperature below 40°F occurs or temperatures below 40°F are predicted, the grouted surfaces shall be protected against freezing for at least 24 hours.

2. Minor Manhole Height Adjustment (New and Existing Manholes)

Minor manhole height adjustments shall be performed as indicated on City of Pflugerville Standard Detail 506S-4, "Minor Manhole Adjustment and New Manhole Construction", and shall consist of adding precast reinforced concrete rings to adjust new and existing manholes to final grade. Brick shall not be used in making height adjustments to wastewater manholes.

If the adjustment involves raising the elevation of the top of the manhole, the top of the concrete ring shall be cleaned and built up vertically to the new elevation, using new concrete or HDPE grade rings, and the ring and cover installed with the top surface conforming to the proposed grade.

For new manhole construction, the maximum allowable throat or chimney height, including the depth of the ring casting, shall be limited to 21 inches of vertical face on the interior surface. For adjustments of existing manholes that fall within the limits of overlay and street reconstruction projects, the maximum vertical allowable height, including the depth of the ring casting, shall be limited to 27 inches of vertical face on the interior surface. All other existing manholes shall have a maximum allowable throat or chimney height adjustment, including the depth of the ring casting, of 12 inches of vertical face on the interior surface. Any adjustment that will exceed these requirements shall be accomplished as indicated on City of Pflugerville Standard Detail 506S-2, "Major Manhole Adjustment" and as described below. Manholes not located in paved areas shall have bolted covers. Manholes located within paved areas (street right of way only) shall be standard non-bolted unless otherwise noted on the drawings.

3. Major Manhole Height Adjustment (Existing Manholes Only)

Any adjustment that exceeds the requirements of Minor Manhole Adjustments, shall be accomplished as indicated on City of Pflugerville Standard Detail 506S-2, "Major Manhole Adjustment", and shall consist of any combination of removing the concrete rings, and/or the manhole cone or riser section, and/or the straight riser section of the manhole in order to bring the manhole to final grade. Major manhole adjustments shall apply only to existing manholes. Manholes not located in paved areas shall have bolted covers. Manholes located within paved areas (street right of way only) shall be standard non-bolted unless otherwise noted on the drawings.

K. Interior Coatings of Wastewater Manholes and Junction Boxes

The interior surfaces of all Portland cement concrete wastewater manholes and junction boxes shall be coated with products specified either on the Drawings, designated in writing by the City Engineer or representative, or listed as SPL Item "Organic Lining for Wastewater Manholes." Product selection shall conform to usage described in that SPL. Surface preparation shall follow the product manufacturer's recommended procedures contained in technical data sheets unless otherwise specified in the contract documents. The Contractor shall measure the coating thickness according to ASTM D 6132, Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Over Concrete Using an Ultrasonic Gage. Thickness measures shall be made at locations

designated by the City Engineer or designated representative. All thickness measurements shall be witnessed by the City Engineer or designated representative.

L. Structural Linings of Existing Wastewater Manholes

The interior surfaces of existing wastewater manholes and junction boxes at locations shown in the Drawings or as designated by the City Engineer or designated representative shall be strengthened by application of structural lining systems either as specified on the Drawings, directed in writing by the City Engineer or designated representative, or listed as SPL Item "Organic Lining for Wastewater Manholes." Selection of products for coating the interior of existing manholes shall be based on the condition of the manholes. Surface preparation shall follow the product manufacturer's recommended procedures contained in technical data sheets unless otherwise specified in the contract documents.

M. Abandonment of Existing Manholes

Manholes designated on the Drawings for abandonment, shall be removed in their entirety, including manhole cone ring and cover. Two-foot long sections of the inlet and outlet pipes shall be cut and removed on the outside of the manhole, the ends of the remaining pipe and the pipe sections penetrating the manhole wall shall be securely plugged, and the structure filled with material in accordance with Standard Detail 506S-15 "Manhole Abandonment" or as directed by the City Engineer or designated representative.

If the manhole is not located within a street, the Contractor shall backfill with compacted 3/8-inch F bedding material to a point 12" above the highest plugged line. Above the bedding material, the Contractor shall backfill to a point 12" below the natural ground surface with compacted select fill. The remaining 12" shall be backfilled with suitable topsoil. If the manhole is located within a street, the Contractor shall backfill with compacted 3/8-inch F bedding material to a point 12" above the highest plugged line. Above the bedding material, the Contractor shall backfill to a point 12" below the natural ground surface with compacted select fill. The remaining 12" shall be backfilled with Flexible Base in accordance with the City of Pflugerville Standard Specification 210S, "Flexible Base".

The Contractor shall provide all labor, equipment and materials necessary to maintain existing flows, including temporary diversions and all pumping of sewage that may be required to prevent backup of wastewater lines and shall immediately remove all offensive matter at his own expense. The Contractor shall not be permitted to overflow, bypass, pump or by any other means convey sewage to any stream or other water source. Should damage of any kind occur to the existing wastewater line, the Contractor shall make repairs to the satisfaction of the City Engineer or designated representative, at the Contractor's expense.

The contractor shall notify the City Engineer or designated representative immediately of any discrepancies in elevations of existing wastewater lines and manholes between those shown on the Drawings and those established during construction so that the City can make necessary modifications.

506.6 - Acceptance Testing of Wastewater Manholes

Manholes shall be tested separately and independently of the wastewater lines.

A. Test by the Vacuum Method

A vacuum test shall be performed by the Contractor prior to backfilling those manholes that fall within the right-of-way that require detouring of vehicular traffic. A second vacuum test will not be required after backfilling and compaction is complete unless there is evidence that the manhole has been damaged or disturbed subsequent to the initial vacuum test.

For manhole installations which do not require detouring of vehicular traffic, the vacuum method is recommended and may be used by the Contractor prior to backfilling the manhole to insure proper installation so that defects may be located and repaired; however, a vacuum test shall be performed after backfilling, and compaction are complete. Testing after backfill and compaction are complete will be the basis for acceptance of the manhole.

1. Equipment

- a) The manhole vacuum tester shall be a device approved for use by the City Engineer or designated representative.
- b) Pipe sealing plugs shall have a load resisting capacity equal to or greater than that required for the size of the connected pipe to be sealed.

2. Procedures - applicable to new 48-inch diameter manholes

- a) Manhole section interiors shall be carefully inspected; units found to have through-wall lift holes, or any penetration of the interior surface by inserts provided to facilitate handling, will not be accepted. Coating shall be applied after the testing unless coating is applied before installation or unless it is applied at the factory. All lift holes and exterior joints shall be plugged with an acceptable non-shrink grout. No grout shall be placed in horizontal joints. Tests shall be performed before grouting the invert or around pipe penetrations and before coating the interior surfaces of the manhole or junction box.
- b) After cleaning the interior surfaces of the manhole, the Contractor shall place and inflate pneumatic plugs in all of the connecting pipes to isolate the manhole; sealing pressure within the plugs shall be as recommended by the plug manufacturer. Plugs and the ends of pipes connected by flexible boots shall be blocked to prevent their movement during the vacuum test.
- c) The vacuum test head shall be placed on the top of the cone or riser section or, inside of the top of the manhole cone or riser section, and the compression seal band inflated to the pressure recommended by its manufacturer. The vacuum pump shall be connected to the outlet port with the valve open. When a vacuum of 10 inches of mercury (-5 psig) has been attained, the valve shall be closed and the time noted. Tampering with the test equipment will not be allowed.
- d) The manhole shall have passed the test if the vacuum does not drop below 9 inches of mercury (-4.5 psig) within 3 minutes of the time the valve was closed. The actual vacuum shall be recorded at the end of the 3 minutes during which the valve was closed.
- e) When the standard vacuum test cannot be performed because of design or material constraints (examples: T-Type manholes, T-Lock Liners, or other reasons acceptable to

the City Engineer or designated representative), testing of individual joints shall be performed as directed by the City Engineer or designated representative.

B. Test by the Exfiltration Method

At the discretion of the City Engineer or designated representative, the Contractor may substitute the Exfiltration Method of testing for the Vacuum test described in Section 506.6.A above. This method may only be used when ground water is not present. If ground water is present a Vacuum Test shall be used unless otherwise directed by the City Engineer or designated representative. All backfilling and compaction shall be completed prior to the commencement of testing.

The procedures for the test shall include the following:

1. Manhole section interiors shall be carefully inspected; units found to have through-wall lift holes, or any penetration of the interior surface by inserts provided to facilitate handling, will not be accepted. Coating shall be applied after the testing unless coating is applied before field assembly, or at the factory. All lift holes and exterior joints shall be plugged with an acceptable non-shrink grout. No grout shall be placed in horizontal joints. Tests shall be performed before grouting the invert or around pipe penetrations and before coating the interior surfaces of the manhole or junction box.
2. After cleaning the interior surface of the manhole, the Contractor shall place and inflate pneumatic plugs in all of the connecting pipes to isolate the manhole; sealing pressure within the plugs shall be as recommended by the plug manufacturer.
3. Concrete manholes shall be filled with water or otherwise thoroughly wetted for a period of 24 hours prior to testing.
4. At the start of the test, the manhole shall be filled to the top with water. The test time shall be 1 hour. The Construction Inspector must be present for observation during the entire time of the test. Permissible loss of water in the 1-hour test time is 0.025 gallons per diameter foot, per foot of manhole depth. For a 4-foot diameter manhole, this quantity converts to a maximum permissible drop in the water level (from the top of the manhole cone or riser) of 0.1 inches per foot of manhole depth or 1.0 inches for a 10-foot deep manhole.

C. Failure to Pass the Test - Records of Tests

If the manhole fails to pass the initial test method as described in (A) Test by the Vacuum Method and, if allowed, (B) Test by the Exfiltration Method, or if visible groundwater leakage into the manhole is observed, the Contractor shall locate the leak, if necessary by disassembly of the manhole. The Contractor shall check the gaskets and replace them if necessary. The Contractor may re-lubricate the joints and re-assemble the manhole, or the Contractor may install an acceptable exterior joint sealing product (see City of Pflugerville SPL Item, "Manhole Seals") on all joints and then retest the manhole. If any manhole fails the vacuum and/or exfiltration test twice, the Contractor shall consider replacing that manhole. If the Contractor chooses to attempt to repair that manhole, the manhole must be retested until it passes. In no case shall cold applied preformed plastic gaskets be used for repair. Records of all manhole testing shall be made available to the City Engineer or designated representative at the close of each working day, or as otherwise directed by the City Engineer or designated representative. Any damaged or visually defective products, or any products out of acceptable tolerance shall be removed from the site.

D. Inspection

The City Engineer or designated representative shall make a visual inspection of each manhole after it has passed the testing requirements and is considered to be in its final condition. The inspection shall determine the completeness of the manhole; any defects shall be corrected to the satisfaction of City Engineer or designated representative.

506.7 - Measurement

A "Junction Box" and "Box Manholes" will be measured by each structure of the indicated size regardless of depth.

A "Standard Pre-cast Manhole with Pre-cast Base", "Standard Pre-cast Manhole with Cast-in-Place (CIP) Base", "Special Manhole", "Drop Manhole with Pre-cast Base", "Drop Manhole with Cast-in-Place (CIP) Base", "Centered Tee Manhole", or "Tangent Tee Manhole" will be measured by each structure of the indicated size for the first 8 feet of depth.

An "Extra Depth Manhole" will be measured by linear vertical foot of Standard Pre-cast Manhole with Pre-cast Base, Standard Pre-cast Manhole with CIP Base, Drop Manhole with Pre-cast Base, Drop Manhole with CIP Base, Special Manhole, Centered Tee Manhole, or Tangent Tee Manhole of the indicated size in excess of eight feet of depth. Manhole depth will be measured from the invert flow line to the finished surface elevation.

"Minor Manhole Height Adjustment" and "Major Manhole Height Adjustment" will be measured by each unit for the indicated size. Only existing manholes will be measured for minor or major manhole height adjustment.

"Connection to Existing Manhole or Junction Box" will be measured per each for the indicated type of structure and location.

"Structural Lining" will be measured by the linear vertical foot for the indicated structure.

New manholes constructed to interim elevations to facilitate stage construction shall be measured as one unit regardless of the number of interim elevations constructed. All labor, materials and other expenses necessary for the stage construction shall be included in the unit price bid for the completed unit. Cost of abandonment of existing manholes shall be included in the unit price bid for the completed unit, unless Pay Item No. 506 AB is indicated on the Drawings and identified in Standard Contract Bid Form 00300U.

506.8 - Payment

Payment for completed junction boxes and manholes of the type indicated on the Drawings shall be made at the appropriate unit bid price. The unit bid price shall include all labor, equipment, materials, (including but not limited to frames and grates, rings and covers, adjusting rings, cone sections, riser sections, gaskets, drop piping and fittings, bases, pipe-to-manhole connectors, concrete, reinforcing steel, non-shrink grout, mortar, joint wrap where specified, and, for wastewater manholes, interior coatings), time and incidentals necessary to complete the work.

Payment for a "Junction Box" and "Box Manhole" will be made at the unit price bid for the indicated size, complete in place.

Payment for the first 8 feet of a "Standard Pre-cast Manhole with Pre-cast Base", "Standard Pre-cast Manhole with Cast-in-Place (CIP) Base", "Special Manhole", "Drop Manhole with Pre-cast Base", "Drop Manhole with Cast-in-Place (CIP) Base", "Centered Tee Manhole", or "Tangent Tee Manhole" will be made at the unit price bid for the indicated type and size, complete in place.

Payment for that portion of a Standard Pre-cast Manhole with Pre-cast Base, Standard Pre-cast Manhole with CIP Base, Drop Manhole with Pre-cast Base, Drop Manhole with CIP Base, Special Manhole, Centered Tee Manhole, or Tangent Tee Manhole in excess of 8 feet in depth will be made at the unit price bid for "Extra Depth Manhole" of the indicated type and size, complete in place.

Payment for "Minor Manhole Height Adjustment" and "Major Manhole Height Adjustment" will be made at the unit bid price, complete in place.

Payment for "Structural Lining" will be made at the unit price per linear vertical foot, which will include surface preparation, environmental adjustments, lining application, and curing, as required.

Payment for "Connection to Existing Manhole or Junction Box" shall be made at the unit price per connection and will include removing the wall section by coring or alternative method approved by the City Engineer or designated representative, rehabilitating the interior walls, rebuilding the invert, and preparing and coating the interior surfaces of the structure.

When indicated in the Drawings, abandonment of existing manholes shall be made at the unit price for abandonment.

The intended use of each item shall be designated by a two-letter code (Wastewater=WW; Stormwater=SW) in the spaces provided after the pay item number:

Pay Item No. 506S-M _____:	Standard Pre-cast Manhole w/Pre-cast Base, _____ Dia.	Per Each.
Pay Item No. 506S-M1 _____:	Standard Pre-Cast Manhole w/CIP Base, _____ Dia.	Per Each.
Pay Item No. 506S-S _____:	Special Manhole, _____ Dia.	Per Each.
Pay Item No. 506S-D _____:	Drop Manhole w/Pre-cast Base, _____ Dia.	Per Each.
Pay Item No. 506S-D1 _____:	Drop Manhole w/CIP Base, _____ Dia.	Per Each.
Pay Item No. 506S-C _____:	Centered Tee Manhole, _____ Dia. × _____ Dia.	Per Each.
Pay Item No. 506S-T _____:	Tangent Tee Manhole, _____ Dia. × _____ Dia.	Per Each.
Pay Item No. 506S-J _____:	Junction Box, _____ Ft. × _____ Ft.	Per Each.
Pay Item No. 506S-B _____:	Box Manhole _____ Ft. × _____ Ft.	Per Each.
Pay Item No. 506S-2 _____:	Major Manhole Height Adjustment, _____ Dia.	Per Each.
Pay Item No. 506S-4 _____:	Minor Manhole Height Adjustment, _____ Dia.	Per Each.

Pay Item No. 506S-AB _____:	Abandonment of existing Manholes:	Per Each.
Pay Item No. 506S-EDM _____	Extra Depth of Manhole, _____ Dia.	Per Linear Vert. Foot.
Pay Item No. 506S-SL _____:	Structural Lining of _____:	Per Linear Vert. Foot.
Pay Item No. 506S-CN _____:	Connection to Existing _____:	Per Each.

END

ITEM NO. 507S - BULKHEADS

507S.1 - Description

This item shall govern furnishing and installing plywood or end caps as a temporary utility plug at locations indicated on the Drawings or as directed by the Engineer or designated representative. The work will be placed in conjunction with installation of a pipe where a continuation of the utility system will be performed later.

507S.2 - Submittals

Within 14 days of the Notice to Proceed, the Contractor shall submit to the City for approval, the required submittals. The submittal requirements of this specification item include the type (wood, plastic, rubber, etc.) and application (pipe characteristics and location) of bulkheads.

507S.3 - Material

Plywood shall be construction grade, 3/4 inch thick and need not be new or treated. End caps may be plastic, vitrified clay pipe, rubber or concrete.

507S.4 - Construction Methods

After installation of the utility requiring temporary bulkheading, an end cap or a section of plywood, having dimensions at least 6 inches in excess of the outside pipe diameter shall be attached to the exposed bell or spigot and backfilled immediately after installation. Care shall be exercised to prevent the backfill material from entering the pipe.

Bulkheads used with staged construction shall be sound, reasonably free of knots and warps and have a 3-inch nominal thickness.

507S.5 - Measurement and Payment

Bulkheading will not be measured and paid for separately but shall be included in the unit price bid for the item of construction in which this item is used.

END

ITEM NO. 508S - MISCELLANEOUS STRUCTURES AND APPURTENANCES

508S.1 - Description

This item governs the construction of miscellaneous structures and appurtenances, complete in place or to the stage detailed and/or indicated in the Drawings, using the materials specified herein, including the excavation, installation, backfilling, placement of the concrete and when required, the furnishing and installation of frames, grates, rings, covers, safety end treatment and any concrete curb and gutter indicated on the Drawings.

508S.2 - Submittals

The submittal requirements of this specification item include:

- A. Type of structure and appurtenances (inlets, headwalls, frames, grates, energy dissipators, etc.), construction methods and sequence (precast, cast in place), materials (bolts, nuts, plates, angles, etc.)
- B. Aggregate types, gradations and physical characteristics for the Portland Cement (PC) concrete mix.
- C. Proposed proportioning of materials for the mortar mix.
- D. Analysis and thickness calculations for temporary steel covers.

508S.3 - Types

The various types of structures and appurtenances such as inlets, headwalls, energy dissipators, etc., are designated on the Drawings by letter or by number for the particular design of structure to be constructed in accordance with the details indicated on the Drawings. Unless otherwise indicated on the Drawings, the Contractor may have the option of furnishing cast in place or precast structures.

508S.4 - Materials

A. PC Concrete

The PC concrete shall conform to Item No. 403S, "Concrete For Structures", with the following classes:

Cast in Place Concrete Class A

Precast Concrete Class C

B. Mortar

Mortar shall be composed of 1 part PC and 2 parts clean, sharp mortar sand suitably graded for the purpose by conforming in other respects to the provisions of Standard Specification Item No. 403S, "Concrete for Structures" for fine aggregate. Hydrated lime or lime putty may be added to the mix, but in no case shall it exceed 10 percent by weight of the total dry mix.

C. Reinforcement and Steel

Reinforcing Steel shall conform to Standard Specification Item No. 406S, "Reinforcing Steel".

Structural Steel shall conform to Standard Specification Item No. 720S, "Metal for Structures".

D. Frames, Grates, Rings and Covers

Frames, grates, rings and covers shall conform to City of Pflugerville Standard Specification Item No. 503S, "Frames, Grates, Rings and Covers".

E. Safety End Treatment for Structures

The safety end treatment for structures shall conform to TxDOT Specification Item No. 467, "Safety End Treatment".

1. Bolts and Nuts. All bolts, nuts and associated hardware shall meet the specifications of ASTM A 307.
2. Plates and Angles. All plates and similar angles and brackets shall meet the specifications of ASTM A 36.
3. Pipe Runners. Pipe Runners shall conform to the requirements of ASTM A53, Grade B.
4. Galvanizing. All hardware including nuts, bolts and plates listed above shall be galvanized conforming to ASTM A 123 or A 153.

F. Miscellaneous Items

Cast iron for supports, steps and inlet units shall conform to the shape and dimensions indicated on the Drawings. The casting shall be clean and perfect, free from sand or blowholes or other defects. Cast iron castings shall meet the requirements of ASTM A 48, Class 30. Steel for temporary covers when used with stage construction shall be adequate for the loads imposed.

508S.5 - Construction Methods

All concrete work shall be performed in accordance with Standard Specification Item No. 410S, "Concrete Structures". Forms will be required for all cast-in-place concrete walls, except where the nature of the surrounding material is such that it can be trimmed to a smooth vertical face (the outside form for concrete bases). Where cast in place concrete is used in wall construction of storm sewers, the steps shall be cast into the wall when the concrete is placed.

The construction inlets shall be completed, as soon as is practicable after installation is complete of the sewer lines in the inlet. All sewer line shall be cut neatly at the inside face of the walls of the inlet and pointed up with mortar.

Bases for cast in place inlets may be placed prior to or at the Contractor's option after the storm sewer is constructed.

Bases for box storm sewers shall be cast as an integral part of the storm sewer. The manholes may be constructed prior to backfilling or if the Contractor so elects, the manhole opening may be covered temporarily with a steel plate to facilitate the compaction of backfill for the storm sewer as a whole. Thereafter, required excavation for the inlet shall be made and the inlet constructed and backfilled.

The inverts passing out or through an inlet shall be shaped and grouted across the floor of the inlet as indicated on the Drawings. This shaping may be accomplished by adding shaping mortar or concrete after the base is cast or by placing the required additional material with the base.

All miscellaneous structures shall be completed in accordance with the details indicated on the Drawings. Backfilling to original ground elevation shall be in accordance with the provisions of the appropriate items and as directed by the Engineer or designated representative.

Energy dissipators and headwalls shall be constructed in accordance with City of Pflugerville Standard Detail 508S-13 "Standard Headwall and Energy Dissipators".

508S.6 - Measurement

All miscellaneous structures and safety end treatments satisfactorily completed as indicated on the Drawings will be measured as completed units per each.

Concrete removal, excavation and backfill, riprap, pipe, headwalls, wing walls, collars and apron slabs will not be measured under this item but will be included in the unit price bid for the item of construction in which this item is used.

Frames, grates, rings, covers, safety end treatment and any concrete curb and gutter indicated will not be measured and paid for but shall be included in the unit price bid of one of the pay items identified in the contract bid form.

508S.7 - Payment

A. Inlets

Payment for Inlets of the type indicated in place in accordance with these specifications and measured as prescribed above will be made at the unit bid price for each Inlet, of the type specified.

B. Energy Dissipators and Headwalls

Payment for special complete structures will be made at the unit price bid per each.

C. Safety End Treatment

Payment for Safety End Treatment, complete in place, will be made at the unit bid price for each unit of the type indicated on the Drawings.

Payment will be made under one of the following:

Pay Item No. 508S-E:	Energy Dissipators, _____ In. Dia.	Per Each.
Pay Item No. 508S-H:	Headwalls, Type _____, _____ In. Dia. Pipe	Per Each.
Pay Item No. 508S-IG:	Inlet, Grated	Per Each.
Pay Item No. 508S-SET	Safety End Treatment, Type _____ Size _____	Per Each.
Pay Item No. 508S-IR:	Inlet (Size _____), Recessed	Per Each.
Pay Item No. 508S-IS:	Inlet (Size _____), Standard	Per Each.

END

ITEM NO. 509S - EXCAVATION SAFETY SYSTEMS

509S.1 - Description

This item shall govern the designing, furnishing, installing, maintaining and removing or abandoning of temporary Excavation Safety Systems consisting of trench shields, aluminum hydraulic shoring, timber shoring, trench jacks, tied-back or braced sheeting, tied-back slurry walls, soil nailing, rock bolting, tied-back or braced soldier piles and lagging, and other systems for protecting workers in excavations. This item shall also govern the designing and constructing of sloping and benching systems for protecting workers in excavations.

At a minimum, the Excavation Safety Systems shall conform to United States Department of Labor Rules 29 CFR, Occupational Safety and Health Administration, Part 1926 Safety and Health Regulations for Construction, Subpart P, Excavation (hereinafter called OSHA).

509S.2 - Definitions

COMPETENT PERSON shall mean one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. The **COMPETENT PERSON** shall be capable of interpreting the manufacturer's data sheets and interpreting and implementing the Excavation Safety System Plan.

An **EXCAVATION** shall mean any cut, cavity, trench, or depression in an earth surface, formed by earth removed by the Contractor. The Contractor shall provide an Excavation Safety System for all excavations except when 1) the excavation is in stable rock as determined by the Texas-licensed Professional Engineer who prepared the Contractor's Excavation Safety System Plan or 2) the excavation is less than 5 feet in depth and examination of the ground by the Contractor's competent person provides no indication of a potential cave-in.

TRENCH (TRENCH EXCAVATION) shall mean any narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth shall be greater than the width, but the trench (measured at the bottom) shall not be wider than 15 feet. Excavation Safety Systems for such trenches shall be defined as Trench Excavation Safety Protective Systems.

If the Contractor installs or constructs forms or other structures in an excavation such that the dimension measured from the forms or structures to the sides of the excavation is reduced to 15 feet or less (measured at the bottom of the excavation), those excavations shall also be defined as a **TRENCH** if workers must enter it. Excavation Safety Systems for such **TRENCHES** shall also be defined as **TRENCH EXCAVATION SAFETY PROTECTIVE SYSTEMS**.

509S.3 - Excavation Safety System Plan Submittal

- A. The Notice to Proceed with construction may be issued by the Owner before the Contractor has submitted the necessary Excavation Safety Plan(s); however, with 14 days of the Notice to Proceed, the Contractor shall submit to the City for approval, the required Excavation Safety Plan(s) for the Project.

B. Prior to Starting Excavation

Prior to starting any Excavation, the Contractor shall submit to the Owner:

1. A certificate indicating that the Contractor's Competent Person(s) has completed training in an excavation safety program based on OSHA regulations within the past 5 years.
2. Manufacturer's tabulated data or other tabulated data for Excavation Safety Systems consisting of pre-engineered protective systems such as trench shields, aluminum hydraulic shoring, timber shoring, pneumatic shoring, or trench jacks, or benching or sloping or other protective systems that are not designed specifically for the Project.

Manufacturer's tabulated data shall meet the requirements in OSHA and shall describe the specific equipment to be used on the Project. Tabulated data must bear the seal of the licensed professional engineer who approved the data. Manufacturer's tabulated data shall be an attachment to the Contractor's Excavation Safety System Plan described below.

509S.4 - Excavation Safety System Plan Review

The Contractor shall prepare an Excavation Safety System Plan (hereafter called the "Plan") specifically for the Project. The Contractor shall retain a Texas-licensed Professional Engineer to prepare the Plan. On City-funded projects, the Contractor must follow qualifications-based procedures to procure the required Professional Engineering services, according to Chapter 2254 of the Texas Government Code.

The Contractor shall be responsible for obtaining geotechnical information necessary for design of the Excavation Safety System. If geotechnical information for design of the Project has been acquired by the Owner or designated representative, it shall be provided to the Contractor for information purposes.

- A. The Plan for Excavation Safety Systems consisting of pre-engineered protective systems such as trench shields, aluminum hydraulic shoring, timber shoring, pneumatic shoring, or trench jacks, or benching or sloping or other protective systems that are not designed specifically for the Project shall include:
1. Detailed Drawings of the Excavation Safety System(s) that will provide worker protection conforming to OSHA. The Drawings shall note the required load carrying capacity, dimensions, materials, and other physical properties or characteristics in sufficient detail to describe thoroughly and completely the Excavation Safety System(s).
 2. Drawings, notes, or tables clearly detailing the specific areas of the Project in which each Excavation Safety System shall be used, the permissible size of the excavation, the length of time that the excavation shall remain open, the means of egress from the excavation, the location of material storage sites in relation to the excavation, the methods for placing/compacting bedding/backfill within the safety of the system, any excavation safety equipment restrictions and subsequent removal of the system.
 3. Recommendations and limitations for using the Excavation Safety Systems.
 4. A Certificate of Insurance of the Excavation Safety System Engineer's Professional Liability Insurance coverage. For City-funded projects, coverage meeting the requirements of Standard Contract Documents Section 00810 shall be provided. For privately funded projects the coverage shall be at least \$1,000,000.

- B. The Plan for Excavation Safety Systems consisting of tied-back or braced sheeting, tied-back or braced soldier piles and lagging, slurry walls, soil nailing, rock bolting or other protective systems that are designed specifically for the Project shall include:
1. Detailed Drawings of the Excavation Safety System(s) that will provide worker protection conforming to OSHA. The Drawings shall note the design assumptions, design criteria, factors of safety, applicable codes, dimensions, components, types of materials, and other physical properties or characteristics in sufficient detail to describe thoroughly and completely the Excavation Safety System(s).
 2. Detailed technical specifications for the Excavation Safety System addressing the properties of the materials, construction means and methods, quality control and quality assurance testing, performance monitoring, and monitoring of adjacent features, as appropriate.
 3. Drawings that clearly detail the specific areas of the Project in which each type of system shall be used and showing the Special Shoring in plan and elevation (vertical profile) views.
 4. Drawings, notes or tables clearly detailing the length of time that the excavation shall remain open, the means of egress from the excavation, the location of material storage sites in relation to the excavation, the methods for placing/compacting bedding/backfill within the safety of the system, any excavation safety equipment restrictions and subsequent removal or abandonment of the system or parts thereof.
 5. Recommendations and limitations for using the Excavation Safety Systems.
 6. A Certificate of Insurance of the Excavation Safety System Engineer's Professional Liability Insurance coverage. For City-funded projects, coverage meeting the requirements of Standard Contract Documents Section 00810 shall be provided. For privately funded projects the coverage shall be at least \$1,000,000.

509S.5 - Excavation Safety System Submittal Review

Review of the Excavation Safety System submittal conducted by the Owner or designated representative shall only relate to conformance with the requirements herein. The Owner's failure to note exceptions to the submittal shall not relieve the Contractor of any or all responsibility or liability for the adequacy of the Excavation Safety System. The Contractor shall remain solely and completely responsible for all Excavation Safety Systems and for the associated means, methods, procedures, and materials.

509S.6 - Contractor's Responsibility

The Contractor shall be responsible for implementing the Excavation Safety System Plan and for confirming that the Excavation Safety System(s) used on the Project meets the requirements of the Plan.

The Contractor's Competent Person(s) shall be on the Project whenever workers are in an excavation meeting the definitions of a Trench given in 509S.2.

509S.7 - Construction Methods

The Contractor's Competent Person(s) shall maintain a copy of appropriate OSHA regulations on-site and shall implement OSHA excavation safety regulations at the work site. The Contractor shall perform all excavation in a safe manner and shall maintain the Excavation Safety Systems to prevent death or injury to personnel or damage to structures, utilities or property in or near excavation.

If evidence of possible cave-ins or earthen slides is apparent or an installed Excavation Safety System is damaged, the Contractor shall immediately cease work in the excavation, evacuate personnel from any potentially hazardous areas and notify the Owner. Personnel shall not be allowed to re-enter the excavation until necessary repairs or replacements are completed and are inspected and approved by the Contractor's Competent Person(s). Repair and replacement of damaged Excavation Safety System shall be at the Contractor's sole expense.

509S.8 - Changed Conditions

When changed conditions require modifications to the Excavation Safety System, the Contractor shall provide to the Owner or designated representative a new design or an alternate Excavation Safety System Plan that is proposed by the Contractor's Excavation Safety System Engineer to address the changed conditions. Copies of the new design or alternate system shall be provided to the Owner or designated representative in accordance with the requirements of section 509S.3, "Excavation Safety System Plan Submittals." A copy of the most current Excavation Safety System Plan shall be maintained on site and made available to inspection and enforcement officials at all times.

Any changes to the Excavation Safety System Plan that are initiated by the Contractor for operational efficiency or as a result of changed conditions, that could be reasonably anticipated, will not be cause for contract time extension or cost adjustment. When changes to the Excavation Safety System Plan are necessitated by severe and uncharacteristic natural conditions or other conditions not reasonably within the control of the Contractor, the Contractor may make a written request to the Owner for a Change Order to address the anticipated work. The Contractor shall notify the Owner in writing within 24 hours of the occurrence of changed conditions that the Contractor anticipates the submittal of a claim for additional compensation. Under "Changed Conditions" the work deemed immediately necessary by the Contractor to protect the safety of workers and public, equipment or materials may only be accomplished until the Owner or designated representative has a reasonable opportunity to investigate the Contractor's written request for a Change Order and respond in writing to the request.

509S.9 - Measurement

Trench Excavation Safety Protective Systems will only be measured and paid for those trenches that workers would reasonably be expected to enter.

Trench Excavation Safety Protective Systems for Trenches excavated to a final width (measured at the bottom of the excavation) not exceeding 15 feet shall be measured by the linear foot through manholes, bore pits, receiving pits, and other appurtenances along the centerline of the trench. This method of measurement shall apply to any and all protective systems, including but not limited to tieback or braced sheeting, tieback or braced soldier piles and lagging, slurry walls, soil nails, rock bolts, shoring, trench boxes, and sloping or benching as used to provide a Trench Excavation Safety Protective System in accordance with the Excavation Safety System Plan.

Trench Excavation Safety Protective Systems for Trenches created by installation or construction of forms or other structures in an excavation whose width is greater than 15 feet such that the dimension measured from the forms or structures to the sides of the excavation is reduced to 15 feet or less (measured at the bottom of the excavation) shall be measured by the linear foot along the centerline of the Trench. Where forms or structures create multiple Trenches in one excavation, each Trench shall be measured separately. This method of measurement shall apply to any and all protective systems, including but not limited to tieback or braced sheeting, tieback or braced soldier piles and lagging, slurry

walls, soil nails, rock bolts, shoring, trench boxes, and sloping or benching as used to provide a Trench Excavation Safety Protective System in accordance with the Excavation Safety System Plan.

509S.10 - Payment

Payment for Trench Excavation Safety Protective Systems, measured as prescribed above, will be made at unit bid price per centerline linear foot of Trench. The unit bid price shall include full compensation for designing, furnishing, installing the system; for dewatering, and for maintaining, replacing, repairing and removing the Trench Excavation Safety Protective System and for sloping, special clearing, and excavation necessary to safely implement the Excavation Safety System Plan. No payment will be made for Trench Excavation Safety Protective Systems made necessary by the Contractor's selection of an optional design or sequence of work that creates the need for the Trench Excavation Safety Protective System

Payment will be made under the following:

Pay Item No. 509S-1:	Trench Excavation Safety Protective Systems (all depths)	Per Linear Foot.

END

ITEM NO. 510 - PIPE

510.1 - Description

This item governs the furnishing and installing all pipe and/or materials for constructing pipe mains, sewers, laterals, stubs, inlet leads, service connections, culverts, temporary service lines and temporary diversion lines, including all applicable Work such as excavating, bedding, jointing, backfilling materials, tests, concrete trench cap, concrete cap and encasement, etc., prescribed under this item in accordance with the provisions of the Edwards Aquifer Protection Ordinance, when applicable, and City of Pflugerville Engineering Design Criteria Manual. The pipe shall be of the sizes, types, class and dimensions indicated or as designated by the City and shall include all joints or connections to new or existing mains, pipes, sewers, manholes, inlets, structures, etc., as may be required to complete the Work in accordance with specifications and published standard practices of the trade associations for the material specified and to the lines and grades indicated. This item shall include any pumping, bailing, and drainage when indicated or applicable. Unless otherwise provided, this item shall consist of the removal and disposition of trees, stumps and other obstructions, old structures or portions thereof such as house foundations, old sewers, masonry or concrete walls, the plugging of the ends of abandoned piped utilities cut and left in place and the restoration of existing utilities damaged in the process of excavation, cutting and restoration of pavement and base courses, the furnishing and placing of select bedding, backfilling and cement or lime stabilized backfill, the hauling and disposition of surplus materials, bridging of trenches and other provisions for maintenance of traffic or access as indicated.

510.2 - Materials

Within 14 days of the Notice to Proceed, the Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation into the Work are of the kind and quality that satisfies the specified functions and quality. The City of Pflugerville Standard Products Lists (SPL) form a part of the Specifications. Contractors may, when appropriate, elect to use products from the SPL; however, submittal to the City is still required. The purpose of the SPL's is to expedite review, by the City, The SPL's shall not be considered as being a pre-approved list of products necessarily meeting the requirements of the Project. Items contained in the SPL cannot be substituted for items shown on the Drawings, or called for in the specifications, or specified in the Bidding Requirements, Contract Forms and Conditions of Contract, unless approved by the City. The Standard Product List current at the time of plan approval will govern.

- 1) Concrete
Concrete shall conform to Specification Item No. 403S, "Concrete for Structures".
- 2) Coarse Aggregate
Coarse aggregate shall conform to Specification Item No. 403S, "Concrete for Structures" or one of the following:
 - a) Pipe Bedding Stone
Pipe bedding stone shall be clean gravel, crushed gravel or crushed limestone, free of mud, clay, vegetation or other debris, conforming to ASTM C 33 for stone quality. Size gradation shall conform to ASTM C-33 No. 57 or No. 67 or the following Table:

Sieve Size	3/8" F (% Retained)	1/2" D (% Retained)	Washed Gravel (% Retained)
1/2"	0	0	0
3/8"	0-2	5-25	--
4m	40-85	80-100	--
10m	95-100	96-100	--
3/4"	--	--	100

Sand will not be allowed as acceptable embedment material.

b) Foundation Rock
Foundation rock shall be well graded coarse aggregate ranging in size from 2 to 8 inches.

c) Flexible Base
Flexible base shall conform to Specification Item No. 210S, "Flexible Base".

3) Fine Aggregate

a) Concrete and Mortar Sand
Fine aggregate shall conform to Specification Item No. 403S, "Concrete for Structures".

4) Controlled Low Strength Material

Controlled Low Strength Material (CLSM) shall conform to Specification Item 402S, "Controlled Low Strength Material."

5) Pea Gravel

Pea gravel bedding shall be clean washed material, hard and insoluble in water, free of mud, clay, silt, vegetation or other debris. Stone quality shall meet ASTM C 33. Size gradation shall be as follows:

SIEVE SIZE	% RETAINED BY WEIGHT
¾"	0
½"	0—25
¼"	90—100

6) Select Backfill or Borrow

This material shall consist of borrow or suitable material excavated from the trench. It shall be free of stones or rocks over 8 inches and shall have a plasticity index of less than 20. The moisture content at the time of compaction shall be within 3 percent of optimum as determined by TxDOT Test Method Tex-114-E. If approved by the City, good, sound earth may be used as select material for backfill over the pipe. Good, sound earth is defined as gravel, sandy loam or loam free from excessive clay and having a Plasticity Index less than 20.

All suitable materials from excavation operations not required for backfilling the trench may be placed in embankments, if applicable. All unsuitable materials that cannot be made suitable shall be considered surplus excavated materials as described in Specification Section 510.3(13). The Contractor may, if approved by the City or designated representative, modify unsuitable materials to make them suitable for use. Modification may include drying, removal or crushing of over-size material, and lime or cement treatment.

7) Cement Stabilized Backfill

When indicated or directed by the City, all backfill shall be with cement-stabilized backfill rather than the usual materials. Unless otherwise indicated, cement stabilized backfill material shall consist of a mixture of the dry constituents described for Class J Concrete. The cement and aggregates shall be thoroughly dry mixed with no water added to the mixture except as may be directed by the City.

8) Pipe

General

Fire line leads and fire hydrant leads shall be ductile iron (DI). Domestic water services shall not be supplied from fire service leads, unless the domestic and fire connections are on separately valved branches with an approved backflow prevention device in the fire service branch. All wastewater force mains shall be constructed of ductile iron pipe Pressure Class 250 minimum for 16-inch size pipe and greater, and Pressure Class 350 for pipe 12-inch size and smaller as defines by AWWA C150. Flanged D.I. Pipe shall be Special Thickness Class 53 meeting AWWA C115. Wastewater pipe shall be in accordance with the City of Pflugerville Standard Products List (SPL) Item "Ductile Iron Wastewater Pipe" and shall have an approved corrosion resistant interior lining acceptable to the City.

All water pipe within utility easements on private property shall be Ductile Iron Pipe, Pressure Class 350 minimum for pipe 12-inch size and smaller and Pressure Class 250 minimum for pipe 16-inch size and greater, wrapped as indicated. Acceptable sizes are 4", 6" 8", 12", 14" (for repairs only), 16", 18" (for repairs only), 20", 24" and 30" and multiples of 6" in larger sizes. For pipe larger than 24" diameter, the manufacturer must provide one of the following with PROJECT submittal:

- a. Evidence of current ISO registration,
- b. Evidence of current City of Pflugerville approved quality control program,
- c. Evidence of current City of Pflugerville approved independent, third party firm that will test and inspect pipe produced for the City of Pflugerville.

Approved service/tapping clamps or saddles shall be used when tapping ductile iron pipe 12 inch size and smaller. All service tubing ($\frac{1}{2}$ inch thru 2 inches) installed in utility easements on private property shall be 150 psi annealed seamless Type K copper tubing meeting ASTM B88 bearing NSF/ANSI Standard 61 approval with no sweat or soldered joints and shall meet the requirements of the City of Pflugerville SPL Item "Seamless Copper Tubing."

All reclaimed water mains shall be constructed of ductile iron pipe, Pressure Class 350 minimum for pipe 12-inch size and smaller and pressure class 250 for pipe size 16-inch and greater. For mains 12-inch size and smaller, PVC pipe, conforming to the requirements of AWWA C-900, DR 14 shall be acceptable. Reclaimed water pipe shall be manufactured purple, painted purple, or wrapped in purple polyethylene film wrap.

The quality of materials, the process of manufacture and the finished pipe shall be subject to inspection and approval by the City at the pipe manufacturing plant and at the project site prior to and during installation. Plant inspections shall be conducted at the discretion of the City Representative. Only manufacturers having a quality control program of the type described above will be considered as approved providers of concrete pipe and pipe products as listed in the SPL.

All water distribution pipe and fittings shall be listed in the Fire Protection Equipment Directory published by the Underwriter's Laboratories, Inc., or shall be Factory Mutual approved for fire service. All water pipe and related products shall be registered by the National Sanitation Foundation as having been certified to meet NSF/ANSI Standard 61.

- (a) Reserved
- (b) Iron Pipe

All DI pipe and fittings shall be from a single Manufacturer. All DI pipe to be installed under this Contract may be inspected at the foundry for compliance with these specifications by an independent testing laboratory provided by the City. The Contractor shall require the Manufacturer's cooperation in these inspections. The cost of foundry inspection of all pipe approved for this Contract, plus the cost of inspection of disapproved pipe, will be borne by the Contractor.

Inspections of the pipe may also be made by the City or designated representative after delivery to the project site. The pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job site immediately

Iron pipe shall be ductile iron pipe as described in the City of Pflugerville SPL Item "Ductile Iron Pipe & Fittings" and meet all requirements of standards as follows:

-For push-on and mechanical joint pipe: AWWA C-151

-For flanged pipe: Special Thickness Class 53 meeting AWWA C-115

Barrels shall have a nominal thickness required by Table 1 of AWWA C-115, which thickness corresponds to Special Class 53 in sizes through 54 inch, and Class 350 in 60 and 64-inch sizes. Flanges shall be ductile iron (gray iron is not acceptable); they shall be as shown in ANSI/AWWA C115/A21.15 and shall conform to dimensions shown in Table 2 and Figure 1 of AWWA C115. These flanges are the same in all respects as flanges shown in ANSI/AWWA C110/A21.10 for fittings and are standard for all flanges used with pipe, valve, and equipment units in the City of Pflugerville water distribution and wastewater force main systems. Flanges shall be fabricated and attached to the pipe barrels by U.S. fabricators using flanges and pipe barrels of U.S. manufacture. If fabrication is to be by other than the pipe barrel manufacturer, a complete product submittal and approval by the City will be required. Additionally, such fabricator shall furnish certification that each fabricated joint has been satisfactorily tested hydrostatically at a minimum pressure of 300 psi.

- Linings and Coating:

Interior surfaces of all iron potable or reclaimed water pipe shall be cement-mortar lined and seal coated as required by AWWA C104. Interior surfaces of all iron wastewater line and force main pipe shall be coated with a non-corrosive lining material meeting the minimum requirements of the City of Pflugerville Standard Products List SPL Item "Ductile Iron Pipe & Fittings." Pipe exteriors shall be coated as required by the applicable pipe specification. The type and brand of interior lining shall be clearly marked on the outside of the pipe and fittings. Except as authorized by the E/A, only one type and brand of pipe lining shall be used on a given project.

Except as described above for flanged pipe (Thickness Class 53) and where not otherwise indicated, ductile iron pipe shall be minimum Class 250 as defined by ANSI/AWWA C150/A21.50-current; all ductile iron pipe and flanges shall meet the following minimum physical requirements:

Grade 60-42-10:

- Minimum tensile strength: 60,000 psi (414 mPa).
- Minimum yield strength: 42,000 psi (290 mPa).
- Minimum elongation: 10 percent.

The flanges for AWWA C115 pipe may be also be made from:

Grade 70-50-05:

- Minimum tensile strength: 70,000 psi (483 mPa).
- Minimum yield strength: 50,000 psi (345 mPa).
- Minimum elongation: 5 percent.

1. Ductile Iron Fittings:

Fittings shall be push-on, flanged or mechanical joint as indicated or approved and shall meet all requirements of standards as follows:

-Sizes 4 inch through 30 inch or greater: AWWA C-110 or AWWA C-153

-Sizes larger than 24 inch: AWWA C-110.

-Lining and Coating:

Interior surfaces of all iron potable/reclaimed water pipe fittings shall be lined with cement-mortar and seal coated as required by AWWA C104. Interior surfaces of all iron wastewater and force main fittings shall be coated with a non-corrosive lining material acceptable to Owner. Fitting exteriors shall be coated as required by the applicable pipe specification. Alternately, the fittings may be fusion-bonded epoxy lined and coated according to AWWA C116.

Exterior – All pipe fittings shall have a bituminous outside coating in accordance with AAWA C151 and C110.

2. Joint Materials

Gaskets for mechanical joints shall conform to ANSI/AWWA A21.11/C-111.

Joining of slip joint iron pipe shall, without exception, be accomplished with the natural or synthetic rubber gaskets laid in the bell end of the manufacturer of that particular pipe being used. A joint lubricant shall be used and applicable recommendations of the manufacturer shall be followed.

Gaskets for flanged joints shall be continuous full face gaskets, of 1/8 inch minimum thickness of natural or synthetic rubber, cloth-reinforced rubber or neoprene material, preferably of deformed cross section design and shall meet all applicable requirements of ANSI/AWWA A21.11/C-111 for gaskets. They shall be manufactured by, or satisfy all recommendations of, the manufacturer of the pipe/fittings being used and be fabricated for use with Class 125 ANSI B16.1 flanges.

Mechanical joints shall be made in accordance with Appendix "A" of AWWA C111 and the manufacturer's instructions.

Tee-head bolts, nuts and washers for mechanical joints shall be high strength, low alloy, corrosion resistant steel stock equal to "COR-TEN A" having UNC Class 2 rolled threads or alloyed ductile iron conforming to ASTM A 536; either shall be fabricated in accordance with ANSI/AWWA A21.11/C-111. Bolts shall be tightened to the specified torque.

Hex head bolts and nuts shall satisfy the chemical and mechanical requirements of ASTM A449 SAE Grade 5 plain, and shall be fabricated in accordance with ASTM B 18.2 with UNC Class 2 rolled threads.

Either Tee-Head or Hex-Head bolts, nuts and washers as required, shall be protected with bonded fluoro-polymer corrosion resistant coating where specifically required by the E/A.

All threaded fasteners shall be marked with a readily visible symbol cast, forged or stamped on each nut and bolt, which will identify the fastener material and grade. The producer and the supplier shall provide adequate literature to facilitate such identification; painted markings are not acceptable.

3. Polyethylene Film Wrap

All iron pipe, fittings and accessories shall be wrapped with standard 8 mil (minimum), Type I, Grade E-1 low density polyethylene film, conforming to AWWA C105 and meeting the requirements of the City of Pflugerville SPL Item "Polyethylene Encasement for Ductile Iron Pipe." All edges of wrap shall be overlapped and taped securely with duct tape to provide a continuous wrap to prevent contact between the piping and the surrounding backfill. Repair all punctures of the polyethylene, including those caused in the placement of bedding aggregates, with duct tape to restore the continuous protective wrap before backfilling. Polyethylene film wrap for reclaimed water pipe shall be purple.

The following classes shall be used:

1. Class A – Natural color where exposure to weather (including sunlight) is less than 48 hours total before burial.
2. Class B – Black where exposure to weather (including sunlight) may be more than 48 hours total before burial.

Exposure to weather shall be kept to a minimum, and in no case shall it exceed 10 days. The Class of polyethylene encasement used shall be approved by the City.

4. Marking

Each pipe joint and fitting shall be marked as required by the applicable AWWA specification. This includes in all cases: Manufacturer's identification, Country where cast, year of casting, and "DUCTILE" or "DI". Barrels of flanged pipe shall show thickness class; others shall show pressure class. The flanges of pipe sections shall be stamped with the fabricators identification; fittings shall show pressure rating, the nominal diameter of openings and the number of degrees for bends. Painted markings are not acceptable.

5. Warning Tape

Warning tape shall be placed on top of pipe for identifying restrained joint pipe and fittings shall be yellow and shall have black lettering at least 2 inches high that reads "Restrained Joint / Junta de Restriction" at intervals not exceeding 24 inches. The warning tape shall be polypropylene having a minimum thickness of 2 mils, a minimum width of 3 inches, and adhesive backing on the side opposite the lettering.

6. Concrete and Blocking

2,500 psi concrete shall be placed for blocking at each change in direction in the pipeline in such a manner as will substantially brace the pipe against undisturbed trench walls. Concrete blocking made from Type I cement shall have been in place for 4 days prior to testing the pipelines. Tests may be made in 2 days after the completion of blocking if Type III cement is used.

At all points where wet connections are made to existing lines, the existing lines shall be adequately blocked and the tapping connection fittings shall be supported by blocking up to the spring line with 2,500 psi concrete.

(c) Concrete

1. General

Pipe shall conform to ASTM C 76 for Circular Pipe. Concrete pipe smaller than 12 inches in diameter shall conform to ASTM C 14, Extra Strength. All pipe shall be machine made or cast by a process which will provide uniform placement of the concrete in the form and compaction by mechanical devices, which will assure a dense concrete. Concrete shall be mixed in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Transit mixed concrete shall not be acceptable for use in precast pipe. The pipe shall be Class III or the class indicated. Storm sewer pipe shall be of the tongue and groove or O-ring joint design.

2. Marking

Each joint of pipe shall be marked with the pipe class, the date of manufacture, the manufacturer's name or trade mark, diameter of pipe and orientation, if required.

Pipe marking shall be waterproof and conform to ASTM C 76.

3. Minimum Age for Shipment

Pipe shall be considered ready for shipment when it conforms to the tests specified in ASTM C 76.

4. Joint Materials

When installing storm sewers (or storm drains), the Contractor shall have the option of using joints with preformed flexible joint sealants or with rubber gaskets. Preformed flexible joint sealants for storm drain joints shall comply with ASTM C990, and rubber gaskets for storm drain joints shall comply with ASTM C 1619. Mortar shall not be used to seal prefabricated joints. Pipe manufacturer shall be responsible for submitting to the Owner a detailed design of the joint upon request. The pipe manufacturer shall be responsible for submitting to the Owner a complete list of joint sizes showing the minimum size of material to be used with each size joint, along with complete instructions on recommended installation procedures. Quality control testing at the manufacturing plant shall be in accordance with Texas Department of Transportation (TxDOT) Departmental Materials Specifications (DMS) 7310, "Reinforced Concrete Pipe And Machine-Made Precast Concrete Box Culvert Fabrication And Plant Qualification". The pipe manufacturer shall be verified as compliant with TxDOT DMS 7310 at time of pipe delivery to the jobsite.

a. Mortar

Mortar for joints shall meet the requirements set forth below in "Mortar".

b. Cold Applied Preformed Plastic Gaskets

Cold Applied Plastic Gaskets shall be suitable for sealing joints of tongue and groove concrete pipe. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes or obnoxious odors. The gasket joint sealer shall not depend on oxidizing, evaporating or chemical action for its adhesive or cohesive strength and shall be supplied in extruded rope form of suitable cross section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and sufficient to obtain squeeze-out around the joint. The gasket joint sealer shall be protected by a suitable removable wrapper that may be removed longitudinally without disturbing the joint sealer to facilitate application.

The chemical composition of the gasket joint sealing compound as shipped shall meet the following requirements:

Composition (% by weight)	Test Method	Typical Analysis
Bitumen (petroleum plastic content)	ASTM D 4	50-70
Ash-inert Mineral Water	Tex-526-C	30-50
Volatile Matter (at 325 F)	Tex-506-C	2.0 Maximum

The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in 5 percent solution of caustic potash, a mixture of 5 percent hydrochloric acid, a 5 percent solution of sulfuric acid and a saturated H₂S solution shall show no visible deterioration.

The physical properties of the gasket joint sealing compound as shipped shall meet the following requirements:

Property	Test Method	Typical Analysis	
		Minimum	Maximum
Specific Gravity at 77 F	ASTM D 71	1.20	1.35
Ductility at 77F (cm) Minimum	Tex-503-C	5.0	
Softening point	Tex-505-C	275 F	
Penetration:			
32 F (300 g) 60 sec	Tex-502-C	75	
77 F (150 g) 5 sec	Tex-502-C	50	120
115 F (150 g) 5 sec	Tex-502-C		150
Flashpoint C.O.C. F	Tex-504-C	600 F	
Fire Point C.O.C. F	Tex-504-C	625 F	

5. Bends

When horizontal or vertical angles in the alignment of storm sewers are indicated, the bend or angle shall be constructed by cutting on a bias one or both pipes as may be required for the alignment indicated. The pipe cut shall be sufficiently long to allow exposing the reinforcement, which shall be bent, welded and incorporated into the pipe bend and reinforced concrete collar to maintain the structural integrity. The collar shall be 6 inches minimum, reinforced with #4 bars on a 1 foot center both directions. Builder's hardware cloth may be used on the outside of the joint to aid in holding cementing materials in place. Plywood, fiberboard or other materials placed on the inside of the pipe as formwork shall be removed as soon as the joint materials have obtained initial set, after which the inside surface of the pipe joint shall be finished smooth and true to the line and grade established. The Contractor may use prefabricated bends meeting the specification requirements in lieu of field fabricated bends. All bends shall be watertight, have a smooth flow line and be equal or greater in strength to the adjacent pipe.

Horizontal or vertical changes in alignment in wastewater lines shall be accomplished by use of manholes. With the E/A's approval, horizontal changes in alignment may be made by the "Joint Deflection" method. Joint deflection is limited by regulations of the Texas Commission on Environmental Quality (TCEQ) to 80 percent of the maximum recommended by the manufacturer; such deflection may not exceed 5 degrees at any joint. Changes in alignment using pipe flexure shall not be allowed.

(d) Polyethylene Tubing

1. General

All polyethylene (PE) tubing shall meet the minimum requirements of the City of Pflugerville SPL Item "Polyethylene Tubing for Low Pressure Sewers". PE tubing shall be high density, high molecular weight plastic tubing meeting ASTM D2737, CTS-OD 1" through 2", made of PE 4710. PE tubing shall be solid green exterior and clear interior or solid green wall with contrasting-color heat-indented printline. Polyethylene tubing for reclaimed service lines shall be purple.

Only compression fittings recommended by the manufacturer may be used and only with stainless steel insert stiffeners.

2. Materials

Polyethylene plastics shall be Designation PE3408 (Grade P34 with hydrostatic design stress of 800 psi).

3. Markings

Permanent marking on the tubing shall include the following at intervals of not more than 5 feet:

Material

Nominal tubing size

Pressure rating for water

Dimension Ratio (SDR)

ASTM designation D2737

Manufacturer's name or trademark and code

Tubing test company

Date of manufacture (recognizable as a date)

Manufacturer's production code (including resin source, manufacturing location and extrusion line)

4. Tube Size

PE tubing shall be standard copper tube size outside diameter, with Standard Dimension Ratio (SDR) of 9.

(e) Copper Tubing

All copper service tubing shall be annealed seamless Type K water tube meeting ASTM B88 bearing a NSF/ANSI Standard 61 approval and rated at 150 psi working pressure. The tubing shall be homogenous throughout and free from cracks, holes, crimping, foreign inclusions or other defects. It shall be uniform in density and other physical properties. Copper tubing for reclaimed water shall be wrapped in purple polyethylene film wrap. Acceptable pipe manufacturers shall be listed on the City of Pflugerville SPL Item "Seamless Copper Tubing."

(f) Service Connection Fittings

All fittings used in customer service connection - tapping mains, connecting meters, etc. - must be currently listed on the applicable City of Pflugerville SPL Item, or called for in the City of Pflugerville Standard Details (520 - series).

(g) Brass Goods

All brass valves, couplings, bends, connections, nipples and miscellaneous brass pipe fittings and accessories used in meter connections, service lines, air release piping assemblies, and wherever

needed in the water distribution system, shall conform to the City of Pflugerville Standards, SPL Item "Brass Goods," and AWWA C-800, except as herein modified or supplemented.

Effective January 1, 2013, all brass goods purchased for the City shall be "lead free" and marked by stamping, etching, or casting "NL" in the main body or by the other methods acceptable to the City.

Exposed threads shall be covered with plastic caps or sheeting to protect the threads.

Brass goods of each type and class shall be compatible with other fittings in common usage for similar purposes. Where not otherwise indicated, all such materials shall meet the following requirements:

Inlet threads of corporation valves shall be AWWA iron pipe (IP) thread (male); outlets of service saddles shall be tapped with AWWA IP thread (female). AWWA IP threads shall conform to ANSI/ASME B1.20.1 as required by AWWA C800 for "General Purpose (Inch) Pipe Threads". For ¾" and 1" sizes only, corporation valve inlet threads, and the internal threads of saddles may be the AWWA taper thread conforming to AWWA C800 Figure 1 and Table 6. External threads of corporation valve inlet must be compatible with internal threads of the service saddle.

Connections of all new tubing, and of tubing repairs wherever possible, shall be made with approved grip type compression fittings. Compression connections shall be designed to provide a seal and to retain the tubing, without slippage, at a working water pressure of 150 psig.

Flanges shall conform to ANSI B16.1, Class 125, as to dimensions, drillings, etc. Copper tubing, when used, shall be Type K tubing having dimensions and weights given in Table A.1 of AWWA C800.

Brass pipe shall conform to the weights and dimensions for Extra Strong pipe given in Table A.2 of AWWA C800.

All fittings shall be suitable for use at hydrostatic working pressures up to 150 psig (hydrostatic testing of installed systems is at 200 psig).

(h) Polyethylene Encased Ductile Iron/Reclaimed Water Pipe

1. General

All ductile iron pipe for reclaimed water shall have linear low-density polyethylene (LLDPE) encasement meeting all the requirements of AWWA C105.

2. Applicable Specifications

Except as modified or supplemented herein, reclaimed water pipe shall meet the following standards:

AWWA C105

3. Material Requirements

All ductile iron pipe with polyethylene encasement shall meet the minimum requirements of the City of Pflugerville SPL Items "Ductile Iron Pipe & Fittings." Polyethylene encasement shall be a minimum thickness of 0.008 inches (8 mils) and be purple for reclaimed water.

4. Marking

Permanent marking on each joint of pipe shall include the following at intervals of not more than 5 feet:

- a) "Warning – Corrosion Protection – Repair any Damage,"
- b) Type of material (LLDPE is required),
- c) Minimum film thickness (0.008 inches or 8 mils is required)
- d) Year of manufacture,
- e) ANSI/AWWA/C105/A21.5,
- f) Applicable range of nominal pipe diameter sizes
- g) Manufacturer's name or trademark .

(i) Polyvinyl Chloride (PVC) Pipe (Nonpressure) and Fittings

1. General

All PVC pipe and fittings shall be from a single Manufacturer. The supplier shall be responsible for the provisions of all test requirements specified in ASTM D3034 or ASTM F789 and/or ASTM F758 as applicable. In addition, all PVC pipe to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by the City. The Contractor shall require the Manufacturer's cooperation in these inspections. The cost of plant inspection of all pipe approved for this Contract, plus the cost of inspection of disapproved pipe, will be borne by the Contractor.

Inspections of the pipe may also be made by the City or designated representative after delivery to the project site. The pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job site immediately.

Pipe and fittings shall be Type PSM, PVC SDR 26 with full diameter dimensions and shall conform to ASTM D3034, or Type PS-46 PVC conforming to ASTM F789, for sizes 4- through 15-inch, and conforming to ASTM F679 for sizes 18- through 27-inch. Straight pipe shall be furnished in lengths of not more than 13 feet and wyes shall be furnished in lengths no of not more than 3 feet. Saddle Wye will not be allowed. Pipe stiffness shall be at least 115 psi as determined by ASTM D 2412. Pipe manufacturers shall be on the City of Pflugerville SPL Item "PVC Gravity Sewer Pipe (6 to 27 inch Diameter)", and fitting manufacturers shall be on SPL Item "PVC Wastewater Line Fittings."

2. Joints

PVC pipe and fittings shall have bell and spigot push-on joints. The bell shall consist of an integral wall section with a solid cross-section elastomeric gasket securely locked in place to prevent displacement during assembly.

PVC pipe and fitting shall have elastomeric gasket joints conforming to ASTM D 3212. Gaskets shall conform to ASTM F 477.

3. Pipe Markings

Pipe meeting ASTM D 3034 shall have permanent marking on the pipe that includes the following at intervals of not more than 5 feet:

- a) Manufacturer's name and/or trademark and code.
- b) Nominal pipe size.
- c) The legend "SDR-__ PVC Sewer Pipe" (SDR 26, 23.5. or less is required)
- d) The designation "ASTM D 3034"
- e) Pipe meeting ASTM F 679 shall have permanent marking that includes the following at intervals of not more than 5 feet:
- f) Manufacturer's name or trademark and code
- g) Nominal pipe size
- h) PVC cell classification per ASTM D 1784
- i) Pipe stiffness designation "PS __ PVC Sewer Pipe" (PS of at least 72 is required)
- j) The designation "ASTM F 679"

4. Fitting Markings

- a) Fittings meeting ASTM D 3034 shall have permanent marking that includes the following:
- b) Manufacturer's name or trademark
- c) Nominal size
- d) The material designation "PVC"
- e) The designation, "ASTM F 679"
- f) Fittings meeting ASTM F 679 shall have permanent marking that includes the following:
- g) Manufacturer's name or trademark and code
- h) Nominal size
- i) The material designation "PVC"
- j) The designation "ASTM F 679"

5. Tracer Tape

Inductive Tracer Detection Tape shall be placed directly above the centerline of all non-metallic pipe a minimum of 12 inches below subgrade or, in areas outside the limits of pavement, a minimum of 18 inches below finished grade. The tracer tape shall be encased in a protective, inert, plastic jacket and color coded according to American Public Works Association Uniform Color Code. Except for minimum depth of cover, the tracer tape shall be placed according to manufacturer's recommendations. Manufacturers must be listed on SPL WW-597.

510.3 - Construction Methods

1) General

Prior to commencing this Work, all erosion control and tree protection measures required shall be in place and all utilities located and protected as set forth in the City of Pflugerville Tree Technical Manual: Standards & Specifications and/or in the Drawings. Clearing the site shall conform to Item No. 102S, "Clearing and Grubbing". Maintenance of environmental quality protection shall comply with all requirements of Specification Item No. 601S, "Salvaging and Placing Topsoil".

The Contractor shall work such that a reasonable minimum of disturbance to existing utilities will result. Particular care shall be exercised to avoid the cutting or breakage of all existing utilities. If at any time the Contractor's operations damage the utilities in place, the Contractor shall immediately notify the owner of the utility to make the necessary repairs. Where existing utilities are damaged, they shall be replaced with material equal to or better than the existing material. When active wastewater sewer lines are cut in the trenching operations, the Contractor shall provide all labor, equipment and materials necessary to maintain existing flows, including temporary diversion and all pumping of sewage that may be required to prevent backing up of the wastewater lines, and shall immediately remove all offensive material at his/her own expense. A detailed written plan of all methods of flow maintenance shall be submitted to the City 10 days in advance of flow interruption. The Contractor shall not be permitted to overflow, bypass, pump or by any other means convey sewage to any stream or water course.

The Contractor shall inform utility owners sufficiently in advance of the Contractor's operations to enable such utility owners to reroute, provide temporary detours or to make other adjustments to utility lines in order that the Contractor may Work with a minimum of delay and expense. The Contractor shall cooperate with all utility owners concerned in effecting any utility adjustments necessary and shall not hold the City liable for any expense due to delay or additional Work because of conflicts arising from existing utilities.

The Contractor shall do all trenching in accordance with the provisions and the directions of the City as to the amount of trench left unfilled at any time. All excavation and backfilling shall be accomplished as indicated and in compliance with State Statutes.

Where excavation for a pipe line is required in an existing City street, a street cut permit is required and control of traffic shall be as indicated in accordance with the Texas Manual on Uniform Traffic Control Devices.

Wherever existing utility branch connections, sewers, drains, conduits, ducts, pipes or structures present obstructions to the grade and alignment of the pipe, they shall be permanently supported, removed, relocated or reconstructed by the Contractor through cooperation with the owner of the utility, structure or obstruction involved. In those instances where their relocation or reconstruction is impractical, a deviation from line and grade will be ordered by the City and the change shall be made in the manner directed.

Adequate temporary support, protection and maintenance of all underground and surface utility structures, drains, sewers and other obstructions encountered in the progress of the Work shall be furnished by, and at the expense of, the Contractor and as approved by the City.

Where traffic must cross open trenches, the Contractor shall provide suitable bridges in conformance with Standard Detail 804S-4. Adequate provisions shall be made for the flow of sewers; drains and watercourses encountered during construction and any structures, which may have been disturbed, shall be satisfactorily restored upon completion of Work.

When rainfall or runoff is occurring or is forecast by the U.S. Weather Service, the Contractor shall not perform or attempt any excavation or other earth moving Work in or near the flood plain of any stream or watercourse or on slopes subject to erosion or runoff, unless given specific approval by the City. When

such conditions delay the Work, an extension of time for working day contracts will be allowed in accordance with "General Conditions".

2) Water Line/New Wastewater Line Separation

Water lines shall maintain a minimum of 18 inches vertical separation from all other utilities. When 18 inches separation is not attainable, encasement of water lines is required.

The separation between wastewater mains and other utilities shall be in accordance with the Rules adopted by the Texas Commission on Environmental Quality.

Crossings of water, reclaimed water, and wastewater lines shall conform to details in the Drawings.

Wastewater manholes within 9 feet of water and reclaimed water lines shall be made watertight according to details in the Drawings.

3) Utility and Storm Sewer Crossings

When the Contractor installs a pipe that crosses under a utility or storm sewer structure and the top of the pipe is within 18 inches of the bottom of the structure, the pipe shall be backfilled as shown in the Drawings. When the Contractor installs a pipe that crosses under a utility or storm sewer structure that is not shown in the Drawings, the pipe shall be backfilled as directed by the City. Payment for backfilling pipe at utility or storm sewer structures not shown in the Drawings shall be by Change Order.

4) Trench Excavation

Excavation in a paved street shall be preceded by saw cutting completely through any asphaltic cement concrete or Portland cement concrete surface, base, or subbase to the underlying subgrade to a width 2 feet wider than the trench itself.

Underground piped utilities shall be constructed in an open cut in accordance with Federal regulations, applicable State Statutes conforming to Specification Item No. 509S, "Excavation Safety Systems" and with a trench width and depth described below. The sides of all excavation shall be cut as nearly vertical as possible. When pipe is to be constructed in fill above the natural ground, Contractor shall construct embankment to an elevation not less than one foot above the top of the pipe, after which trench is excavated. Required vertical sides shall be sheeted and braced as indicated to maintain the sides of the required vertical excavation throughout the construction period. Adequacy of the design of sheeting and bracing shall be the responsibility of the Contractor's design professional. The Contractor shall be responsible for installation as indicated. After the pipe has been laid and the backfill placed and compacted to 12 inches above the top of the pipe, any sheeting, shoring and bracing required may be removed with special care to insure that the pipe is not disturbed. As each piece of sheeting is removed, the space left by its removal must be thoroughly filled and compacted with screened material and the screened material shall be re-compacted to provide uniform support for the pipe. As each piece of sheeting is removed, provisions made to prevent the sides of the trench from caving until the backfill has been completed. Any sheeting left in place will not be paid for and shall be included in the unit price bid for pipe.

5) Trench Width

Trenches for water, reclaimed, and wastewater lines shall have a clear width on each side beyond the outside surfaces of the pipe not less than 18 inches plus the outside diameter of the pipe, and the maximum width shall be not more than 24 inches plus the outside diameter of the pipe, measured at an elevation in the trench which is 12" above the top of pipe when it is laid to grade.

Trenches for Storm Sewers up to 42 inches shall have a width of 1 foot on each side beyond the outside surfaces of the pipe. Pipes more than 42 inches shall have a trench width not to exceed 18 inches on each side beyond the outside surfaces of the pipe.

If the trench width within the pipe zone exceeds this maximum, the Contractor shall use class embedment or encasement required by the City to provide load carrying capacity for the trench width as actually cut, and the additional cost incurred will be borne by the Contractor. Excavation along curves and bends shall be so oriented that the trench and pipe are approximately centered on the centerline of the curve, using short lengths of pipe and/or bend fittings if necessary.

For all utilities to be constructed in fill above natural ground, the embankment shall first be constructed to an elevation not less than 1 foot above the top of the utility after which excavation for the utility shall be made.

6) Trench Depth and Depth of Cover

All pipe and in-line appurtenances shall be laid to the grades indicated. The depth of cover shall be measured from the established finish grade, natural ground surface, subgrade for staged construction, street or other permanent surface to the top or uppermost projection of the pipe.

(a) Where not otherwise indicated, all potable/reclaimed water piping shall be laid to the following minimum depths:

- Potable/reclaimed water piping installed in undisturbed ground in easements of undeveloped areas, which are not within existing or planned streets, roads or other traffic areas shall be laid with at least 42 inches of cover.
- Potable/reclaimed water piping shall be laid with at least 42 inches of cover below finish grade and measured from either the top of the pipe or valve actuating nut (whichever is applicable) to the finished ground surface.
- Unless approved by the City, installation of potable/reclaimed water piping in proposed new streets will not be permitted until paving and drainage plans have been approved and the roadway traffic areas excavated to the specified or standard paving subgrade, with all parkways and sidewalk areas graded according to any applicable provisions of the drainage plans or sloped upward from the curb line to the right-of-way line at a minimum slope of $\frac{1}{4}$ inch per foot. Piping and appurtenances installed in such proposed streets shall be laid with at least 48 inches of cover below the actual subgrade.

(b) Where not otherwise indicated, all wastewater piping shall be laid to the following minimum depths:

- Wastewater piping shall be laid with at least 48 inches of cover below actual subgrade.

7) Classification of Excavation

Excavation will not be considered or paid for as a separate item of Work, so excavated material will not be classified as to type or measured as to quantity. Full payment for all excavation required for the construction shall be included in the various unit or lump sum Contract prices for the various items of Work installed, complete in place. No extra compensation, special treatment or other consideration will be allowed due to rock, pavement, caving, sheeting and bracing, falling or rising water, working under and in the proximity of trees or any other handicaps to excavation.

8) Dewatering Excavation

Underground piped utilities shall not be constructed, or the pipe laid, in the presence of water. All water shall be removed from the excavation prior to the pipe placing operation to ensure a dry firm granular bed on which to place the underground piped utilities and shall be maintained in such unwatered condition until all concrete and mortar is set. Removal of water may be accomplished by bailing, pumping or by a well-point installation as conditions warrant. Provisions shall be made for the satisfactory disposal of surface water pumped, so as to prevent damage to public or private property. The Contractor shall be responsible for maintaining safe working conditions and suitable construction techniques.

In the event that the excavation cannot be dewatered to the point where the pipe bedding is free of mud, a seal shall be used in the bottom of the excavation. Such seal shall consist of Class B concrete, conforming to Item No. 403, "Concrete for Structures", with a minimum depth of 3 inches.

9) Trench Conditions

Before attempting to lay pipe, all water, slush, debris, loose material, etc., encountered in the trench must be pumped or bailed out and the trench must be kept clean and dry while the pipe is laid and backfilled. Where needed, sump pits shall be dug adjoining the trench and pumped as necessary to keep the excavation dewatered.

Backfilling shall closely follow pipe laying so that no pipe is left exposed and unattended after initial assembly. All open ends, outlets or other openings in the pipe shall be protected from damage and shall

be properly plugged and blocked watertight to prevent the entrance of trench water, dirt, etc. The interior of the pipeline shall at all times be kept clean, dry and unobstructed.

Where the soil encountered at established footing grade is a quicksand, saturated or unstable material, the following procedure shall be used unless other methods are indicated:

Unsuitable material shall be removed to such a depth that a stable foundation is achieved by replacing the unsuitable material with tamped gravel, brought to the bottom of bedding. Gravel used shall be washed gravel or crushed stone and may fit any gradation of size up to 3 inches in accordance with Section 510S.3(14) herein. The particular gradation shall take into consideration the actual field conditions. Gravel shall be placed across the entire trench width in uniform layers not to exceed 6 inches, loose measure and compacted by mechanical tamping or other means which shall provide a stable foundation for the utility.

Forms, sheathing and bracing, pumping, additional excavation and backfill required in unstable trench conditions shall be included in the unit price bid for pipe.

10) Blasting

Blasting is not permitted.

11) Removing Old Structures

When out of service masonry structures or foundations are encountered in the excavation, such obstructions shall be removed for the full width of the trench and to a depth of 1 foot below the bottom of the trench. When abandoned inlets or manholes are encountered and no plan provision is made for adjustment or connection to the new sewers, such manholes and inlets within the construction limits shall be removed completely to a depth 1 foot below the bottom of the trench. In each instance, the bottom of the trench shall be restored to grade by backfilling and compacting by the methods provided above. Where the trench cuts through storm or wastewater sewers which are known to be abandoned, these sewers shall be cut flush with the sides of the trench and blocked with a concrete plug in a manner satisfactory to the E/A. When old structures are encountered, which are not visible from the existing surface and are still in service, they shall be protected and adjusted as required to the finished grade.

12) Lines and Grades

Grades, lines and levels shall conform to the General Conditions and/or "Grades, Lines and Levels". Any damage to the above by the Contractor shall be re-established at the Contractor's expense. The Contractor shall furnish copies of all field notes and "cut sheets" to the City.

The location of the lines and grades indicated may be changed only by direction of the City. It is understood that the Contractor will be paid for Work actually performed on the basis of the unit Contract prices and that the Contractor shall make no claim for damages or loss of anticipated profits due to the change of location or grade.

All necessary batter boards or electronic devices for controlling the Work shall be furnished by, and at the expense of, the Contractor. Batter boards shall be of adequate size material and shall be supported substantially. The boards and all location stakes must be protected from possible damage or change of location. The Contractor shall furnish good, sound twilled lines for use in achieving lines and grades and the necessary plummets and graduated poles.

Within 14 days of the Notice to Proceed, the Contractor shall submit to the City at least 6 copies of any layout Drawings from the pipe manufacturer for review and approval. The Contractor shall submit the layout Drawings at least 30 days in advance of any actual construction of the project. The City will forward all comments of the review to the Contractor for revision. Revisions shall be made and forwarded to the City for acceptance. Prior to commencement of the Project, reviewed layout Drawings will be sent to the Contractor marked for construction.

Should the Contractor's procedures not produce a finished pipe placed to grade and alignment, the pipe shall be removed and relaid and the Contractor's procedures modified to the satisfaction of the E/A. No additional compensation shall be paid for the removal and relaying of pipe required above.

13) Surplus Excavated Materials

Excess material or material which cannot be made suitable for use in embankments will be declared surplus by the City and shall become the property of the Contractor to dispose of off-site at a permitted fill site, without liability to the City or any individual. Such surplus material shall be removed from the Work site promptly following the completion of the portion of the utility involved.

14) Pipe Bedding Envelope

Pipe shall be installed in a continuous bedding envelope of the type shown on the drawings or as described herein. All embedment material shall be free from grass, roots, vegetation, and other deleterious materials. The bedding shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the bedding under the haunches of the pipe and into the bell holes to give a firm continuous support for the pipe. The envelope shall extend the full trench width, to a depth of at least 6 inches below the pipe and to a depth of the springline of storm water pipe and at least 12 inches above water, reclaimed, and wastewater pipe.

(a) Standard Bedding Materials

Sieve Size	3/8" F (% Retained)	1/2" D (% Retained)	Washed Gravel (% Retained)
1/2"	0	0	0
3/8"	0-2	5-25	--
4m	40-85	80-100	--
10m	95-100	96-100	--
3/4"	--	--	100

(b) General requirements and limitations governing bedding selection.

- (1) Crushed gravel or crushed stone shall not be used with polyethylene tubing or polyethylene film wrap.
- (2) Uncrushed gravel may be used with polyethylene film wrap in trenches up to 6 feet deep and in deeper trenches where ample trench width, a tremmie, or conditions will allow controlled placement of the gravel without damaging the polyethylene wrap.
- (3) Bedding shall be placed in lifts not exceeding 8 inches loose thickness and compacted thoroughly with hand tamping to provide uniform support for the pipe barrel and to fill all voids around the pipe.

(c) Requirements to prevent particle migration.

Bedding material shall be compatible with the materials in the trench bottom, walls and backfill so that particle migration from, into or through the bedding is minimized. The City may require one or more of the following measures to minimize particle migration: use of impervious cut-off collars; selected bedding materials; filter fabric envelopment of the bedding; cement stabilized backfill; or other approved materials or methods. Measures to minimize particle migration will be shown on the Drawings or designated by the City, and, unless provisions for payment are provided in the contract documents, the cost of these measures shall be agreed by change order. The following limitations shall apply.

- (1) Sand, alone, shall not be used.
- (2) Pea gravel or bedding stone, alone, shall not be used in the street right-of-way within 5 feet of subgrade elevation in trenches that are 3 feet or wider.
- (3) Each gravel or bedding stone, alone, shall not be used where the trench bottom, sides, or backfill is composed of non-cementitious, silty or sandy soils having plasticity indices less than 20, as determined by the City.
- (4) For concrete storm water pipe, uncrushed gravel, crushed gravel, crushed stone, or combination thereof is used for pipe bedding material, a geotextile filter fabric shall be placed around the perimeter of the joint.

15) Laying Pipe

Care shall be taken in loading, transporting and unloading to prevent injury to the pipe, lining or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe linings or coatings shall be repaired as directed by the City. Handling and laying of pipe and fittings shall be in accordance with the Manufacturer's instruction and as specified herein.

No pipe shall be installed in the trench until excavation has been completed, the bottom of the trench graded, and the trench completed as indicated.

No debris shall remain in the drainways or drainage structures.

All recommendations of the manufacturer shall be carefully observed during handling and installation of each material. Unless otherwise indicated, all materials shall be delivered to the project by the manufacturer or agent and unloaded as directed by the Contractor. Each piece shall be placed facing the proper direction near to where it will be installed.

The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign matter at all times and stored in a manner that will protect them from damage. Stockpiled materials shall be stacked so as to minimize entrance of foreign matter. The interior of all pipeline components shall be clean, dry and unobstructed when installed. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plugs or other approved means.

Piping materials shall not be skidded or rolled against other pipe, etc. and under no circumstances shall pipe, fittings or other accessories be dropped or jolted.

During handling and placement, materials shall be carefully observed and inspected, and any damaged, defective or unsound materials shall be marked, rejected and removed from the job site. The City or designated representative may examine the bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Minor damage shall be marked and repaired in a manner satisfactory to the City. Any pipe or fittings discovered to be defective after laying shall be removed and replaced with a sound piece. Joints, which have been placed, but not joined, backfilled, etc., shall be protected in a manner satisfactory to the City.

16) Assembling of Pipe

No single piece of pipe shall be laid unless it is generally straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the Site and the cost shall be borne by the Contractor. Laying instructions of the manufacturer shall be explicitly followed.

Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched to conform to the required grade. The pipe shall not be driven down by striking it.

Joints shall not be "pulled" or "cramped." Angular spacing of all joints shall meet the manufacturer's recommendations for the pipe and accessories being used. Side outlets shall be rotated so that the operating stems of valves shall be vertical when the valves are installed. Pressure pipe shall be laid with bell ends facing the direction of pipe installation. Pipe end bells shall be placed upgrade for all wastewater lines.

Orientation marks, when applicable, shall be in their proper position before pipe is seated.

Before joining any pipe, all foreign matter, lumps, blisters, excess coal tar coating, oil or grease shall be removed from the ends of each pipe and the pipe ends shall then be wire brushed and wiped clean and dry. Pipe ends shall be kept clean until joints are made.

Every precaution shall be taken to prevent foreign material from entering the pipe during installation. No debris, tools, clothing or other materials shall be placed in the pipe.

17) Joints

Pipes shall be jointed in accordance with recommendations of the latest ASTM Standards and detailed instructions of the manufacturer.

(a) Mortar (Storm Drain joints only)

Pipe ends shall be clean, free of asphalt or other contaminants, which will inhibit the bond of the mortar to the pipe. The pipe ends shall be moistened immediately prior to placing the mortar in the joint.

(b) Cold Applied Preformed Plastic Gaskets (Storm Drain joints only)

The pipe ends shall be clean and the joint material applied to the dry pipe. In cold weather, the joint material shall be heated to facilitate the seal of the joint.

(c) O-Ring and Push-on Joints

Pipe shall be laid with bell ends in the direction of trenching. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be laid shall then be aligned and inserted in the bell of the pipe to which it is to be joined and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

Pipe shall be laid with bell ends in the direction of trenching. Just before making a joint the ends of the pipe shall be clean, dry, free of any foreign matter, lump blisters, excessive coal tar coating and grease or oil and shall be wire brushed. The gasket and the inside surface of the bell shall be lubricated with a light film of soft vegetable soap compound (Flax Soap) to facilitate telescoping the joints. The rubber gasket if not factory installed shall be stretched uniformly as it is placed in the spigot groove to insure a uniform volume of rubber around the circumference of the groove. The plain end of the pipe to be laid shall then be aligned and inserted in the bell of the pipe to which it is to be joined and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located. material shall be placed and tamped against pipe to secure the joint. Care should be taken to prevent dirt or foreign matter from entering the joint space.

Push-on joints for DI pipe shall be made in accordance with AWWA C111 and the Manufacturer's instructions.

(d) Bolted Joints

All flanged, mechanical or other bolted joints shall be joined with nuts and bolts and be coated as indicated above in Iron Pipe.

(e) Storm Drain Joints

Storm drain joints sealed with preformed flexible joint sealants shall be provided and installed in compliance with ASTM C990. Storm drain joints sealed with rubber gaskets shall comply with ASTM C443 Install joint sealants in accordance with the pipe and joint sealant manufacturers' recommendations. Place the joint sealer so that no dirt or other deleterious materials come in contact with the joint sealing material. Pull or push home the pipe with enough force to properly seal the joint with the final joint opening (gap) on the inside of the installed pipe being less than or equal to the pipe manufacturer's recommended dimensions. Protrusion of joint material greater than 1/8 " into the interior of the pipe will not be accepted. Excess joint material will be removed to within 1/8 " of pipe surface. Observe joint sealant manufacturer's recommendations for installation temperature of the joint sealant. Apply joint sealant to pipe joint immediately before placing pipe in trench, and then connect pipe to previously laid pipe.

If inspection (video or other means) reveal C-990 joints that show signs of backfill infiltration, or where joints or conduits exhibit excessive joint gap or are otherwise defective, then the contractor has the following options:

1. Conduits less than 36-inches in any dimension: pour a concrete collar around the joint or wrap joint with a wrap meeting requirements of ASTM C-877 or approved equal.
2. Conduits greater than or equal to 36-inches in all dimensions: repair joints using joint repair techniques recommended by the manufacturer to achieve a completed system that meets all Contract requirements.

18) Placing Pipe in Tunnels

Piping installed as a carrier pipe in a tunnel, encasement pipe, etc., shall have uniform alignment, grade, bearing and conform to the reviewed Shop Drawings. All necessary casing spacers, bedding material, grout cradle or paving, bracing, blocking, etc., as stipulated by the Contract or as may be required to provide and maintain the required pipe alignment and grade, shall be provided by the Contractor at no cost except as provided by the Bid Items. This shall include casing spacers acceptable to the Owner attached to the carrier pipe in accordance with the manufacturer's recommendations. The insertion pushing forces shall not exceed the pipe manufacturer's recommendation. Such carrier piping shall have flexible bolted or gasketed push-on joints or Concrete Steel Cylinder pipe installed as follows:

(a) 21 Inch Pipe and Smaller

Prior to placing the pipe in the tunnel, the inside joint recess at the bell shall be buttered with cement mortar.

After the joint is engaged, the excess mortar shall be smoothed by pulling a tight fitting swab through the joint. Cement mortar protection shall then be placed in the normal manner to the exterior of the joint and allowed to harden sufficiently to avoid dislodgment during installation. If time is of the essence, a quick setting compound may be used.

(b) 24 Inch Pipe and Larger

Each length of pipe shall be pushed into the tunnel as single units. A flexible mastic sealer shall be applied to the exterior of the joint prior to joint engagement. The surfaces receiving the mastic sealer shall be cleaned and primed in accordance with the manufacturer's recommendation. Sufficient quantities of the mastic sealer shall be applied to assure complete protection of all steel in the joint area. The interior of the joint shall be filled with cement mortar in the normal manner after the pipe is in its final position within the tunnel.

19) Temporary Pipe Plugs, Caps, Bulkheads and Trench Caps

Temporary plugs, caps or plywood bulkheads shall be installed to close all openings of the pipe and fittings when pipeline construction is not in progress.

All temporary end plugs or caps shall be secured to the pipe as provided under Item No. 507, "Bulkheads".

The City may require a trench cap to be installed where 42-inch minimum cover cannot be obtained, or due to potential surface loading. Trench caps shall have a compressive strength of 2,000 psi at 28 days.

20) Corrosion Control

(a) Protective Covering

Unless otherwise indicated, all flanges, nuts, bolts, threaded outlets and all other iron or steel components buried and in contact with earth or backfill shall be wrapped with 8-mil (minimum) polyethylene film meeting ANSI/AWWA C-105 to provide a continuous wrap.

21) Pipe Anchorage, Support and Protection

Pressure pipeline tees, plugs, caps and bends exceeding 22½ degrees; other bends as directed shall be securely anchored by suitable concrete thrust blocking or by approved metal harness. Unless otherwise indicated, on 24 inch or larger piping, all bends greater than 11 ¼ degrees shall be anchored as described herein.

Storm sewers on steep grades shall be lugged as indicated.

(a) Concrete Thrust Blocking

Concrete for use as reaction or thrust blocking shall be Class B (2,500 psi) conforming to Item No. 403, "Concrete for Structures".

Concrete blocking shall be placed at each change in direction in the pipeline, in a manner as will substantially brace the pipe against undisturbed trench walls with adequate space and bearing area for the concrete. Concrete blocking shall be placed between solid ground and the fitting to be anchored. The area of bearing on the pipe and on the ground shall be as indicated on the Drawings or as directed by the City. In no event shall the concrete blocking be less than those shown in the

Drawings. The blocking shall, unless otherwise indicated, be so placed that the pipe, fittings and joints will be accessible for repair.

At all points where wet connections are made to existing lines, the existing lines shall be adequately blocked and the tapping connection fittings shall be supported by blocking up to the spring line with Class B concrete.

Concrete blocking made from Type I cement shall have been in place for 4 days prior to testing the pipeline as herein specified. Tests may be made two days after completion of blocking if Type III cement is used.

The pipe and fittings shall be adequately weighted and laterally braced to prevent floating, shifting or straining of the pipeline while the concrete is being placed and taking initial set. The Contractor shall be solely responsible for the sufficiency of such restraints.

(b) Metal Thrust Restraint

Fabricated thrust restraint systems such as those described below may be approved for use instead of concrete blocking. To obtain approval, the project Drawings must include sufficient drawings, notes, schedules, etc., to assure that the proposed restraints as installed will be adequate to prevent undesirable movement of the piping components. Such restraint systems may only be used where and as specifically detailed and scheduled on approved Project Drawings.

1. Thrust Harness

A metal thrust harness of tie rods, pipe clamps or lugs, turnbuckles, etc., may be approved. All carbon steel components of such systems, including nuts and washers, shall be hot-dip galvanized; all other members shall be cast ductile iron. After installation, the entire assembly shall be wrapped with 8-mil polyethylene film, overlapped and taped in place with duct tape to form a continuous protective wrap.

2. Restrained Joints

Piping or fitting systems utilizing integral mechanically restrained joints may be approved for DI pipe sizes 4 inch through 16 inch or for 4 inch through 12 inch PVC (AWWA C900) pipe. Mechanically restrained joint devices shall be one of the following:

- a) Wedge-action lug type mechanical joint (MJ) retainer glands,
- b) Split, full-circle grip-ring type with High Strength Low Alloy (HSLA) threaded thrust rods and nuts and stainless steel clamping bolts and nuts, or
- c) Single-piece, solid-body, bolt-through type.

Manufacturers of pipe with restrained joints integral to the pipe shall be listed on the City of Pflugerville SPL Items "Joint Restraint Devices, 4 Inch through 16 Inch Diameter" and "Joint Restraint Gaskets for Ductile Iron Pipe (4 Inch through 16 Inch)." All pipe and fitting systems with restrained joints shall be identified by applying an adhesive-backed warning tape to the top of the pipe and for the full length of the pipe, regardless of the type of pipe. For plastic pipes the warning tape shall be applied directly to the top of the pipe. For metal pipes and fittings the warning tape shall be applied to the top of the polyethylene film wrap. The warning tape shall conform to 510.2(8)(b)5.

For PVC applications, restraint devices shall have the working pressure rating that equals or exceeds the pressure of the pipe, fittings or valves on which they are used. For DI pipe applications, restraint devices shall be suitable for 250 psi working pressure and be fabricated of heavy section ductile iron casting, and bolts and nuts shall be low carbon steel conforming to ASTM, Grade B.

Location, configuration and description of such products shall be specifically detailed on the Drawings. (Add-on attachments such as retainer glands, all-thread rods, etc., are not acceptable.)

(c) Concrete Encasement, Cradles, Caps and Seals

When trench foundation is excessively wet or unstable or installation of water or wastewater pipe will result in less than 42 inches of cover, Contractor shall notify the City. The City may require Contractor to install a concrete seal, cradle, cap, encasement or other appropriate action.

All concrete cap, etc., shall be continuous and begin and end within 6 inches of pipe joints. Concrete cap, cradle and encasement shall conform to City of Pflugerville Standard No. 510S-1, "Concrete Trench Cap". The pipe shall be well secured to prevent shifting or flotation while the concrete is being placed.

Concrete embedment and encasement and cap shall have a minimum compressive strength of 2,000 pounds per square inch at 28 days.

Dry mix will not be permitted. The concrete cushion portion of the embedment or encasement will be mixed moist or damp to give a slump of not more than one (1) inch. Concrete for the sides and top, if specified, shall be mixed to obtain a slump of not less than one (1) inch or more than three (3) inches.

After pipe joints are completed, the voids at the joints in the embedment section shall be filled with concrete, and the embedment shall be brought up to proper grade. Where concrete is placed over or along the pipe, it shall be placed in such a manner as not to damage or injure the joints or displace the pipe. Care shall be taken in the placement of concrete to assure that a uniform pad, free of voids and of specified thickness, is constructed under the entire pipe section.

A cleavage line between the base concrete and the side embedment concrete will not be allowed. Backfilling shall be done in a careful manner and at such time, after concrete embedment or encasement has been placed, as not to damage the concrete in any way.

(d) Anchorage Bulkheads

Concrete bulkheads keyed into the undisturbed earth shall be placed as indicated to support and anchor the pipe and/or backfill against end thrust, slippage on slopes, etc. Concrete material and placement shall be Class A, Item No. 403, "Concrete for Structures".

22) Wastewater Connections

(a) Connections to Mains 12 Inches and Smaller

All branch connections of new main lines shall be made by use of manholes.

Service stubs shall be installed as indicated. Minimum grade shall be 0.33% percent downward to main and minimum cover shall be 4½ feet at the curb. Standard plugs shall be installed in the dead end before backfilling.

Where a service connection to a main 12 inches or smaller is indicated, a wye, tee or double wye shall be installed.

Where water pressures are determined to be above 80 psi, service connections shall incorporate individual pressure reducing valves (PRV).

Where a service connection to a main 15 inches or larger is indicated, a field tap may be made with the pipes installed crown to crown. The tap should be made conforming to the pipe manufacturer's recommendations with the City's approval.

Where not otherwise indicated, (wastewater) service connections shall be installed so that the outlet is at an angle of not more than 45 degrees above horizontal at the main line.

(b) Connections to the Existing System

Unless otherwise specified by the City, all connections made to existing mains shall be made at manholes with the crown of the inlet pipe installed at the same elevation as the crown of the existing pipe. Service stubs installed on the existing system shall be installed by use of tapping saddles unless otherwise approved by the City. Extreme care shall be exercised to prevent material from depositing in the existing pipe as the taps are being made.

When connections to existing mains are made, a temporary plug approved by the City must be installed downstream in the manhole to prevent water and debris from entering the existing system before Final Completion. These plugs shall be removed after the castings are adjusted to finish grade or prior to Final Completion. The Contractor shall supply all materials, equipment and labor required for plugging existing wastewater lines. Should damage of any kind occur to the existing

wastewater line, the Contractor shall, at his/her own expense, make repairs to the satisfaction of the City.

The Contractor shall provide all labor, equipment and materials necessary to maintain existing flows, including temporary diversions and all pumping of sewage that may be required to prevent backup of wastewater lines and shall immediately remove all offensive matter at his/her expense. The Contractor shall not be permitted to overflow, bypass, pump or by any other means convey sewage into any stream or other water course. All procedures for maintaining flows must meet the approval of the City. The Contractor shall be required to submit to the City, for approval, a detailed plan of all method of flow maintenance 10 days in advance of flow interruption.

The Contractor shall notify the City of any discrepancies in elevations of the existing wastewater lines and manholes between those shown on the Drawings and those established during construction so that the City can make the necessary modifications.

(c) Connecting Existing Services to New Mains

Where wastewater services currently exist and are being replaced from the main to the property line, those services shall be physically located at the property line prior to installing any new mains into which the services will be connected. Where wastewater services currently exist but are not being replaced to the property line, those services shall be physically located at the point of connection between the new and existing pipes prior to installing any new mains into which the services will be connected.

23) Potable Water System Connections

All necessary connections of new piping or accessories to the existing potable or reclaimed water system shall be made by, and at the expense of, the Contractor. To minimize any inconvenience from outages, the Contractor shall schedule all such connections in advance and such schedule must be approved by the City before beginning any Work. In each case, when work is started, it shall be prosecuted expeditiously and continuously until completed.

(a) Shutoffs

The City will make all shutoffs on existing potable water mains. The Contractor shall be required to notify the Owner's Representative in writing a least twenty five (25) Calendar Days prior to the anticipated date for a wet-connection. The Owner's Representative is defined as the City Inspector. The Owner's Representative will notify any affected utility customers at least 48 hours prior to the shutoff. The City of Pflugerville Water Department will make the shutoff after ensuring that all appropriate measures have been taken to protect the potable water system, customers and employees.

The City will operate all valves to fill existing mains. Where a newly constructed main has not been placed in service and has only one connection to the potable or reclaimed system, the Contractor may operate one valve to fill the main after approval has been obtained from AW. The operation of the valve is to be conducted under the immediate supervision of the Owner's Representative.

(b) Wet Connections to Existing Potable Water System

The Contractor shall make all wet connections called for by the Contract or required to complete the Work. Two connections to an existing line performed during the same shutout, at the same time and at a distance less than 50 linear feet apart, will be considered one wet connection. Two connections to an existing line performed during the same shutout, at the same time and at a distance equal to, or greater than 50 linear feet will be considered two wet connections. A wet connection shall include draining and cutting into existing piping and connecting a new pipeline or other extension into the existing pressure piping, forming an addition to the potable water transmission and distribution network.

To prevent contamination of the potable water system from stagnant water in dead end potable water service lines (e.g., private fire systems, private fire mains, sections for future use, etc.), the installation of an approved backflow prevention assembly is required on the private side of the City water meter. If the dead end potable water service line is unmetered, then an approved detector backflow prevention assembly is required at a point on the dead end potable water service line where no more than 100 gallons of water volume in the service line is reached. The 100 gallon threshold is determined by calculating the volume of water that would be contained in the service line as

measured from the connection to the City's water main and the location of the approved backflow prevention assembly.

The Contract price for wet connections shall be full payment for all necessary shutoffs, excavation, removing plugs and fittings, pumping water to drain the lines, cutting in new fittings, blocking and anchoring piping, bedding and backfilling, placing the lines and service and all site cleanup.

No water containing detectable amounts of chlorine may be drained, released or discharged until specific planning and appropriate preparations to handle, dilute and dispose of such chlorinated water are approved in advance by the City and the disposal operations will be witnessed by an authorized representative from the City.

(c) Pressure Taps to Existing Potable Water System

The Contractor shall make all pressure taps called for by the Contract Documents or required to complete the Work. A pressure tap shall consist of connecting new piping to the existing potable water system by drilling into the existing pipe while it is carrying water under normal pressure without taking the existing piping out of service.

Unless otherwise provided by the Contract, the Contractor shall, at the Contractor's expense, perform all necessary excavation, furnish and install the tapping sleeve, valve and accessories, provide the tapping machine, drill the tap and shall block, anchor and backfill the piping, valve and all accessories, place the new piping in service and perform all site cleanup. When the City makes the tap, City forces are not obligated or expected to perform any Work except to provide tapping machine and drill the actual hole. If City crews are to make the tap, fiscal arrangements must be made in advance at the Taps Office, Waller Creek Center, 625 East 10th Street.

If a private Contractor makes the tap, a City Inspector or designated representative must be present. "Size on size" taps will not be permitted, unless made by use of an approved full bodied mechanical joint tapping sleeve. Concrete blocking shall be placed behind and under all tap sleeves 24 hours prior to making the wet tap.

(d) Service Connections

Service connection taps into PVC or DI pipe 12 inches or smaller shall be made using either a service clamp or saddle or a tapping sleeve as recommended by the pipe manufacturer and as approved by the City. Direct tapping of these pipes will not be permitted.

All potable water service connections shall be installed so that the outlet is at an angle of not more than 45 degrees above horizontal at the main line.

Precautions should be taken to ensure that the tapping saddle or sleeve is placed on the pipe straight to prevent any binding or deformation of the PVC pipe. The mounting chain or U-bolt strap must be tight.

Tapping shall be performed with a sharp shell type cutter so designed that it will smoothly penetrate heavy walled PVC DR14 and 200 psi AC and will retain and extract the coupon from the pipe.

24) Backfilling

(a) General

Special emphasis is placed upon the need to obtain uniform density throughout the backfill material. The maximum lift of backfill shall be determined by the compaction equipment selected and in no case shall it exceed 18 inches, loose measurement.

No heavy equipment, which might damage pipe, will be allowed over the pipe until it has been completely backfilled to finished grade. All internal pipe bracing installed or recommended by the manufacturer shall be kept in place until the pipe bedding and trench backfill have been completed over the braced pipe section. Testing of the completed backfill in streets and under and around structures shall meet the specified density requirements. Initial testing shall not be at Contractor's expense and shall conform to the "General Conditions."

(b) Backfill Materials

Unless otherwise shown on the Drawings, select material shall be used for backfill. Select materials shall be placed over the top of embedment/encasement material, where designated on the Drawings and as specified herein. Select material shall consist of a free-flowing material like sand or mixed sand and gravel, free from lumps, large stones, clay, debris and organic matter. Select backfill may also include rock cuttings from a ditching machine (preferably wheel-type), provided that the largest chips shall have an average dimension in one place less than 1 inch, and no dimensions greater than 2 inches.

If approved by the City, good, sound earth may be used as select material for backfill over the pipe. Good, sound earth is defined as gravel, sandy loam or loam, free from excessive clay and having a Plasticity Index less than 20.

Select backfill shall be compacted to 95% of TEX 114E at optimum moisture content to 3% above optimum moisture content.

It shall be the full responsibility of the Contractor to explore the project and subsurface materials to determine if the trench excavation will be suitable for use as select materials and to follow as closely as possible to this Specification to insure a good, sound pipeline when completed.

(c) Backfill in Non-Paved Areas

After the pipe and embedment or encasement have been placed in trenches under non-paved areas, the remainder of the trench shall then be filled with select material. Mechanical tamping in six (6) inch maximum lifts shall be used. Select Backfill material shall be compacted to 95% density TEX 114E.

After the trench has been refilled, topsoil shall be replaced to the extent that rock excavated from the trench will be completely covered or removed and the area is returned to its original condition, except that in cultivated areas a minimum of six (6) inches of topsoil shall be replaced.

(d) Backfill in Street Right of Way

All trenches under proposed or existing concrete roadways, driveways and sidewalks, paved waterways, brick roadways, asphaltic roadways with concrete base, gravel roadways, and roadways with gravel base and asphalt surface, shall be backfilled by hand or mechanically tamping selected materials in six (6) to eight (8) inch layers to a minimum compaction of 95% TEX 114E at optimum moisture density. Jetting with water will not be permitted.

After each layer of backfill is complete, tests may be made by the City or designated representative. If the material fails to meet the density indicated, the course shall be reworked as necessary to obtain the indicated compaction and the compaction method shall be altered on subsequent Work to obtain indicated density.

At any time, the City or designated representative may order proof rolling to test the uniformity of compaction of the backfill layers. All irregularities, depressions, weak or soft spots that develop shall be corrected immediately by the Contractor.

Should the backfill, due to any reason, lose the required stability, density or finish before the pavement structure is placed, it shall be re-compacted and refinished at the sole expense of the Contractor. Excessive loss of moisture in the subgrade shall be prevented by sprinkling, sealing or covering with a subsequent backfill layer or granular material. Excessive loss of moisture shall be construed to exist when the subgrade soil moisture content is more than 4 percent below the optimum of compaction ratio density. Backfill shall be placed from the top of the bedding material to the existing grade, base course, subgrade or as indicated. The remainder of the street backfill shall be Flexible Base, Concrete or Hot Mix Asphalt Concrete as indicated or to be replaced in kind to the surface removed to construct the pipe.

(e) Backfill in County Street or State Highway Right of Way

All Work within the right-of-way shall meet the requirements of (d) above, as a minimum and shall meet the requirements of the permit issued by the County when their requirements are more stringent. Prior to the start of construction, the Contractor shall be responsible for contacting the appropriate TxDOT office or County Commissioner's Precinct Office and following the operating procedures in effect for utility cut permits and pavement repair under their jurisdiction. Approval for all completed Work in the State or County right-of-way shall be obtained from the appropriate Official prior to final payment by the Owner.

(f) Backfill in Railroad Right-of-Way

All Work within the railroad right-of-way shall meet the requirements of (d) above, as a minimum and shall meet the requirements of the permit issued by the Railroad Owner when their requirements are more stringent. Approval for all completed Work in the railroad right of way shall be obtained from the Railroad prior to Final Completion.

(g) Backfill in Easements

Where not otherwise indicated, Contractor may select whatever methods and procedures may be necessary to restore entire Work area to a safe, useful and geologically stable condition with a minimum density of 85 percent or a density superior to that prior to construction.

In and near flood plain of all streams and watercourses, under or adjacent to utilities, structures, etc. all backfill shall be compacted to a density of not less than 95 percent conforming to TxDOT Test Method Tex-114-E, unless otherwise directed by the City.

All soil areas disturbed by construction shall be covered with topsoil and seeded conforming to Item No. 604, "Seeding for Erosion Control". All turf, drainways and drainage structures shall be constructed or replaced to their original condition or better. No debris shall remain in the drainways or drainage structures.

(h) Temporary Trench Repair/Surfacing

If details of temporary trench repair/surfacing are not provided in the contract documents, the Contractor shall submit for approval of the City (1) a plan for temporary trench repair for areas that will be open to traffic but will be excavated later for full depth repair, and (2) a proposed method for covering trenches to maintain access to properties. The temporary surfacing shall afford a smooth riding surface and shall be maintained by the Contractor the entire time the temporary surface is in place.

(i) Permanent Trench Repair

The Contractor shall install permanent trench repairs conforming to details in the drawings.

25) Quality Testing for Installed Pipe

(a) Wastewater Pipe Acceptance Testing

The entire length of the installed gravity line and the force main shall be field tested for water tightness. Gravity wastewater lines shall be video taped by camera.

Hydrostatic pressure and leakage (exfiltration and infiltration) tests shall be made on all pressure pipelines carrying wastewater.

All labor and equipment, including, but not limited to test pump with regulated by-pass meters and gauges required for conducting pipeline tests, shall be furnished by the Contractor. The Contractor shall furnish equipment and necessary piping as required to transport water used in testing from source to test location.

Time and sequence of testing shall be scheduled by the Contractor, subject to observation and approval by the City. The Contractor shall provide adequate labor, tools and equipment to operate valves and to locate and repair any leaks discovered during the initial filling of the pipeline prior to actual testing or during the course of the tests.

The Contractor, at his expense, shall perform quality testing for all wastewater pipe installed and pressure pipe hydrostatic testing of all water lines constructed and shall provide equipment included pumps, gauges, supplies, and labor necessary to perform the tests. Quality and pressure testing shall be monitored by City of Pflugerville personnel. Water samples will be collected by the City of Pflugerville to verify each treated line has attained an initial chlorine concentration of 50 ppm.

The Contractor shall coordinate testing with the City of Pflugerville and provide no less than 24 hour notice prior to performing sterilization, quality testing or pressure testing.

The City will certify that all required pressure and leakage tests have been successfully completed before the pipeline is accepted.

(b) Exfiltration or Infiltration Test

Preparation: Seal ends of line section being tested with water tight plugs, equipped with pipe riser inserted and braced in the inlet of the manholes. Fill section with water 24-hours prior to start of test. Fill slowly from downstream manhole in test section so that no air is trapped in the line. Leave outlets of stacks and service lines exposed and unplugged until after exfiltration test has been made. Outlets terminating below level of test water surface to be temporarily extended upward by installing additional lengths of pipe. After completion of satisfactory test, remove lengths of pipe added for test.

Duration of Test: Test for 24-hours. Minimum head of either two (2) feet measured above the crown, inside pipe at upper end of section or four (4) feet measured above trench water table, whichever is higher, so that a net positive of two (2) feet TCEQ is used for testing.

Allowable Leakage: Allowable leakage or exfiltration in any individual section under construction shall not exceed 10 gallons per inch of inside diameter per mile of pipe per 24 hours.

No pipe installation will be accepted until all known leaks have been repaired whether or not leakage is within allowable limits. Remove and replace or make approved corrective repairs to any section of wastewater line which has leakage that exceeds above amounts. Repair any individual leaks that may appear whether or not overall section meets leakage requirements. Individual leaks will ordinarily be revealed by looking through sewer with a light while groundwater level is over sewer, during water tamping operations or immediately after water leakage is emptied from sewer. Wastewater lines failing to meet requirements of leakage test will, after repair by Contractor, be tested again for leakage. No sewer or manhole will be accepted until leakage is less than allowable amount. Locating and repairing of leaks shall be performed by the Contractor at no additional cost to the City.

(c) Pipeline Settlement Test

During the infiltration test or after the exfiltration test, the pipe will be TV inspected for possible settlement. When air testing has been used, water shall be flowed into the pipe to permit meaningful observations. Any pipe settlement which causes excessive ponding of water in the pipe shall be cause for rejection. Excessive ponding shall be defined as a golf ball (1 5/8 " dia.) submerged at any point along the line.

(d) Low Pressure Air Test of Gravity Flow Wastewater Lines

Preparation: Clean pipe to be tested by propelling snug fitting inflated rubber ball through the pipe with water or by use of water jet cleaning equipment. After manhole to manhole reach of pipe has been backfilled and cleaned, pneumatic plugs shall be placed in the line at each manhole and inflated to 25 psig. Add air slowly to the section under test until the internal pressure of 4.0 psig is obtained. Allow at least two (2) minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

Duration of Test and Allowable Leakage: Decrease pressure to 3.5 psig and start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding times are indicated in seconds and shall be computed by the following equation:

$$T = (0.085 \times D \times K) / Q$$

Where,

T = time for pressure to drop 1.0 pound per square inch gauge in seconds

K = 0.000419 x D x L, but not less than 1.0

D = average inside diameter in inches

L = length of line of same pipe size being tested, in feet

Q = rate of loss assume 0.0015 cubic feet per minute per square foot internal surface shall be used

Since K value of less than 1.0 shall not be used, there are minimum times for each pipe diameter as outlined below:

Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length
(inches)	(seconds)	(feet)	(seconds)
6	340	398	0.855(L)
8	454	298	1.520(L)

Pipe Diameter	Minimum Time	Length for Minimum Time	Time for Longer Length
10	567	239	2.374(L)
12	680	199	3.419(L)
15	850	159	5.342(L)
18	1020	133	7.693(L)
21	1190	114	10.471(L)
24	1360	100	13.676(L)
27	1530	88	17.309(L)
30	1700	80	21.369(L)
33	1870	72	25.856(L)
36	2040	66	30.771(L)

The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration as outlined above or until failure. Lines with a 27-inch average inside diameter and larger may be air tested at each joint. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing. The pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum time allowable for the pressure to drop from 3.5 psi gauge to 2.5 psi gauge shall be 10 seconds.

(e) Deflection Test

Deflection tests shall be performed on all flexible pipes. For pipes with inside diameters less than 27-inches, a rigid mandrel shall be used to measure deflection. For pipelines with an inside diameter of 27-inches and greater, the Contractor shall submit to the Engineer the proposed method, with which shall provide a precision of $\pm$ two tenths of one percent (0.2%) deflection, for review and approval by the Texas Natural Resource Conservation Commission. The test shall be conducted after final backfill has been in place at least 30 days in the presence of a representative of the City's Utilities Department. No pipe shall exceed a deflection of five percent (5%). If a pipe should fail to pass the deflection test, the problem shall be corrected and a second test shall be conducted after the final backfill has been in place an additional 30 days. Test shall be performed without mechanical pulling devices.

Mandrel Sizing: The rigid mandrel shall have an outside diameter (O.D.) equal to 95% of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter of the pipe minus two minimum wall thickness for O.D. controlled pipe and the average inside diameter for the I.D. Controlled pipe, all dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.

Mandrel Design: The rigid mandrel shall be constructed of a metal or rigid plastic material that can withstand 200 psi without being deformed. The mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75% of the inside diameter of the pipe. A proving ring shall be provided and used for each size mandrel in use.

Method Options: Adjustable or flexible mandrels are prohibited. A television inspection is not a substitute for the deflection test. A deflectometer may be approved provided the Contractor notifies the Engineer in a timely manner and submits adequate information for the Engineer to submit to the Texas Natural Resource Conservation Commission for review and approval. Mandrels with removable legs or runners may also be approved provided the Contractor notifies the Engineer in a timely manner and submits adequate information for the Engineer to submit to the Texas Natural Resource Conservation Commission for review and approval.

(f) Inspection of Installed Storm Drain Conduits

(1) General

All storm drain conduits (pipe and box culvert) shall be inspected for conformance to the requirements of this specification. Smart Housing, low/moderate income housing, and projects that are 100-percent privately funded are exempt from the cost of the initial video inspection. All deficiencies revealed by inspection shall be corrected. Video re-inspection meeting the requirements of this specification shall be provided at the Contractor's expense to show that deficiencies have been corrected satisfactorily. Further, the contractor shall provide video in complete segments (manhole to manhole) versus specific deficiency locations.

Projects that are not exempt from the cost of the initial video inspection are also subject to the following constraints:

All inspectors utilized by the Contractor for video inspection shall be NASSCO-PACP certified for a minimum of 3 years.

The Contractor will be required to inspect, assess, and record the condition of the storm drain pipe using National Association of Sewer Service Companies (NASSCOs) Pipeline Assessment Certification Program (PACP) coding standards.

(2) Video Inspection of Installed Storm Drain Conduits

Contractor shall provide all labor, equipment, material and supplies and perform all operations required to conduct internal closed-circuit television and video recording of all storm drain conduits. Video recording of each storm drain conduit section shall be conducted after the trench has been backfilled and prior to placement of permanent pavement repairs or permanent pavement reconstruction. The video recording shall be provided to the Owner for review. Contractor shall not place permanent pavement repairs or permanent pavement reconstruction over the storm drain conduit until Owner has reviewed the video and agrees that there are no defects in the storm drain conduit installation shown in the video submitted by the Contractor or shown in any video acquired by the Owner through other means. Placement of permanent pavement repair or permanent pavement reconstruction over the installed storm drain conduit before the Owner acknowledges no defects shall be at the Contractor's risk. Any defects revealed by the video inspection shall be corrected at the Contractor's expense and a new video submitted to the Owner for review prior to acceptance of the conduit.

All video work shall be conducted under the direct full-time supervision of a NASSCO-PACP certified operator.

The conduit inspection camera shall have the capability of panning plus/minus 275 degrees and rotating 360 degrees. The television camera shall be specifically designed and constructed for such use. The camera shall be operative in 100% humidity conditions. Camera shall have an accurate footage counter that displays on the monitor the exact distance of the camera (to the nearest tenth of a foot) from the centerline of the starting manhole or access point. Camera shall have height adjustment so that the camera lens is always centered within plus/minus 10% of the center axis of the conduit being videoed. Camera shall provide a minimum of 460 lines of horizontal resolution and 400 lines of vertical resolution. Camera shall be equipped with a remote iris to control the illumination range for an acceptable picture. Geometrical distortion of the image shall not exceed one percent (1%). The video image produced by each camera shall be calibrated using a Marconi Resolution Chart No. 1 or equivalent.

Lighting for the camera shall be sufficient to allow a clear picture of the entire periphery of the conduit without loss of contrast, flare out of picture or shadowing. A reflector in front of the camera may be required to enhance lighting in dark or large sized conduit. The video camera shall be capable of showing on the digital display the Owner's name, Project name, Contractor name, date, line size and material, conduit identification, and ongoing footage counter. The camera, television monitor, and other components of the video system shall be capable of producing a picture quality satisfactory to the satisfaction of the Owner. The recording of the internal condition of the storm drain conduit shall be clear, accurate, focused and in color. If the recording fails to meet these requirements, the equipment shall be removed and replaced with equipment that is suitable. No payment will be made for an unsatisfactory recording.

If during video inspection, water is encountered inside the conduit, the conduit shall be dewatered by the Contractor. The storm drain section must be dry. Video recording conducted while the camera is floating is not acceptable unless approved by the Owner.

If during video inspection, debris is encountered that prohibits a proper inspection of the conduit, the Contractor shall remove the debris before proceeding.

All video shall be documented using a data logger and reporting system that are PACP compliant and which use codes as established by the National Association of Sewer Service Companies (NASSCO)s - Pipeline Assessment and Certification Program (PACP).

Computer printed location records shall be kept by the Contractor and shall clearly show the location and orientation of all points of significance such as joints, conduit connections, connections at manholes and inlets, and defects. Copy of all records shall be supplied to the Owner. Noted defects shall be documented as color digital files and color hard copy print-outs. Photo logs shall accompany each photo submitted.

The video recording shall supply a visual and audio record of the storm drain conduits that may be replayed. Video recordings shall include an audio track recorded by the video technician during the actual video work describing the parameters of the storm drain conduit being videoed (i.e. location, depth, diameter, pipe material), as well as describing connections, defects and unusual conditions observed during the video work. Video recording playback shall be at the same speed that it was recorded. Slow motion or stop-motion playback features may be supplied at the option of the Contractor. Once videoed, the CDs/DVDs shall be labeled and become the property of the Owner. The Contractor shall have all video and necessary playback equipment readily accessible for review by the Owner while the project is under construction.

Post-installation video shall not be completed until all work is completed on a section of storm drain conduit. Post-installation video work shall be completed by the Contractor in the presence of the Owner. The post-installation video work shall be completed to confirm that the storm drain conduits are free of defects. Provide a color video showing the completed work. Prepare and submit video logs providing location of storm drain conduit along with location of any defects. Manhole and inlet work shall be complete prior to post-installation video work.

For post-installation video, exercise the full capabilities of the camera equipment to document the completion and conformance of the storm drain installation work with the Contract Documents. Provide a full 360-degree view of conduit, all joints, and all connections. The camera shall be moved through the storm drain conduit in either direction at a moderate rate, stopping and slowly panning when necessary to permit proper documentation of the conduit condition at each pipe connection, joint, and defect. In no case shall the camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the storm drain conditions shall be used to move the camera through the storm drain conduit. When manually operated winches are used to pull the camera through the conduit, telephones or other suitable means of communication shall be set up between the two access points of the conduit being videoed to insure good communication between members of the video crew.

Distance measurements shall be provided to an accuracy of one tenth of a foot.

Video shall be continuous for each storm drain conduit segment. Do not show a single segment on more than one CD/DVD, unless specifically allowed by the Owner.

Contractor shall submit to Owner the following:

- A. National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) certification of operators who will be performing video work.
- B. Compact Disc (CD) or Digital Video Disc (DVD) of recording of storm drain conduits (concrete storm water pipe or box culvert).
 - a. The color CD or DVD shall include a digital color key map in a format acceptable to the Owner with each segment of storm drain conduit labeled with the appropriate inspection ID on the map.

- b. The file folder for each segment of the storm drain conduit shall have a unique name based on the Owner's approved inspection naming convention and shall contain the following:
 - i. Video files
 - ii. Video inspection logs with information coded in accordance with the PACP
 - iii. Photo logs
 - iv. A report summarizing the results of the video inspection
 - v. A proposed method of repair for any defects discovered.

- (3) Time commitments from City for projects that are exempt from the cost of the initial video inspection

Projects that are exempt from the cost of the initial video inspection are afforded the following time commitments from the City.

- A. Initial inspection - contractor must inform the City of Pflugerville construction inspector assigned to the project in writing that all stormdrain infrastructure for the project has been completed according to the permit and is ready for inspection. The inspector will then notify the Watershed Protection Department (WPD) in writing that all of the stormdrain infrastructure for the project has been completed and is ready for inspection. The WPD is allowed 15-days to complete inspection from written notification by the inspector. The outcome of this item does not impact the one-year warranty requirements.
- B. Video re-inspection by the contractor for deficient installed stormdrain infrastructure. The contractor must submit the video inspection data as defined in this specification to the City of Pflugerville construction inspector assigned to the project along with a written letter of transmittal certified by a professional engineer stating that all identified stormdrain infrastructure installation deficiencies for the project have been corrected. The inspector will then notify the Watershed Protection Department (WPD) in writing and convey the video inspection data to the WPD. The WPD is allowed 15-days to complete review of the data from the date of delivery by the inspector.

26) Pressure Pipe Hydrostatic Testing

a) General

After the pipe has been laid and backfilled and the backfill has been otherwise consolidated, all newly laid pipe, or any valved section thereof, shall be subjected to the hydrostatic pressure specified below for that particular type of pipe. The duration of the hydrostatic test shall be at least two (2) hours. Unless otherwise specified or noted on the Plans. All meters, fixtures, devices or appliances which are connected to the pipeline system and which might be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped during the testing procedures.

Each valved (capped or plugged) section of pipe shall be filled slowly with water and all air shall be expelled. If permanent air vents are not located at all high points, the Contractor shall install, at his own expense, corporation or blow-off cocks at such points so that air can be expelled as filling takes place. After verification that all air has been expelled, the cocks shall be closed and the pipe kept filled until tested. All exposed pipe, fittings, valves, hydrants and joints shall be examined while under test pressure and all visible leaks shall be stopped. Any cracked or defective pipe, fittings, valves or hydrants discovered during testing shall be removed and replaced by the Contractor. Replacement shall be with sound material and the test shall be repeated until satisfactory to the City.

- b) Special Requirements: Where any section of pipeline is provided with concrete reaction blocking, the hydrostatic pressure shall not be made until at least five (5) days have elapsed after installation of the blocking. However, if high-early-strength cement is used in the concrete, two (2) days shall have elapsed prior to testing.
- c) Leakage Test: A Leakage Test will be conducted on each valved section over the entire Project. The leakage test shall be at 150 psi for at least four (4) hours.
- d) Allowable Leakage
 - 1. The allowable hydrostatic leakage rate shall be based on the following formula:

$$L = \frac{SD \sqrt{P}}{133,200}$$

L = testing allowance in gallons per hour

S = length of pipe tested in feet

D = nominal diameter of the pipe in inches

P = average test pressure during the hydrostatic test in pounds per square inch (gauge)

Table 6A

Hydrostatic testing allowance per 1,000 ft of pipeline* - *gph*[†]

Avg. Test Pressure <i>psi</i>	Nominal Pipe Diameter – in.																	
	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
450	.48	.64	.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60	9.56	10.19
400	.45	.60	.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11	9.01	9.61
350	.42	.56	.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58	8.43	8.99
300	.39	.52	.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02	7.80	8.32
275	.37	.50	.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72	7.47	7.97
250	.36	.47	.71	.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41	7.12	7.60
225	.34	.45	.68	.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03	6.76	7.21
200	.32	.43	.64	.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73	6.37	6.80
175	.30	.40	.59	.80	.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36	5.96	6.36
150	.28	.37	.55	.74	.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97	5.52	5.88
125	.25	.34	.50	.67	.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53	5.04	5.37
100	.23	.30	.45	.60	.75	.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05	4.50	4.80

* If the pipeline under test contains sections of various diameters, the testing allowance will be the sum of the testing allowance for each size.

[†] Calculated on the basis of Eq. 1.

- a. These formulas are based on a testing allowance of 11.65 gpd/mi/in. of nominal diameter at a pressure of 150 psi.
- b. 5.2.1.6.1 Testing allowance at various pressures is shown in Tables 6A and 6B.
- c. 5.2.1.6.2 When testing against closed metal-seated valves, an additional testing allowance per closed valve of 0.0078 gal/h/in. (1.2 mL/h/mm) of nominal valve size shall be allowed.
- d. 5.2.1.6.3 When hydrants are in the test section, the test shall be made against the main valve in the hydrant.
- e. 5.2.1.7 Acceptance of installation. Acceptance shall be determined on the basis of testing allowance. If any test of laid pipe discloses a testing allowance greater than that specified in Sec. 5.2.1.6, repairs or replacements shall be accomplished in accordance with the specifications.
- f. 5.2.1.7.1 All visible leaks are to be repaired regardless of the allowance used for testing.
If such testing discloses leakage in excess of this specified allowable, the Contractor, at his expense, shall locate and correct all defects in the pipeline until the leakage is within the specified allowance. All known leaks, irregardless of this test, shall be repaired.

- e) Pressure Test: After satisfactorily completing the leakage test, each valved section over the entire project, shall be tested at 200 psi for a sufficient period (approximately 10 min) to discover all leaking or defective materials and/or workmanship.

27) Service Charges for Testing

No separate payment will be made for work completed in accordance with this specification, and the cost thereof will be included in appropriate items of the Proposal and Bid Schedule.

28) Disinfection of Potable Water Lines

- (1) The Contractor shall disinfect all water mains before the new facilities are placed into service. Disinfection must be performed in accordance with AWWA C651, latest revision and water samples must be submitted to a laboratory approved by the Texas Department of Health. Sample must be collected by the Contractor or his representative in the presence of the City or his representative. The Contractor shall be responsible for delivering the samples to an approved laboratory for testing. Sample results must indicate the facility is free of microbiological contamination before it is placed into service. It shall be the Contractor's responsibility to obtain a current copy of AWWA C651 to determine the correct forms of chlorine for disinfection, the basic disinfection procedure, preventive and corrective measures during construction, methods of chlorination, final flushing procedures, procedures for bacteriological tests, procedures for re-disinfection and disinfection procedures when cutting into existing mains. The Contractor, at its expense, will supply the concentrated chlorine disinfecting material, the City's personnel will supervise and direct the overall sterilization procedure. The Contractor, at his own expense, shall provide all other equipment, supplies and necessary labor to perform the sterilization under general supervision by the City.
 - A. All valves shall be arranged to prevent the strong disinfecting dosage from flowing back into the existing water supply piping. The new pipeline shall then be completely filled with disinfecting solution by feeding the concentrated chlorine and approved water from the existing system uniformly into the new piping in such proportions that every part of the line has a minimum concentration of chlorine as prescribed in AWWA C651.
 - B. Unless otherwise identified, all quantities called for herein refer to measurements by the testing procedures in the current edition of "Standard Methods of Examination of Water and Wastewater". The chlorine concentration of each step in the sterilization procedure shall be verified by chlorine residual determinations. This disinfecting solution shall be retained in the piping for at least twenty-four (24) hours, and all valves, hydrants, etc., shall be operated to disinfect all their parts. After this retention period, the water shall contain no less than the chlorine residual prescribed in AWWA C651 throughout the treated section of the pipeline.
 - C. This heavily chlorinated water shall then be carefully flushed from the line until the chlorine concentration is not higher than the residual generally prevailing in the existing distribution system, or approximately 1.0 parts per million. Proper planning and appropriate preparations to handle, dilute and dispose of this strong chlorine solution without causing injury or damage to the public, the water system, the environment must be approved by the City before flushing of the line may begin, and the flushing shall be witnessed by an authorized representative of the City.

(2) Bacteriological Testing

- A. After final flushing of the strong disinfecting solution, water samples from the line shall be tested for bacteriological quality, at the Contractor's expense, and must be found free of coliform organisms before the pipeline may be placed in service. One (1) test sample shall be drawn from the end of the main and additional samples collected at intervals of not more than one-thousand (1,000) feet along the pipeline. A minimum of three (3) samples must be collected.
- B. The Contractor, at his own expense, shall install sufficient sampling taps at proper locations along the pipeline. Each sampling tap shall consist of a standard corporation cock installed in the line and extended with a copper tubing gooseneck assembly. After samples have been collected, the gooseneck assembly shall be removed and retained for future use.
- C. Samples for bacteriological analysis shall be collected only from suitable taps, in sterile bottles. Collection of the test samples shall be made in the presence of City personnel. If the initial disinfection fails to produce acceptable sample tests, the disinfection procedure shall be repeated (without extra compensation) until satisfactory test results have been obtained, before the piping may be placed in service.

29) Cleanup and Restoration

It shall be the Contractor's responsibility to keep the construction site neat, clean and orderly at all times. Cleanup shall be vigorous and continuous to minimize traffic hazards or obstructions along the streets and to driveways. Trenching, backfill, pavement repair (as necessary), and cleanup shall be coordinated as directed by the City. The E/A will regulate the amount of open ditch and may halt additional trenching if cleanup is not adequate to allow for orderly traffic flow and access.

Materials at the site shall be stored in a neat and orderly manner so as not to obstruct pedestrian or vehicular traffic. All damaged material shall be removed from the construction site immediately and disposed of in a proper manner. During excavation, all materials shall be piled adjacent to the Work to be used for backfilling as required. Where required on the Drawings or when otherwise specified, desirable topsoil shall be piled separately in a careful manner and replaced in its original position. All surplus excavated materials shall become the property of the Contractor for disposal at the Contractor's expense. After trenching, the Contractor shall immediately remove all excavated materials unsuitable for or in excess of, backfill requirements. Immediately following the pipe laying Work as it progresses, the Contractor shall backfill, grade and compact all excavations as provided elsewhere. The backfill placed at that time shall meet all compaction test requirements. The Contractor shall immediately clean up and remove all unused soil, waste and debris and restore all surfaces and improvements to a condition equal or superior to that before construction began and to an appearance which complements the surroundings. The Contractor shall grade and dress the top 6 inches of earth surfaces with soil or other material similar and equal to the surrounding, fill and smooth any visible tracks or ruts, replace and re-establish all damaged or disturbed turf or other vegetation and otherwise make every effort to encourage the return of the entire surface and all improvements to a pleasant appearance and useful condition appropriate and complementary to the surroundings and equal or similar to that before construction began.

Placement of the final lift of permanent pavement, if a pavement is required, shall begin immediately after all testing of each segment of piping is satisfactorily completed.

30) Valve Turn Walk-through

As part of the acceptance of Water pressure pipe, a Valve Walk-through will be performed after an initial inspection by the Owner's Representative to identify any deficient items. If deficient items are present during the AW Valve Walk-Through and the project fails acceptance, a re-inspection fee will apply and must be paid before a re-inspection is scheduled to confirm correction of deficient items. See AW Fee Schedule for the current Distribution Walk-Through Re-inspection Fee.

31) 2-inch Jumper Hose

During connections to the water distribution system, the Contractor may be required to install a temporary jumper hose between the unpressurized water segment and an adjacent pressurized water segment for the purpose of maintaining water service to customers who can't operate without water service during the connection. The jumper shall include an approved backflow preventer and be of adequate size and pressure rating to maintain service to the customer. It shall be polyethylene tubing meeting the requirements of the City of Pflugerville SPL Item "Polyethylene Tubing for Low Pressure Sewers.". The jumper hose and other components in the temporary service shall be disinfected, and bacteriological samples will be taken and pass before the temporary service is provided to the customer. Contractor shall provide adequate protection for the jumper hose in vehicular traffic areas at all times during use.

510.4 - Measurement

Pipe will be measured complete in place by the linear foot along the centerline for the various types, sizes and classes installed. Parallel lines will be measured individually.

Where a line ties into an existing system, the length of the new line will be measured from the visible end of the existing system at the completed joint. Unless otherwise indicated, the length of water, reclaimed, and wastewater lines will be measured along pipe horizontal centerline stationing through fittings, valves, manholes, and other appurtenances.

Ductile iron fittings, whether standard mechanical joint or integral factory restrained joint type, will be measured by the ton and paid for in accordance with the schedule in Standard Products List WW-27C. Bolts, glands and gaskets will not be measured for payment. Steel cylinder concrete pipe fittings and welded steel pipe fittings will not be measured separately and are included in the unit price for the respective pipe bid items.

Factory restrained joint pipe meeting the requirements of Standard Products List Item, "Restrained Joint Ductile Iron Pipe and Fittings" will be measured by the linear foot. The estimated quantity on the bid form is only for restrained joint pipe having integral mechanically restrained joints.

Connecting a new water, wastewater, or reclaimed water service to an existing, comparable type of private service will be measured by each connection. Service pipe from the main to the service connection will be measured by the linear foot.

The Contractor shall be responsible for removing and treating all ground water and surface water flowing into a trench.

Adjustment of elevations during construction resulting in changes in flow line elevations of plus or minus two feet or less will not be considered for credit or additional compensation and no measurement for payment will be made.

Stormwater pipe will be measured along the slope of the pipe. Where drainage pipe ties into inlets, headwalls, catch basins, manholes, junction boxes or other structures that length of pipe tying into the structure wall will be included for measurement, but no other portion of the structure length or width will be so included.

Excavation and backfill, when included as pipe installation will not be measured as such but shall be included in the unit price bid for constructing pipe and measured as pipe complete in place including excavation and backfill.

When pay items are provided for the other components of the system, measurement will be made as addressed hereunder.

Video inspection of newly installed box culverts and storm drain pipe will be measured per linear foot of pipe videoed.

Jumper hose will be measured per linear foot of hose installed, including all depths, excavation and backfill, complete, and in place.

510.5 - Payment

Payment for pipe, measured as prescribed above, will be made at the unit price bid per linear foot for the various sizes of pipe, of the materials and type indicated, unless unstable material is encountered or trench excavation and backfill is bid as a separate item.

The concrete seal, foundation rock or coarse aggregate when used as directed in unstable material will be paid for at the unit price bid per cubic yard, which shall be full payment for all excavation and removal of unsuitable material and furnishing, placing and compacting the foundation rock, coarse aggregate or other approved material all complete in place.

Excavation and backfill, when included as a separate pay item, will be paid for by Pay Item No. 510-E or 510-F.

No separate payment will be made for dewatering a trench.

(1) Pipe

Payment for pipe, measured as prescribed above, will be made at the unit price bid per linear foot complete-in-place as designed and represented in the Drawings and other Contract documents. Restrained joint pipe meeting the requirements of Item, "Restrained Joint Ductile Iron Pipe and Fittings" will be paid for separately at the unit price bid per linear foot. Unless otherwise provided herein, as separate pay item(s), the bid price per linear foot of pipe shall include the following:

- a. clearing
- b. constructing any necessary embankment
- c. excavation
- d. disposal of surplus or unusable excavated material
- e. furnishing, hauling and placing pipe
- f. field constructed joints, collars, temporary plugs, caps or bulkheads
- g. all necessary lugs, rods or braces
- h. pipe coatings and protection
- i. connections to existing systems or structures, concrete blocking and thrust blocks and restrained joints
- j. preparing, shaping, pumping for dewatering, and shoring of trenches
- k. bedding materials
- l. backfill materials
- m. hauling, placing and preparing bedding materials
- n. particle migration measures
- o. hauling, moving, placing and compacting backfill materials
- p. temporary and permanent pavement repairs and maintenance
- q. temporary removal and replacement of pavement, curb, drainage structures, driveways, sidewalks and any other improvements damaged or removed during construction
- r. cleanup
- s. vertical stack on deep wastewater services
- t. all other incidentals necessary to complete the pipe installation as indicated.
- u. pipe joint restraint devices, where specified or allowed, meeting Standard Products List Item "Joint Restraint Devices, 4 Inch through 16 Inch Diameter."

No separate payment will be made for thrust restraint measures.

Steel cylinder concrete pipe fittings will not be paid for separately. These will be included in the unit price bid for the bid item Pipe.

(2) Concrete Cradles and Seals

When called for in the Bid, concrete cradles and seals will be paid for at the unit Contract price bid per linear foot for the size of pipe specified, complete in place.

(3) Concrete Retards

When called for in the Bid, Concrete retards will be paid under Item No. 593S, Concrete Retards."

(4) Boring or Jacking.

When called for in the Bid, boring or jacking will be paid under Item 501S, "Jacking or Boring Pipe.

(5) Wet Connections to Potable or Reclaimed Water Mains

When called for in the bid, wet connections will be paid at the unit price bid per each, complete in place, according to the size of the main that is in service and shall be full compensation for all Work required to make the connection and place the pipe in service. (See subsection 510.3 'Construction Methods' part (24) (b) 'Wet Connections to Existing Water System').

(6) Fittings

Ductile iron fittings, furnished in accordance with these specifications, will be paid for at the unit price bid per ton, complete in place, according to the schedule of weights in Standard Products List Item "Ductile Iron Pipe & Fittings." Bolts, glands, and gaskets will not be paid for separately and shall be included in the contract unit price for fittings.

(7) Concrete Trench Cap and Encasement

Where the distance between the top of the concrete encasement and the top of the trench cap is less than 36 inches, the concrete cap and encasement shall be poured as one unit and paid for under this bid item at the Contract price bid per linear foot. When the distance above is greater than 36 inches or when the trench cap is placed separately, the trench cap shall be paid for as a separate item, per linear foot, complete in place.

(8) Cement-Stabilized Backfill

Cement-stabilized backfill will be paid for at the unit price bid per linear foot and shall be full payment to the Contractor for furnishing and installing the required material, mixed, placed and cured complete in place.

(9) Concrete Encasement

When called for in the Bid, Concrete Pipe Encasement will be paid under Item No. 505S, "Encasement and Encasement Pipe".

(10) Pressure Taps

Pressure taps will be paid for at the unit price bid, complete in place, according to the size tap made and the size main tapped and shall be full payment for furnishing all necessary materials, including tapping sleeve and valve, making the tap, testing and placing the connection in service.

(11) Excavation Safety Systems

When called for in Bid, Trench Safety Systems shall conform to Item No. 509S, "Excavation Safety Systems."

(12) Connecting a New Water, Wastewater, or Reclaimed Water Service to an existing, comparable type of private service will be paid for at the unit price bid, complete in place, according to the size of new service and size of existing private service, and shall be full payment for furnishing and installing all necessary materials, such as cleanouts, pipe, couplings, and fittings, and including excavation and backfill.

(13) Video Inspection

Video Inspection of Newly Installed Box Culverts and Storm Drain Pipe will be paid for at the unit price bid per linear foot and shall be full payment for all labor, equipment, and materials required for video inspection per this specification, including all submittals of CD/DVD as required.

(14) Jumper Hose

Jumper Hose will be paid at the unit bid price, complete and in place, including installation and removal of all materials necessary to provide a fully functional jumper hose. This item shall also include adequate protection for the jumper hose within vehicular traffic areas.

Payment, when included as a Contract pay item, will be made under one of the following:

Pay Item No. 510-AR _____ Dia.:	Pipe, _____ Dia. _____ Type (all depths), including Excavation and Backfill	Per Linear Foot.
Pay Item No. 510-ARRJ _____ Dia.:	Factory Restrained Joint Pipe, _____ Dia., Class _____ Ductile Iron, (all depths) including Excavation and Backfill	Per Linear Foot.
Pay Item No. 510-BR _____ x _____ Dia.:	Connecting New _____ Service to Existing Private Service (_____ Dia. New Service to _____ Dia. Private Service)	Per Each.
Pay Item No. 510-CR:	Pipe Excavation, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-DR:	Pipe Trench Backfill, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-ER:	Concrete Seal or Cradle, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-FR:	Concrete Trench Cap, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-GR:	Concrete Cap and Encasement, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-HR:	Cement Stabilized Backfill, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-IR: _____ x _____ Dia.:	Pressure Taps, _____ Dia. x _____ Dia.	Per Each.
Pay Item No. 510-JR: _____ x _____ Dia.:	Wet Connections, _____ Dia. x _____ Dia.	Per Each.

Pay Item No. 510-KR:	Ductile Iron Fittings	Per Ton.
Pay Item No. 510-ASD_____Dia.:	Pipe, _____ Dia. (all depths), including excavation and backfill	Per Linear Foot.
Pay Item No. 510-CSD:	Pipe Excavation, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-DSD:	Pipe Trench Backfill, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-ESD:	Concrete Seal or Cradle, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-FSD:	Concrete Trench Cap, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-GSD:	Concrete Cap and Encasement, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-HSD:	Cement Stabilized Backfill, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-AW_____Dia.:	Pipe, _____ Dia. _____ Type (all depths), including excavation and backfill	Per Linear Foot
Pay Item No. 510-AWRJ_____Dia.:	Factory Restrained Joint Pipe, _____ Dia., Class Ductile Iron, (all depths) including Excavation and Backfill	Per Linear Foot.
Pay Item No. 510- BW_____×_____Dia.:	Connecting New _____ Service to Existing Private Service (_____ Dia. New Service to _____ Dia. Private Service)	Per Each.
Pay Item No. 510-CW:	Pipe Excavation, _____ Ft. Width	Per Linear

		Foot.
Pay Item No. 510-DW:	Pipe Trench Backfill, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-EW:	Concrete Seal or Cradle, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-FW:	Concrete Trench Cap, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-GW:	Concrete Cap and Encasement, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-HW:	Cement Stabilized Backfill, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-IW: _____ x _____ Dia.:	Pressure Taps, _____ Dia. x _____ Dia.	Per Each.
Pay Item No. 510-JW: _____ x _____ Dia.:	Wet Connections, _____ Dia. x _____ Dia.	Per Each.
Pay Item No. 510-KW:	Ductile Iron Fittings	Per Ton.
Pay Item No. 510-AWW: _____ Dia.:	Pipe, _____ Dia. _____ Type (all depths), including Excavation and Backfill	Per Linear Foot.
Pay Item No. 510-AWRJ _____ Dia.:	Factory Restrained Joint Pipe, _____ Dia., Class ductile Iron, (all depths) including Excavation and Backfill	Per Linear Foot.
Pay Item No. 510-BWW _____ x _____ Dia.:	Connecting New _____ Service to Existing Private Service (_____ Dia. New Service to _____ Dia. Private Service)	Per Each.
Pay Item No. 510-CWW:	Pipe Excavation, _____ Ft. Width	Per Linear

		Foot.
Pay Item No. 510-DWW:	Pipe Trench Backfill, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-EWW:	Concrete Seal or Cradle, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-FWW:	Concrete Trench Cap, _____ Ft. Width	Per Linear Foot.
Pay Item No. 510-GWW:	Concrete Cap and Encasement, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-HWW:	Cement Stabilized Backfill, _____ Dia. Pipe	Per Linear Foot.
Pay Item No. 510-KWW:	Ductile Iron Fittings	Per Ton.
Pay Item No. 510-VIDEO	Video Inspection of Newly Installed Box Culverts and Storm Drain Pipe	Per Linear Foot.
Pay Item No. 510-JH	2-inch Jumper Hose	Per Linear Foot.

An "R" after the pay item indicates the use for reclaimed water.

An "SD" after the pay item indicates the use for storm drain.

A "W" after the pay item indicates the use for water.

A "WW" after the pay item indicates the use for wastewater.

END

ITEM NO. 511S - WATER VALVES

511S.1 - Description

This item shall govern the valves furnished and installed as indicated on the Drawings. Unless otherwise indicated on the Drawings, all valves 4 inches and larger shall be AWWA-type valves of suitable design and fully equipped for service buried in the earth, without need for further modification and shall be wrapped with 8-mil polyethylene film with all edges and laps securely taped to provide a continuous wrap. For reclaimed water piping, the polyethylene film shall be purple. Unless otherwise indicated on the Drawings, all valve stems shall be adjusted to situate the operating nut not more than 24 inches below the proposed ground or paving surface of the finished project. Laydown valves shall not be used unless called out on the Drawings. Standard details shall not be used as an indicator of available options.

All valves shall open counterclockwise.

Valves shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard to which they are manufactured cast in raised letters on some appropriate part of the body.

Unless otherwise noted, valves shall have a minimum working pressure of 200 psi or be of the same working pressure as the pipe they connect to, whichever is higher, and suitable for the pressures noted where they are installed.

Valves shall be of the same nominal diameter as the pipe or fittings they are connected to. Except as otherwise noted, joints shall be mechanical joints, with joint restraint where the adjacent piping is required to be restrained.

511S.2 - Submittals

Within 14 days of the Notice to Proceed, the Contractor shall submit to the Engineer or the City for approval, technical product literature including Manufacturer's literature, illustrations, specifications and engineering data which includes dimensions, size, materials of construction, weight, protection coating, and all other pertinent data to illustrate conformance to the specification found within. The Contractor shall also submit four (4) copies of all certified shop test results specified herein, complete operation and maintenance manuals including all copies of all approved shop drawings, and certificates of compliance where required by referenced standards: For each valve specified to be manufactured and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests, and certification of proper installation.

Each submittal shall be accompanied by:

1. Complete data covering:
 - a. the operator, including type and size, model number, etc.,
 - b. the name and address of the manufacturer's nearest service facility,
 - c. the number of turns to fully open or close the valve.
2. detailed instructions for calibrating the limit stops for open and closed positions, and
3. any other information, that may be necessary to operate and maintain the operator.
4. Complete dimensional data and installation instructions for the valve assembly as it is to be installed, including the operator.
5. Complete replacement parts lists and drawings, identifying every part for both the valve and operator.

Contractor's/manufacture's submittal for valves larger than 24" diameter, when approved for use, shall include catalogue drawings and assembly (shop) drawings specific to valves required for the project.

As far as possible, equipment of the same type shall be identical and from one manufacturer. All valves must be "lead free" and marked by stamping, etching, or casting "NL" in the main body or by other methods acceptable to the City.

511S.3 - Materials

The Contractor shall submit descriptive information and evidence that the materials and equipment the Contractor proposes for incorporation in the Work is of the kind and quality that satisfies the specified functions and quality. The City of Pflugerville Standard Products Lists (SPL) are considered to form a part of these Specifications. Contractors may, when appropriate, elect to use products from the SPL; however, submittal to the City is still required. If the Contractor elects to use any materials from these lists, each product shall be completely and clearly identified by its corresponding SPL number when making the product submittal. This will expedite the review process in which the City.

The SPL's should not be interpreted as being a pre-approved list of products necessarily meeting the requirements for a given construction Project. Items contained in the SPL cannot be substituted for items shown on the Drawings, or called for in the specifications, or specified in the Bidding Requirements, Contract Forms and Conditions of Contract, unless approved by the City. The Standard Product List current at the time of plan approval will govern.

A. Samples, Inspection and Testing Requirements

All tests and inspections called for by the applicable standards shall be performed by the manufacturer. Upon request, results of these tests shall be made available to the purchaser.

The interior ferrous metal surfaces, except finished or bearing surfaces, shall be blast cleaned in accordance with SSPC SP-6 (NACE No. 3) and painted with 2 coats of an approved 2 component coal tar epoxy coating specifically formulated for potable water use. The coating used must appear on the current edition of the United States Environmental Protection Agency's list entitled "Accepted Categories and Subcategories of Coatings, Liners and Paints for Potable Water Usage."

511S.3 - Valves

A. Resilient Seated Gate Valves

Gate valves furnished under these specifications shall be of the solid wedge, resilient seat type with cast iron/ductile iron body and bronze stem for 250 psi working pressure. All gate valves shall be tested hydrostatically to 400 psi. Wedges shall be totally encapsulated with rubber. All units shall be UL and FM approved.

Resilient-seated gate valves for potable or reclaimed service, including tapping valves, shall conform to AWWA C-509 and shall conform to the latest ASTM A-126 and the City of Pflugerville Standard Products List Item "Resilient Seated Gate Valves, AAWA C509."

Reduced-wall, resilient-seated gate valves for potable or reclaimed service, including tapping valves, shall conform to AWWA C-515 and Standard Products List Item "Resilient-Seated Gate Valves, AWWA C515."

1. Stem Seals: All valves shall have a minimum of 2 approved O-ring type stem seals. At least two O-rings shall be in contact with the valve stem where it penetrates the valve body.
2. Operation: All valves shall have non-rising stems with gaskets, glands, bolts etc. as requisitioned. Copper alloy parts (bronze or brass) shall contain not over 16 percent zinc. Copper alloy UNS No. shall be shown on permanent external marking in addition to markings required by AWWA C509. Valve stems shall turn clockwise to close.
3. Gearing: Gate valves in 24-inch (610 mm) and larger sizes shall be geared and, when necessary for proper bury depth and cover, shall be the horizontal bevel-geared type enclosed in a lubricated gear case.
4. Seats: The seat shall be made of Styrene Butadiene rubber and provide a positive watertight seal. The seat shall be permanently bonded or mechanically attached to the wedge with stainless steel screws. Non-rising stem gate valves shall be equipped with "O" ring type packing gland consisting of at least two (2) "O" rings. The thrust collar shall work in an "O" ring seal lubricant

reservoir or against bearings or washers, above and below constructed of Delrin or approved equal material. Gate valve stems shall be fabricated from solid bronze rod having a tensile strength of not less than 60,000 pounds per square inch, and a minimum yield strength of 30,000 pounds per square inch.

5. Valve Body: Cast iron body shall be of iron with an even grain and shall possess a tensile strength of not less than 32,000 pounds per square inch. All bronze castings, except the stem, shall have a tensile strength of not less than 30,000 pounds per square inch. The entire internal valve body surfaces shall be coated with a factory applied two (2) component epoxy system or approved equal. The seating surface shall be machined or otherwise constructed to provide a smooth, even surface for the resilient seat. All valves shall open left (counterclockwise) and have a two (2) inch square wrench nut unless specified otherwise.
6. Bonnet and gland bolts and nuts shall be either fabricated from a low alloy-steel for corrosion resistance or electroplated with zinc or cadmium. The hot-dip process in accordance with ASTM A153 is not acceptable.

All gate valves shall be provided with extension shafts (where the operating nut is greater than 5 feet below grade), operating nuts and valve boxes as follows:

1. Extension shafts shall be steel, and the operating nut shall be two 2 inches square. Shafts shall be designed to provide a factor of safety of not less than 4. Operating nuts shall be pinned to the shafts.
2. Valve boxes shall be a heavy-pattern cast iron, 3 piece, telescoping type box with dome base suitable for installation on the buried valves. Inside diameter shall be at least 5¼-inches. Barrel length shall be adapted to the depth of cover, with a lap of at least 6 inches when in the most extended position. Covers shall be cast iron with integrally-cast direction-to-open arrow and "WATER" shall be cast in the cover when used on a water line or "SEWER" when used on a wastewater force main. Aluminum or plastic are not acceptable. A means of lateral support for the valve extension shafts shall be provided in the top portion of the valve box. The valve box lid shall be furnished with a pentagon-head bolt for locking.
3. The upper section of each box shall have a bottom flange of sufficient bearing area to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve and shall be oval.
4. An approved operating key or wrench shall be provided.
5. All fasteners shall be Type 304 stainless steel.

B. Ball Valves

Ball valves for curb stops shall comply with the minimum requirements of the City of Pflugerville SPL Item "Ball Valves for Curb Stops."

C. Air-Vacuum Release Valves

Air-vacuum release valves shall comply with the minimum standards in AWWA C512 and SPL Items "Air Release / Vacuum Relief Valves for Potable Water," and "Air Release / Vacuum Relief Valves for Reclaimed Water."

The air-vacuum release valves shall be installed as shown on the Drawings. The valve body shall be of cast iron ASTM A126-B; the floats, float guide, and stem shall be of Type 316 stainless steel. The resilient seat shall be of Buna N. The valve shall be suitable for 150 psig working pressure. Valve shall have standard NPT inlets and outlet ports with diameters as indicated on the Plans. Valve shall be Model 200A Series by APCO Valve and Primer Corporation, Schaumburg, IL, or approved equal.

D. Check Valves

Controlled closing swing check valves shall meet the minimum requirements of AWWA C508, the City of Pflugerville SPL Item "Swing Check Valves, AWWA C508" and the following:

1. Check valves shall be of the controlled closing swing type. The controlled closing swing check valves shall be guaranteed to operate under severe conditions as check valves. The valve shall be

designed to open smoothly, provide full pipe line flow, permit minimum head loss and close at a controlled rate of speed for the final predetermined portion of its stroke. All bolts and nuts used in the assembly shall be steel, commercial.

2. The valve body shall be Cast Iron ASTM A126-B/ductile iron ASTM A536. The disc arm and chamber level shall be of heavy steel construction and keyed to the hinge shaft. The hinge shaft shall be of 18-8 stainless steel and of adequate diameter to withstand a complete hydraulic unbalance pressure of 125 psi on the valve disc. A single cushioning device mounted on the external side of the valve shall control the valve closure by way of the interchange of oil to and from an oil reservoir. The use of air or gas pressurized oil reservoir shall not be permitted. The oil plunger assembly shall be rigidly attached to the valve body by shoulder bolts or dowel pins to prevent fretting.
3. The Manufacturer, if required by the Engineer or the City, shall submit design calculations of principle component stresses to substantiate the integrity of the valve for the working pressure involved.
4. The valve when closed shall be tight seating by way of a resilient replaceable seat against a bronze seat ring in the body.
5. Valves shall be as manufactured by GA Industries or Series 6000 as manufactured by APCO. The City reserves the right to inspect all valves before shipment is made. Any failure of valves to operate satisfactorily during the first year of installation due to faulty workmanship or defective material shall be replaced and made good by the Manufacturer. Under these specifications, any valve stuffing box that leaks for any reason or because of excessive wear or deterioration of packing, shall be reason for classification as defective material.

Slanted/Tilted check valves shall meet following requirements:

1. Slanted or tilted check valves shall be furnished and installed where shown on the Plans.
2. The body of the valve shall be ductile iron or cast iron with access ports to the disc. The disc shall be cast iron. The seat and disc rings shall be bronze. Pivot pins and bushings shall be bronze or stainless steel. The valve shall include a localized indicator of the position of the valve.
3. The valves shall include a top mounted oil dash pot to prevent slamming of the disc. The dash pot shall control the last 10% of closure of the disc. The speed of closure within this 10% shall be adjustable.
4. Valves shall be APCO Slanting Disc, Valmatic or Golden Anderson Tilted Disc or approved equal.

E. Tapping Sleeves and Tapping Valves

Tapping sleeves shall conform to the applicable City of Pflugerville SPL Items including:

1. Cutting-In Sleeves
2. Tapping Sleeves: Iron Full-Body MJ (4 Inch & Larger)
3. Tapping Sleeves: Iron Full-Body for CSC Pipe
4. Tapping Sleeves: Iron Full-Body for Line Stops on CSC Pipe
5. Tapping Sleeves: Iron Full-Body for Line Stops
6. Tapping Sleeves: Iron Full-Body MJ (16 Inch & Larger)

F. Fire Hydrants

All fire hydrants shall be Dry Barrel, Traffic Model (break-away), Post Type having Compression Type Main Valves with 5 ¼" (133 mm) opening, closing with line pressure. Approved models are listed on SPL Item "Fire Hydrants" of the City of Pflugerville Standard Products List and shall meet the requirements of AAWA C502.

All fire hydrants shall have manufacturer's name, initial, insignia, or abbreviations in common usage, designated size of main valve and year of manufacture cast into upper barrel.

All fire hydrants shall meet the following requirements:

1. Fire hydrants shall be dry-barrel type conforming to the requirements of the latest revision of AWWA C502. Hydrants shall be designed such that the hydrant valve closes with line pressure preventing loss of water and consequent flooding in the event of traffic damage.
2. Hydrants shall have six (6)-inch mechanical joint inlet connections, two 2½-inch hose connections and one 5¼-inch pumper connection. Threads for the hose and pumper connections shall be in accordance with National Standard Thread. Hydrants shall be according to Manufacturer's standard pattern. Hydrants shall be equipped with "O" ring packing. Each nozzle cap shall be provided with a Buna-N rubber washer.
3. Hydrants shall be so arranged that the direction of outlets may be turned 90 degrees without interference with the drip mechanism or obstructing the discharge from any outlet. The body of the hydrant shall be equipped with a breakable flange, or breakable cast iron flange bolts, just above the grade line.
4. A bronze or rustproof steel nut and check nut shall be provided to hold the main hydrant valve on its stem.
5. Hydrant valve opening shall have an area at least equal to that area of a 5¼-inch minimum diameter circle and be obstructed only by the valve rod. Each hydrant shall be able to deliver 500 gallons minimum through its two 2½-inch hose nozzles when opened together with a loss of not more than 2 psi in the hydrant.
6. Hydrants shall be designed for installation in a trench that will provide minimum cover as noted on Drawings and for the flange to be 3 1/2-inches above ground surface. Hydrant extensions shall be as manufactured by the company furnishing the hydrants and of a style appropriate for the hydrants as furnished.
7. Hydrants shall be provided with an automatic and positively operating, non-corrodible drain or drip valve so as to drain the hydrant completely when the main valve is shut. A drain valve operating by springs or gravity is not acceptable.
8. Operating stems whose threads are located in the barrel or waterway shall be of manganese bronze, everdur, or other high-quality non-corrodible metal, and all working parts in the waterway shall be bronze to bronze.
9. Hydrants shall open by turning operating nut to left (counter-clockwise) and shall be marked with a raised arrow and the word "open" to indicate the direction to turn stem to open hydrant.
10. Hydrants shall be furnished with caps, double galvanized steel hose cap chain, galvanized steel pumper hose cap chain, a galvanized steel chain holder and any other hooks and/or appurtenances required for proper use.
11. Hydrant operating nut shall be AWWA Standard pentagonal type measuring 1½-inch point to flat.
12. Hydrants shall be hydrostatically tested as specified in AWWA C502.
13. M. Hydrants shall be of the following:
 - (a) Meuller Company – FH85
 - (b) American Flow Contril – B84B
 - (c) CLOW Corporation – F2545
14. All iron work to be set below ground, after being thoroughly cleaned, shall be painted with two (2) coats of asphalt varnish specified in AWWA C502. Iron work to be left above ground shall be factory primed and painted silver using a high grade enamel paint of quality and color to correspond to the present standard of the City.
15. Fire hydrants shall be installed on the same side of the street or roadway as the water main and shall be installed plumb and true.
16. Heel and thrust blocks shall be placed in undisturbed soil as shown in the details of the Drawings.
17. Double blue reflector "HYE – LITES" brand as manufactured by pavement markers ink shall be installed at the centerline of the street or roadway perpendicular to the hydrant.

G. Pressure/Flow Control Valves

All control valves to regulate pressure, flow, etc., in City lines shall be models listed in the City of Pflugerville Standard Products List (SPL) Item "Pressure Reducing Valves."

H. Drain Valves

Drain valve materials and installation shall conform to City of Pflugerville Standard Detail No. 511S-9.

I. Valve Stem Extensions:

Valve stem extensions shall consist of a single piece of the required length with a socket on one end and a nut on the other.

J. Flanges:

Flanges shall be cast solid and faced accurately at right angles to the axis of the casting. Dimensions and drilling of flanges shall be in accordance with the American Standard Association for a working pressure of 125 pounds per square inch. Special drilling shall be provided where necessary.

K. Corporation Stops:

Corporation stops shall be brass, not less than 1-inch in diameter and shall be installed where shown, specified or required and shall comply with the City of Pflugerville SPL Item "Brass Goods." All corporation stops shall have a 2" square operating nut.

Provide corporation stops as manufactured by the following:

1. Ford Company
2. Mueller
3. A.Y. McDonald Mfg. Co.

511S.4 - Construction Methods

A. Delivery, Storage and Handling

Deliver materials to the site to ensure uninterrupted progress of the work.

Protect threads and seats from corrosion and damage. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until time of use.

Provide covers for all openings.

1. All valves three (3) inches and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.
2. All valves smaller than three (3) inches shall be shipped and stored as above except that heavy card board covers may be furnished instead of wood.

Store equipment to permit easy access for inspection and identification. Any corrosion in evidence at the time of City acceptance shall be removed, or the valve shall be removed from the job. Store all equipment in covered storage off the ground.

B. Setting Valves, Tapping Sleeves, Drains and Air Releases

Unless otherwise indicated, main line valves, drain valves and piping, air and vacuum release assemblies and other miscellaneous accessories shall be set and jointed in the manner described for cleaning, laying, and jointing pipe. During Installation of all valves and appurtenances, the Contractor shall verify that all items are clean, free of defect in material and workmanship, and function properly. All valves shall be closed and kept closed until otherwise directed by the City.

Unless otherwise indicated, valves shall be set at the locations shown on the Drawings and such that their location does not conflict with other appurtenances such as curb ramps. Valves shall be cleaned and manually operated before installation. Buried valves and valve boxes shall be set with the stem vertically aligned in the center of the valve box. Valves shall be installed so that the tops of operating

stems will be at the proper elevation required for the piping at the location indicated above; the top of the box or casing approximately 6 inches below the standard street subgrade in streets which are excavated for paving construction or where such excavation is scheduled or elsewhere as directed by the City or designated representative.

Valves shall be set on a firm foundation and supported by tamping pipe bedding material under the sides of the valve. The valve box shall be supported during backfilling and maintained in vertical alignment with the top flush with finish grade. The valve box shall be set so as not to transmit traffic loads to the valve. Before backfilling, all exposed portions of any bolts shall be coated with two (2) coats of bituminous paint.

Drainage branches or air blowoffs shall not be connected to any sanitary sewer or submerged in any stream or be installed in any other manner that will permit back siphonage into the distribution system (see City of Pflugerville "Standard Detail Drawings- Series 500/500S"). Every drain line and every air release line shall have a full-sized independent gate valve flanged directly to the main. Flap-valves, shear gates, etc., will not be accepted.

The City of Pflugerville shall be contacted, and their permission granted, prior to tapping a line. The required procedures and timetable shall be followed exactly. Installation shall be made under pressure and flow shall be maintained. The diameters of the tap shall be a minimum of $\frac{1}{4}$ -inch less than the inside diameter of the branch line. The entire operation shall be conducted by workers experienced in the installation of tapping sleeves and valves. The tapping machine shall be furnished by the Contractor. Determine the location of the line to be tapped to confirm that the proposed location will be satisfactory and that no interference will be encountered such as joints or fittings. No tap or sleeve will be made closer than three (3) feet from a pipe joint.

A tapping sleeve and valve with boxes shall be set squarely centered on the line to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Thrust blocks or other permanent restraint acceptable to the City shall be provided behind all tapping sleeves. Proper tamping of supporting pipe bedding material around and under the valve and sleeve is mandatory for buried installations.

After completing the tap, the valve shall be flushed to ensure that the valve seat is clean. All proper regulatory procedures (including disinfection) shall be followed exactly.

Conduct a functional field test of each valve, including actuators and valve control equipment, in presence of Engineer or the Representative of the City to demonstrate that each part and all components together function correctly. All testing equipment required shall be provided by the Contractor at his/her sole expense.

C. Setting Fire Hydrants

Fire hydrants shall be set at the locations as shown on the Plans and bedded on a firm foundation. Hydrants and connecting pipe shall have at least the same depth of cover as the distributing pipe. A drainage pit as detailed on the Plans shall be filled with $\frac{3}{4}$ -inch washed rock gravel and compacted. The hydrants shall be set upon a slab of concrete not less than four (4)-inches thick and 15-inches square. During backfilling, additional screened gravel shall be brought up around and six (6) inches over the drain port. Each hydrant shall be set in true vertical alignment and properly braced.

2,500 psi concrete thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Minimum bearing area shall be as shown on the Plans. Eight (8) mil. Polyethylene film shall be placed around the hydrant elbow before placing concrete. CARE SHALL BE TAKEN TO ENSURE THAT CONCRETE DOES NOT PLUG THE DRAIN PORTS.

All connections from the main to the fire hydrants shall be anchoring mechanical joints designed to prevent movement due to thrust or pressure.

The hydrant shall be tied to the pipe with suitable rods or clamps and shall be coated with Koppers 300 or approved equal at a minimum of 8 mil. thick. Bolts shall have a zinc bolt cover per AWWA. Hydrant paint shall be touched up as required after installation.

Fire hydrants shall be factory primed and painted silver using a high-grade enamel.

D. Pressure Taps: Refer to Section 510.3 (24) of Standard Specification Item Number 510, "Pipe."

E. Plugging Dead Ends

Standard plugs shall be inserted into the bells of all dead ends of pipes, tees or crosses and spigot ends shall be capped. All end plugs or caps shall be secured to the pipe conforming to Section 510.3 (22) of Standard Specification Item Number 510, "Pipe."

F. Protective Covering

Unless otherwise indicated, all flanges, nuts, bolts, threaded outlets and all other steel component shall be coal tar coated and shall be wrapped with standard minimum 8-mil low density polyethylene film, with all edges and laps taped securely to provide a continuous and watertight wrap. Repair all punctures of the polyethylene, including those caused in the placement of bedding aggregates, with duct tape to restore the continuous protective wrap before backfilling. For reclaimed water piping, the polyethylene shall be purple.

G. Valve Box, Casing and Cover

Stems of all buried valves shall be protected by valve box assemblies. Valve box castings shall conform to ASTM A 48, Class 30B. Testing shall be verified by the manufacturer at the time of shipment. Each casting shall have cast upon it a distinct mark identifying the manufacturer and the country of origin. Valve boxes and covers for potable water shall be round. Valve boxes and covers for reclaimed water piping shall be square and shall have "Reclaimed Water" indicated on the lid.

H. Drain Valve Installations

Refer to City of Pflugerville Standards 511S-9A.

I. Air Release Assemblies

Refer to City of Pflugerville Standards 511S-1A, 511S-1B, 511S-2A, 511S-2B, 511S-3A and 511S-3B.

J. Pressure/Flow Control Valves

Assemblies shall be installed as indicated.

K. Connections to Existing System

Refer to Item No. 510, "Pipe" for connections to the existing system.

L. Shutoffs

Refer to Item No. 510, "Pipe" for shutoffs.

511S.5 - Measurement

All types of valves will be measured per each. Fire hydrants and drain valve assemblies will be measured per each. Fire Hydrant barrel extensions will be measured per vertical foot. Pressure/Flow control valve assemblies and both manual and automatic air release assemblies will be measured per each.

Bury depths exceeding 5.5 feet are defined as Additional Bury Depths. Additional bury depths will only be measured if indicated on the Drawings and identified in the Standard Contract Bid Form 00300U; otherwise, the unit bid price for each completed unit includes all depths.

511S.6 - Payment

Payment shall include full compensation, in accordance with the pay item established in the bid, for excavation, furnishing, hauling and placing valves, drain valve assemblies, fire hydrants and barrel extensions including anchorage and all incidental materials and work; preparing, shaping, dewatering, bedding, placing and compacting backfill materials and for all other incidentals necessary to complete the installation, as indicated in the Drawings, complete in place.

Payment for iron fittings and for wet connections is covered in Section 510.6 of Standard Specification Item 510, "Pipe."

Payment for excavation safety systems is covered in Section 509S.10 of Standard Specification Item 509S, Excavation Safety Systems.

- A. Valves: Valves will be paid for at the unit bid price for the size and type valve installed, including valve stem casing and cover, excavation and backfill, setting, adjusting to grade, anchoring in place, and other appurtenances necessary for proper operation.
- B. Fire Hydrants: Fire Hydrants installation shall be paid for at the unit bid price, which includes all necessary labor and materials to set, adjust to grade and anchor the hydrant body, barrel extensions, concrete block, gravel drain and other appurtenances necessary for proper operation; but shall not include pipe and valve between the main line and fire hydrant base. The 6 inch connection pipe, 6 inch gate valve, test station, concrete collar, thrust block, drain pit, concrete pad, rods, bolts, paint, protective coatings and fittings for fire hydrants shall not be paid for separately. Fire hydrants shall be furnished with the proper length of barrel to comply with these Specifications. Reflectorized pavement markers shall be installed at the centerline of the street or roadway, perpendicular to the hydrant. Barrel extensions and reflectorized pavement markers will not be measure and paid for separately.
- C. Pressure or Flow Control Valve Assemblies: Pressure control and flow control valve assemblies will be paid for at the unit bid price, including box or vault, setting, adjusting to grade, anchoring in place, adjusting the control device to the required conditions, providing other appurtenances necessary for proper operation, and placing in operation.
- D. Drain Valve Assemblies: Drain valve installation shall be paid for at the unit bid price, which includes all necessary labor and materials to set, adjust to grade and anchor the bends, vertical piping, blind flange, joint restraint devices, concrete blocking, concrete pad the drain valve, setting, adjusting to grade, anchoring in place, and other appurtenances necessary for proper operation; but shall not include pipe and valve between the main line and drain valve buried bend.
- E. Air/Vacuum Release Valve Assembly: Automatic air-vacuum release assemblies will be paid for at the unit bid price and will include the main line tap or outlet, all pipe, valves, fittings, box or vault and cover, and other appurtenances necessary for proper operation.
- F. Reflectorized Pavement Markers: Pavement markers will be paid for at the unit bid price, which will include necessary surface preparation and adhesive, as per Standard Specification Item No. 863S.8.

Payment, when included as a contract pay item, will be made under one of the following:

Pay Item No. 511S-A:	Valves, _____ Type, _____ Diameter	Per Each.
Pay Item No. 511S-B:	Fire Hydrants (See Standard No. 511S-17)	Per Each.
Pay Item No. 511S-C:	Pressure or Flow Control Valve Assemblies	Per Each.
Pay Item No. 511S-D:	Drain Valve Assemblies (See Standard No. 511S-9A)	Per Each.
Pay Item No. 511S-E:	Automatic Combination Air/Vacuum Release Valve Assembly, _____ Diameter.	Per Each.

END

ITEM NO. 639S - ROCK BERM

639S.1 - Description

This item shall govern the construction of a temporary berm of open graded rock that is installed at the toe of a slope on the perimeter of a developing area. Rock berms are appropriate for use as flow diverters, energy dissipators, grade control, and level spreaders to release the water in sheet flow. This item shall also govern the removal of the "Rock Berm" and re-vegetation of the area.

639S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall submit electronically the following submittal requirements:

- A. Function (flow diversion, grade control, energy dissipator, level spreader, or other) and dimensions of the rock berm
- B. Source, type and gradation of rock
- C. Re-vegetation program, including:
 - 1. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.
 - 2. Type of mulch.
 - 3. Type of tacking agent.
 - 4. Type and rate of application of fertilizer.

639S.3 - Design Criteria

A detailed design is not required for the installation of a rock berm; however, the following criteria shall be observed:

Drainage Area	-	less than 5 acres (2 hectares).
Height	-	18 inches minimum height, measured vertically from the top of the existing ground at the upslope toe to the top of the berm.
Top Width	-	2 feet minimum.
Side Slopes	-	2:1 or flatter.
Grade	-	Berms will be built along a contour as near possible to a 0 percent grade.

639S.4 - Materials

Rock shall be 3 inches to 5 inches, open graded as indicated on Standard Detail No. 639S-1 "Rock Berm". Seeding for re-vegetation shall conform to Item No. 604S, "Seeding for Erosion Control".

Woven wire sheathing shall be 20-gauge with 1-inch openings.

639S.5 - Construction Methods

All trees, brush, stumps and objectionable material shall be removed and disposed in a manner that will not interfere with the construction of the berm.

A trench shall be excavated to a minimum depth of 4 inches below existing grade for placement of the rock as indicated on Standard Detail No. 639S-1 "Rock Berm" and the Drawings. Woven wire fabric shall be placed on the ground along the proposed installation with enough overlap to completely encircle the finished size of berm. Rock shall be placed along the center of the wire to the designated height indicated on the Drawings, and the structure wrapped in the previously placed wire mesh secure enough so that when it is walked across its shape is maintained. The wire mesh shall be secured with tie wire. The ends of the berm shall be tied into existing upslope grade.

The area upstream from the rock berm shall be maintained in a condition, which will allow sediment to be removed following the runoff from a rainfall event. After each rainfall event with an accumulation of 1 inch or more, an inspection of the rock berm will be made by the Contractor and the stone shall be replaced, when the structure ceases to function as intended because of sediment accumulation among the rocks, washout, construction traffic damage, etc.

If the sediment reaches a depth equal to $\frac{1}{3}$ the height of the berm or 6 inches, whichever is less, the Contractor will remove the accumulated sediment and dispose of it at an approved disposal site in a manner that will not contribute to additional sedimentation. The berm will be reshaped as needed during construction.

When the site is completely stabilized, the berm will be removed and disposed of in a manner approved by the City Engineer or designated representative.

The area will be re-vegetated as required by Item No. 604S, "Seeding for Erosion Control".

639S.6 - Measurement

Acceptable work performed and prescribed in this item will be measured by the linear foot along the centerline of top of berm

639S.7 - Payment

The work performed and material furnished and measured as provided under "Measurement" to construct this item will be paid for at the unit bid price per linear foot of rock berm barrier as indicated on the Drawings. The Unit Bid Price shall include full compensation for: (a) furnishing, hauling and placing all materials including all labor, tools, equipment and incidentals needed to complete the work, (b) maintaining the berm, (c) removing sediment accumulations, (d) rock replacement, (e) removing and disposing of all materials when the berm is no longer required and (f) re-vegetating the site upon removal of the berm.

Payment will be made under:

Pay Item No. 639S-A:	Rock Berm	Per Lineal Foot.

END

ITEM NO. 641S - STABILIZED CONSTRUCTION ENTRANCE

641S.1 - Description

This item governs the construction of a stabilized pad of crushed stone located at any point where traffic will be entering or leaving a construction site to or from a public right of way, street, alley, sidewalk or parking area. The removal of the stabilized pad of crushed stone shall also be included in the item. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking or deposition of sediment onto public right of way.

641S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall submit electronically the following submittal requirements:

- A. Source, type and gradation of rock

641S.3 - Materials

Rock shall be 4-inch to 8-inch coarse aggregate.

641S.4 - Construction Methods

All trees, brush, stumps, obstructions and other objectionable material shall be removed and disposed of in a manner that will not interfere with the excavation and construction of the entrance as indicated on the Drawings or as presented in Standard Details No. 641S-1 "Stabilized Construction Entrance".

The stabilized construction entrance shall have a minimum width not less than the full width of the ingress/egress and a minimum length of 50 feet. An 8-inch high diversion ridge shall be constructed 15 feet from the edge of the existing roadway. Rock used shall be 4-inch to 8-inch coarse aggregate and shall be placed to a depth of at least 8 inches. Geotextile fabric shall be used as required in accordance with the Drawings.

The entrance shall not drain onto the public right of way or shall not allow surface water runoff to exit the construction site. Runoff from the stabilized construction entrance onto a public street will not be allowed except for the first 15 feet connecting to the public street.

When necessary, vehicle wheels shall be cleaned to remove sediment prior to entrance onto public right of way. When vehicle washing is required, it shall be done on an area stabilized with crushed stone, which drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch or watercourse through use of sandbags, gravel, boards, silt fence (Standard Specification Item No 642S "Temporary Erosion and Sediment Control") or other methods approved by the City Engineer or designated representative.

The entrance shall be maintained in a condition that will prevent tracking or disposition of sediment onto public right of way. This restriction may require periodic top dressing with additional stone as conditions demand, as well as the repair and/or cleanout of any measures used to trap sediment. All sediment that is spilled, dropped, washed or tracked onto public right of way must be removed immediately.

641S.5 - Measurement

Acceptable work performed as prescribed in this item will be measured by unit of each stabilized construction entrance installed.

641S.6 - Payment

The work performed and materials furnished and measured as provided under "Measurement" will be paid for at the unit bid price per lineal foot of "Stabilized Construction Entrance". The price shall include full compensation for furnishing, hauling and placing all materials, labor, tools, equipment and incidentals necessary to complete the work including inspecting, repairing, replacing and relocating existing fencing, removal of silt and removal and disposal of all materials at the completion of construction.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 641S-A:	Stabilized Construction Entrance	Per Each.

END

ITEM NO. 642S - TEMPORARY EROSION AND SEDIMENT CONTROL

642S.1 - Description

This item shall govern the provision and placement of a silt fence fabric fence, triangular filter dike, curb inlet protection and soil retention blankets, including maintenance, removal of accumulated silt, removal of the temporary erosion control devices and re-vegetation of disturbed areas upon completion of the project.

642S.2 - Submittals

Within 14 days prior to the commencement of related work, the Contractor shall submit electronically the following submittal requirements:

- A. Source, manufacturer, characteristics and test data for the silt fence fabric
- B. Manufacturer, characteristics and test data for the posts and wire fence for silt fence
- C. Source, manufacturer, characteristics and test data for wire mesh for silt fence
- D. Source, manufacturer, characteristics and test data for the geotextile fabric for triangular filter dikes
- E. Source, type and gradation of rock for triangular filter dikes
- F. Source, manufacturer, characteristics and test data for welded wire mesh for triangular filter dikes
- G. Source, manufacturer, characteristics and test data for the geotextile fabric for curb inlet protection
- H. Re-vegetation program, including:
 - 1. Identification of the type, source, mixture, Pure Live Seed (PLS) and rate of application of the seeding.
 - 2. Type of mulch.
 - 3. Type of tacking agent.
 - 4. Type and rate of application of fertilizer.

642S.3 - Materials

A. Fabric

1. Silt Fence

The silt fence fabric shall be 4.5 oz. per SY minimum and supplied in rolls a minimum of 36 inches wide. Silt fence shall conform to the City of Pflugerville Standard Detail 642S-1 "Silt Fence".

2. Triangular Filter Dike

Geotextile fabric shall be nonwoven, 4.5 oz. minimum and 30 inches wide.

3. Curb Inlet Protection

Geotextile fabric shall be nonwoven, 4.5 oz. minimum.

B. Posts

Posts for silt fence shall be heavy-weight steel Tee posts, not less than 4 feet in length.

C. Wire Fence

1. Silt Fence

Welded wire fabric for silt fence shall be 2-inch by 4-inch mesh of 12-gauge by 12-gauge galvanized wire.

2. Triangular Filter Dike

Welded wire mesh fabric for triangular filter dikes shall be 6-inch by 6-inch mesh of 6-gauge by 6-gauge wire.

D. Tie Wires

Tie wires for securing silt fence fabric to wire mesh shall be light gauge metal clips (hog rings) or 1/32-inch diameter soft aluminum wire.

E. Rock

Rock for triangular filter dikes shall be 3-inch to 5-inch open graded.

F. Soil Retention Blanket

Only soil retention blankets included on TxDOT's Approved Product List will be considered acceptable.

G. Prefabricated Commercial Silt Fence

Prefabricated commercial silt fence may be substituted for built-in-field fence. Prefabricated silt fence shall be "Envirofence" as manufactured by Mirafi Inc., Charlotte, NC or approved equivalent.

642S.4 - Construction Methods

A. Silt Fence

The silt fence shall be laid out as closely as possible to the contour. The ground shall be cleared of debris, rocks, and plants (including grasses taller than 2 inches) to provide a smooth flow approach surface. A trench 4 inches deep by 4 inches wide shall be excavated on the upstream side of the fence per the Drawings.

Heavy Tee posts shall be driven at least 12 inches to the ground and at a slight angle towards the flow. Wire mesh shall be attached to the Tee posts with 11 ½-inch galvanized Tee post clips. The top of the wire is to be 24 inches above ground level. The welded wire mesh shall be overlapped 6 inches and tied at least 6 times with hog rings.

The site fence shall be installed with a skirt (11 inches wide, minimum) placed on the uphill side of the fence inside the excavated trench. The fabric shall overlap the top of the wire by 1 inch.

The silt fence shall be anchored by backfilling the trench with excavated dirt and rocks.

The silt fence shall be repaired, replaced, and/or relocated when necessary or as directed by the City Engineer or designated representative. Accumulated silt shall be removed when it reaches a depth of 6 inches.

Per OSHA §1926.701, "all protruding reinforcing steel, onto and into which employees could fall, shall be guarded to eliminate the hazard of impalement". Caps must be large enough to dissipate the forces of impact to prevent impalement from a reasonably foreseeable fall distance. It should be noted that the use of impalement protection caps is but one method of protection; covers or wooden troughs can be another means of meeting the guarding requirement. For City of Pflugerville purposes, this also applies to Tee posts.

B. Triangular Filter Dike

The triangular filter dike shall be laid out as closely as possible to the contour. The area for the filter dike shall be cleared of debris, rocks and plants that will interfere with installation. The dike shall be placed 1 section at a time, with the skirt on the uphill side on the uphill side towards the direction of flow, anchoring each section to the ground before the next section is placed. Anchors should be placed 2 feet on center alternating from front to back so that there is actually 1 foot in between anchors. Securely fasten the skirt from 1 section of filter dike to the next. Filter dikes must maintain continuous contact with the ground.

Triangular filter dike sections shall be either 10 feet or 20 feet in length, and 18 inches wide on all 3 faces. Geotextile fabric shall extend to 12-inches upstream of the triangular filter dike structure. 3-inch to 5-inch open graded rock shall be placed over the skirt to anchor it on the upstream side.

The triangular filter dike shall be repaired, replaced and/or relocated when necessary or as directed by the City Engineer or designated representative. After the site is completely stabilized, the dikes and any remaining silt should be removed. Silt should be disposed of in a manner that will not contribute to additional siltation.

C. Curb Inlet Protection

Pavement shall be cleared of debris, rock and other objectionable materials to provide a smooth surface for installation.

The Contractor shall place the nonwoven 4.5 oz. (minimum) filter fabric over the inlet and extend to 5 feet beyond the opening, upstream of the inlet. Fabric shall be terminated in the street gutter with sandbags placed in the gutter flow line. Sandbags shall be placed on top of filter fabric around the perimeter of the protected area to secure the fabric. The fabric must be secured to wire backing with clips or hog rings. A section of filter fabric shall be removed to allow for a clear gap near the top of the inlet opening. The bottom of the gap must be a minimum of 4" from the bottom of the inlet opening.

Care shall be taken to ensure that the inlet protection will remain in place during periods of heavy runoff and that severe ponding will not occur in the street.

D. Soil Retention Blankets

Soil retention blankets shall be installed in all seeded drainage swales and ditches as shown on the Drawings or as directed by the City Engineer or designated representative. Only soil retention blankets included on TxDOT's Approved Product List will be considered acceptable for use.

The area to be covered shall be properly prepared, fertilized and seeded with permanent vegetation before the blanket is applied.

When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area.

The blankets shall be applied in the direction of water flow, and stapled. Blankets shall be placed a minimum of three (3) rows, of four (4) foot wide (total approx. 12-foot width) within the drainage swale/ditch and stapled together in accordance with Manufacturer's instructions.

Side overlaps shall be four (4) inch minimum. The staples shall be made of wire, 0.091-inch in diameter or greater, "U" shaped with legs 10-inches in length and a 1 1/2-inch crown. The staples shall be driven vertically into the ground, spaced approximately two (2) linear feet apart, on each side, and one (1) row in the center alternately spaced between each side.

Upper and lower ends of the matting shall be buried to a depth of four (4) inches in a trench.

Erosion stops shall be created every 25-feet by making a fold in the fabric and carrying the fold into a silt trench across the full width of the blanket. The bottom of the fold shall be four (4) inches below the ground surface. Staple on both sides of fold.

Where the matting must be cut or more than one (1) roll length is required in the swale, turn down upper end of downstream roll into a slit trench to a depth of four (4) inches. Overlap lower end of upstream roll four (4) inches past edge of downstream roll and staple.

To ensure full contact with soil surface, roll matting with a roller weighing 100-pounds per foot of width perpendicular to flow direction after seeding, placing matting and stapling.

Thoroughly inspect channel after completion. Correct any areas where matting does not present a smooth surface in full contact with the soil below.

E. Tree Protection – Chain Link Fence

Chain link fence shall be five (5) feet in height.

Fence shall be installed around the driplines of the trees to be protected.

Tree protection fences shall be installed prior to the commencement of any site preparation work (clearing, grubbing, or grading).

Fences shall completely surround the tree, or clusters of trees; will be located at the outermost limit of the tree branches (dripline), and will be maintained throughout the construction of the project in order to prevent the following:

1. Soil compaction in the root zone area resulting from vehicular traffic, or storage of equipment or materials.

2. Root zone disturbances due to grade changes greater than six (6) inches cut or fill or trenching not reviewed and authorized by the City.
3. Wounds to exposed roots, trunks or limbs by mechanical equipment.

Other activities detrimental to trees, such as chemical storage, cement truck cleaning and fire.

Exceptions to installing fences at tree driplines may be permitted in the following cases:

Where permeable paving is to be installed, erect the fence at the outer limits of the permeable paving area.

Where trees are close to a proposed building, erect the fence no closer than six (6) feet to building.

F. Tree Protection – Wood Slats

Where any exceptions result in a fence being closer than four (4) feet to a tree trunk, protect the trunk with strapped-on-planking two inches by four inches (2"x4") wood slats to a height of eight (8) feet, or to the limits of lower branching in addition to the reduced fencing provided.

Trees most heavily impacted by construction activities should be watered deeply once a week during periods of hot, dry weather. Tree crowns should be sprayed with water periodically to reduce dust accumulation on the leaves.

Any trenching required for the installation of landscape irrigation shall be placed as far from existing tree trunks as possible.

No landscape topsoil dressing greater than four (4) inches shall be permitted within the dripline of the tree. No soil is permitted on the root flare of any tree.

Any roots exposed by construction activity shall be pruned flush with the soil. Backfill root areas with good quality topsoil as soon as possible. If exposed root areas are not backfilled within two (2) days, cover them with organic material in a manner which reduces soil temperature, and minimizes water loss due to evaporation.

Prior to excavation or grade cutting within tree dripline, make a clean cut between the disturbed and undisturbed root zones with a rock saw or similar equipment, to minimize damage to remaining roots.

Pruning to provide clearance for structures, vehicular traffic and equipment shall take place before construction starts.

642S.5 - Measurement

The work performed and the materials furnished under this item will be measured by the lineal foot of "Silt Fence", complete in place.

642S.6 - Payment

The work performed and materials furnished and measured as provided under "Measurement" will be paid for at the unit bid price per lineal foot of "Silt Fence". The price shall include full compensation for furnishing, hauling and placing all materials, labor, tools, equipment and incidentals necessary to

complete the work including inspecting, repairing, replacing and relocating the fence, removal of silt and removal and disposal of all materials at the completion of construction in and re-vegetation of disturbed areas.

Payment will be made under:

Pay Item No. 642S-A:	Silt Fence for Erosion Control	Per Lineal Foot.
Pay Item No. 642S-B:	Rock Berm	Per Lineal Foot.
Pay Item No. 642S-C:	Tree Protection	Per Each.

END

SERIES 700 - INCIDENTAL CONSTRUCTION

ITEM NO. 700S - MOBILIZATION

700S.1 - Description

This item shall govern the mobilization of personnel, equipment and materials at the work site for other contract items that will be performed by the Contractor. Mobilization shall include, but not be limited to the movement of equipment, personnel, material, supplies, etc. to the Work site; the installation of temporary facilities (when not paid for separately) and the establishment of office and other necessary facilities prior to the initiation of the Work. The cost of the Payment Bond and Performance Bond on the Work that is delayed due to circumstances beyond Contractor's control, a closed construction season or for the convenience of the City of Pflugerville will be considered part of the mobilization item under this Contract.

700S.2 - Measurement.

Measurement of the Specification Item, "Mobilization", as specified herein as "Total Mobilization Payment", will be by the "Lump Sum", as the Work progresses.

700S.3 - Payment.

The adjusted contract amount as used below is defined as the original contract amount less the lump sum bid for Mobilization and any payments for materials or equipment not yet incorporated in the Work. The Contractor shall submit a lump sum amount for Payment Item No. 700S-TM, "Total Mobilization Payment".

"Initial Mobilization Payout" as used below is defined as:

1. 8% of the original contract amount for projects with an original contract amount of \$ 0.5 million or less; or
2. 4% of the original contract amount for projects with an original contract amount greater than \$ 0.5 million.

In those instances where the "Initial Mobilization Payout", as defined above, exceeds the "Total Mobilization Payment" lump sum bid item (i.e. Payment Item No. 700S-TM), the "Total Mobilization Payment" shall be used as the "Initial Mobilization Payout". In no instance shall the "Initial Mobilization Payout" exceed the "Total Mobilization Payment" bid item.

Partial payments of the "Initial Mobilization Payout" shall be as follows:

- A. Upon presentation of a paid invoice for the Payment Bond, Performance Bond and/or required insurance, the Contractor will be paid that cost from the amount bid for "Total Mobilization Payment".
- B. The Mobilization of tunnel boring machines, batch plants or other similar facilities, along with supporting materials and equipment, to the work site or to the vicinity of the Work site will be considered as partial Mobilization under this contract. The Contractor shall provide a certified statement of the Contractor's expenditure for the Mobilization and setup of the facility and supporting equipment. Upon approval by the Engineer or designated representative, the certified expenditure will be paid from the amount bid for the Specification Item, "Total Mobilization Payment". In no case shall the combined amount for all of these facilities be more than 10 percent of the Mobilization "Total Mobilization Payment" lump sum bid or one (1) percent of the total contract amount, whichever is less.

- C. When one (1) percent of the adjusted contract amount is earned, 50 percent of the "Initial Mobilization Payout will be paid. Previous payments under this item will be deducted from this amount.
- D. When five (5) percent of the adjusted contract amount is earned, seventy-five (75) of the "Initial Mobilization Payout will be paid. Previous payments under this item will be deducted from this amount.
- E. When ten (10) percent of the adjusted contract amount is earned, one hundred (100) percent of the "Initial Mobilization Payout will be paid. Previous payments under this item will be deducted from this amount.
- F. Payment for the remainder of Pay Item No. 700S-TM, "Total Mobilization Payment" will be made upon receipt of the final pay estimate.

Payment will be made under:

Pay Item No. 700S-TM:	"Total Mobilization Payment"	Lump Sum

END

ITEM NO. 720S - METAL FOR STRUCTURES

720S.1 - Description

This item shall govern all structural and miscellaneous steel, anchor bolts, and miscellaneous metals used in structures. Reinforcing steel (Item No. 406S) and other structural materials are not included.

720S.2 - Submittals

The submittal requirements of this specification item include:

1. Certification or mill test reports indicating that all materials supplied are in accordance with this specification.
2. Any material proposed for use and not designated herein, including type and trade name for any material not generically specified by the American Society for Testing and Materials (ASTM). Submittal shall include material specification and technical data as required to show that the proposed material meets the intent of those specified herein.
3. When SI unit bolts are proposed for use on a project, submit sizing of bolt(s) and the U.S. Customary Unit (USCU) bolt size(s) the SI unit bolt(s) will be substituted for. Note: although this specification includes ASTM standards for both USCU and SI, there is no conversion between these standards; each contains a different set of bolts with different physical size characteristics. When SI unit bolts are used, appropriately sized SI unit nuts and washers shall also be provided.

720S.3 - Structural Steel for Main Members

Unless otherwise indicated, structural steel for main members shall conform to the longitudinal Charpy V-notch (CVN) requirements in accordance with Table A. Sampling and testing shall be in accordance with ASTM A673 (A673M).

A. Structural Steel

When indicated as Structural Steel, the material shall conform to ASTM A 36 (A36M), with a minimum specified yield strength of 36 ksi.

B. High Strength Structural Steel (HS)

When indicated as Structural Steel-HS, the material shall have a minimum required yield strength of 50 ksi, conforming to one of the following ASTM specifications:

1. ASTM A 572 (A572M).
2. ASTM A 588 (A588M).
3. ASTM A709 (A709M).
4. ASTM A992 (A992M).

C. Extra High Strength Structural Steel (XHS)

When indicated as Structural Steel-XHS, the material shall have a minimum specified yield strength of 90 ksi, conforming to one of the following ASTM specifications:

1. ASTM A 514 (A514M). Structural shapes and seamless tubing, meeting the requirements of A514 (A514M) will be permitted with a maximum tensile strength of 140 ksi for structural shapes and 145 ksi for seamless tubing.
2. ASTM A 517 (A517M).
ASTM A514 (A514M) and ASTM A517 (A517M) steels are considered weldable.

TABLE A				
Min. Spec. Yield Strength, F_y [ksi]	Thickness, t [in.]	Welded	Mech. Fastened	Min. CVN Toughness [ft. lb. @ °F]
$F_y \leq 40$	$t \leq 4$	X	X	15 @ 70
$40 < F_y \leq 65$	$t \leq 2$	X	X	15 @ 70
	$2 < t \leq 4$		X	15 @ 70
	$>2 < t \leq 4$	X		20 @ 70
$65 < F_y \leq 90$ (Refer to note 3 below)	$t \leq 2.5$	X	X	20 @ 50
	$2.5 < t \leq 4$		X	20 @ 50
	$2.5 < t \leq 4$	X		25 @ 50

Notes for Table A:

1. For $F_y \leq 50$ ksi, use the (H) frequency of testing in accordance with ASTM A673 (A673M).
2. For $F_y > 50$ ksi, use the (P) frequency of testing in accordance with ASTM A673 (A673M).
3. If the yield strength of the material exceeds 90 ksi, the testing temperature shall be reduced 15°F per 10 ksi increment, or portion thereof.

720S.4 - Miscellaneous Steel

A. High Strength Bolts

High strength bolts shall conform to ASTM A325, A325M, A490, or A490M, unless otherwise indicated. For submittal requirements of SI unit bolts, refer to 720S.3 C. Nuts for high strength bolts shall conform to ASTM A563 or A563M and washers shall conform to ASTM F436 or F436M.

B. Unless otherwise indicated, structural steel for secondary members such as shoes, diaphragms, stiffeners, bearing stiffeners, lateral bracing, diagonals, armor joints, and finger joints shall conform to one of the following:

1. ASTM A36 (A36M), with a minimum specified yield strength of 36 ksi.
2. ASTM A500, with a minimum specified yield strength of 46 ksi.

Structural steels used for secondary or nonstress-carrying members will not be subject to impact requirements.

All steels greater than 0.5-inch in thickness used for structural supports for highway signs, luminaries, and traffic signals shall conform to the longitudinal Charpy V-notch requirements of Table A.

C. Stud shear connectors, slab anchors, and anchors on armor and finger joints shall conform to ASTM A108, Grades 1015, 1018, or 1020, either semi- or fully-killed, with a minimum specified yield strength of 50 ksi.

D. Piling

Steel piling shall conform to one of the following:

1. ASTM A36 (A36M), with a minimum specified yield strength of 36 ksi.
2. ASTM A252, greater than or equal to 10 gauge, with a minimum specified yield strength of 35 ksi.
3. ASTM A328 (A328M), with a minimum specified yield strength of 39 ksi.
4. ASTM A1011 (A1011M), with a minimum specified yield strength of 33 ksi.

E. Deck Plates

Material for deck plates shall be corrosive-resistant structural steel conforming to ASTM A242 (A242M). The material must be of weldable quality and shall contain alloying elements that furnish corrosion resistance at least twice that of copper bearing structural steel. The type and trade name shall be submitted for review.

F. Rail Posts

Material for rail posts shall conform to ASTM A36 (A36M), with a minimum specified yield strength of 36 ksi.

G. Forgings

Steel forgings from which pins, rollers, trunnions, or other forged parts are to be fabricated shall conform to ASTM A668 (A668M), class C, D, F, or G, with a minimum specified yield strength of 33 ksi. As an alternate for pins four (4) inches in diameter or less, ASTM A108, grades 1016-1030, with a minimum specified yield strength of 36 ksi may be used.

H. Castings

Steel castings shall conform to ASTM A27 (A27M), Grade 70-36, with a minimum specified yield strength of 36 ksi.

I. Anchor Bolts

Anchor bolts shall conform to one of the following:

1. Plain and threaded bars used for anchorage purposes, ASTM A36 (A36M).
2. Headed bolts and nuts, ASTM A307, Grade A.
3. High strength anchor bolts, ASTM A193 (A193M). Nuts for high strength anchor bolts shall conform to ASTM A194 (A194M).

Anchor bolts shall not be galvanized unless otherwise indicated. When galvanized, anchor bolts and nuts shall be tapped or chased after galvanizing.

When heat treated material is specified or required, the test report for certification shall include the necessary certification relative to the heat-treating process.

J. Steel Pipe

Steel pipe shall conform to Item No. 510, "Pipe".

K. Tubing

Steel tubing shall conform to one of the following:

1. ASTM A500, Grade B.
2. API Standard 5L, Grade X52, except as noted herein, may be used if produced by a mill recognized as authorized to produce pipe with the API monogram and listed as such in the standard API specifications. Hydrostatic tests will not be required.

In lieu of the mill test report, a certificate from the manufacturer will be required for each lot or shipment certifying that the tubing meets the requirements stated above.

L. Pipe Rail

Pipe rail shall be construed to include special extruded and bent shapes and shall be of the section indicated. Pipe may be rolled or extruded to the shape indicated or may be cold pressed from a round pipe or flat plate.

If cold pressed, the design of the press and dies shall result in a pipe of uniform section and free from die marks. After the pipe has been formed to the required section, it shall be cut to the lengths required. The end cuts and notches shall be made at such angles with the axis of the pipe as required to produce vertical end faces and plumb posts when indicated. Cutting and notching of pipe shall be done with a saw or machine guided torch or other means that will insure a neat and uniform finish.

M. Deep Beam Rail

Deep beam rail shall conform to AASHTO M180, 10 or 12-gage (exclusive of protective coating). The terminal connector shall be of the same material, not less than 10-gage. Unless otherwise indicated, the rail element shall be galvanized.

720S.5 - Miscellaneous Metals

A. Iron

All iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. Castings shall conform to the following ASTM designations:

1. Malleable iron, ASTM A47 (A47M), grade 35018.
2. Gray iron, ASTM A48 (A48M), class 30 or 35.
3. Ductile iron, ASTM A536, grade 60-40-18 or 65-45-12.

B. Lead

Sheet lead shall conform to ASTM B29, refined lead or pig.

C. Copper

Copper strip or sheet shall conform to the following:

1. ASTM B100, alloy 510 or 511.
2. ASTM B152 (B152M).

D. Aluminum

Unless otherwise indicated, aluminum materials shall conform to the following:

1. Castings, ASTM B108, alloy A444-T4.
2. Extrusions, ASTM B221, alloy 6061-T6.
3. Sheet and plate, ASTM B209, alloy 2024-T3. If welding is required, alloy 6061-T6 can be substituted, but must be heat treated after fabrication and welding.
4. Deep beam rail, ASTM B209, alloy 2024-T3. The minimum thickness of the rail element shall be 0.156 inch (nominal) unless otherwise indicated.

E. Bronze

Bronze bearing and expansion plates shall conform to ASTM B22, alloy 911.

720S.6 - Fabrication, Erection and Painting

Fabrication, erection and painting of metal for structures shall conform to the following:

- A. Item No. 721S, "Steel Structures".
- B. Item No. 722S, "Protective Coatings". Aluminum or galvanized steel members shall not require painting.
- C. Item No. 723, "Structural Welding".

720S.7 - Galvanizing

Galvanizing, where indicated, shall conform to the following:

- A. Fabricated items, rolled, pressed or forged steel shapes, plates, pipes, tubular items, and bars, ASTM A123 (A123M).
- B. Steel or iron castings, ASTM A153 (A153M).
- C. Bolts, nuts, screws, washers, and other miscellaneous hardware, ASTM A153 (A153M), Class C or D or ASTM B695, Class 50.

The measurements of thickness and weight of galvanized coating shall be in accordance with TxDOT test method Tex-728-I.

720S.8 - Measurement

Measurement shall be in accordance with the following:

- A. Weights of supplied metal for structures shall be determined in accordance with Table B:

TABLE B	
Material	Weight [lb./cu. ft.]
Steel	490
Iron, cast	450
Iron, wrought	485
Lead	710
TABLE B (continued)	
Material	Weight [lb./cu. ft.]
Copper	556
Aluminum	165
Bronze	509

- B. Weights of bolts, nuts, and washers shall be in accordance with the American Institute of Steel Construction's "Steel Construction Manual".
- C. The quantity of metal for structures furnished and placed will be based on the weight of metal in the fabricated structure. The weight of erection bolts, paint or weld metal shall be excluded.
- D. The weights of secondary metals in steel or concrete structures (such as castings, bearing plates, anchor bolts, drains, deck plates, armor joints, and finger joints) for which no separate measurement is specified, shall be in accordance with this specification.
- E. The weights of rolled shapes and plates shall be computed on the basis of their normal weights and dimensions.
- F. The weights of castings will be computed from the dimensions indicated.
- G. Deductions will be made for all cuts, copes, perforations, and all holes except bolt holes.

Splices will be measured as follows:

- A. No additional weight will be allowed for weld metal in a welded splice.
- B. Where a bolted splice is permitted as an alternate for a welded splice, measurement will be made on the basis of a welded splice.
- C. Where a bolted splice is required, the weight of splice material, bolt heads, washers and nuts, with no deduction for holes, will be measured.

A change in design may be required and approved by the Engineer or designated representative, due to unforeseen conditions or other reason, which either increases or decreases the quantity of metal in the completed structure; the increase or decrease in weight will be measured in accordance with this specification and shall be included as a change from the original quantity computed. No adjustment will be made for a change which has not been approved by the Engineer or designated representative and which either increases or decreases the quantity of metal in the completed structure. These changes are subject to approval by the Engineer or designated representative nonetheless to assure that the completed structure is in accordance with the original design intent.

720S.9 - Payment

Structural steel for main members will be paid for at the unit price bid per pound for "Structural Steel", "Structural Steel-HS", "Structural Steel-XHS", or such other classification(s) of metal indicated.

Shipping invoice or acceptance slip weights will not be used as basis for payment.

Payment will be made based on the quantity indicated, except as may be modified by the following:

- A. Either party to the contract may request an adjustment of the quantities indicated (by each separate bid item), if the weights calculated in accordance with this specification vary from those indicated by more than the following:
1. Over 500 tons - 0.5 percent.
 2. 50 tons through 500 tons - 1 percent.
 3. Less than 50 tons - 1.5 percent.

When adjustment is required, the Contractor shall furnish the Engineer or designated representative three sets of shop bills showing the calculated weights of all parts of the structure. The weights shall be computed from the approved shop drawings, except as noted above. When this quantity is certified correct by the Engineer or designated representative, it will become the revised plan quantity. Quantities revised in this manner will not be subject to the provisions of the "General Conditions".

- B. When quantities are revised by a change in design, the plan quantity will be increased or decreased by the amount involved in the design change. Quantities revised in this manner will be subject to the provisions of the "General Conditions".

The unit bid price(s) shall include full compensation for furnishing all materials and for all fabrication, shopwork, transportation, erection, paint, painting, galvanizing, and for furnishing all equipment, tools, labor, and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under:

Pay Item No. 720S-A:	Structural Steel	Per Pound.
Pay Item No. 720S-B:	Structural Steel-HS	Per Pound.
Pay Item No. 720S-C:	Structural Steel-XHS	Per Pound.

END

ITEM NO. 802S - PROJECT SIGNS

802S.1 - Description

This item shall govern furnishing, fabricating, erecting, maintaining and removing Project Signs on Capital Improvement Projects (CIP), Bond Program Projects and for project identification at other construction sites, when required on the Drawings. The CIP signs shall be constructed in accordance with Standard City of Pflugerville CIP signs or as indicated on the Drawings.

802S.2 - Materials

A. Sign Face

Sign face shall be manufactured on standard exterior waterproof plywood sheets or other suitable material approved by the Engineer or designated representative. Unless indicated otherwise on the Standard Details or Drawings, the thickness of the plywood sheet shall be a minimum of 3/4 inches.

B. Posts

Lumber posts, of the size indicated on the Standard Details or on the Drawings, shall be pressure treated with pentachlorophenol.

C. Paint

Exterior oil base paint, colors as indicated on the Standard Details or on the Drawings.

D. Decals for Capital Improvement Projects and Bond Program Projects

City seal shall be in color using the 4-color process.

802S.3 - Installation

The signs shall be erected at each major entrance to the project for maximum public identification and exposure. At locations where construction is confined to a specific area, the installed sign size shall be 4-foot x 8-foot. At locations where CIP roadway construction is in progress, such as a street paving or construction of a sidewalk, the sign shall be 2-foot x 3-foot. Signs for Bond Program Projects shall be 3 x 4 foot.

The signs shall be posted on portable wood frames or stanchions and will be located in the proximity of the work area as construction progresses. All lumber shall be painted with two coats of paint as indicated herein, on the Standard Details or in the Drawings.

In special cases the size of the sign may be changed to meet special requirements, but general proportions shall be maintained.

It shall be the responsibility of the contractor to maintain and relocate signs, if necessary, during the progression of the project. Care shall be exercised to assure that placement of the signs does not interfere with or cause sight obstruction to vehicular and pedestrian traffic.

For projects located on a street with curb and gutter, signs shall be installed no closer than 2 feet from the face of curb on the street.

For projects located on a street without curb and gutter, signs shall be installed no closer than 6 feet from the edge of street pavement.

The contractor may install, at the Contractor's own expense, company signs to identify the contractor, architectural firm, etc. Signs are to be securely attached to the posts at locations indicated on the drawings and shall not be larger than 18 x 36 inches.

802S.4 - Measurement

In the CIP contract and/or Bond Program, signs shall be measured by either lump sum or per each.

802S.5 - Payment

The work performed and the materials furnished as prescribed by this item shall be paid for by lump sum or per each price bid only. The "lump sum" bid or "per each" price bid shall include full compensation for all work performed and all materials furnished in constructing, transporting, maintaining and removing the signs as specified on the Drawings and as directed by the Engineer or designated representative.

Payment will be made under one of the following:

Pay Item No. 802S-BCIP:	CIP Project Sign	Per Each.
Pay Item No. 802S-BBOND:	Bond Project Sign	Per Each.

END

ITEM NO. 803S - BARRICADES, SIGNS AND TRAFFIC HANDLING

803S.1 - Description

This item shall govern for providing, installing, moving, replacing, maintaining, cleaning and removing upon completion of the work, all temporary or permanent street closure barricades, signs, cones, lights or other devices required to handle the traffic in conformance with the current edition of the Texas Manual of Uniform Traffic Control Devices for Street and Highways and as indicated on the Drawings or directed by the Engineer or designated representative.

Constructing a detour, if required, shall conform to Standard Specification Item No. 801S, "Constructing a Detour." Capital Improvement Project Signs shall conform to Standard Specification Item No. 802S, "Project Signs."

This item shall also include the installation of all required safety fencing as described in the latest adopted version of Standard Detail 804S-4 "Safety Fence".

803S.2 - Submittals

Within 10 days after the Notice to Proceed, the Contractor shall submit to the Engineer a site-specific Traffic Control Plan. The Traffic Control Plan shall be sealed by a Professional Engineer registered in the State of Texas as required by the Project Specifications, City, or Engineer.

Other submittal requirements of this specification item include:

- A. Type of Barricade and proposed materials and Construction of the barricade,
- B. Test results for Retro-Reflective sheeting.

803S.3 - Materials

All barricades, signs, cones, lights and other types of devices to handle traffic, as indicated on the Drawings or directed by the Engineer or designated representative, shall conform to details shown on the Drawings or those indicated in the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

803S.4 - Construction Methods

Prior to commencement of construction, suitable "Barricades, Signs and Traffic Handling" devices shall be installed to protect the workers and the public.

The Contractor shall be responsible for the installation of all markers, signs and barricades in accordance with the Drawings and in conformance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD) and/or as indicated on the Drawings or directed by the Engineer or designated representative. If, in the opinion of the Engineer or designated representative, additional markers, signs or barricades are needed in the interest of safety, the Contractor will install such as are required or as directed by the Engineer or designated representative. All changes and/or revisions to the detour/traffic control plan shall be approved by the Engineer or designated representative.

803S.5 - Maintenance

It shall be the Contractor's responsibility to maintain, clean, move and replace if necessary, barricades, signs and traffic handling devices during the time required for construction of the project. Permanent barricades shall be constructed as required after the completion of the street by drilling holes and placing

hot-dipped galvanized (wedge) anchor bolts designed for use in concrete foundations. Posts shall be bolted to the galvanized (wedge) anchor bolts. Foundation concrete shall be cured before the rails are attached. When no longer needed, all temporary Barricades, Signs and Traffic Handling Devices shall be removed, and the area restored to its original condition or as directed by the Engineer or designated representative.

803S.6 - Measurement

The work performed and material furnished as prescribed by this item, City of Pflugerville Standard Details, details included on the Drawings or indicated in the TMUTCD shall be measured as follows:

A. Pavement Markings.

All pavement marking required for proper installation of the designated Traffic Control Plans and Details, as well as required removal of existing pavement marking, shall be measured and paid for under Standard Specification Item No. 870S, "Work Zone Pavement Markings" and Standard Specification Item No. 874S, "Eliminating Existing Pavement Markings".

B. Barricades, Signs and Traffic Handling.

All work performed and material furnished as prescribed by this item, City of Pflugerville Standard Details, details shown on the Drawings or indicated in the TMUTCD, that are not included in the above paragraph, shall be measured by the number of calendar days, working days or months of actual service.

Traffic control for the project will be measured and paid for once per contract defined time period, i.e. either per Calendar Day, Working day or Month at the contract rate, regardless of the number of set-ups, locations or streets under construction.

C. Safety Fencing

Safety fencing will be measured by the lineal foot.

803S.7 - Payment

The work performed and materials furnished as prescribed by this item, measured as provided under section "803S.6 Measurement" shall be paid for at the contract unit price for barricades, signs and traffic handling. This unit price shall include full compensation for furnishing, placement and removal of all materials and for all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item No. 803S-CD:	Barricades, Signs, and Traffic Handling	Per Calendar Day.
Pay Item No. 803S-WD:	Barricades, Signs, and Traffic Handling	Per Working Day.
Pay Item No. 803S-MO:	Barricades, Signs, and Traffic Handling	Per Month.
Pay Item No. 803S-SF:	Safety Fence	Per Lineal Foot.

END

ITEM NO. 824S – TRAFFIC SIGNS

824S.1 – Description

- **Installation.** Furnish, fabricate, and erect aluminum signs. Sign supports are provided for under other Items.
- **Replacement.** Replace existing signs on existing sign supports.
- **Refurbishing.** Refurbish existing aluminum signs on existing sign supports.

824S.2 – Materials

- Sign Blanks.** Furnish sign blank substrates in accordance with [DMS-7110](#), “Aluminum Sign Blanks,” and in accordance with the types shown on the plans. Use single-piece sheet-aluminum substrates for Type A (small) signs and extruded aluminum substrates for Type G (ground-mounted) or Type O (overhead-mounted) signs.
- Sign Face Retroreflectorization.** Retroreflectorize the sign faces with flat surface reflective sheeting. Furnish sheeting that meets [DMS-8300](#), “Sign Face Materials.” Use retroreflective sheeting from the same manufacturer for the entire sign face background. Ensure that sign legend, symbols, borders, and background exhibit uniform color, appearance, and retroreflectivity when viewed both day and night.
- Sign Messages.** Fabricate sign messages to the sizes, types, and colors shown on the plans. Use sign message material from the same manufacturer for the entire message of a sign. Use screen ink and background reflective sheeting that are from the same manufacturer when fabricating signs.
 - Ensure that the screened messages have clean, sharp edges and exhibit uniform color and retroreflectivity. Prevent runs, sags, and voids. Furnish screen inks in accordance with [DMS-8300](#), “Sign Face Materials.”
 - Fabricate colored, transparent film legend, and retroreflectorized sheeting legend from materials that meet [DMS-8300](#), “Sign Face Materials.”
 - Fabricate non-reflective black film legend from materials meeting [DMS-8300](#), “Sign Face Materials.”
 - Furnish direct-applied route markers and other attachments within the parent sign face unless otherwise specified on the plans.
- Hardware.** Use galvanized steel, stainless steel, or dichromate-sealed aluminum for bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. Use plastic or nylon washers to avoid tearing the reflective sheeting. Furnish steel or aluminum products in accordance with [DMS-7120](#), “Sign Hardware.”

When dissimilar metals are used, select or insulate metals to prevent corrosion.

824S.3 – Construction

- Fabrication.** Sign fabrication plants that produce permanent highway signs must be approved in accordance with DMS 7390, “Permanent Highway Sign Fabrication Plant Qualification.” Furnish signs from prequalified fabrication plants listed in the Department’s MPL.

- **Sign Blanks.** Furnish sign blanks to the sizes and shapes shown on the plans and that are free of buckles, warps, burrs, dents, cockles, or other defects. Do not splice individual extruded aluminum panels.

Complete the fabrication of sign blanks, including the cutting and drilling or punching of holes, before cleaning and degreasing. After cleaning and degreasing, ensure the substrate does not come into contact with grease, oils, or other contaminants before the application of the reflective sheeting.

- **Sheeting Application.** Apply sheeting to sign blanks in conformance with the sheeting manufacturer's recommended procedures.

When using rotational sensitive white sheeting, fabricate signs by applying the sheeting for cut-out legend, symbols, borders, and route marker attachments within the parent sign face with the identification marks or other orientation features in the optimum rotation as identified by the sheeting manufacturer.

Clean and prepare the outside surface of extruded aluminum flanges in the same manner as the sign panel face.

Minimize the number of splices in the sheeting. Overlap the lap-splices by at least 1/4 in. for encapsulated glass bead sheeting unless otherwise recommended by the reflective sheeting manufacturer. Use butt splices for prismatic reflective sheeting. Provide a 1 ft. minimum dimension for any piece of sheeting. Do not splice sheeting for signs fabricated with transparent screen inks or colored transparent films.

- **Sign Assembly.** Assemble extruded aluminum signs in accordance with the details shown on the plans. Sign face surface variation must not exceed 1/8 in. per foot. Surface misalignment between panels in multi-panel signs must not exceed 1/16 in. at any point.
- **Decals.** Code and apply sign identification decals in accordance with TxDOT Specification Item No. 643, "Sign Identification Decals."

- B. **Storage and Handling.** Ship, handle, and store completed sign blanks and completed signs so that corners, edges, and faces are not damaged. Damage to the sign face that is not visible when viewed at a distance of 50 ft., night or day, will be acceptable. Replace unacceptable signs.

Store all finished signs off the ground and in a vertical position until erected. Store finished sheet aluminum substrate signs in a weatherproof building. Extruded aluminum substrate signs may be stored outside.

Stockpile salvageable materials at the location shown on the plans or as directed. Accept ownership of unsalvageable materials and dispose of them in accordance with federal, state, and local regulations

- C. **Cleaning.** Wash completed signs in the fabrication shop with a biodegradable cleaning solution acceptable to the manufacturers of the sheeting, colored transparent film, and screen ink to remove grease, oil, dirt, smears, streaks, finger marks, and other foreign material. Wash again before final inspection after erection.

- D. **Installation.** Install signs as shown on the plans or as directed.

- E. **Replacement.** Remove the existing signs from the existing supports and replace with new signs, including mounting hardware, as shown on the plans.
- F. **Refurbishing.** Refurbish existing signs by providing and installing new messages and mounting hardware. Install new retroreflectorized legend and supplemental signs as shown on the plans.
- G. **Documentation.** Provide the following documentation from the sign fabricator with each shipment of furnished signs:
 - A notarized original of the Signing Material Statement (Form 2273) with the proper attachments for verification of compliance, and
 - A notarized certification stating that the completed signs were fabricated in accordance with this Item and the plans.

824S.4 – Measurement

Signs installed or replaced will be measured by the square foot of the sign face. Signs refurbished will be measured by each sign.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

824S.5 – Payment

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Aluminum Signs," "Replacing Existing Aluminum Signs," or "Refurbishing Aluminum Signs," of the type specified.

- A. **Installation.** This price is full compensation for furnishing and installing new signs and hardware; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.
- B. **Replacement.** This price is full compensation for furnishing and installing new aluminum signs and hardware; removal of existing signs; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; salvaging and disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.
- C. **Refurbishing.** This price is full compensation for modifying existing sign messages; removing and replacing existing route markers, reflectorized legend, or supplemental signs attached to the parent sign; preparing and cleaning the signs; furnishing sheeting and hardware; salvaging and disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

ITEM NO. 863S - REFLECTORIZED PAVEMENT MARKERS

863S.1 - Description

This item governs reflectorized pavement markers to be used to delineate traffic lanes or fire hydrants.

863S.2 - Submittals

The submittal requirements of this specification item include:

- List of specific application(s) [i.e. type: (reflectorized Type I-A, I-C or II-A-A, II-B-B or II-C-R)] and applicable epoxy system and adhesive types [867S.5].
- Specific manufacturer with test results and technical specifications for proposed pavement markers.
- Manufacturer's recommendations for surface preparation, cleaning, placement temperatures and installation instructions.
- Adhesive components and mixing recommendations.

863S.3 - Materials

All materials shall meet the requirements as specified below and indicated on City of Pflugerville Standard Detail 863S-1, "Pavement Markers (Reflectorized - Type I & II)". The pavement markers shall comply with TxDOT Departmental Materials Specifications DMS-4210 "Snowplowable Pavement Markers".

A. Design and Shape

The outer surface of the marker shall be smooth, and all corners and edges exposed to traffic must be rounded. The base of the marker shall have a width of 4.0 inches + 1/2 inch and shall have a minimum area exposed to traffic of 12.5 square inches. The maximum height shall be 3/4 inch. The maximum slope of the reflector face or faces shall be not more than 30 degrees from the horizontal.

The bottom surface of the markers shall be of a design for adhesion with epoxy adhesives to comply with TxDOT Test Method Tex-611-J.

The marker shall be designed to show no change in shape or color when subjected to the requirements of TxDOT Test Method Tex-846-B, at a temperature of 140°F with the marker in a vertical position.

B. Optical

1. Definitions

- a. Horizontal entrance angle is defined as being in a plane parallel to the base of the road marker, between a line in the direction of the incident light and a line that is perpendicular to the leading edge of the reflective surface.
- b. Divergence angle shall mean the angle at the reflector between observer's line of sight and the direction of the light incident on the marker.
- c. Specific intensity shall mean candle power of the returned light at the chosen divergence and entrance angles for each footcandle of incident light per reflective face. TxDOT Test Method Tex-842-B will be used to determine specific intensity.

2. Performance

For the pavement markers the specific intensity of the reflecting surface at a 15-degree divergence angle shall be not less than the following when the incident light is parallel to the base of the marker.

Horizontal Entrance Angle, Degrees	Specific Intensity	
	Crystal	Amber
0	3.0	2.0
20	1.5	1.0

The specific intensity of the marker shall not be less than 80 percent of the above minimum values after being subjected to heat test of TxDOT Test Method Tex-846-B.

C. Pavement Marker Types

Pavement markers shall be of the following types:

1. Type I-A shall contain an approach face that reflects amber light. The body, other than the reflective face, shall be yellow.
2. Type I-C shall contain an approach face that reflects white light. The body, other than the reflective face, shall be white, silver white or light gray.
3. Type II-A-A, shall contain two reflective faces (approach and trailing), each of which shall reflect amber light. The body, other than the reflective faces, shall be yellow.
4. Type II-B-B shall contain two reflective faces (approach and trailing) with glass covered pneumatic reflective faces, each of which shall reflect blue light. The body, other than the reflective faces, shall be blue.
5. Type II-C-R shall contain two reflective faces (approach and trailing), one of which reflects white light and one of which reflects red light. The body, other than the reflective faces, shall be either white, silver white or light gray or one-half white, silver white or light gray on the side that reflects white light and one-half red on the side that reflects red light.

The reflective faces of the Type II markers shall be located so that the direction from one face shall be directly opposite the direction of reflections of the other face.

863S.4 - Sampling

Sampling will be conducted in accordance with TxDOT Test Method Tex-729-I.

863S.5 - Testing

The Contractor shall certify that the markers meet the requirements defined in the specification and meet or exceed the applicable tests required. All testing will be in accordance with the TxDOT manual of Testing Procedures. Applicable tests shall include the following:

- Tex-611-J: Adhesion Requirements
- Tex-842-B: Light Retroreflectivity
- Tex-846-B: Heat Resistance

Blue markers' color will conform to Fire Department requirements.

863S.6 - Construction Methods

The Contractor shall use a crew experienced in the work of installing reflectorized pavement markers and in the necessary traffic control for such operations on the roadway surface and shall supply all the equipment, personnel, traffic control and materials necessary for the placement of the pavement markings as indicated on the Drawings or as directed by the Engineer or designated representative. All work shall conform to the current edition of the Texas Manual of Uniform Traffic Control Devices (TMUTCD) and Standard Detail 863S-1 "Pavement Markers (Reflectorized – Type I & II)".

All reflectorized pavement markers shall be from the same manufacturer. Surfaces to which markers are to be attached by an adhesive shall be prepared by any method approved by the Engineer or designated representative to ensure that the surface is free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings and any other material which would adversely affect the adhesive bond. Unless indicated otherwise on the Drawings, surface preparation for installation of raised reflectorized pavement markers will not be paid for directly but shall be included in the unit price bid for this specification item.

Guides to mark the lateral location of pavement markings shall be established as indicated on the Drawings or as directed by the Engineer or designated representative. The Contractor will establish the pavement marking guides and the Engineer or designated representative will verify the location of the guides prior to final installation.

The pavement markers shall be placed in proper alignment with the Guides. The deviation rate in alignment shall not exceed 1 inch per 200 feet of roadway. The maximum deviation shall not exceed 2 inches, nor shall any deviation be abrupt.

Markers placed which are not in alignment indicated on the Drawings shall be removed by the Contractor at the Contractor's expense. Removal shall be in accordance with Specification Item No. 874S "Eliminating Existing Pavement Markings and Markers" except for measurement and payment. Guides placed on the roadway for alignment purposes shall not establish a permanent marking on the roadway.

The Reflectorized Pavement Markers shall be applied using an approved epoxy adhesive (City of Pflugerville Standard Specification Item No. 867S "Epoxy Adhesive") to the lines and spacings as indicated on the Drawings or as directed by the Engineer or designated representative. The adhesive shall be applied in sufficient quantity to ensure that 100 percent of the bonding area of the pavement markers shall be in contact with the adhesive. The adhesive shall be applied in accordance with the manufacturer's recommendations.

Pavement markers shall be placed immediately after the adhesive is applied and shall be firmly bonded to the pavement. Adhesive or any other material that impairs functional reflectivity will not be acceptable.

When deemed necessary by the Engineer or designated representative, the Contractor, at the Contractor's expense, shall place any additional pilot markings required to facilitate the placement of the permanent markings in the alignment specified. Any and all additional markings placed on the roadway for alignment purposes shall be temporary in nature and shall not establish a permanent marking on the roadway. Materials used for pilot markings and equipment used to place such markings shall be approved by the Engineer or designated representative.

863S.7 - Measurement

Reflectorized Pavement Marker will be measured as per each, complete in place.

863S.8 - Payment

Payment will be made at the unit bid price per each. The price shall include full compensation for all work performed and all materials furnished in constructing, transporting and placing the markers.

Payment will be made under:

Pay Item No. 863S-1:	Reflectorized Pavement Markers (Type I-A)	Per Each.
Pay Item No. 863S-2:	Reflectorized Pavement Markers (Type I-C)	Per Each.
Pay Item No. 863S-3:	Reflectorized Pavement Markers (Type II-A-A)	Per Each.
Pay Item No. 863S-4:	Reflectorized Pavement Markers (Type II-B-B)	Per Each.
Pay Item No. 863S-5:	Reflectorized Pavement Markers (Type II-C-R)	Per Each.

END

ITEM NO. 867S - EPOXY ADHESIVE

867S.1 - Description

This item shall govern the various types of epoxy materials suitable for the construction and maintenance of streets and roads indicated on the Drawings or considered in the Item.

All of these materials shall consist of a resin component and a hardener component, which must be mixed immediately prior to use to produce the finished epoxy. Unless otherwise indicated on the Drawings, these materials should not be used if the substrate temperature is below 50°F. The specific materials covered by this item are as follows:

- Traffic marker adhesives
- Concrete adhesives
- Binder for epoxy grout or concrete
- Epoxy for crack injection
- Epoxy coating for concrete
- Surface sealing of cracks

867S.2 - Submittals

The submittal requirements of this specification item include:

- List of specific application(s) [i.e. items A through F in Section 867S.1] and applicable epoxy system and adhesive types [Section 867S.5].
- Manufacturer's recommendations for surface preparation, cleaning, placement temperatures and installation instructions.
- Adhesive components and mixing recommendations.

867S.3 - Epoxy Materials Requirements

A. General

Epoxy materials described herein shall be in accordance with TxDOT Departmental Material Specification DMS-6100 "Epoxyes and Adhesives". Additional information regarding epoxy characteristics and copies of specification DMS-6100 are available from the TxDOT Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483.

B. Packaging, Labeling and Storage

The components shall be packaged in suitable, well-sealed containers clearly labeled as to the type material and the ratio of the components to be mixed by volume. Any special instructions regarding mixing shall be included. The label shall show resin or hardener component, the brand name, name of manufacturer, lot or batch number, date of packaging and the quantity contained therein. Caution warnings regarding contact of the epoxy with skin and eyes, shelf life and vapor warning must be included on the labels.

The epoxy components must be stored at temperatures between 60°F and 100°F. Any material which shows evidence of crystallization, lumps, skinning, extreme thickening or settling of pigments which cannot be readily redispersed with normal agitation shall not be used.

C. Mixing

Prior to use, each component shall be stirred to re-disperse any settling or separation of the fillers and liquid portions. The components shall then be placed immediately in the proper reservoir when used in automatic mixing and dispensing equipment. For application by other means, the components must be properly proportioned and mixed until a uniform color and appearance are obtained. Unless otherwise indicated by the manufacturer or approved by the Engineer or designated representative no addition of solvents is allowed.

867S.4 - Application and Surface Preparation

Requirements on application and preparation of the surface upon which the epoxy is to be placed shall be in accordance with manufacturer's recommendation and applicable specification items.

867S.5 - Epoxy System

The various types of materials and their intended use are described below.

A. Traffic Marker Adhesive System

This system consists of five basic types of epoxy adhesive for bonding ceramic, plastic or metal traffic markers to roadway, bridge, or other concrete surfaces.

1. Types I and I-M

Rapid Setting Marker Adhesive for use when a very fast set is required or if markers must be placed when pavement temperature is below 50°F.

2. Types II, II-M and II-MA

Medium Setting Marker Adhesive

3. Types III and III-M

Standard Setting Marker Adhesive

4. Types IV and IV-M

Slow Setting Marker Adhesive for use where setting time is not a consideration.

Those adhesives designated as Types I through IV are intended for hand mixing and application. On projects where the adhesive is to be handled by automatic metering, mixing and application equipment, Types I-M through IV-M, which are designed specifically for machine application, shall be used. Type II- MA adhesive is designed for placement of all-weather markers. For all types of marker adhesives, the resin component shall be pigmented white and the hardener component black.

The type of adhesive to be used for placing ceramic or plastic markers on a specific project shall be designated by the Contractor and approved by the Engineer or designated representative, based upon the setting time required under the prevailing weather and traffic conditions.

B. Concrete Adhesives System

This system consists of three types of epoxy adhesive with different viscosities designed to bond fresh Portland Cement (PC) concrete to existing PC concrete, hardened concrete to hardened concrete and steel to fresh or hardened concrete.

1. Type V

Standard (medium viscosity) for applying to horizontal and vertical surfaces. This material is suitable for surface sealing of fine cracks in concrete and setting of dowels in accordance with Specification Item No. 410, "Concrete Structures".

2. Type VI

Low viscosity for application with spray equipment to horizontal surfaces.

3. Type VII

Paste consistency for overhead application and where a high build-up is required. This material is suitable for surface sealing of cracks in concrete, which are veed out prior to sealing and for grouting of dowel bars where clearance is 1/16 inch or less.

Any specific coloring of resin and hardener components shall be as directed by the Engineer or designated representative.

C. Epoxy Binder System (Type VIII)

This system is intended for mixing with selected aggregates to produce an epoxy mortar or concrete for grouting dowel bars or repairing spalls and other defects in existing PC concrete. Type VIII shall comply with the requirements for Type VI epoxy except that the mixing ratio of resin and hardener shall be as specified by the manufacturer and the requirement for ability to bond fresh PC concrete to hardened concrete does not apply.

The aggregates used with the epoxy binder to form the epoxy mortar or concrete must be clean and surface dry. Siliceous aggregates are required unless otherwise approved by the Engineer or designated representative.

D. Crack Injection (Type IX)

This system is a low viscosity epoxy material designed for pressure injection into cracks in existing concrete to restore the structural integrity. The system shall be capable of bonding to damp surfaces.

E. Epoxy Coating (Type X)

This is a high-solids epoxy used for waterproofing columns, caps, etc. The material is designated for application by brush or roller but can also be applied by airless spray by addition of a maximum of 5 percent toluene solvent at the direction of the Engineer or designated representative. This material may also be used to coat the interior concrete block walls and as a coating for concrete picnic tables and benches.

867S.6 - Measurement and Payment

The work performed, the materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this item will not be measured for payment, but shall be included in the unit price bid for the particular bid items indicated on the Drawings or included in the Contract.

END

ITEM NO. 871S – REFLECTORIZED PAVEMENT MARKINGS

871S.1 – Description

Furnish and place retroreflectorized, non-retroreflectorized (shadow) and profile pavement markings.

871S.2 - Materials

- A. **Type I Marking Materials.** Furnish in accordance with [DMS-8220](#), “Hot Applied Thermoplastic.”

Furnish pavement marking material used for Type I profile markings and shadow markings that have been approved by the Construction Division, and in accordance with [DMS-8220](#), “Hot Applied Thermoplastic.”

- B. **Type II Marking Materials.** Furnish in accordance with [DMS-8200](#), “Traffic Paint.”

- C. **Glass Traffic Beads.** Furnish drop-on glass beads in accordance with [DMS-8290](#), “Glass Traffic Beads” or as approved. Furnish a double-drop of Type II and Type III drop-on glass beads where each type bead is applied separately in equal portions (by weight), unless otherwise approved. Apply the Type III beads before applying the Type II beads.

- D. **Labeling.** Use clearly marked containers that indicate color, mass, material type, manufacturer, and batch number.

871S.3 - Equipment

- A. **General Requirements.** Use equipment that:

1. Is maintained in satisfactory condition,
2. Meets or exceeds the requirements of the national board of fire underwriters and the Texas Railroad Commission for this application,
3. Applies beads by an automatic bead dispenser attached to the pavement marking equipment in such a manner that the beads are dispensed uniformly and almost instantly upon the marking as the marking is being applied to the road surface. The bead dispenser must have an automatic cut-off control, synchronized with the cut-off of the pavement marking equipment,
4. Has an automatic cut-off device with manual operating capabilities to provide clean, square marking ends,
5. Is capable of producing the types and shapes of profiles specified, and
6. Can provide continuous mixing and agitation of the pavement marking material. The use of pans, aprons, or similar appliances which the die overruns will not be permitted for longitudinal striping applications.

Provide a hand-held thermometer capable of measuring the temperature of the marking material when applying Type I material.

When pavement markings are required to meet minimum retroreflectivity requirements on the plans:

1. Use a mobile retroreflectometer approved by the Construction Division and certified by the Texas A&M Transportation Institute Mobile Retroreflectometer Certification Program.
2. Use a portable retroreflectometer that:
 - a. Uses 30-meter geometry and meets the requirements described in ASTM E1710;
 - b. Has either an internal global positioning system (GPS) or the ability to be linked with an external GPS with a minimum accuracy rating of 16 ft. 5 in., in accordance with the circular error probability (CEP) method (CEP is the radius of the circle with its origin at a known position that encompasses 50% of the readings returned from the GPS instrument);
 - c. Can record and print the GPS location and retroreflectivity reading for each location where readings are taken.

B. Material Placement Requirements. Use equipment that can place:

1. At least 40,000 ft. Of 4-in. Solid or broken non-profile markings per working day at the specified thickness;
2. At least 15,000 ft. Of solid or broken profile pavement markings per working day at the specified thickness;
3. Linear non-profile markings up to 8 in. Wide in a single pass;
4. Non-profile pavement markings other than solid or broken lines at an approved production rate;
5. A centerline and no-passing barrier-line configuration consisting of 1 broken line and 2 solid lines at the same time to the alignment, spacing, and thickness for non-profile pavement markings shown on the plans;
6. Solid and broken lines simultaneously;
7. White line from both sides;
8. Lines with clean edges, uniform cross-section with a tolerance of $\pm 1/8$ in. Per 4 in. Width, uniform thickness, and reasonably square ends;
9. Skip lines between 10 and 10-1/2 ft., a stripe-to-gap ratio of 10 to 30, and a stripe-gap cycle between 39-1/2 ft. And 40-1/2 ft., automatically;
10. Beads uniformly and almost instantly on the marking as the marking is being applied;
11. Beads uniformly during the application of all lines (each line must have an equivalent bead yield rate and embedment); and
12. Double-drop bead applications using both type ii and type iii beads from separate independent bead applicators, unless otherwise approved by the engineer.

871S.4 - Construction

Place markings before opening to traffic unless short-term or work zone markings are allowed.

- A. **General.** Obtain approval for the sequence of work and estimated daily production. Minimize interference to roadway operations when placing markings on roadways open to traffic. Use traffic control as shown on the plans or as approved. Protect all markings placed under open-traffic conditions from traffic damage and disfigurement.

Establish guides to mark the lateral location of pavement markings as shown on the plans or as directed, and have guide locations verified. Use material for guides that will not leave a permanent mark on the roadway.

Apply markings on pavement that is completely dry and passes the following tests:

1. Type I Marking Application—Place a sample of Type I marking material on a piece of tarpaper placed on the pavement. Allow the material to cool to ambient temperature, and then inspect the underside of the tarpaper in contact with the pavement. Pavement will be considered dry if there is no condensation on the tarpaper.
2. Type II Marking Application—Place a 1-sq. ft. piece of clear plastic on the pavement, and weight down the edges. The pavement is considered dry if, when inspected after 15 min., no condensation has occurred on the underside of the plastic.

Apply markings:

1. That meet the requirements of [Tex-828-B](#),
2. That meet minimum retroreflectivity requirements when specified on the plans (applies to Type I markings only),
3. Using widths and colors shown on the plans,
4. At locations shown on the plans,
5. In proper alignment with the guides without deviating from the alignment more than 1 in. Per 200 ft. Of roadway or more than 2 in. Maximum,
6. Without abrupt deviations,
7. Free of blisters and with no more than 5% by area of holes or voids,
8. With uniform cross-section, density and thickness,
9. With clean and reasonably square ends,
10. That are retroreflectorized with drop-on glass beads, and
11. Using personnel skilled and experienced with installation of pavement markings.

Remove all applied markings that are not in alignment or sequence as stated on the plans, or in the specifications, at the Contractor's expense in accordance with TxDOT Specification Item No. 677, "Eliminating Existing Pavement Markings and Markers," except for measurement and payment.

- B. **Surface Preparation.** Prepare surfaces in accordance with this Section unless otherwise shown on the plans.
1. **Cleaning for New Asphalt Surfaces and Retracing of All Surfaces.** Air blast or broom the pavement surface for new asphalt surfaces (less than 3 years old) and for retracing of all surfaces to remove loose material, unless otherwise shown on the plans. A sealer for Type I markings is not required unless otherwise shown on the plans.

2. **Cleaning for Old Asphalt and Concrete Surfaces (Excludes Retracing).** Clean old asphalt surfaces (more than 3 years old) and all concrete surfaces in accordance with TxDOT Specification Item No. 678, "Pavement Surface Preparation for Markings," to remove curing membrane, dirt, grease, loose and flaking existing construction markings, and other forms of contamination.
 3. **Sealer for Type I Markings.** Apply a pavement sealer to old asphalt surfaces (more than 3 years old) and to all concrete surfaces before placing Type I markings on locations that do not have existing markings, unless otherwise approved. The pavement sealer may be either a Type II marking or an acrylic or epoxy sealer as recommended by the Type I marking manufacturer unless otherwise shown on the plans. Follow the manufacturer's directions for application of acrylic or epoxy sealers. Clean sealer that becomes dirty after placement by washing or in accordance with Section 666.4.2.1., "Cleaning for New Asphalt Surfaces and Retracing of All Surfaces," as directed. Place the sealer in the same configuration and color (unless clear) as the Type I markings unless otherwise shown on the plans.
- C. **Application.** Apply markings during good weather unless otherwise directed. If markings are placed at Contractor option when inclement weather is impending and the markings are damaged by subsequent precipitation, the Contractor is responsible for all required replacement costs.
1. **Type I Markings.** Place the Type I marking after the sealer cures. Apply within the temperature limits recommended by the material manufacturer. Flush the spray head if spray application operations cease for 5 min or longer by spraying marking material into a pan or similar container until the material being applied is at the recommended temperature.

Apply on clean, dry pavements passing the moisture test described in Section 666.4.1., "General," and with a surface temperature above 50°F when measured in accordance with [Tex-829-B](#).

- a. **Non-Profile Pavement Markings.** Apply Type I non-profile markings with a minimum thickness of:
 - 0.100 in. (100 mils) for new markings and retracing water-based markings on surface treatments involving TxDOT Specification Item No. 316, "Seal Coat,"
 - 0.060 in. (60 mils) for retracing on thermoplastic pavement markings, or
 - 0.090 in. (90 mils) for all other Type I markings.

The maximum thickness for Type I non-profile markings is 0.180 in. (180 mils). Measure thickness for markings in accordance with [Tex-854-B](#) using the tape method.

- b. **Profile Pavement Markings.** Apply Type I profile markings with a minimum thickness of:
 - 0.060 in. (60 mil) for edgeline markings, or
 - 0.090 in. (90 mil) for gore and centerline/no-passing barrier line markings.

In addition, at a longitudinal spacing indicated on the plans, the markings must be profiled in a vertical manner such that the profile is transverse to the longitudinal marking direction. The profile must not be less than 0.30 in. (300 mil) nor greater than 0.50 in. (500 mil) in height when measured above the normal top surface plane of the roadway. The transverse width of the profile must not be less than 3.25 in., and the longitudinal width not less than 1 in., when measured at the top surface plane of the profile bar. The profile may

be either a 1 or 2 transverse bar profile. When the 2 transverse bar profile is used, the spacing between the bases of the profile bars must not exceed 0.50 in. The above transverse bar width is for each 4 in. of line width.

2. **Type II Markings.** Apply on surfaces with a minimum surface temperature of 50°F. Apply at least 20 gal. per mile on concrete and asphalt surfaces and at least 22 gal. per mile on surface treatments for a solid 4-in. line. Adjust application rates proportionally for other widths. When Type II markings are used as a sealer for Type I markings, apply at least 15 gal. per mile using Type II drop-on beads.
 3. **Bead Coverage.** Provide a uniform distribution of beads across the surface of the stripe for Type I and Type II markings, with 40% to 60% bead embedment.
- D. **Retroreflectivity Requirements.** When specified on the plans, Type I markings must meet the following minimum retroreflectivity values for edgeline markings, centerline or no passing barrier-line, and lane lines when measured any time after 3 days, but not later than 10 days after application:
- White markings: 250 millicandelas per square meter per lux (mcd/m²/lx)
 - Yellow markings: 175 mcd/m²/lx
- E. **Retroreflectivity Measurements.** Use a mobile retroreflectometer for projects requiring minimum retroreflectivity requirements to measure retroreflectivity for Contracts totaling more than 200,000 ft. of pavement markings, unless otherwise shown on the plans. For Contracts with less than 200,000 ft. of pavement markings or Contracts with callout work, mobile or portable retroreflectometers may be used at the Contractor's discretion.
1. **Mobile Retroreflectometer Measurements.** Provide mobile measurements averages for every 0.1 miles unless otherwise specified or approved. Take measurements on each section of roadway for each series of markings (i.e., edgeline, center skip line, each line of a double line, etc.) and for each direction of traffic flow. Measure each line in both directions for centerlines on two-way roadways (i.e., measure both double solid lines in both directions and measure all center skip lines in both directions). Furnish measurements in compliance with Special Specification, "Mobile Retroreflectivity Data Collection for Pavement Markings," unless otherwise approved. The Engineer may require an occasional field comparison check with a portable retroreflectometer meeting the requirements listed above to ensure accuracy. Use all equipment in accordance with the manufacturer's recommendations and directions. Inform the Engineer at least 24 hr. before taking any measurements.

A marking meets the retroreflectivity requirements if:

- the combined average retroreflectivity measurement for a one-mile segment meets the minimum retroreflectivity values specified, and
- no more than 30% of the retroreflectivity measurement values are below the minimum retroreflectivity requirements value within the one-mile segment.

The Engineer may accept failing one-mile segments if no more than 20% of the retroreflectivity measurements within that mile segment are below the minimum retroreflectivity requirement value.

The one-mile segment will start from the beginning of the data collection and end after a mile worth of measurements have been taken; each subsequent mile of measurements will be a new segment. Centerlines with 2 stripes (either solid or broken) will result in 2 miles of data for each mile segment. Each centerline stripe must be tested for compliance as a stand-alone stripe.

Restripe at the Contractor's expense with a minimum of 0.060 in. (60 mils) of Type I marking if the marking fails retroreflectivity requirements. Take measurements every 0.1 miles a minimum of 10 days after this second application within that mile segment for that series of markings.

If the markings do not meet minimum retroreflectivity after 10 days of this second application, the Engineer may require removal of all existing markings, a new application as initially specified, and a repeat of the application process until minimum retroreflectivity requirements are met.

2. **Portable Retroreflectometer Measurements.** Take a minimum of 20 measurements for each 1-mi. section of roadway for each series of markings (i.e., edgeline, center skip line, each line of a double line, etc.) and direction of traffic flow when using a portable reflectometer. Measure each line in both directions for centerlines on two-way roadways (i.e., measure both double solid lines in both directions and measure all center skip lines in both directions). The spacing between each measurement must be at least 100 ft. The Engineer may decrease the mileage frequency for measurements if the previous measurements provide satisfactory results. The Engineer may require the original number of measurements if concerns arise.

Restripe once at the Contractor's expense with a minimum of 0.060 in. (60 mils) of Type I marking material if the average of these measurements fails. Take a minimum of 10 more measurements after 10 days of this second application within that mile segment for that series of markings. Restripe again at the Contractor's expense with a minimum of 0.060 in. (60 mils) of Type I marking material if the average of these measurements fall below the minimum retroreflectivity requirements. If the markings do not meet minimum retroreflectivity after this third application, the Engineer may require removal of all existing markings, a new application as initially specified, and a repeat of the application process until minimum retroreflectivity requirements are met.

3. **Traffic Control.** Provide traffic control, as required, when taking retroreflectivity measurements after marking application. On low volume roadways (as defined on the plans), refer to the figure, "Temporary Road Closure" in Part 6 of the *Texas Manual on Uniform Traffic Control Devices* for the minimum traffic control requirements. For all other roadways, the minimum traffic control requirements will be as shown on the Traffic Control Plan (TCP) standard sheets TCP (3-1) and TCP (3-2). The lead vehicle will not be required on divided highways. The TCP and traffic control devices must meet the requirements listed in TxDOT Specification Item No. 502, "Barricades, Signs, and Traffic Handling." Time restrictions that apply during striping application will also apply during the retroreflectivity inspections except when using the mobile retroreflectometer unless otherwise shown on the plans or approved.

- F. **Performance Period.** All markings must meet the requirements of this specification for at least 30 calendar days after installation. Unless otherwise directed, remove pavement markings that fail to meet requirements, and replace at the Contractor's expense. Replace failing markings within 30 days of notification. All replacement markings must also meet all requirements of this Item for a minimum of 30 calendar days after installation.

871S.5 - Measurement

This Item will be measured by the foot; by each word, symbol, or shape; or by any other unit shown on the plans. Each stripe will be measured separately.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

Acrylic or epoxy sealer, or Type II markings when used as a sealer for Type I markings, will be measured by the foot; by each word, symbol, or shape; or by any other unit shown on the plans.

871S.6 - Payment

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pavement Sealer" of the size specified, "Retroreflectorized Pavement Markings" of the type and color specified and the shape, width, size, and thickness specified as applicable, "Retroreflectorized Pavement Markings with Retroreflective Requirements" of the types, colors, sizes, widths, and thicknesses specified or "Retroreflectorized Profile Pavement Markings" of the various types, colors, shapes, sizes, and widths specified.

This price is full compensation for application of pavement markings, materials, equipment, labor, tools, and incidentals.

Surface preparation of new concrete and asphalt concrete pavements more than 3 years old, where no stripe exists, will be paid for under TxDOT Specification Item No. 678, "Pavement Surface Preparation for Markings." Surface preparation of all other asphalt and old concrete pavement, except for sealing, will not be paid for directly but is subsidiary to this Item.

Work zone pavement markings (Type II, paint and beads) used as a sealer for Type I markings (thermoplastic) will be paid for under TxDOT Specification Item No. 662, "Work Zone Pavement Markings."

If the Engineer requires that markings be placed in inclement weather, repair or replacement of markings damaged by the inclement weather will be paid for in addition to the original plans quantity.

ITEM NO. 873S – RAISED PAVEMENT MARKERS

873S.1 – Description

Furnish and install raised pavement markers (RPMs).

873S.2 – Materials

A. **Markers.** Furnish RPMs in accordance with the following Department Material Specifications:

- Reflectorized Pavement Markers. DMS 4200, “Pavement Markers (Reflectorized),” types I A, I C, I R, II A A, and II C R.
- Traffic Buttons. DMS 4300, “Traffic Buttons,” types I A, I C, I R, II A A, II C R, W, Y and B. Round or oval unless otherwise specified on the plans.
- Plowable Reflectorized Pavement Markers. DMS 4210, “Snowplowable Pavement Markers,” types I A, I C, I R, II A A, and II C R.

The following are descriptions for each type of RPM:

- **Type I A.** The approach face must retro-reflect amber light. The body, other than the retro-reflective face, must be yellow.
- **Type I C.** The approach face must retro-reflect white light. The body, other than the retro-reflective face, must be white or silver-white.
- **Type I R.** The trailing face must retro-reflect red light. The body, other than the retro-reflective face, must be white or silver-white, except for I R plowable markers which may be black.
- **Type II A A.** The 2 retro-reflective faces (approach and trailing) must retro-reflect amber light. The body, other than the retro-reflective faces, must be yellow.
- **Type II C R.** Contain 2 retro-reflective faces with an approach face that must retro-reflect white light and a trailing face that must retro-reflect red light. The body, other than the retro-reflective faces, must be white or silver-white.
- **Type W.** Must have a white body and no reflective faces.
- **Type Y.** Must have a yellow body and no reflective faces.
- **Type B.** Must have a black body and no reflective faces.

B. **Adhesives.** Furnish adhesives that conform to the following requirements:

- [DMS-6100](#), “Epoxy and Adhesives,” Type II—Traffic Marker Adhesives.
- [DMS-6130](#), “Bituminous Adhesive for Pavement Markers.”
- The Contractor may propose alternate adhesive materials for consideration and approval.

C. **Sampling.** The Engineer will sample in accordance with [Tex-729-I](#).

873S.3 – Construction

Remove existing RPMs in accordance with TxDOT Specification Item No. 677, “Eliminating Existing Pavement Markings and Markers,” except for measurement and payment. Furnish RPMs for each class from the same manufacturer. Prepare all surfaces in accordance with TxDOT Specification Item No. 678, “Pavement Surface Preparation for Markings,” when shown on the plans. Ensure the bond surfaces are free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings, and any other material that would adversely affect the adhesive bond.

Establish pavement marking guides to mark the lateral location of RPMs as shown on the plans and as directed. Do not make permanent marks on the roadway for the guides.

Place RPMs in proper alignment with the guides. Acceptable placement deviations are shown on the plans.

Remove RPMs placed out of alignment or sequence, as shown on the plans or stated in this specification, at Contractor's expense, in accordance with TxDOT Specification Item No. 677, "Eliminating Existing Pavement Markings and Markers" (except for measurement and payment).

Use the following adhesive materials for placement of reflectorized pavement markers, and traffic buttons unless otherwise shown on the plans:

- standard or flexible bituminous adhesive for applications on bituminous pavements, and
- epoxy adhesive or flexible bituminous adhesive for applications on hydraulic cement concrete pavements.

Use epoxy adhesive for plowable reflectorized pavement markers.

Apply enough adhesives to:

- ensure that 100% of the bonding area of RPMs is in contact with the adhesive, and
- ensure that RPMs, except for plowable markers, are seated on a continuous layer of adhesive and not in contact with the pavement surface.

Apply adhesives in accordance with manufacturer's recommendations unless otherwise required by this Article. Apply bituminous adhesive only when pavement temperature and RPM temperature are 40°F or higher. Do not heat bituminous adhesive above 400°F. Machine agitate bituminous adhesive continuously before application to ensure even heat distribution.

Machine-mix epoxy adhesive. Apply epoxy adhesive only when pavement temperature is 50°F or higher.

Furnish RPMs free of rust, scale, dirt, oil, grease, moisture, and contaminants that might adversely affect the adhesive bond.

Place RPMs immediately after the adhesive is applied and ensure proper bonding. Do not use adhesives or any other material that impairs the functional retro-reflectivity of the RPMs.

Provide a 30 day performance period that begins the day following written acceptance for each separate location. The date of written acceptance will be the last calendar day of each month for the RPMs installed that month for the completed separate project locations. This written acceptance does not constitute final acceptance.

Replace all missing, broken or non-reflective RPMs. Visual evaluations will be used for these determinations. Upon request, the Engineer will allow a Contractor representative to accompany the Engineer on these evaluations.

The Engineer may exclude RPMs from the replacement provisions of the performance, provided the Engineer determines the failure is a result of causes other than defective material or inadequate installation procedures. Examples of outside causes are extreme wear at intersections, damage by snow or ice removal, and pavement failure.

Replace all missing or non-reflective RPMs identified during the performance period within 30 days after notification. The end of the performance period does not relieve the Contractor from the performance deficiencies requiring corrective action identified during the performance period.

873S.4 – Measurement

This Item will be measured by each RPM.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments are required.

873S.5 – Payment

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Reflectorized Pavement Marker,” “Traffic Button,” or “Plowable Reflectorized Pavement Marker” of the types specified. This price is full compensation for removing existing markers; furnishing and installing RPMs; and materials, equipment, labor, tools, and incidentals.

No additional payment will be made for replacement of RPMs failing to meet the performance requirements.

ITEM NO. 874S – ELIMINATING EXISTING PAVEMENT MARKINGS AND MARKERS

874S.1 - Description

Eliminate existing pavement markings and raised pavement markers (RPMs).

874S.2 - Materials

Furnish surface treatment materials in accordance with the following Items:

- Standard Specification Item No. 301S, "Asphalts, Oils, and Emulsions"
- Standard Specification Item No. 302S, "Aggregates for Surface Treatments"
- Standard Specification Item No. 312S, "Seal Coat"

Use approved patching materials for repairing damaged surfaces.

Use a commercial abrasive blasting medium capable of producing the specified surface cleanliness. Use potable water when water is required.

874S.3 - Equipment

Furnish and maintain equipment in good working condition. Use moisture and oil traps in air compression equipment to remove all contaminants from the blasting air and prevent the deposition of moisture, oil, or other contaminants on the roadway surface.

874S.4 - Construction

Eliminate existing pavement markings and markers on both concrete and asphaltic surfaces in such a manner that color and texture contrast of the pavement surface will be held to a minimum. Remove all markings and markers with minimal damage to the roadway to the satisfaction of the Engineer. Repair damage to asphaltic surfaces, such as spalling, shelling, etc., greater than 1/4 in. deep resulting from the removal of pavement markings and markers. Dispose of markers in accordance with federal, state, and local regulations. Use any of the following methods unless otherwise shown on the plans:

- Surface Treatment Method.** Apply surface treatment material at rates shown on the plans, or as directed. Place a surface treatment a minimum of 2 ft. wide to cover the existing marking. Place a surface treatment, thin overlay, or microsurfacing a minimum of one lane in width in areas where directional changes of traffic are involved or other areas as directed.
- Burn Method.** Use an approved burning method. For thermoplastic pavement markings or prefabricated pavement markings, heat may be applied to remove the bulk of the marking material before blast cleaning. When using heat, avoid spalling pavement surfaces. Sweeping or light blast cleaning may be used to remove minor residue.
- Blasting Method.** Use a blasting method such as water blasting, abrasive blasting, water abrasive blasting, shot blasting, slurry blasting, water-injected abrasive blasting, or brush blasting as approved. Remove pavement markings on concrete surfaces by a blasting method.
- Mechanical Method.** Use any mechanical method except grinding. Flail milling is acceptable in the removal of markings on asphalt and concrete surfaces.

874S.5 - Measurement

This Item will be measured by each word, symbol, or shape eliminated; by the foot of marking eliminated; or by any other unit shown on the plans.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

874S.6 - Payment

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Eliminating Existing Pavement Markings and Markers" of the type and width as applicable. This price is full compensation for the elimination method used and materials, equipment, tools, labor, and incidentals. Removal of RPMs will not be paid for directly but will be subsidiary to the pertinent bid items.

ITEM NO. 875S – PAVEMENT SURFACE PREPARATION FOR MARKINGS

875S.1 - Description

Prepare pavement surface areas before placement of pavement markings and raised pavement markers (RPMs). TxDOT Specification Item No. 677, "Eliminating Existing Pavement Markings and Markers," governs removal of existing markings.

875S.2 - Materials

Use a commercial abrasive blasting medium capable of producing the specified surface cleanliness. Use potable water, when water is required.

875S.3 - Equipment

Furnish and maintain equipment in good working condition. Use moisture and oil traps in air compression equipment to remove all contaminants from the blasting air and prevent the deposition of moisture, oil, or other contaminants on the roadway surface.

875S.4 - Construction

Prepare enough pavement surface for the pavement markings or RPMs shown on the plans. Remove all contamination and loose material. Avoid damaging the pavement surface. Remove loose and flaking material when existing pavement markings are present. Approved pavement surface preparation methods are sweeping, air blasting, flail milling, and blast cleaning unless otherwise specified on the plans.

Air blast concrete pavement surfaces, in addition to the above, after the removal of contamination or existing material and just before placing the stripe. Perform air blasting with a compressor capable of generating compressed air at a minimum of 150 cu. ft. per minute and 100 psi using 5/16 in. or larger hosing.

Contaminants up to 0.5 sq. in. may remain if they are not removed by the following test, performed just before application of markings:

- **Step 1.** Air blast the surface to be tested, to simulate blasting during application of markings.
- **Step 2.** Firmly press a 10-in. long, 2-in. wide strip of monofilament tape onto the surface, leaving approximately 2 in. free.
- **Step 3.** Grasp the free end and remove the tape with a sharp pull.

875S.5 - Measurement

This Item will be measured by the foot for each width specified; by each word, shape, or symbol; or by any other unit except lump sum.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

875S.6 - Payment

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pavement Surface Preparation for

Markings" of the type and width as applicable. This price is full compensation for the cleaning method used, materials, equipment, labor, tools, and incidentals.

ITEM NO. 876S – DELINEATOR AND OBJECT MARKER ASSEMBLIES

876S.1 - Description

- **Installation.** Install delineator or object maker assembly.
- **Removal.** Remove delineator or object marker assembly.

876S.2 - Materials

Furnish only new materials in accordance with details shown on the plans unless otherwise directed. The Engineer will sample in accordance with [Tex-725-I](#) or [Tex-737-I](#).

A. Delineator and Object Marker Assemblies. Fabricate in accordance with the following:

- DMS 8600, "Delineators, Object Markers, and Barrier Reflectors."
- DMS 4400, "Flexible Delineator and Object Marker Posts (Embedded and Surface-Mount Types)."

B. Wing Channel Post. Furnish material of the size shown on the plans. Supply a notarized original of the Form D-9-USA-1 (Department Form 1818) with supporting mill test report certifying that the base metal is in accordance with the following:

- ASTM A1011, SS Grade 50.
- ASTM A499.

Galvanize material in accordance with TxDOT Specification Item No. 445, "Galvanizing."

876S.3 - Construction

A. **Installation.** Locate delineators and object markers as shown on the plans or as directed.

Locate barrier reflectors as shown on the plans or as directed and install in accordance with manufacturers recommendations.

Install winged channel post and flexible delineator posts to allow the reflector units and reflectorized panels to be installed at the specified height and orientation. Align post as shown or as directed.

Drive post plumb using a driving cap to prevent visible cross-section dimension distortion. Drill or drive a pilot hole when post cannot be driven without visibly distorting the cross-section dimension. Backfill pilot holes thoroughly by tamping in 6-in. lifts to grade.

Install surface-mount and other types of delineators and object markers in accordance with details shown on the plans.

Repair damaged galvanizing in accordance with Section 445.3.5., "Repairs." Install reflector units on wing channel posts after the posts have been erected.

B. **Removal.** Remove post assemblies without damaging materials and salvage when indicated on the plans. Remove post to a minimum of 6 in. below finish grade. Stockpile salvaged materials at the location shown on the plans or as directed. Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local requirements.

876S.4 - Measurement

Installation will be measured by each delineator or object marker assembly installed. When removal is specified on the plans to be a pay item, it will be measured by each delineator or object marker assembly removed.

This is a plans quantity measurement item. The quantity to be paid for is shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

876S.5 - Payment

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Delineator Assemblies" or "Install Object Marker Assemblies" of the types and colors specified and for "Remove Delineator or Object Marker Assemblies."

- A. **Installation.** This price is full compensation for furnishing and fabricating when required, and installing and mounting the delineator or object marker assemblies including posts, adhesive or pads for surface mount assemblies, back plates, reflector units, fastening plates, brackets, bolts, nuts, and washers; and materials, equipment, labor, tools, and incidentals.
- B. **Removal.** Unless otherwise shown on the plans, removal will not be paid for directly but is subsidiary to bid items of the Contract.

When removal is shown on the plans as a bid item, this price is full compensation for removal and disposal of delineator and object marker assemblies and for materials, equipment, labor, tools, and incidentals.

Item 104

Removing Concrete



1. DESCRIPTION

Break, remove, and salvage or dispose of existing hydraulic cement concrete.

2. CONSTRUCTION

Remove existing hydraulic cement concrete from locations shown on the plans. Avoid damaging concrete that will remain in place. Saw-cut and remove the existing concrete to neat lines. Replace any concrete damaged by the Contractor at no expense to the Department. Accept ownership and properly dispose of broken concrete in conformance with federal, state, and local regulations unless otherwise shown on the plans.

3. MEASUREMENT

Removing concrete pavement, floors, porches, patios, riprap, medians, foundations, sidewalks, driveways, and other appurtenances will be measured by the square yard (regardless of thickness) or by the cubic yard of calculated volume, in its original position.

Removing curb, curb and gutter, and concrete traffic barrier will be measured by the foot in its original position. The removal of monolithic concrete curb or doweled concrete curb will be included in the concrete pavement measurement.

Removing retaining walls will be measured by the square yard along the front face from the top of the wall to the top of the footing.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

4. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Concrete" of the type specified. This price is full compensation for breaking the concrete; loading, hauling, and salvaging or disposing of the material; and equipment, labor, tools, and incidentals.

Removing retaining wall footings will not be measured or paid for directly but will be subsidiary to this item.

Item 110

Excavation



1. DESCRIPTION

Excavate areas as shown on the plans or as directed. Remove materials encountered to the lines, grades, and typical sections shown on the plans and cross-sections.

2. MATERIALS

Accept ownership of unsuitable or excess material and dispose of material in conformance with local, state, and federal regulations, at locations outside the right of way.

3. CONSTRUCTION

Maintain drainage in the excavated area to avoid damage to the roadway section. Correct any damage to the subgrade caused by weather at no additional cost to the Department.

Shape slopes to avoid loosening material below or outside the proposed grades. Remove and dispose of slides or slope failures as directed.

Excavate to the grade and sections shown on the plans. Manipulate and compact subgrade in accordance with Section 132.3.4., "Compaction Methods," unless excavation is to clean homogenous rock at final grade.

Correct unsuitable material encountered at or below subgrade as directed.

3.1. **Rock Cuts.** Use approved embankment material compacted in accordance with Section 132.3.4., "Compaction Methods," to replace undercut material at no additional cost if excavation extends below the grade shown on the plans.

3.2. **Earth Cuts.** Scarify remaining material to a depth at least 6 in. below the grade shown on the plans in areas where pavement structure will be placed. Compact subgrade in accordance with Section 132.3.4., "Compaction Methods."

3.3. **Acceptance Criteria.**

3.3.1. **Grade Tolerances.**

3.3.1.1. **Staged Construction.** Grade to within 1.25 in. in the cross-section and 1.25 in. in 16 ft. measured longitudinally.

3.3.1.2. **Turnkey Construction.** Grade to within 0.5 in. in the cross-section and 0.5 in. in 16 ft. measured longitudinally.

4. MEASUREMENT

This Item will be measured by the cubic yard in its original position as computed by the method of average end areas or as shown on the plans.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

Limits of measurement for excavation in retaining wall areas will be as shown on the plans.

Shrinkage or swelling factors will not be considered in determining the calculated quantities.

5. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Excavation (Roadway)," "Excavation (Channel)," "Excavation (Special)," or "Excavation (Roadway and Channel)." This price is full compensation for authorized excavation; drying; undercutting subgrade in rock cuts and reworking or replacing the undercut material; hauling; disposal of material not used elsewhere on the project; scarification and compaction; and equipment, labor, materials, tools, and incidentals.

Drying subgrade deeper than 6 in. below grade as shown on the plans will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method." Excavation and replacement of unsuitable material below grade as shown on the plans will be performed and paid for in conformance with the applicable bid items. However, if Item 132, "Embankment," is not included in the Contract, payment for replacement of unsuitable material will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

Removing, reworking, reshaping, or re-laying existing pavement structure will be paid for in conformance with the appropriate item.

When a slide or slope failure not due to the Contractor's negligence or operation occurs, payment for removal and disposal of the slide material will be in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

Excavation in backfill areas of retaining walls will not be measured or paid for directly, but will be subsidiary to pertinent items.

Item 132

Embankment



1. DESCRIPTION

Furnish, place, and compact materials for construction of roadways, embankments, levees, dikes, or any designated section of the roadway where additional material is required.

2. MATERIALS

Furnish approved material capable of forming a stable embankment from required excavation in the areas shown on the plans or from sources outside the right of way. Provide one or more of the following types as shown on the plans.

- **Type A.** Granular material that is free of vegetation or other objectionable material and meets the requirements shown in Table 1.

Table 1
Testing Requirements

Property	Test Method	Specification Limit
Liquid limit	Tex-104-E	≤45
Plasticity index (PI)	Tex-106-E	≤15
Bar linear shrinkage	Tex-107-E	≥2

Perform the linear shrinkage test only as indicated in [Tex-104-E](#).

- **Type B.** Materials such as rock, loam, clay, or other approved materials.
- **Type C.** Material meeting the specification requirements shown on the plans. Type C may be further designated as Type C1, C2, etc.
- **Type D.** Material from required excavation areas shown on the plans.

Meet the requirements of the pertinent retaining wall Items for retaining wall backfill material.

3. CONSTRUCTION

Meet the requirements of Item 7, "Legal Relations and Responsibilities," when off right of way sources are used. Notify the Engineer before opening a material source to allow for required testing. Complete preparation of the right of way in accordance with Item 100, "Preparing Right of Way," for areas to receive embankment.

Backfill tree-stump holes or other minor excavations with approved material and tamp. Restore the ground surface, including any material disked loose or washed out, to its original slope. Compact the ground surface by sprinkling in accordance with Item 204, "Sprinkling," and by rolling using equipment complying with Item 210, "Rolling," when directed.

Scarify and loosen the unpaved surface areas, except rock, to a depth of at least 6 in. unless otherwise shown on the plans. Bench slopes before placing material. Begin placement of material at the toe of slopes. Do not place trees, stumps, roots, vegetation, or other objectionable material in the embankment. Simultaneously recompact scarified material with the placed embankment material. Do not exceed the layer depth specified in Section 132.3.4., "Compaction Methods."

Construct embankments to the grade and sections shown on the plans. Construct the embankment in layers approximately parallel to the finished grade for the full width of the individual roadway cross-sections unless

otherwise shown on the plans. Ensure that each section of the embankment conforms to the detailed sections or slopes. Maintain the finished section, density, and grade until the project is accepted.

- 3.1. **Earth Embankments.** Earth embankment is mainly composed of material other than rock. Construct embankments in successive layers, evenly distributing materials in lengths suited for sprinkling and rolling.

Obtain approval to incorporate rock and broken concrete produced by the construction project in the lower layers of the embankment. Place the rock and concrete outside the limits of the completed roadbed when the size of approved rock or broken concrete exceeds the layer thickness requirements in Section 132.3.4., "Compaction Methods." Cut and remove all exposed reinforcing steel from the broken concrete.

Move the material dumped in piles or windrows by blading or by similar methods and incorporate it into uniform layers. Featheredge or blend abutting layers of dissimilar material for at least 100 ft. to ensure there are no abrupt changes in the material. Break down clods or lumps of material.

Apply water free of industrial wastes and other objectionable matter to achieve the uniform moisture content specified for compaction.

Roll and sprinkle each embankment layer in accordance with Section 132.3.4.1., "Ordinary Compaction," when ordinary compaction is specified. Compact the layer to the required density in accordance with Section 132.3.4.2., "Density and Moisture Control," when density control is specified.

- 3.2. **Rock Embankments.** Rock embankment is mainly composed of rock. Construct rock embankments in successive layers for the full width of the roadway cross-section with a depth of 18 in. or less. Increase the layer depth for large rock sizes as approved. Do not exceed a depth of 2-1/2 ft. in any case. Fill voids created by the large stone matrix with smaller stones during the placement and filling operations.

Ensure the depth of the embankment layer is greater than the maximum dimension of any rock. Do not place rock greater than 2 ft. in its maximum dimension, unless otherwise approved. Construct the final layer with graded material so that the density and uniformity are in accordance with Section 132.3.4., "Compaction Methods." Break up exposed oversized material as approved.

Roll and sprinkle each embankment layer in accordance with Section 132.3.4.1., "Ordinary Compaction," when ordinary compaction is specified. Compact each layer to the required density in accordance with Section 132.3.4.2., "Density and Moisture Control," when density control is specified. Proof-roll each rock layer as directed, where density testing is not possible, in accordance with Item 216, "Proof Rolling," to ensure proper compaction.

- 3.3. **Embankments Adjacent to Culverts and Bridges.** Compact embankments adjacent to culverts and bridges in accordance with Item 400, "Excavation and Backfill for Structures."

- 3.4. **Compaction Methods.** Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller. Begin rolling at the lower side and progress toward the high side on superelevated curves. Alternate roller trips to attain slightly different lengths. Compact embankments in accordance with Section 132.3.4.1., "Ordinary Compaction," or Section 132.3.4.2., "Density and Moisture Control," as shown on the plans.

- 3.4.1. **Ordinary Compaction.** Use approved rolling equipment complying with Item 210, "Rolling," to compact each layer. Use specific equipment when required by the Engineer or as shown on the plans. Do not allow the loose depth of any layer to exceed 8 in., unless otherwise approved. Bring each layer to the moisture content directed before and during rolling operations. Compact each layer until there is no evidence of further consolidation. Maintain a level layer to ensure uniform compaction. Recompact and refinish the subgrade at no additional expense to the Department if the required stability or finish is lost for any reason.

- 3.4.2. **Density and Moisture Control.** Compact each layer to the required density using equipment complying with Item 210. Determine the maximum lift thickness based on the ability of the compacting operation and

equipment to meet the required density. Do not exceed layer thickness of 16 in. loose or 12 in. compacted material unless otherwise approved. Maintain a level layer to ensure uniform compaction.

The Engineer will use [Tex-114-E](#) to determine the maximum dry density (D_a) and optimum moisture content (W_{opt}). Meet the requirements for field density and moisture content shown in Table 2 unless otherwise shown on the plans.

Table 2
Field Density Control Requirements

Description	Density	Moisture Content
	Tex-115-E	
PI ≤ 15	≥ 98% D_a	—
15 < PI ≤ 35	≥ 98% D_a and ≤ 102% D_a	≥ W_{opt}
PI > 35	≥ 95% D_a and ≤ 100% D_a	≥ W_{opt}

Each layer is subject to testing by the Engineer for density and moisture content. Each layer must be brought to the moisture content necessary to obtain the required density and placed in a manner to ensure uniform compaction over the entire layer. The density and moisture contents for the descriptions shown in Table 2 are illustrated in the Moisture-Density Curve of [Tex-114-E](#).

Provide the Engineer with the beginning and ending station numbers of the area completed for testing. The Engineer will determine roadway density and moisture content of completed sections in accordance with [Tex-115-E](#), Part I. The Engineer will determine random locations for testing in accordance with [Tex-115-E](#), Part IV. When the density is less than the required density shown in Table 2, the Engineer may perform additional testing to determine the extent of the area to correct.

Remove small areas of the layer to allow for density tests as required. Replace the removed material and recompact at no additional expense to the Department. Proof-roll in accordance with Item 216, when shown on the plans or as directed. Correct soft spots as directed.

- 3.5. **Maintenance of Moisture and Reworking.** Maintain the density and moisture content once all requirements shown in Table 2 are met. Maintain the moisture content no lower than 4% below optimum for soils with a PI greater than 15. Rework the material to obtain the specified compaction when the material loses the required stability, density, moisture, or finish. Alter the compaction methods and procedures on subsequent work to obtain specified density as directed.
- 3.6. **Acceptance Criteria.**
 - 3.6.1. **Grade Tolerances.**
 - 3.6.1.1. **Staged Construction.** Grade to within 1.25 in. in the cross-section and 1.25 in. in 16 ft. measured longitudinally.
 - 3.6.1.2. **Turnkey Construction.** Grade to within 0.5 in. in the cross-section and 0.5 in. in 16 ft. measured longitudinally.
 - 3.6.2. **Gradation Tolerances.** Ensure no more than one of the five most recent gradation tests is outside the specified limits on any individual sieve by more than 5% when gradation requirements are shown on the plans.
 - 3.6.3. **Density Tolerances.** Ensure no more than one of the five most recent density tests for compaction work is outside the specified density limits and no test is outside the limits by more than 3 pcf.
 - 3.6.4. **Plasticity Tolerances.** Ensure no more than one of the five most recent PI tests for material is outside the specified limit by more than 2 points.

4. MEASUREMENT

Shrinkage or swell factors are the Contractor's responsibility. When shown on the plans, factors are for informational purposes only.

Measurement of retaining wall backfill in embankment areas will be paid for as embankment unless otherwise shown on the plans. Limits of measurement for embankment in retaining wall areas are shown on the plans.

Embankment will be measured by the cubic yard. Measurement will be further defined for payment as follows.

- 4.1. **Final.** The cubic yard will be measured in its final position using the average end area method or as shown on the plans. The volume is computed between the original ground surface or the surface upon which the embankment is to be constructed and the lines, grades, and slopes of the embankment. In areas of salvaged topsoil, payment for embankment will be made in accordance with Item 160, "Topsoil." Shrinkage or swell factors will not be considered in determining the calculated quantities.

When measured by the cubic yard in its final position, this is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

- 4.2. **Original.** The cubic yard will be measured in its original and natural position using the average end area method or as shown on the plans.

- 4.3. **Vehicle.** The cubic yard will be measured in vehicles at the point of delivery.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Embankment (Final)," "Embankment (Original)," or "Embankment (Vehicle)" of the compaction method and type specified. This price is full compensation for furnishing embankment; hauling; placing, compacting, finishing, and reworking; disposal of waste material; and equipment, labor, tools, and incidentals.

When proof rolling is directed, it will be paid for in accordance with Item 216.

All sprinkling and rolling, except proof rolling, will not be paid for directly, but will be subsidiary to this Item, unless otherwise shown on the plans.

In fill sections, excavation and replacement of unsuitable material below existing elevations will be performed and paid for in conformance with the applicable bid items. However, if Item 110, "Excavation," is not included in the Contract, payment for replacement of unsuitable material will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

When rework, removal, or scarification is required for existing pavement structure that will remain, it will be measured and paid for as shown on the plans for the appropriate type.

Item 160

Topsoil



1. DESCRIPTION

Furnish and place topsoil to the depths and on the areas shown on the plans.

2. MATERIALS

Use easily cultivated, fertile topsoil that is free of objectionable material and resists erosion. Obtain topsoil from the right of way at sites of proposed excavation or embankment when specified on the plans, or as directed. Secure additional topsoil, if necessary, from approved sources outside the right of way in accordance with Article 7.7., "Preservation of Cultural and Natural Resources and the Environment." Ensure that the topsoil obtained from sites outside the right of way has a pH of 5.5–8.5, per [Tex-128-E](#). Topsoil is subject to testing by the Engineer. Furnish water in accordance with Article 168.2., "Materials."

3. CONSTRUCTION

Remove and dispose of objectionable material from the topsoil source before beginning the work. Stockpile topsoil, when necessary, in a windrow at designated locations along the right of way line or as directed. Keep source and stockpile areas drained during topsoil removal and leave them in a neat condition when removal is complete. Scarify the area to a depth of 4 in. before placing topsoil. Spread the topsoil to a uniform loose cover at the thickness specified. Place and shape the topsoil as directed. Water and roll the topsoil using a light roller or other suitable equipment.

4. MEASUREMENT

This Item will be measured by the 100-ft. station along the baseline of each roadbed, by the square yard, or by the cubic yard in vehicles at the point of delivery.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Furnishing and Placing Topsoil" of the depth specified on the plans (except for measurement by the cubic yard). This price is full compensation for securing necessary sources and royalties; furnishing topsoil; excavation, loading, hauling, stockpiling, and placing; watering; rolling; and equipment, labor, materials, tools, and incidentals. Limits of excavation and embankment for payment are shown in Figure 1.

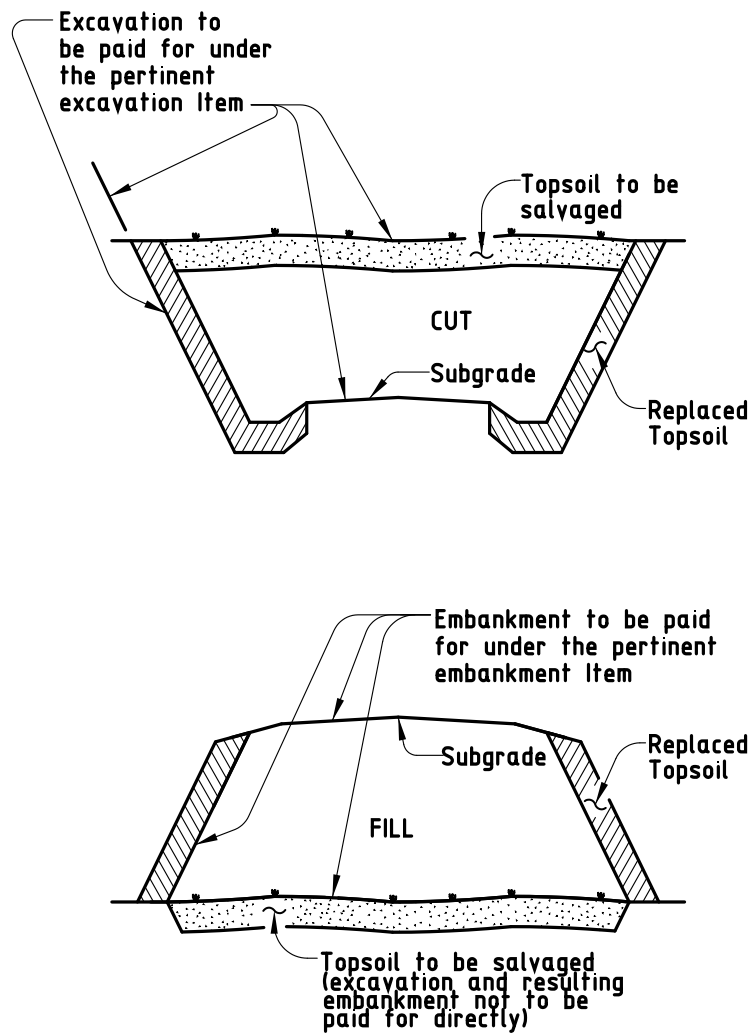


Figure 1
Roadway Cross-Sections Showing Payment for Excavation and Embankment

Item 162

Sodding for Erosion Control



1. DESCRIPTION

Provide and install grass sod as shown on the plans or as directed.

2. MATERIALS

Use live, growing grass sod of the type specified on the plans. Use grass sod with a healthy root system and dense matted roots throughout the soil of the sod for a minimum thickness of 1 in. Do not use sod from areas where the grass is thinned out. Keep sod material moist from the time it is dug until it is planted. Grass sod with dried roots is unacceptable.

- 2.1. **Block Sod.** Use block, rolled, or solid sod free of noxious weeds, Johnson grass, other grasses, or any matter deleterious to the growth and subsistence of the sod.
- 2.2. **Mulch Sod.** Use mulch sod from an approved source, free of noxious weeds, Johnson grass, other grasses, or any matter deleterious to the growth and subsistence of the sod.
- 2.3. **Fertilizer.** Furnish fertilizer in accordance with Article 166.2., "Materials."
- 2.4. **Water.** Furnish water in accordance with Article 168.2., "Materials."
- 2.5. **Mulch.** Use straw mulch consisting of oat, wheat, or rice straw or hay mulch of either Bermudagrass or prairie grasses. Use straw or hay mulch free of Johnson grass and other noxious and foreign materials. Keep the mulch dry and do not use molded or rotted material.
- 2.6. **Tacking Methods.** Use a tacking agent applied in conformance with the manufacturer's recommendations or by a crimping method on all straw or hay mulch operations. Use tacking agents as approved or as specified on the plans.

3. CONSTRUCTION

Scarify the area to a depth of 4 in. before placing the sod. Plant the sod specified and mulch, if required, after the area has been completed to lines and grades as shown on the plans. Apply fertilizer uniformly over the entire area in accordance with Article 166.3., "Construction," and water in accordance with Article 168.3., "Construction." Plant between the average date of the last freeze in the spring and 6 weeks before the average date for the first freeze in the fall in accordance with the *Texas Almanac* for the project area.

- 3.1. **Sodding Types.**
 - 3.1.1. **Spot Sodding.** Use only Bermudagrass sod. Create furrows parallel to the roadway, approximately 5 in. deep and on 18-in. centers. Sod a continuous row not less than 3 in. wide in the two furrows adjacent to the roadway. Place 3-in. squares of sod on 15-in. centers in the remaining furrows. Place sod so that the root system will be completely covered by the soil. Firm all sides of the sod with the soil without covering the sod with soil.
 - 3.1.2. **Block Sodding.** Place sod over the prepared area. Roll or tamp the sodded area to form a thoroughly compacted, solid mat filling all voids in the sodded area with additional sod. Trim and remove all visible netting and backing materials. Keep sod along edges of curbs, driveways, and walkways trimmed until acceptance.

- 3.1.3. **Mulch Sodding.** Mow sod source to no shorter than 4 in., and rake and remove cuttings. Disk the sod in two directions, cutting the sod to a minimum of 4 in. Excavate the sod material to a depth of no more than 6 in. Keep excavated material moist, or it will be rejected. Distribute the mulch sod uniformly over the area to a depth of 6 in. loose, unless otherwise shown on the plans, and roll using a light roller or other suitable equipment.
- Add or reshape the mulch sod to meet the requirements of Section 162.3.2., "Finishing."
- 3.2. **Finishing.** Smooth and shape the area after planting to conform to the desired cross-sections. Spread any excess soil uniformly over adjacent areas or dispose of the excess soil as directed.
- 3.3. **Straw or Hay Mulch.** Apply straw or hay mulch for "Spot Sodding" and "Mulch Sodding" uniformly over the area as shown on the plans. Apply straw or hay mulch in accordance with Section 164.3.6., "Straw or Hay Mulching." Apply tack in accordance with Section 162.2.6., "Tacking Methods."

4. MEASUREMENT

"Spot Sodding," "Block Sodding," and "Straw or Hay Mulch" will be measured by the square yard in its final position. "Mulch Sodding" will be measured by the square yard in its final position or by the cubic yard in vehicles as delivered to the planting site.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Spot Sodding," "Block Sodding," "Straw or Hay Mulch," or "Mulch Sodding." This price is full compensation for securing a source, excavation, loading, hauling, placing, rolling, finishing, furnishing materials, equipment, labor, tools, supplies, and incidentals.

Fertilizer will not be paid for directly but will be subsidiary to this Item.

Water for irrigating the sodded area, when specified, will be paid for in accordance with Item 168, "Vegetative Watering." Water for maintaining and preparing the sod before planting will not be paid for directly but will be subsidiary to this Item.

Item 164

Seeding for Erosion Control



1. DESCRIPTION

Prepare the surface and provide and distribute temporary or permanent seeding for erosion control as shown on the plans or as directed.

2. MATERIALS

- 2.1. **Seed.** Provide seed from the previous season's crop meeting the requirements of the Texas Seed Law, including the testing and labeling for pure live seed (PLS = Purity × Germination). Furnish seed of the designated species in labeled unopened bags or containers to the Engineer before planting. Use within 12 mo. from the date of the analysis. When Buffalograss is specified, use seed that is treated with potassium nitrate (KNO_3) to overcome dormancy.

Use Tables 1–5 to determine the appropriate seeding mix and rates as shown on the plans. Include flower seeding mix in accordance with Table 5 with seeding mix shown in Table 1 and Table 2.

If a grass plant species is not available by the producers, the other grass plant species in the seeding mix will be increased proportionally by the percentage of the missing plant grass species. If a flower plant species is not available by the producers, the other flower species in the seeding mix will be increased proportionally by the percentage of the missing flower species. Substitute species and rates require approval of the Engineer before being incorporated into the seeding mx. The rates listed in the tables are for drill seeding. All other methods of placing seed will require a 25% increase in rate.

Table 1
Permanent Rural Seeding Mix

District	Clay Soils Species, Percent, and Rate (lb. PLS per acre)	Sandy Soils Species, Percent, and Rate (lb. PLS per acre)
1 (Paris)	Hooded Windmillgrass (Burnet)	15% 0.3
	White Tridens (Guadalupe)	20% 0.4
	Little Bluestem (Coastal Plains)	20% 2.0
	Florida Paspalum (Harrison)	15% 2.25
	Sideoats Grama (Haskell)	05% 0.5
	Splitbeard Bluestem (Neches)	05% 0.5
	Sand Dropseed (Taylor)	05% 0.1
	Canada Wildrye (Lavaca)	10% 2.0
	Green Sprangletop (Van Horn)	05% 0.2
2 (Fort Worth)	Hooded Windmillgrass (Burnet)	15% 0.3
	White Tridens (Guadalupe)	15% 0.3
	Sideoats Grama (Haskell)	10% 1.0
	Little Bluestem (OK Select)	10% 0.7
	Buffalograss (Texoka)	10% 1.5
	Silver Bluestem (Santiago)	10% 0.4
	Green Sprangletop (Van Horn)	10% 0.4
	Sand Dropseed (Taylor)	10% 0.2
	Canada Wildrye (Lavaca)	10% 2.0
	Sand Dropseed (Taylor)	15% 0.3
	Sideoats Grama (Haskell)	15% 1.5
	Little Bluestem (OK Select)	15% 1.05
	Hairy Grama (Chaparral)	15% 0.6
	Green Sprangletop (Van Horn)	10% 0.2
	Hooded Windmillgrass (Burnet)	10% 0.2
	Shortspike Windmillgrass (Welder)	10% 0.2
	Silver Bluestem (Santiago)	10% 0.4

Table 1 (continued)
Permanent Rural Seeding Mix

District	Clay Soils		Sandy Soils	
	Species, Percent, and Rate (lb. PLS per acre)		Species, Percent, and Rate (lb. PLS per acre)	
3 (Wichita Falls)	Sideoats Grama (Haskell)	15% 1.5	Hooded Windmillgrass (Burnet)	10% 0.2
	Green Sprangletop (Van Horn)	10% 0.4	Sand Dropseed (Taylor)	15% 0.3
	Hooded Windmillgrass (Burnet)	10% 0.2	Green Sprangletop (Van Horn)	15% 0.6
	White Tridens (Guadalupe)	10% 0.2	Sideoats Grama (Haskell)	10% 1.0
	Little Bluestem (OK Select)	15% 1.05	Little Bluestem (OK Select)	10% 0.7
	Silver Bluestem (Santiago)	10% 0.4	Silver Bluestem (Santiago)	10% 0.4
	Buffalograss (Texoka)	10% 1.5	Hairy Grama (Chaparral)	10% 0.4
	Blue Grama (Hachita)	05% 0.2	Arizona Cottontop (La Salle)	10% 0.4
	Sand Dropseed (Taylor)	05% 0.1	Blue Grama (Hachita)	10% 0.4
	Canada Wildrye (Lavaca)	10% 2.0		
4 (Amarillo)	Sideoats Grama (Haskell)	15% 1.5	Green Sprangletop (Van Horn)	15% 0.6
	Silver Bluestem (Santiago)	15% 0.6	Sideoats Grama (Haskell)	10% 1.0
	Buffalograss (Texoka)	15% 2.25	Sand Dropseed (Taylor)	10% 0.2
	Green Sprangletop (Van Horn)	10% 0.4	Silver Bluestem (Santiago)	10% 0.4
	Blue Grama (Hachita)	15% 0.6	Little Bluestem (OK Select)	15% 1.05
	Hooded Windmillgrass (Burnet)	05% 0.1	Arizona Cottontop (La Salle)	10% 0.4
	White Tridens (Guadalupe)	10% 0.2	Blue Grama (Hachita)	10% 0.4
	Western Wheatgrass (Barton)	10% 3.0	Sand Lovegrass (Mason)	10% 0.3
	Canada Wildrye (Lavaca)	05% 1.0	Hooded Windmillgrass (Burnet)	10% 0.2
5 (Lubbock)	Sideoats Grama (Haskell)	15% 1.5	Green Sprangletop (Van Horn)	15% 0.6
	Blue Grama (Hachita)	15% 0.6	Blue Grama (Hachita)	15% 0.6
	Silver Bluestem (Santiago)	15% 0.6	Sideoats Grama (Haskell)	10% 1.0
	Buffalograss (Texoka)	10% 1.5	Little Bluestem (OK Select)	10% 0.7
	White Tridens (Guadalupe)	10% 0.2	Hooded Windmillgrass (Burnet)	10% 0.2
	Green Sprangletop (Van Horn)	10% 0.4	Sand Dropseed (Taylor)	10% 0.2
	Hooded Windmillgrass (Burnet)	05% 0.1	Silver Bluestem (Santiago)	10% 0.4
	Galleta Grass (Viva)	05% 0.3	Arizona Cottontop (La Salle)	10% 0.4
	Western Wheatgrass (Barton)	10% 3.0	Sand Lovegrass (Mason)	10% 0.3
	Canada Wildrye (Lavaca)	05% 1.0		
6 (Odessa)	Whiplash Pappusgrass (Permian)	15% 0.9	Sand Dropseed (Taylor)	15% 0.3
	Green Sprangletop (Van Horn)	10% 0.4	Green Sprangletop (Van Horn)	10% 0.4
	Silver Bluestem (Santiago)	15% 0.6	Sideoats Grama (Brewster)	15% 1.5
	Sideoats Grama (Brewster)	10% 1.0	Whiplash Pappusgrass (Permian)	10% 0.6
	Sand Dropseed (Taylor)	10% 0.2	Hooded Windmillgrass (Burnet)	10% 0.2
	Alkali Sacaton (Saltalk)	10% 0.2	Blue Grama (Hachita)	10% 0.4
	Arizona Cottontop (La Salle)	10% 0.4	Hairy Grama (Chaparral)	10% 0.4
	Blue Grama (Hachita)	10% 0.4	Sand Lovegrass (Mason)	10% 0.3
	Galleta Grass (Viva)	10% 0.6	Little Bluestem (Pastura)	05% 0.5
			Galleta Grass (Viva)	05% 0.3
7 (San Angelo)	Sideoats Grama (Brewster)	15% 1.5	Sand Dropseed (Taylor)	15% 0.3
	Hooded Windmillgrass (Burnet)	10% 0.2	Green Sprangletop (Van Horn)	15% 0.6
	Silver Bluestem (Santiago)	10% 0.4	Hooded Windmillgrass (Burnet)	15% 0.3
	Sand Dropseed (Taylor)	10% 0.2	Shortspike Windmillgrass (Welder)	10% 0.2
	White Tridens (Guadalupe)	10% 0.2	Hairy Grama (Chaparral)	10% 0.4
	Whiplash Pappusgrass (Permian)	15% 0.9	Sand Lovegrass (Mason)	10% 0.3
	Texas Grama (Atascosa)	05% 0.5	Sideoats Grama (Brewster)	10% 1.0
	Green Sprangletop (Van Horn)	10% 0.4	Little Bluestem (OK Select)	10% 0.7
	Little Bluestem (OK Select)	05% 0.35	Whiplash Pappusgrass (Permian)	05% 0.3
	Blue Grama (Hachita)	05% 0.2		
	Galleta Grass (Viva)	05% 0.3		

Table 1 (continued)
Permanent Rural Seeding Mix

District	Clay Soils		Sandy Soils	
	Species, Percent, and Rate (lb. PLS per acre)		Species, Percent, and Rate (lb. PLS per acre)	
8 (Abilene)	Sideoats Grama (Haskell)	10% 1.0	Sand Dropseed (Taylor)	15% 0.3
	Hooded Windmillgrass (Burnet)	10% 0.2	Green Sprangletop (Van Horn)	10% 0.4
	Buffalograss (Texoka)	10% 1.5	Hooded Windmillgrass (Burnet)	15% 0.3
	Blue Grama (Hachita)	10% 0.4	Silver Bluestem (Santiago)	10% 0.4
	Silver Bluestem (Santiago)	10% 0.4	Little Bluestem (OK Select)	10% 0.7
	White Tridens (Guadalupe)	15% 0.2	Shortspike Windmillgrass (Welder)	10% 0.2
	Little Bluestem (OK Select)	10% 0.7	Hairy Grama (Chaparral)	10% 0.4
	Green Sprangletop (Van Horn)	10% 0.4	Sand Lovegrass (Mason)	10% 0.3
	Whiplash Pappusgrass (Permian)	10% 0.6	Arizona Cottontop (La Salle)	10% 0.4
	Galleta Grass (Viva)	10% 0.6		
9 (Waco)	Sideoats Grama (Haskell)	15% 1.5	Hooded Windmillgrass (Burnet)	15% 0.3
	White Tridens (Guadalupe)	15% 0.3	Shortspike Windmillgrass (Welder)	10% 0.2
	Hooded Windmillgrass (Burnet)	10% 0.2	Hairy Grama (Chaparral)	10% 0.4
	Little Bluestem (OK Select)	10% 0.7	Sand Dropseed (Taylor)	15% 0.3
	Buffalograss (Texoka)	10% 1.6	Sideoats Grama (Haskell)	10% 1.0
	Halls Panicum (Oso)	05% 0.1	Little Bluestem (OK Select)	10% 0.7
	Silver Bluestem (Santiago)	10% 0.4	Green Sprangletop (Van Horn)	10% 0.4
	Sand Dropseed (Taylor)	05% 0.1	Texas Grama (Atascosa)	05% 0.15
	Green Sprangletop (Van Horn)	10% 0.4	Silver Bluestem (Santiago)	10% 0.4
	Canada Wildrye (Lavaca)	05% 1.0	Canada Wildrye (Lavaca)	05% 1.0
	Texas Grama (Atascosa)	05% 0.5		
10 (Tyler)	Hooded Windmillgrass (Burnet)	15% 0.3	Hooded Windmillgrass (Burnet)	15% 0.3
	White Tridens (Guadalupe)	15% 0.3	Sand Dropseed (Taylor)	10% 0.2
	Sand Dropseed (Taylor)	05% 0.1	Little Bluestem (Coastal Plains)	20% 2.0
	Little Bluestem (Coastal Plains)	20% 2.0	Florida Paspalum (Harrison)	15% 2.25
	Florida Paspalum (Harrison)	15% 2.25	Splitbeard Bluestem (Neches)	10% 1.0
	Splitbeard Bluestem (Neches)	10% 1.0	Green Sprangletop (Van Horn)	05% 0.2
	Green Sprangletop (Van Horn)	05% 0.2	Sand Lovegrass (Mason)	10% 0.4
	Sideoats Grama (Haskell)	05% 0.5	Red Lovegrass (Duval)	10% 0.2
	Canada Wildrye (Lavaca)	10% 2.0	Hairy Grama (Chaparral)	05% 0.2
11 (Lufkin)	Hooded Windmillgrass (Burnet)	15% 0.3	Hooded Windmillgrass (Burnet)	15% 0.3
	White Tridens (Guadalupe)	15% 0.3	Sand Dropseed (Taylor)	10% 0.2
	Little Bluestem (Coastal Plains)	20% 2.0	Little Bluestem (Coastal Plains)	20% 2.0
	Florida Paspalum (Harrison)	15% 2.25	Florida Paspalum (Harrison)	15% 2.25
	Green Sprangletop (Van Horn)	05% 0.2	Splitbeard Bluestem (Neches)	10% 1.0
	Sideoats Grama (Haskell)	05% 0.5	Green Sprangletop (Van Horn)	05% 0.2
	Splitbeard Bluestem (Neches)	10% 1.0	Red Lovegrass (Duval)	10% 0.2
	Sand Dropseed (Taylor)	05% 0.1	Sand Lovegrass (Mason)	10% 0.4
	Canada Wildrye (Lavaca)	10% 2.0	Hairy Grama (Chaparral)	05% 0.2
12 (Houston)	White Tridens (Guadalupe)	10% 0.2	Hooded Windmillgrass (Mariah)	15% 0.3
	Hooded Windmillgrass (Mariah)	10% 0.2	Sand Dropseed (Nueces)	15% 0.3
	Shortspike Windmillgrass (Welder)	15% 0.3	Shortspike Windmillgrass (Welder)	10% 0.2
	Little Bluestem (Coastal Plains)	15% 1.5	Little Bluestem (Coastal Plains)	15% 1.5
	Florida Paspalum (Harrison)	15% 2.25	Red Lovegrass (Duval)	10% 0.2
	Red Lovegrass (Duval)	05% 0.1	Florida Paspalum (Harrison)	15% 2.25
	Halls Panicum (Oso)	10% 0.2	Splitbeard Bluestem (Neches)	10% 1.0
	Splitbeard Bluestem (Neches)	05% 0.5	Hairy Grama (Chaparral)	05% 0.2
	Sand Dropseed (Nueces)	05% 0.1	Green Sprangletop (Van Horn)	05% 0.2
	Canada Wildrye (Lavaca)	10% 2.0		

Table 1 (continued)
Permanent Rural Seeding Mix

District	Clay Soils		Sandy Soils	
	Species, Percent, and Rate (lb. PLS per acre)		Species, Percent, and Rate (lb. PLS per acre)	
13 (Yoakum)	White Tridens (Guadalupe)	15% 0.3	Hairy Grama (Chaparral)	15% 0.6
	Shortspike Windmillgrass (Welder)	15% 0.3	Hooded Windmillgrass (Mariah)	15% 0.3
	Halls Panicum (Oso)	10% 0.2	Shortspike Windmillgrass (Welder)	10% 0.2
	Plains Bristlegrass (Catarina Blend)	10% 0.6	Sand Dropseed (Nueces)	10% 0.2
	Little Bluestem (Coastal Plains)	15% 1.5	Little Bluestem (Carrizo)	10% 1.5
	Sideoats Grama (South Texas)	05% 0.75	Red Lovegrass (Duval)	10% 0.2
	Texas Grama (Atascosa)	10% 1.0	Slender Grama (Dilley)	10% 1.0
	Hooded Windmillgrass (Mariah)	05% 0.1	Plains Bristlegrass (Catarina)	10% 0.4
	Sand Dropseed (Nueces)	05% 0.1	Green Sprangletop (Van Horn)	10% 0.4
	Canada Wildrye (Lavaca)	10% 2.0		
14 (Austin)	Hooded Windmillgrass (Burnet)	20% 0.4	Hairy Grama (Chaparral)	15% 0.6
	White Tridens (Guadalupe)	10% 0.2	Shortspike Windmillgrass (Welder)	10% 0.2
	Sideoats Grama (South Texas)	10% 1.5	Hooded Windmillgrass (Burnet)	10% 0.2
	Shortspike Windmillgrass (Welder)	10% 0.2	Red Lovegrass (Duval)	10% 0.2
	Plains Bristlegrass (Catarina Blend)	10% 0.6	Sand Dropseed (Nueces)	10% 0.2
	Silver Bluestem (Santiago)	10% 0.4	Little Bluestem (Carrizo)	10% 1.5
	Little Bluestem (OK Select)	10% 0.7	Sideoats Grama (South Texas)	10% 1.5
	Halls Panicum (Oso)	05% 0.1	Silver Bluestem (Santiago)	10% 0.4
	Texas Grama (Atascosa)	05% 0.5	Plains Bristlegrass (Catarina)	10% 0.4
	Canada Wildrye (Lavaca)	10% 2.0	Arizona Cottontop (La Salle)	05% 0.2
15 (San Antonio)	Sideoats Grama (South Texas)	15% 2.25	Slender Grama (Dilley)	15% 1.5
	White Tridens (Guadalupe)	15% 0.3	Hairy Grama (Chaparral)	15% 0.6
	Shortspike Windmillgrass (Welder)	10% 0.2	Shortspike Windmillgrass (Welder)	10% 0.2
	Halls Panicum (Oso)	10% 0.2	Hooded Windmillgrass (Mariah)	10% 0.2
	Plains Bristlegrass (Catarina Blend)	10% 0.6	Red Lovegrass (Duval)	10% 0.2
	False Rhodes Grass (Kinney)	05% 0.1	Sand Dropseed (Nueces)	10% 0.2
	Hooded Windmillgrass (Mariah)	05% 0.1	Pink Pappusgrass (Maverick)	05% 0.3
	Pink Pappusgrass (Maverick)	10% 0.6	Little Bluestem (Carrizo)	10% 1.5
	Texas Grama (Atascosa)	05% 0.5	Arizona Cottontop (La Salle)	05% 0.2
	Multiflower False Rhodes Grass (Hidalgo)	10% 0.2	Multiflower False Rhodes Grass (Hidalgo)	05% 0.1
	Arizona Cottontop (La Salle)	05% 0.2	Plains Bristlegrass (Catarina)	05% 0.2
16 (Corpus Christi)	Shortspike Windmillgrass (Welder)	15% 0.3	Slender Grama (Dilley)	15% 1.5
	Pink Pappusgrass (Maverick)	10% 0.6	Hairy Grama (Chaparral)	15% 0.6
	Halls Panicum (Oso)	10% 0.2	Hooded Windmillgrass (Mariah)	10% 0.2
	Plains Bristlegrass (Catarina Blend)	10% 0.6	Red Lovegrass (Duval)	10% 0.2
	White Tridens (Guadalupe)	10% 0.2	Sand Dropseed (Nueces)	10% 0.2
	Multiflower False Rhodes Grass (Hidalgo)	10% 0.2	Shortspike Windmillgrass (Welder)	10% 0.2
	Hooded Windmillgrass (Mariah)	10% 0.2	Pink Pappusgrass (Maverick)	10% 0.6
	Arizona Cottontop (La Salle)	05% 0.2	Multiflower False Rhodes Grass (Hidalgo)	10% 0.2
	Sand Dropseed (Nueces)	05% 0.1	Arizona Cottontop (La Salle)	05% 0.2
	Sideoats Grama (South Texas)	10% 1.5	Little Bluestem (Carrizo)	05% 0.75
	Texas Grama (Atascosa)	05% 0.5		
17 (Bryan)	White Tridens (Guadalupe)	15% 0.3	Sand Dropseed (Taylor)	10% 0.2
	Hooded Windmillgrass (Burnet)	15% 0.3	Shortspike Windmillgrass (Welder)	10% 0.2
	Little Bluestem (Coastal Plains)	15% 1.5	Little Bluestem (Coastal Plains)	15% 1.5
	Florida Paspalum (Harrison)	15% 2.25	Green Sprangletop (Van Horn)	05% 0.2
	Shortspike Windmillgrass (Welder)	10% 0.2	Florida Paspalum (Harrison)	15% 2.25
	Splitbeard Bluestem (Neches)	05% 0.5	Splitbeard Bluestem (Neches)	10% 1.0
	Green Sprangletop (Van Horn)	05% 0.2	Hooded Windmillgrass (Burnet)	15% 0.3
	Halls Panicum (Oso)	05% 0.1	Red Lovegrass (Duval)	10% 0.2
	Sand Dropseed (Taylor)	05% 0.1	Hairy Grama (Chaparral)	10% 0.4
	Canada Wildrye (Lavaca)	10% 2.0		

Table 1 (continued)
Permanent Rural Seeding Mix

District	Clay Soils		Sandy Soils	
	Species, Percent, and Rate (lb. PLS per acre)		Species, Percent, and Rate (lb. PLS per acre)	
18 (Dallas)	Sideoats Grama (Haskell)	15% 1.5	Shortspike Windmillgrass (Welder)	10% 0.2
	Hooded Windmillgrass (Burnet)	15% 0.3	Hairy Grama (Chaparral)	15% 0.6
	White Tridens (Guadalupe)	15% 0.3	Sand Dropseed (Taylor)	10% 0.2
	Little Bluestem (OK Select)	15% 1.05	Little Bluestem (OK Select)	15% 1.05
	Buffalograss (Texoka)	10% 1.5	Sideoats Grama (Haskell)	10% 1.0
	Silver Bluestem (Santiago)	05% 0.2	Green Sprangletop (Van Horn)	10% 0.4
	Green Sprangletop (Van Horn)	05% 0.2	Hooded Windmillgrass (Burnet)	10% 0.2
	Shortspike Windmillgrass (Welder)	05% 0.1	Sand Lovegrass (Mason)	10% 0.4
	Canada Wildrye (Lavaca)	10% 2.0	Silver Bluestem (Santiago)	10% 0.4
	Sand Dropseed (Taylor)	05% 0.1		
19 (Atlanta)	White Tridens (Guadalupe)	15% 0.3	Hooded Windmillgrass (Burnet)	15% 0.3
	Hooded Windmillgrass (Burnet)	15% 0.3	Sand Dropseed (Taylor)	10% 0.2
	Little Bluestem (Coastal Plains)	20% 2.0	Little Bluestem (Coastal Plains)	20% 2.0
	Florida Paspalum (Harrison)	15% 2.25	Florida Paspalum (Harrison)	15% 2.25
	Sideoats Grama (Haskell)	10% 1.0	Splitbeard Bluestem (Neches)	10% 1.0
	Splitbeard Bluestem (Neches)	05% 0.5	Sand Lovegrass (Mason)	10% 0.4
	Green Sprangletop (Van Horn)	05% 0.2	Red Lovegrass (Duval)	10% 0.2
	Sand Dropseed (Taylor)	05% 0.1	Hairy Grama (Chaparral)	10% 0.4
	Canada Wildrye (Lavaca)	10% 2.0		
20 (Beaumont)	White Tridens (Guadalupe)	10% 0.2	Hooded Windmillgrass (Mariah)	15% 0.3
	Hooded Windmillgrass (Mariah)	10% 0.2	Sand Dropseed (Nueces)	15% 0.3
	Shortspike Windmillgrass (Welder)	15% 0.3	Shortspike Windmillgrass (Welder)	10% 0.2
	Little Bluestem (Coastal Plains)	15% 1.5	Little Bluestem (Coastal Plains)	15% 1.5
	Florida Paspalum (Harrison)	15% 2.25	Red Lovegrass (Duval)	10% 0.2
	Red Lovegrass (Duval)	05% 0.1	Florida Paspalum (Harrison)	15% 2.25
	Halls Panicum (Oso)	10% 0.2	Splitbeard Bluestem (Neches)	10% 1.0
	Splitbeard Bluestem (Neches)	05% 0.5	Hairy Grama (Chaparral)	05% 0.2
	Sand Dropseed (Nueces)	05% 0.1	Green Sprangletop (Van Horn)	05% 0.2
	Canada Wildrye (Lavaca)	10% 2.0		
21 (Pharr)	Shortspike Windmillgrass (Welder)	10% 0.2	Slender Grama (Dilley)	10% 1.0
	Halls Panicum (Oso)	10% 0.2	Hairy Grama (Chaparral)	10% 0.4
	White Tridens (Guadalupe)	10% 0.2	Shortspike Windmillgrass (Welder)	10% 0.2
	Plains Bristlegrass (Catarina Blend)	10% 0.6	Red Lovegrass (Duval)	10% 0.2
	Pink Pappusgrass (Maverick)	10% 0.6	Sand Dropseed (Nueces)	10% 0.2
	Texas Grama (Atascosa)	10% 1.0	Hooded Windmillgrass (Mariah)	10% 0.2
	Multiflower False Rhodes Grass (Hidalgo)	05% 0.1	Pink Pappusgrass (Maverick)	10% 0.6
	Hooded Windmillgrass (Mariah)	10% 0.2	Whiplash Pappusgrass (Webb)	10% 0.6
	Arizona Cottontop (La Salle)	10% 0.4	Multiflower False Rhodes Grass (Hidalgo)	10% 0.2
	Sand Dropseed (Nueces)	05% 0.1	Arizona Cottontop (La Salle)	10% 0.4
	Whiplash Pappusgrass (Webb)	10% 0.6		
22 (Laredo)	Sideoats Grama (South Texas)	15% 2.25	Slender Grama (Dilley)	15% 1.5
	Pink Pappusgrass (Maverick)	10% 0.6	Hairy Grama (Chaparral)	15% 0.6
	Halls Panicum (Oso)	10% 0.2	Hooded Windmillgrass (Mariah)	10% 0.2
	Plains Bristlegrass (Catarina Blend)	10% 0.6	Red Lovegrass (Duval)	10% 0.2
	White Tridens (Guadalupe)	10% 0.2	Sand Dropseed (Nueces)	10% 0.2
	Whiplash Pappusgrass (Webb)	10% 0.6	Pink Pappusgrass (Maverick)	10% 0.6
	Shortspike Windmillgrass (Welder)	05% 0.1	Arizona Cottontop (La Salle)	10% 0.4
	Texas Grama (Atascosa)	10% 1.0	Little Bluestem (Carrizo)	05% 0.75
	False Rhodes Grass (Kinney)	10% 0.2	Sideoats Grama (South Texas)	10% 1.5
	Hooded Windmillgrass (Mariah)	10% 0.2	Shortspike Windmillgrass (Welder)	05% 0.1

Table 1 (continued)
Permanent Rural Seeding Mix

District	Clay Soils Species, Percent, and Rate (lb. PLS per acre)		Sandy Soils Species, Percent, and Rate (lb. PLS per acre)	
23 (Brownwood)	Sideoats Grama (Haskell)	15% 1.5	Green Sprangletop (Van Horn)	15% 0.6
	Hooded Windmillgrass (Burnet)	15% 0.3	Sand Dropseed (Taylor)	15% 0.3
	White Tridens (Guadalupe)	15% 0.3	Sideoats Grama (Haskell)	10% 1.0
	Texas Grama (Atascosa)	10% 1.0	Little Bluestem (OK Select)	15% 1.05
	Little Bluestem (OK Select)	10% 0.7	Silver Bluestem (Santiago)	10% 0.4
	Buffalograss (Texoka)	10% 1.5	Hooded Windmillgrass (Burnet)	10% 0.2
	Silver Bluestem (Santiago)	10% 0.4	Shortspike Windmillgrass (Welder)	10% 0.2
	Shortspike Windmillgrass (Welder)	05% 0.1	Hairy Grama (Chaparral)	10% 0.4
	Sand Dropseed (Taylor)	05% 0.1	Sand Lovegrass (Mason)	05% 0.2
	Green Sprangletop (Van Horn)	05% 0.2		
24 (El Paso)	Green Sprangletop (Van Horn)	10% 0.4	Sand Dropseed (Taylor)	20% 0.4
	Sideoats Grama (Brewster)	10% 1.0	Sideoats Grama (Brewster)	15% 1.5
	Whiplash Pappusgrass (Permian)	10% 0.6	Green Sprangletop (Van Horn)	15% 0.6
	Silver Bluestem (Santiago)	10% 0.4	Hooded Windmillgrass (Burnet)	10% 0.2
	Blue Grama (Hachita)	10% 0.4	Blue Grama (Hachita)	10% 0.4
	Galleta Grass (Viva)	10% 0.6	Hairy Grama (Chaparral)	05% 0.2
	Alkali Sacaton (Saltalk)	10% 0.2	Spike Dropseed (Potter)	10% 0.1
	Arizona Cottontop (La Salle)	10% 0.4	Little Bluestem (Pastura)	05% 0.5
	Plains Bristlegrass (Catarina Blend)	10% 0.4	Galleta grass (Viva)	10% 0.6
	False Rhodes Grass (Kinney)	10% 0.2		
25 (Childress)	Sideoats Grama (Haskell)	15% 1.5	Sideoats Grama (Haskell)	15% 1.5
	Hooded Windmillgrass (Burnet)	15% 0.3	Green Sprangletop (Van Horn)	10% 0.4
	Blue Grama (Hachita)	10% 0.4	Sand Dropseed (Taylor)	10% 0.2
	Buffalograss (Texoka)	10% 1.5	Hooded Windmillgrass (Burnet)	10% 0.2
	Galleta Grass (Viva)	10% 0.6	Arizona Cottontop (La Salle)	10% 0.4
	Silver Bluestem (Santiago)	15% 0.6	Blue Grama (Hachita)	10% 0.4
	White Tridens (Guadalupe)	10% 0.2	Little Bluestem (OK select)	10% 1.0
	Green Sprangletop (Van Horn)	05% 0.2	Galleta Grass (Viva)	10% 0.6
	Western Wheatgrass (Barton)	05% 1.5	Sand Lovegrass (Mason)	05% 0.15
	Canada Wildrye (Lavaca)	05% 1.0	Canada Wildrye (Lavaca)	10% 2.0

Table 2
Permanent Urban Seeding Mix

District	Clay Soils Species and Rates (lb. PLS per acre)		Sandy Soils Species and Rates (lb. PLS per acre)	
1 (Paris)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
2 (Fort Worth)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (El Reno)	3.6	Sideoats Grama (El Reno)	3.6
	Bermudagrass	2.4	Bermudagrass	2.1
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.3
3 (Wichita Falls)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (El Reno)	4.5	Sideoats Grama (El Reno)	3.6
	Bermudagrass	1.8	Bermudagrass	1.8
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.4
4 (Amarillo)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (El Reno)	3.6	Sideoats Grama (El Reno)	2.7
	Blue Grama (Hachita)	1.2	Blue Grama (Hachita)	0.9
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.4
5 (Lubbock)			Buffalograss (Texoka)	1.6
	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (El Reno)	3.6	Sideoats Grama (El Reno)	2.7
	Blue Grama (Hachita)	1.2	Blue Grama (Hachita)	0.9
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.4
			Buffalograss (Texoka)	1.6

Table 2 (continued)
Permanent Urban Seeding Mix

District	Clay Soils Species and Rates (lb. PLS per acre)		Sandy Soils Species and Rates (lb. PLS per acre)	
6 (Odessa)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (Haskell)	3.6	Sideoats Grama (Haskell)	2.7
	Blue Grama (Hachita)	1.2	Sand Dropseed (Borden Co.)	0.4
	Buffalograss (Texoka)	1.6	Blue Grama (Hachita)	0.9
			Buffalograss (Texoka)	1.6
7 (San Angelo)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (Haskell)	7.2	Sideoats Grama (Haskell)	3.2
	Buffalograss (Texoka)	1.6	Sand Dropseed (Borden Co.)	0.3
			Blue Grama (Hachita)	0.9
			Buffalograss (Texoka)	1.6
8 (Abilene)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (Haskell)	3.6	Sand Dropseed (Borden Co.)	0.3
	Blue Grama (Hachita)	1.2	Sideoats Grama (Haskell)	3.6
	Buffalograss (Texoka)	1.6	Blue Grama (Hachita)	0.8
			Buffalograss (Texoka)	1.6
9 (Waco)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Bermudagrass	1.8	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6	Bermudagrass	3.6
	Sideoats Grama (Haskell)	4.5	Sand Dropseed (Borden Co.)	0.4
10 (Tyler)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
11 (Lufkin)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
12 (Houston)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (Haskell)	4.5	Bermudagrass	5.4
	Bermudagrass	2.4		
13 (Yoakum)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (South Texas)	4.5	Bermudagrass	5.4
	Bermudagrass	2.4		
14 (Austin)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Bermudagrass	2.4	Bermudagrass	4.8
	Sideoats Grama (South Texas)	3.6	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6		
15 (San Antonio)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (South Texas)	3.6	Bermudagrass	4.8
	Bermudagrass	2.4	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6		
16 (Corpus Christi)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (South Texas)	3.6	Bermudagrass	4.8
	Bermudagrass	2.4	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6		
17 (Bryan)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
18 (Dallas)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Sideoats Grama (El Reno)	3.6	Buffalograss (Texoka)	1.6
	Buffalograss (Texoka)	1.6	Bermudagrass	3.6
	Bermudagrass	2.4	Sand Dropseed (Borden Co.)	0.4
19 (Atlanta)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		
20 (Beaumont)	Green Sprangletop	0.3	Green Sprangletop	0.3
	Bermudagrass	2.4	Bermudagrass	5.4
	Sideoats Grama (Haskell)	4.5		

Table 2 (continued)
Permanent Urban Seeding Mix

District	Clay Soils Species and Rates (lb. PLS per acre)	Sandy Soils Species and Rates (lb. PLS per acre)
21 (Pharr)	Green Sprangletop 0.3	Green Sprangletop 0.3
	Sideoats Grama (South Texas) 3.6	Buffalograss (Texoka) 1.6
	Buffalograss (Texoka) 1.6	Bermudagrass 3.6
	Bermudagrass 2.4	Sand Dropseed (Borden Co.) 0.4
22 (Laredo)	Green Sprangletop 0.3	Green Sprangletop 0.3
	Sideoats Grama (South Texas) 4.5	Buffalograss (Texoka) 1.6
	Buffalograss (Texoka) 1.6	Bermudagrass 3.6
	Bermudagrass 1.8	Sand Dropseed 0.4
23 (Brownwood)	Green Sprangletop 0.3	Green Sprangletop 0.3
	Sideoats Grama (Haskell) 3.6	Buffalograss (Texoka) 1.6
	Bermudagrass 1.2	Bermudagrass 3.6
	Blue Grama (Hachita) 0.9	Sand Dropseed (Borden Co.) 0.4
24 (El Paso)	Green Sprangletop 0.3	Green Sprangletop 0.3
	Sideoats Grama (South Texas) 3.6	Buffalograss (Texoka) 1.6
	Blue Grama (Hachita) 1.2	Sand Dropseed (Borden Co.) 0.4
	Buffalograss (Texoka) 1.6	Blue Grama (Hachita) 1.8
25 (Childress)	Green Sprangletop 0.3	Green Sprangletop 0.3
	Sideoats Grama (El Reno) 3.6	Sand Dropseed (Borden Co.) 0.4
	Blue Grama (Hachita) 1.2	Buffalograss (Texoka) 1.6
	Buffalograss (Texoka) 1.6	Bermudagrass 1.8

Table 3
Temporary Cool Seeding Mix

District	All Soils Species and Rates (lb. PLS per acre)
1 (Paris), 2 (Fort Worth), 3 (Wichita Falls), 4 (Amarillo), 5 (Lubbock), 6 (Odessa), 7 (San Angelo), 8 (Abilene), 18 (Dallas), 19 (Atlanta), 23 (Brownwood), 24 (El Paso), 25 (Childress)	Oats 30.0 Wheat 30.0 Little Barley 5.0 Western Wheatgrass 5.0
9 (Waco), 10 (Tyler), 11 (Lufkin), 12 (Houston), 13 (Yoakum), 14 (Austin), 15 (San Antonio), 16 (Corpus Christi), 17 (Bryan), 20 (Beaumont), 21 (Pharr), 22 (Laredo)	Oats 40.0 Little Barley 5.0

Table 4
Temporary Warm Seeding Mix

District	All Soils Species and Rates (lb. PLS per acre)
All	Brownton Millet 20.0

Table 5
Flower Seeding Mix

District	All Soils Species and Rates (lb. PLS per acre)
1 (Paris), 10 (Tyler), 11 (Lufkin), 12 (Houston), 17 (Bryan), 19 (Atlanta), 20 (Beaumont)	Herbaceous Mimosa (Crockett) 1.5
	Illinois Bundleflower (Sabine) 1.5
	Thickspike Gayfeather (Pineywoods) 1.5
	Purple Prairie Clover (Kaneb) 0.6
	Rio Grange Clammyweed (Zapata) 2.0
2 (Fort Worth), 3 (Wichita Falls), 4 (Amarillo), 5 (Lubbock), 6 (Odessa), 7 (San Angelo), 8 (Abilene), 9 (Waco), 18 (Dallas), 23 (Brownwood), 25 (Childress)	Engelmann Daisy (Eldorado) 1.5
	Awnless Bushsunflower (Plateau) 1.5
	Partridge Pea 1.5
	Illinois Bundleflower (Sabine) 1.5
	Rio Grande Clammyweed (Zapata) 2.0
13 (Yoakum), 14 (Austin), 15 (San Antonio), 16 (Corpus Christi), 21 (Pharr), 22 (Laredo), 24 (El Paso)	Indian Blanket (Fuego) 1.0
	Awnless Bushsunflower (Venado) 0.4
	Prostrate Bundleflower (Balli) 1.5
	Orange Zexmenia (Goliad) 0.4
	Rio Grande Clammyweed (Zapata) 2.0

- 2.2. **Fertilizer.** Use fertilizer in accordance with Article 166.2., "Materials."
- 2.3. **Water.** Use water in accordance with Article 168.2, "Materials."
- 2.4. **Highly Erodible Land (HEL).** Add Bermudagrass to the mix shown in Table 1 at 1.0 PLS per acre if shown on the plans.
- 2.5. **Mulch.**
- 2.5.1. **Straw or Hay Mulch.** Use straw or hay mulch in accordance with Section 162.2.5., "Mulch."
- 2.5.2. **Hydro Mulch.** Use mulches that are on the Approved Products List. Submit one full set of manufacturer's literature for the selected material. Keep mulch dry until applied. Do not use molded or rotted material.
- 2.6. **Tacking Methods.** Use a tacking agent applied in conformance with the manufacturer's recommendations or by a crimping method on all straw or hay mulch operations. Use tacking agents as approved or as shown on the plans.

3. CONSTRUCTION

Scarify the area to a depth of 4 in. before placing the seed, unless otherwise directed. Use approved equipment to vertically track the seedbed as shown on the plans or as directed. Scarify the seedbed to a depth of 4 in. or mow the area before placement of the permanent seed mix when performing permanent seeding after an established temporary seeding. Plant the seed mix specified and mulch, if required, after the area has been completed to lines and grades as shown on the plans.

Apply fertilizer in accordance with Article 166.3., "Construction." Grass seed, flower seed, and fertilizer may be distributed simultaneously during dry seeding operations, provided each component is applied at the specified rate. Do not combine fertilizer and seed in the same slurry during hydro mulch seeding operations. Apply half of the required fertilizer during the temporary seeding operation and the other half during the permanent seeding operation when temporary and permanent seeding are both specified for the same area.

Water the seeded areas at the rates and frequencies as shown on the plans or as directed.

Distribute the seed or seed mixture uniformly over the areas shown on the plans. Provide equipment with an agitator or method to maintain a uniform seed mixture during distribution.

3.1. Planting Season.

3.1.1. **Temporary Seed.** Plant cool seeding mix September 1–January 31. Plant warm seeding mix February 1–August 30.

3.1.2. **Permanent Seed.** End planting season for all Districts by May 15. Begin planting season for each District based on the following.

- **January 15.** 1 (Paris), 10 (Tyler), 11 (Lufkin), 12 (Houston), 13 (Yoakum), 15 (San Antonio), 16 (Corpus Christi), 17 (Bryan), 19 (Atlanta), 20 (Beaumont), 21 (Pharr), and 22 (Laredo).
- **February 1.** 2 (Fort Worth), 3 (Wichita Falls), 6 (Odessa), 7 (San Angelo), 8 (Abilene), 9 (Waco), 14 (Austin), 18 (Dallas), 23 (Brownwood), 24 (El Paso), and 25 (Childress).
- **February 15.** 4 (Amarillo) and 5 (Lubbock).

3.2. **Broadcast Seeding.** Use hand or mechanical distribution or hydro-seeding on top of the soil unless otherwise directed. Apply the mixture to the area to be seeded within 30 min. of placement of components in the equipment when seed and water are to be distributed as a slurry during hydro-seeding. Roll the planted area using a light roller or other suitable equipment. Roll sloped areas along the contour of the slopes.

3.3. **Straw or Hay Mulch Seeding.** Plant seed in accordance with Section 164.3.2., “Broadcast Seeding.” Apply straw or hay mulch uniformly over the seeded area immediately after planting the seed or seed mixture. Apply straw or hay mulch in accordance with Section 164.3.6., “Straw or Hay Mulching.” Apply tack in accordance with Section 164.2.6., “Tacking Methods.”

3.4. **Hydro Mulch Seeding.** Plant seed in accordance with Section 164.3.2., “Broadcast Seeding,” before placing mulch. Apply mulch uniformly over the seeded area immediately after planting the seed or seed mixture at the following rates.

- **Sandy Soils with Slopes of 3:1 or Less.** 2,500 lb. per acre.
- **Sandy Soils with Slopes Greater than 3:1.** 3,000 lb. per acre.
- **Clay Soils with Slopes of 3:1 or Less.** 2,000 lb. per acre.
- **Clay Soils with Slopes Greater than 3:1.** 2,300 lb. per acre.

Mulch rates are based on dry weight of mulch per acre. Mix mulch and water to make a slurry and apply uniformly over the seeded area using suitable equipment.

3.5. **Drill Seeding.** Plant at a depth of 1/4–1/3 in. using a pasture- or rangeland-type drill unless otherwise directed. Plant seed along the contour of the slopes.

3.6. **Straw or Hay Mulching.** Apply straw or hay mulch uniformly over the area as shown on the plans. Apply straw mulch at 2–2.5 ton per acre. Apply hay mulch at 1.5–2 ton per acre. Use a tacking method over the mulched area in accordance with Section 164.2.6., “Tacking Methods.”

4. MEASUREMENT

This Item will be measured by the square yard or by the acre.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Broadcast Seeding (Perm)” of the rural or urban seed mixture and sandy or clay soil specified, “Broadcast Seeding (Temp)” of warm or cool season specified, “Straw or Hay Mulch Seeding (Perm)” of the rural or urban seed mixture and sandy or clay soil specified, “Straw or Hay Mulch Seeding (Temp)” of warm or cool season specified, “Hydro Mulch Seeding (Perm)” of the rural or urban seed mixture and sandy or clay soil specified, “Hydro Mulch Seeding (Temp)” of warm or cool season specified, “Drill Seeding (Perm)” of the rural or urban seed mixture and sandy or clay soil

specified, "Drill Seeding (Temp)" of warm or cool season specified, and "Straw or Hay Mulching." This price is full compensation for furnishing materials, seeding mix, flower seeding mix, HEL seeding mix, water for hydro-seeding and hydro-mulching operations, mowing, tacking, labor, equipment, tools, supplies, and incidentals.

Fertilizer will not be paid for directly, but will be subsidiary to this Item.

Water for irrigating the seeded area, when specified, will be paid for under Item 168, "Vegetative Watering."

Item 166

Fertilizer



1. DESCRIPTION

Furnish and distribute fertilizer over areas specified on the plans.

2. MATERIALS

Use straight fertilizers or fertilizer-mixture containing nitrogen (N), phosphorus (P_2O_5), and potash (K_2O) nutrients unless otherwise specified on the plans. Ensure at least 50% of the nitrogen component is a slow-release granulated, sulfur-coated, or plastic-covered urea. Ensure that fertilizer-mixture or straight fertilizers are in an acceptable condition for distribution in containers labeled with the analysis data. The materials are subject to testing by the Texas A&M University Feed and Fertilizer Control Service in accordance with the Texas Commercial Fertilizer Control Act.

3. CONSTRUCTION

Furnish and distribute the fertilizer uniformly at a rate equal to 60 lb. of nitrogen per acre or at the analysis and rate specified on the plans.

Apply fertilizer as a dry material, and do not mix with water to form a slurry.

Incorporate fertilizer during seedbed preparation as specified on the plans.

4. MEASUREMENT

When fertilizer is specified on the plans to be a pay item, measurement will be by the acre of surface area covered or by the ton (2,000 lb.). Measurement by the ton will use guaranteed weight of bags or containers as shown by the manufacturer or certified scales meeting the requirements of Item 520, "Weighing and Measuring Equipment," unless otherwise approved.

5. PAYMENT

Unless otherwise specified on the plans, the work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent bid items.

When fertilizer is specified on the plans to be a pay item, the work performed, and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fertilizer." This price is full compensation for furnishing materials and performing operations.

Item 168

Vegetative Watering



1. DESCRIPTION

Provide and distribute water to promote growth of vegetation as directed.

2. MATERIALS

Use water that is clean and free of industrial wastes and other substances harmful to the growth of vegetation.

3. CONSTRUCTION

Apply water when directed. Furnish and operate equipment to distribute water at a uniform and controllable rate. Ensure that watering does not erode soil or plantings. Apply water in the required quantity where shown on the plans or as directed.

4. MEASUREMENT

This Item will be measured by the 1,000 gal. (TGL) of water as applied.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Vegetative Watering." This price is full compensation for furnishing and operating watering equipment and measuring devices and for furnishing and applying water, including hauling, equipment, labor, and incidentals.

Item 169

Soil Retention Blankets



1. DESCRIPTION

Provide and install soil retention blankets (SRB) as shown on the plans or as directed.

2. MATERIALS

Provide only SRB in accordance with [DMS-6370](#), "Soil Retention Blankets," and on the Approved Products List. Use material of the following product type as shown on the plans and provide a copy of the manufacturer's label for the selected product.

Provide an approved wildlife-friendly or spray-on SRB as shown on the plans.

2.1. Slope Protection Categories.

2.1.1. Slope Type.

2.1.1.1. **Moderate.** Slopes 3:1 or flatter.

2.1.1.2. **Steep.** Slopes steeper than 3:1.

2.1.2. **Soil Type.** Clay or sandy soils as shown on the plans.

2.1.3. **Application Type.** Unless otherwise shown on the plans, use rolled SRB or sprayed SRB.

2.1.4. Duration.

2.1.4.1. **Rolled SRB.** Short-term SRB lasting up to 12 mo. and long-term SRB lasting 12 mo. to 35 mo.

2.1.4.2. **Sprayed SRB.** Short-term SRB lasting up to 6 mo. and long-term SRB lasting 6 mo. or more.

2.2. Channel Protection Categories.

2.2.1. **Duration.** Temporary or permanent as shown on the plans.

2.2.2. **Shear Stress Condition.** 2, 4, 6, or 8 lb. per square foot as shown on the plans.

3. CONSTRUCTION

Provide a copy of the manufacturer's installation instructions to the Engineer before placement of the material. Place the SRB within 24 hr. after the seeding or sodding operation, or when directed. Install and anchor the SRB in conformance with the manufacturer's published literature. Before placement, mow the area to a maximum height of 4 in. or in conformance with the manufacturer's instructions. Installation includes the repair of ruts, reseeding or resodding, and the removal of rocks, clods, and other foreign materials that may prevent contact of the blanket with the soil.

4. MEASUREMENT

This Item will be measured by the square yard of surface area covered.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Soil Retention Blanket" of the product type shown on the plans. This price is full compensation for equipment, materials, labor, tools, mowing, and incidentals.

Item 204

Sprinkling



1. DESCRIPTION

Apply water for dust control, earthwork, or base construction.

2. MATERIALS

Furnish water free of industrial wastes and other objectionable matter.

3. EQUIPMENT

Use sprinklers and spray bars equipped with positive and rapidly working cut-off valves.

4. CONSTRUCTION

Apply water at a uniform rate and in the required quantity, or as directed.

5. MEASUREMENT

This Item will be measured by the 1,000 gal. (TGL) of water as applied.

6. PAYMENT

Unless sprinkling is specified as a pay item, the work performed and materials furnished in accordance with this Item will not be measured or paid for directly, but will be subsidiary to pertinent Items.

When sprinkling is specified on the plans as a pay item, the work performed and water furnished will be paid for at the unit price bid for "Sprinkling (Base)," "Sprinkling (Earthwork)," or "Sprinkling (Dust Control)." This price is full compensation for furnishing and applying water; furnishing and operating sprinklers and measuring devices; and hauling, equipment, labor, fuel, materials, tools, and incidentals.

Item 210

Rolling



1. DESCRIPTION

Compact embankment, subgrade, base, surface treatments, broken concrete pavement, or asphalt pavement using rollers. Break up asphalt mats, pit run material, or base materials.

2. EQUIPMENT

Use any type of roller to meet the production rates and quality requirements of the Contract unless otherwise shown on the plans or directed. Use equipment that meets the requirements of this Item when specific types of equipment are required. The Engineer may allow the use of rollers that operate in one direction only when turning does not affect the quality of work or encroach on traffic.

Table 1
Roller Requirements¹

Roller Type	Materials to be Compacted	Load (ton)	Contact Pressure	Roller Speed (mph)
Steel wheel	Embankment, subgrade, base, asphalt concrete	≥10	≥325 lb. per inch of wheel width	2–3
Tamping	Embankment, subgrade	–	125–550 psi per tamping foot	2–3
Heavy tamping	Embankment, subgrade	–	≥550 psi per tamping foot	2–3
Vibratory	Embankment, subgrade, base, asphalt concrete	Type A < 6 Type B > 6 Type C as shown on the plans	Per equipment specification and as approved	As approved
Light pneumatic	Embankment, subgrade, surface treatment	4.5–9.0	≥45 psi	2–6
	Asphalt concrete			4–12
Medium pneumatic	Embankment, subgrade, base, surface treatment	12–25	≥80 psi, as directed	2–6
	Asphalt concrete			4–12
Heavy pneumatic	Embankment, subgrade, base, previously broken concrete pavement, other pavements	≥25	≤150 psi	2–6
Grid	Embankment, breaking up existing asphalt mats or base	5–13	–	2–3

1. Unless otherwise specified in the Contract.

- 2.1. **Static Steel Wheel Rollers.** Furnish single, double, or triple steel wheel, self-propelled power rollers weighing at least 10 ton capable of operating in a forward and backward motion. Ensure all wheels are flat. The Contractor may use vibratory rollers in the static mode when static steel wheel rollers are required.

For single steel wheel rollers, pneumatic rear wheels are allowed for embankment, subgrade, and base. Provide rear wheels for triple steel wheel rollers with a minimum diameter of 48 in., a minimum width of 20 in., and a minimum compression of 325 lb. per inch of wheel width.

- 2.2. **Tamping Rollers.** Furnish self-propelled rollers with at least one self-cleaning metal tamping drum capable of operating in a forward or backward motion with a minimum effective rolling width of 5 ft. Mount drums in a frame so that each drum moves independently of the other for rollers with more than one drum. Operate rollers in static or vibratory mode.
- 2.2.1. **Tamping Roller (Minimum Requirement).** Provide tamping feet that exert a static load of 125–550 psi and project at least 3 in. from the surface of the drum for all tamping rollers except for heavy tamping rollers.
- 2.2.2. **Heavy Tamping Roller.** Provide tamping rollers that have:
- two metal tamping drums, rolls, or shells, each with a 60-in. minimum diameter and a 5-ft. minimum width; or
 - one rear and two forward drums, each with a 60-in. minimum diameter. Arrange drums so that the rear drum compacts the space between the two forward drums and the minimum overall rolling width is 10 ft.

Equip drums with tamping feet that:

- project at least 7 in. from the drum surface,
- have an area of 7–21 sq. in.,
- are self-cleaning,
- exert a static load of at least 550 psi, and
- are spaced at 1 tamping foot per 0.65–0.70 sq. ft. of drum area.

- 2.3. **Vibratory Rollers.** Furnish self-propelled rollers with at least one drum equipped to vibrate. Select and maintain amplitude and frequency settings per manufacturer's specifications to deliver maximum compaction without material displacement or shoving, as approved. Furnish the equipment manufacturer's specifications concerning settings and controls for amplitude and frequency. Operate rollers at speeds that will produce at least 10 blows per foot unless otherwise shown on the plans or approved. Pneumatic rear wheels are allowed for embankment, subgrade, and base. Equip each vibrating drum with:
- separate frequency and amplitude controls,
 - controls to manually start and stop vibration, and
 - a mechanism to continuously clean the face of the drum.

For asphalt-stabilized base and asphalt concrete pavement, furnish a roller that also can:

- automatically reverse the direction of the rotating eccentric weight,
- stop vibration before the motion of the roller stops, and
- thoroughly moisten the drum with water or approved asphalt release agent.

- 2.3.1. **Drum (Type A).** Furnish a roller with a static weight less than 6 ton and a vibratory drum.
- 2.3.2. **Drum (Type B).** Furnish a roller with a minimum static weight of 6 ton and a vibratory drum.
- 2.3.3. **Drum (Type C).** Furnish a roller as shown on the plans.
- 2.4. **Pneumatic Tire Rollers.** Pneumatic tire rollers consist of rubber tire wheels on axles mounted in a frame with either a loading platform or body suitable for ballast loading. Arrange the rear tires to cover the gaps between adjacent tires of the forward group. Furnish rollers capable of forward and backward motion. Compact asphalt pavements and surface treatments using a roller equipped with smooth-tread tires. Compact without damaging the surface. Moisten the wheels with water or an approved asphalt release agent when necessary.

Select and maintain the operating load and tire air pressure within the range of the manufacturer's charts or tabulations to attain maximum compaction throughout the lift, as approved. Furnish the manufacturer's chart or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the tires furnished. Maintain individual tire inflation pressures within 5 psi of each other. Provide uniform compression under all tires.

2.4.1. **Light Pneumatic Tire.** Furnish a unit:

- with at least nine pneumatic tires,
- with an effective rolling width of approximately 5 ft.,
- capable of providing a total uniform load of 4.5–9 ton, and
- with tires capable of maintaining a minimum ground contact pressure of 45 psi.

2.4.2. **Medium Pneumatic Tire.** Furnish a unit:

- with at least seven pneumatic tires,
- with an effective rolling width of approximately 7 ft.,
- capable of providing a total uniform load of 12–25 ton, and
- with tires capable of maintaining a minimum ground contact pressure of 80 psi or 90 psi as directed.

2.4.3. **Heavy Pneumatic Tire.** Furnish a unit:

- with at least four pneumatic-tired wheels mounted on axles carrying no more than two wheels,
- with wheels arranged to carry approximately equal loads on uneven surfaces,
- with a width between 8 and 10 ft. that can turn 180° in the crown width,
- capable of providing a total uniform load of at least 25 ton,
- with tires capable of maintaining a maximum ground contact pressure of 150 psi, and
- with liquid-filled tires inflated to such a level that liquid will flow from the valve stem when the stem is in the uppermost position.

2.5. **Grid Rollers.** Furnish rollers that have two cylindrical cages with a minimum diameter of 66 in. and a minimum width of 32 in. Mount cages in a rigid frame with weight boxes. Use a cage surface of cast or welded steel fabric grid with bars 1-1/2 in. wide, spaced on 5-in. centers in each direction, that undulate approximately 1 in. between the high and low points.

Furnish rollers capable of providing a total load of 5–13 ton and capable of being operated in a forward or backward motion.

2.6. **Alternate Equipment.** The Contractor may use alternate compaction equipment that produces results equivalent to the specified equipment as approved. Discontinue the use of the alternate equipment and furnish the specified equipment if the desired results are not achieved.

3. CONSTRUCTION

Perform this work in conformance with the applicable Items using equipment and roller speeds shown in Table 1. Use only rubber-tired equipment to push or pull compaction equipment on base courses. Use equipment that does not damage material being rolled.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

Item 216

Proof Rolling



1. DESCRIPTION

Proof-roll earthwork, base, or both to locate unstable areas.

2. EQUIPMENT

- 2.1. **Specified Equipment.** Furnish rollers that weigh at least 25 ton when loaded. The maximum acceptable load is 50 ton. Provide rollers that meet the requirements of Section 210.2.4., "Pneumatic Tire Rollers."
- 2.2. **Alternative Equipment.** The Contractor may use alternate compaction equipment that produces results equivalent to the specified equipment in the same period of time as approved. Discontinue the use of the alternative equipment and furnish the specified equipment if the desired results are not achieved.

3. CONSTRUCTION

Perform proof rolling as directed. Adjust the load and tire inflation pressures within the range of the manufacturer's charts or tabulations, as directed. Make at least two coverages with the proof roller. Offset each trip of the roller by at most one tire width. Operate rollers at a speed between 2 and 6 mph, as directed. Correct unstable or nonuniform areas, if found, in conformance with the applicable Item.

4. MEASUREMENT

Rolling will be measured by the hour operated on surfaces being tested.

5. PAYMENT

The work performed and equipment furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Proof Rolling." This price is full compensation for furnishing and operating equipment and for labor, materials, tools, and incidentals.

Item 247

Flexible Base



1. DESCRIPTION

Construct a foundation course composed of flexible base.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. The Engineer may sample and test project materials at any time before compaction throughout the duration of the project to assure specification compliance.

- 2.1. **Aggregate.** Furnish aggregate of the type and grade shown on the plans and meeting the requirements shown in Table 1. Each source must meet Table 1 requirements for liquid limit, plasticity index, and wet ball mill for the grade specified. Do not use additives, such as but not limited to lime, cement, or fly ash to modify aggregates to meet the requirements of Table 1, unless shown on the plans.

Unless otherwise shown on the plans, the unconfined compressive strength is waived when the flexible base material meets the #200 sieve requirement. When the #200 sieve requirement does not meet the specification in Table 1, the unconfined compressive strength is required.

Table 1
Material Requirements

Property	Test Method	Grade 1-2 ³	Grade 3	Grade 4	Grade 5
Master gradation sieve size (cumulative % retained)					
2-1/2"		0	0		0
1-3/4"		0-10	0-10		0-5
7/8"	Tex-110-E	10-35	—		10-35
3/8"		30-65	—		35-65
#4		45-75	45-75		45-75
#40		65-90	50-85		70-90
#200 ^{1, 2}		85-95	—		—
Liquid limit, % Max	Tex-104-E	40	40	As shown on the plans	35
Plasticity index, Max		10	12		10
Plasticity index, Min	Tex-106-E	As shown on the plans	As shown on the plans		As shown on the plans
Wet ball mill, % Max		40	—		40
Wet ball mill, % Max increase passing the #40 sieve	Tex-116-E	20	—		20
Min compressive strength ² , psi					
lateral pressure 0 psi	Tex-117-E	35	—		—
lateral pressure 3 psi		—	—		90
lateral pressure 15 psi		175	—		175

- The #200 sieve test is only required to meet the waiver of the unconfined compressive strength requirement. The #200 sieve test requirement is only applicable to stockpile samples from Section 247.2.4.
- Compressive strength and #200 sieve test requirements are waived when the flexible base is mixed with or without existing material and treated with cement, emulsion, foamed asphalt, or lime, unless otherwise shown on the plans.
- Grade 3 may be substituted for Grade 1-2 or Grade 5 when the flexible base is mixed with or without existing material and treated with cement, emulsion, foamed asphalt, or lime, as approved. Grade 3 flexible base must meet the wet ball mill requirements of Grade 1-2 or Grade 5 as applicable.

- 2.1.1. **Material Tolerances.** The Engineer may accept material if no more than one of the five most recent gradation tests has an individual sieve outside the specified limits of the gradation. This allowance does not apply to the #200 sieve requirement.
- The Engineer may accept material if no more than one of the five most recent liquid limit or plasticity index tests is outside the specified limit. No single failing liquid limit or plasticity index test may exceed the allowable limit by more than 2 percentage points.
- 2.1.2. **Material Types.** Do not use fillers or binders unless approved. Furnish the type shown on the plans in accordance with the following.
- 2.1.2.1. **Type A.** Crushed stone produced and graded from oversize quarried aggregate that originates from a single, naturally occurring source. Do not use gravel or multiple sources.
- 2.1.2.2. **Type B.** Crushed or uncrushed gravel. Blending of two or more sources is allowed.
- 2.1.2.3. **Type C.** Crushed gravel with a minimum of 60% of the particles retained on a No. 4 sieve with two or more crushed faces as determined in accordance with [Tex-460-A](#), Part I. Blending of two or more sources is allowed.
- 2.1.2.4. **Type D.** Type A material or crushed concrete. Crushed concrete containing gravel will be considered Type D material. Crushed concrete must meet the requirements of Section 247.2.1.2.6., "Recycled Material," and be managed in a way to provide for uniform quality. The Engineer may require separate dedicated stockpiles to verify compliance.
- 2.1.2.5. **Type E.** Caliche, iron ore, or as otherwise shown on the plans.
- 2.1.2.6. **Recycled Material.** Reclaimed asphalt pavement (RAP) and other recycled materials may be used when shown on the plans. Request approval to blend two or more sources of recycled materials. When RAP is allowed, do not exceed 20% RAP by weight, unless otherwise shown on the plans. The percentage limitations for other recycled materials will be as shown on the plans.
- Provide recycled materials, other than RAP, that have a maximum sulfate content of 3,000 ppm when tested in accordance with [Tex-145-E](#). Certify compliance with [DMS-11000](#), "Evaluating and Using Nonhazardous Recyclable Materials Guidelines." In addition, recycled materials must be free of reinforcing steel and other objectionable material and have at most 1.5% deleterious material when tested in accordance with [Tex-413-A](#). The liquid limit, plasticity index, wet ball mill, and compressive strength for all recycled materials are waived. When using RAP, crush RAP so that 100% passes the 2-in. sieve and does not exceed a maximum percent loss from decantation of 5.0% when tested in accordance with [Tex-406-A](#). Test RAP without removing the asphalt. The final product must meet the requirements shown in Table 1 for the grade specified except when the Department requires a specific amount of Department-furnished RAP be added to the blend, unless otherwise shown on the plans.
- The Contractor is responsible for uniformly blending the recycled material with the flexible base material to build a stockpile to meet the percentages required. Any Contractor-furnished surplus of recycled materials will remain the property of the Contractor. Remove Contractor-owned recycled materials from the project and dispose of them in accordance with federal, state, and local regulations before project acceptance.
- 2.2. **Water.** Furnish water free of industrial wastes and other objectionable matter.
- 2.3. **Material Sources.** Expose the vertical faces of all strata of material proposed for use when non-commercial sources are used. Secure and process the material by successive vertical cuts extending through all exposed strata, when directed.
- 2.4. **Stockpile Approval.** Stockpile is approved when the Engineer's test results meet the material requirements shown in Table 1.

- 2.4.1. **Sampling.** The Contractor and the Engineer will sample flexible base from completed stockpiles in accordance with [Tex-100-E](#). Personnel conducting sampling must be certified by the Department-approved soils and base certification program.

Sampling stockpiles may be located at the production site or at the project location. The Contractor will witness the Engineer's sampling and sample the stockpile for their own testing, and label as deemed necessary.

Sample the stockpile for the Engineer when shown on the plans. When the Contractor samples the stockpile for the Engineer, the Engineer must witness the sampling of material designated for the Engineer and the Materials and Tests Division (MTD). The Engineer will label their sampling containers as "Engineer" and "MTD," or as deemed necessary.

The Engineer will take immediate possession of the sample containers for the Engineer and MTD. The Engineer will maintain custody of the samples until all testing and reporting are completed.

- 2.4.2. **Referee Testing.** Referee testing is applicable for stockpile testing only. MTD is the referee laboratory. MTD may designate a laboratory from the Department's MPL for Commercial Laboratories Approved for Flexible Base Referee Requests as the referee laboratory as deemed necessary. The designated laboratory cannot be performing any testing under this Item for the Engineer or Contractor.

The Contractor may request referee testing when the Engineer's test results fail to meet any of the material requirements shown in Table 1 and the Contractor's sample from Section 2.4.1., "Sampling," for the same failing Department test, passes. The tests must be performed by a laboratory listed on the Department's MPL for Commercial Laboratories Approved for Flexible Base Referee Requests. Submit the request by email within 5 working days after receiving failing test results from the Engineer. Include completed test reports passing the applicable requirements shown in Table 1 in the email.

Record and submit completed test reports electronically on Department-provided templates in their original format meeting the applicable material requirements shown in Table 1. Use Department-provided templates to record and calculate all test data. The Engineer and the Contractor will provide any available test results to the other party when requested.

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work.

- 3.1. **Rollers.** Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with Item 216, "Proof Rolling," when required.
- 3.2. **Inertial Profiler.** When ride quality measurement is required, provide a high-speed or lightweight inertial profiler certified at the Texas A&M Transportation Institute. Provide equipment certification documentation. Display a current decal on the equipment indicating the certification expiration date.

4. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

Stockpile base material temporarily at an approved location before delivery to the roadway. Build stockpiles in layers no greater than 2 ft. thick. Stockpiles must have a total height between 10 and 16 ft. unless otherwise approved. After construction and acceptance of the stockpile in accordance with Section 247.2.4., "Stockpile Approval," loading from the stockpile for delivery is allowed. Load by making successive vertical cuts through the entire depth of the stockpile.

Do not add or remove material from temporary stockpiles that require sampling and testing before delivery, unless otherwise approved. Charges for additional sampling and testing required as a result of adding or removing material will be deducted from the Contractor's estimates.

Haul approved flexible base in clean trucks. Deliver the required quantity to each 100-ft. station or designated stockpile site as shown on the plans. Prepare stockpile sites as directed. When delivery is to the 100-ft. station, manipulate in conformance with the applicable Items.

- 4.1. **Preparation of Subgrade or Existing Base.** Remove or scarify existing asphalt concrete pavement in accordance with Item 105, "Removing Treated and Untreated Base and Asphalt Pavement," when shown on the plans or as directed. Shape the subgrade or existing base to conform to the typical sections shown on the plans or as directed.

When new base is required to be mixed with existing base, deliver, place, and spread the new flexible base in the required amount per station. Manipulate and thoroughly mix the new base with existing material to provide a uniform mixture to the specified depth before shaping.

Proof roll the roadbed in accordance with Item 216 before pulverizing or scarifying when shown on the plans or directed. Correct soft spots as directed.

- 4.2. **Placing.** Spread and shape flexible base into a uniform layer using an approved spreader the same day as delivered unless otherwise approved. Construct layers to the thickness shown on the plans. Maintain the shape of the course. Control dust by sprinkling, as directed. Correct or replace segregated areas as directed at no additional expense to the Department.

Place successive base courses and finish courses using the same construction methods required for the first course.

- 4.3. **Compaction.** Compact using density control unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. When necessary, sprinkle the material in accordance with Item 204, "Sprinkling." Maintain moisture during compaction within $\pm 2.0\%$ of the optimum moisture content as determined in accordance with [Tex-113-E](#).

Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller unit. Begin rolling at the low side and progress toward the high side on superelevated curves. Offset alternating trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish requirements before the next course is placed or the project is accepted. Continue work until specification requirements are met. Perform the work at no additional expense to the Department.

Before final acceptance, the Engineer will select the locations of tests and measure the flexible base depth in accordance with [Tex-140-E](#). Correct areas deficient by more than 1/2 in. in thickness by scarifying, adding material as required, reshaping, recompact, and refinishing at the Contractor's expense.

- 4.3.1. **Ordinary Compaction.** Roll using approved compaction equipment as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing approved material as required, reshaping, and recompact.

- 4.3.2. **Density and Moisture Control.** Compact to a minimum of 100% of the maximum dry density and within $\pm 2.0\%$ of the optimum moisture content as determined in accordance with [Tex-113-E](#), unless otherwise shown on the plans. Provide the Engineer with the beginning and ending station numbers of the area completed for testing. The Engineer will determine roadway density and moisture content of completed sections in accordance with [Tex-115-E](#), Part I. The Engineer will determine random locations for testing in accordance with [Tex-115-E](#), Part IV. Do not achieve density by drying the material after compaction.

When the density is less than 100% of the maximum dry density, the Engineer may perform additional testing to determine the extent of the area to correct. The Engineer may accept the section if no more than one of the five most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

- 4.3.3. **Miscellaneous and Small Areas.** Miscellaneous areas are those that typically involve handwork or discontinuous paving operations, such as temporary detours, driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Miscellaneous and small areas are not subject to density testing but may be tested as directed.

- 4.4. **Finishing.** After completing compaction, clip, skin, or tight-blade the surface using a maintainer or subgrade trimmer to a depth of approximately 1/4 in. Remove loosened material and dispose of it at an approved location. Seal the clipped surface immediately by rolling using a pneumatic tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades as shown on the plans or as directed.

Correct grade deviations greater than 1/4 in. in 16 ft. measured longitudinally. Correct grade deviations greater than 1/4 in. over the entire width of the cross-section in areas where surfacing is to be placed. Correct by loosening and adding or removing material. Reshape and recompact in accordance with Section 247.4.3., "Compaction."

- 4.5. **Curing.** Cure the finished section until the moisture content is at least 2 percentage points below optimum or as directed before applying the next successive course or prime coat.

- 4.6. **Ride Quality.** Measurement of ride quality only applies to the final travel lanes that receive a one- or two-course surface treatment for the final riding surface, unless otherwise shown on the plans. Measure the ride quality of the base course either before or after the application of the prime coat, as directed, and before placement of the surface treatment. Use a certified profiler operator listed on the Department's MPL. When requested, furnish the Engineer with documentation for the person certified to operate the profiler.

Provide all profile data to the Engineer in electronic data files within 3 days of measuring the ride quality using the format specified in [Tex-1001-S](#). The Engineer will use Department software to evaluate longitudinal profiles to determine areas requiring corrective action. Correct 0.1-mi. sections with an average international roughness index (IRI) value greater than 100 in. per mile to an IRI value of 100 in. per mile or less, unless otherwise shown on the plans. Reprofile and correct sections that fail to maintain ride quality before the placement of the surface treatment, as directed. Unless ride deterioration is due to environmental impact, traffic, or other incidents outside the Contractor's control, perform this work at no additional expense to the Department, as approved.

5. MEASUREMENT

Flexible base will be measured as follows.

- **Flexible Base (Complete in Place).** The ton, square yard, or any cubic yard method.
- **Flexible Base (Roadway Delivery).** The ton or any cubic yard method.
- **Flexible Base (Stockpile Delivery).** The ton, cubic yard in vehicle, or cubic yard in stockpile.

Measurement by the cubic yard in final position and square yard is a plans quantity measurement. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

Measurement is further defined for payment as follows.

- 5.1. **Cubic Yard in Vehicle.** By the cubic yard in vehicles of uniform capacity at the point of delivery.

- 5.2. **Cubic Yard in Stockpile.** By the cubic yard in the final stockpile position, by the method of average end areas, or as shown on the plans.
- 5.3. **Cubic Yard in Final Position.** By the cubic yard in the completed and accepted final position. The volume of base course is computed in place by the method of average end areas between the original subgrade or existing base surfaces and the lines, grades, and slopes of the accepted base course, or as shown on the plans.
- 5.4. **Square Yard.** By the square yard of surface area in the completed and accepted final position. The surface area of the base course is based on the width of flexible base, or as shown on the plans.
- 5.5. **Ton.** By the ton of dry weight in vehicles as delivered. The dry weight is determined by deducting the weight of the moisture in the material at the time of weighing from the gross weight of the material. The Engineer will determine the moisture content in the material in accordance with [Tex-103-E](#) from samples taken at the time of weighing.

When material is measured in trucks, the weight of the material will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at an approved location. Scales must meet the requirements of Item 520, "Weighing and Measuring Equipment."

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the types of work described below. No additional payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans for cubic yard in the final position or square yard measurement.

Sprinkling and rolling, except proof rolling, will not be paid for directly, but will be subsidiary to this Item unless otherwise shown on the plans. When proof rolling is shown on the plans or directed, it will be paid for in accordance with Item 216.

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade will be paid in conformance with pertinent Items or in accordance with Article 4.4., "Changes in the Work."

- 6.1. **Flexible Base (Complete in Place).** Payment will be made for the type and grade specified. For cubic yard measurement, "In Vehicle," "In Stockpile," or "In Final Position" will be specified. For square yard measurement, a depth will be specified. This price is full compensation for furnishing materials, temporary stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement, loading, hauling, delivery of materials, spreading, blading, mixing, shaping, placing, compacting, reworking, finishing, correcting locations where thickness is deficient, curing, furnishing scales and labor for weighing and measuring, equipment, labor, tools, and incidentals.
- 6.2. **Flexible Base (Roadway Delivery).** Payment will be made for the type and grade specified. For cubic yard measurement, "In Vehicle," "In Stockpile," or "In Final Position" will be specified. The unit price bid will not include processing at the roadway. This price is full compensation for furnishing materials, temporary stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement, loading, hauling, delivery of materials, furnishing scales and labor for weighing and measuring, equipment, labor, tools, and incidentals.
- 6.3. **Flexible Base (Stockpile Delivery).** Payment will be made for the type and grade specified. For cubic yard measurement, "In Vehicle" or "In Stockpile" will be specified. The unit price bid will not include processing at the roadway. This price is full compensation for furnishing and disposing of materials, preparing the stockpile area, temporary or permanent stockpiling, assistance provided in stockpile sampling and operations to level

stockpiles for measurement, loading, hauling, delivery of materials to the stockpile, furnishing scales and labor for weighing and measuring, equipment, labor, tools, and incidentals.

Item 260

Lime Treatment (Road-Mixed)



1. DESCRIPTION

Mix and compact lime, water, and subgrade or base (with or without asphaltic concrete pavement) in the roadway.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. Obtain verification from the Engineer that the specification requirements are met before using the sources. The Engineer may sample and test project materials at any time before compaction. Use material definitions in accordance with [Tex-100-E](#).

- 2.1. **Lime.** Furnish lime that meets the requirements of [DMS-6350](#), "Lime and Lime Slurry." When dry lime is required, provide dry quicklime. When lime slurry is required, provide commercial lime slurry or quicklime slurry. Do not use dry quicklime when sulfates are present in quantities greater than 3,000 parts per million (ppm). When furnishing quicklime, provide it in bulk.
- 2.2. **Subgrade.** The Engineer will determine the sulfate content of the subgrade in accordance with [Tex-145-E](#) and organic content in accordance with [Tex-148-E](#) before lime treatment begins. Suspend operations when material to be treated has a sulfate content greater than 7,000 ppm or an organic content greater than 2.0%, unless otherwise directed.
- 2.3. **Flexible Base.** Unless otherwise shown on the plans, furnish base material that meets the requirements of Item 247, "Flexible Base," for the type and grade shown on the plans, before the addition of lime. Unless otherwise shown on the plans, the compressive strength of the flexible base is waived.
- 2.4. **Water.** Furnish water free of industrial wastes and other objectionable material.
- 2.5. **Asphalt.** When asphalt or emulsion is permitted for curing purposes, furnish materials that meet the requirements of Item 300, "Asphalts, Oils, and Emulsions," as shown on the plans or as directed.
- 2.6. **Mix Design.** The Engineer will determine the target lime content and optimum moisture content in accordance with [Tex-121-E](#) or prior experience with the project materials. The Contractor may propose a mix design developed in accordance with [Tex-121-E](#). The Engineer will use [Tex-121-E](#) to verify the Contractor's proposed mix design before acceptance. Reimburse the Department for subsequent mix designs or partial designs necessitated by changes in the material or requests by the Contractor. Limit the amount of recycled asphalt pavement to no more than 50% of the mix, unless otherwise shown on the plans or directed.

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with Item 216, "Proof Rolling," when required.

- 3.1. **Storage Facility.** Store quicklime in closed, weatherproof containers.
- 3.2. **Slurry Equipment.** Use slurry tanks equipped with agitation devices to slurry quicklime on the project or other approved location. The Engineer may approve other slurring methods.

Provide a pump for agitating the slurry when the distributor truck is not equipped with an agitator. Equip the distributor truck with a sampling device in accordance with [Tex-600-J](#), Part I, when using commercial lime slurry.

- 3.3. **Hydrated Lime Distribution Equipment.** Provide equipment to spread lime evenly across the area to be treated. Provide equipment with a rotary vane feeder to spread lime, when shown on the plans.
- 3.4. **Pulverization Equipment.** Provide pulverization equipment that:
- cuts and pulverizes material uniformly to the proper depth using cutters that plane to a uniform surface over the entire width of the cut,
 - provides a visible indication of the depth of cut at all times, and
 - uniformly mixes the materials.

4. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

- 4.1. **Preparation of Subgrade or Existing Base for Treatment.** Before treating, remove existing asphalt concrete pavement in accordance with Item 105, "Removing Treated and Untreated Base and Asphalt Pavement," when shown on the plans or as directed. Shape existing material in conformance with applicable bid items to conform to typical sections shown on the plans and as directed.

Unless otherwise approved, proof roll the roadbed in accordance with Item 216 before pulverizing or scarifying existing material. Correct soft spots as directed.

When material is imported from a borrow source, notify the Engineer of the location of the borrow source well in advance to allow time for testing and approval to avoid delay to the project. Stockpile as directed. The Engineer will test the borrow source and determine the sulfate and organic contents. When the borrow source has a sulfate content greater than 3,000 ppm or an organic content greater than 2.0%, proceed as directed.

When new base material is required to be mixed with existing base, deliver, place, and spread the new material in the required amount per station. Manipulate and thoroughly mix new base with existing material to provide a uniform mixture to the specified depth before shaping.

- 4.2. **Pulverization.** Pulverize or scarify existing material after shaping. If the material cannot be uniformly processed to the required depth in a single pass, excavate and windrow the material to expose a secondary grade to achieve processing to plan depth.
- 4.3. **Application of Lime.** Uniformly apply lime using dry or slurry placement as shown on the plans or as directed. Add lime at the percentage determined in accordance with Section 260.2.6., "Mix Design." Apply lime only on an area where mixing can be completed during the same working day.

Start lime application only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be taken in the shade and away from artificial heat. Suspend application when the Engineer determines that weather conditions are unsuitable.

Minimize dust and scattering of lime by wind. Do not apply lime when wind conditions, in the opinion of the Engineer, cause blowing lime to become dangerous to traffic or objectionable to adjacent property owners. When pebble grade quicklime is placed dry, mix the material and lime thoroughly at the time of lime application. Use of quicklime can be dangerous. Inform users of the recommended precautions for handling and storage.

4.3.1. **Dry Placement.** Before applying lime, bring the prepared roadway to approximately two percentage points above optimum moisture content. When necessary, sprinkle in accordance with Item 204, "Sprinkling." Distribute the required quantity of pebble grade quicklime using approved equipment.

4.3.2. **Slurry Placement.** Provide slurry free of objectionable materials, at or above the minimum dry solids content, and with a uniform consistency that will allow ease of handling and uniform application. Deliver commercial lime slurry to the jobsite or use quicklime to prepare lime slurry at the jobsite or other approved location, as specified. When dry quicklime is applied as slurry, use 80% of the amount shown on the plans.

Distribute slurry uniformly by making successive passes over a measured section of roadway until the specified lime content is reached. Uniformly spread the residue from quicklime slurry over the length of the roadway being processed, unless otherwise directed.

4.4. **Mixing.** Begin mixing within 6 hr. of application of lime. Lime exposed to the open air for 6 hr. or more between application and mixing, or that experiences excessive loss due to washing or blowing, will not be accepted for payment. Thoroughly mix the material and lime using approved equipment. When treating subgrade, bring the moisture content above the optimum moisture content to ensure adequate chemical reaction of the lime and subgrade materials.

Ensure 100% of the material passes a 2-1/2 in. sieve, except rock, before mellowing. Allow the mixture to mellow for 1–4 days, as directed. When pebble grade quicklime is used, allow the mixture to mellow for 2–4 days, as directed. Sprinkle the treated materials during the mixing and mellowing operation, as directed, to achieve adequate hydration and proper moisture content. When the material to be treated has a sulfate content greater than 3,000 ppm but less than or equal to 7,000 ppm, mellow for a minimum of 7 days. Maintain in a continuously moist condition by sprinkling in accordance with Item 204. After mellowing, resume mixing until a homogeneous, friable mixture is obtained. After mixing, the Engineer may sample the mixture at roadway moisture and test in accordance with [Tex-101-E](#), Part III, to determine compliance with the gradation requirements shown in Table 1.

Table 1
Gradation Requirements (Min % Passing)

Sieve Size	Base	Subgrade
1-3/4"	100	100
3/4"	85	85
#4	—	60

4.5. **Strength Testing.** The Engineer will sample and test the lime-treated mixture for unconfined compressive strength in accordance with [Tex-117-E](#), Part II. The unconfined compressive strength must be greater than 50 psi for lime-treated subgrade and 150 psi for lime-treated flexible base or lime-treated flexible base with existing material, unless otherwise shown on the plans.

4.6. **Compaction.** Compact the mixture using density control, unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. Sprinkle the treated material in accordance with Item 204, or aerate the treated material to adjust the moisture content during compaction so that it is no more than 1.0% below optimum and 2.0% above optimum as determined in accordance with [Tex-121-E](#).

Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least one-half the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternating trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Before final acceptance, the Engineer will select the locations of tests in each unit and measure the treated depth in accordance with [Tex-140-E](#). Correct areas deficient by more than 1/2 in. in thickness or more than 1/2% in target lime content by adding lime as required, reshaping, recompacting, and refinishing at the Contractor's expense.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish before the next course is placed or the project is accepted. Continue work until specification requirements are met. Rework in accordance with Section 260.4.7., "Reworking a Section." Perform the work at no additional expense to the Department.

- 4.6.1. **Ordinary Compaction.** Roll using approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompact.
- 4.6.2. **Density and Moisture Control.** Compact to at least 95% of the maximum density, and moisture content no more than 1.0% below optimum and 2.0% above optimum as determined in accordance with [Tex-121-E](#), unless otherwise shown on the plans. Provide the Engineer with the beginning and ending station numbers of the area completed for testing. The Engineer will determine roadway density and moisture content of completed sections in accordance with [Tex-115-E](#), Part I. The Engineer will determine random locations for testing in accordance with [Tex-115-E](#), Part IV.
- When the density is less than 95% of the maximum dry density, the Engineer may perform additional testing to determine the extent of the area to correct. The Engineer may accept the section if no more than one of the five most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.
- 4.7. **Reworking a Section.** When a section is reworked within 72 hr. after completion of compaction, rework the section to provide the required density. When a section is reworked more than 72 hr. after completion of compaction, add additional lime at 25% of the percentage determined in accordance with Section 260.2.6., "Mix Design." Reworking includes loosening, adding material or removing unacceptable material if necessary, mixing as directed, compacting, and finishing. When density control is specified, determine a new maximum density of the reworked material in accordance with [Tex-121-E](#), and compact to at least 95% of this density.
- 4.8. **Finishing.** Immediately after completing compaction of the final course, clip, skin, or tight-blade the surface of the lime-treated material using a maintainer or subgrade trimmer to a depth of approximately 1/4 in. Remove loosened material and dispose of at an approved location. Roll the clipped surface immediately using a pneumatic tire roller until a smooth surface is attained. Add small amounts of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades shown on the plans or as directed.
- Finish grade of constructed subgrade to within 0.1 ft. in the cross-section and 0.1 ft. in 16 ft. measured longitudinally.
- Correct grade deviations of constructed base greater than 1/4 in. in 16 ft. measured longitudinally or greater than 1/4 in. over the entire width of the cross-section in areas where surfacing is to be placed. Remove excess material, reshape, and roll using a pneumatic-tire roller. Correct as directed if material is more than 1/4 in. low. Do not surface patch. The 72-hr. time limit required for completion of placement, compaction, and finishing does not apply to finishing required just before applying the surface course.
- 4.9. **Miscellaneous and Small Areas.** Miscellaneous areas are those that typically involve handwork or discontinuous paving operations, such as temporary detours, driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Miscellaneous and small areas are not subject to density testing but may be tested as directed.
- 4.10. **Curing.** Cure for the minimum number of days shown in Table 2 by sprinkling in accordance with Item 204, or by applying an asphalt material at a rate of 0.05–0.20 gal. per square yard, as shown on the plans or as directed. Maintain moisture during curing. Upon completion of curing, maintain the moisture content in accordance with Section 132.3.5., "Maintenance of Moisture and Reworking," for subgrade and Section 247.4.5., "Curing," for bases before placing subsequent courses. Do not allow equipment on the finished course during curing except as required for sprinkling, unless otherwise approved. Apply seals or additional courses within 14 calendar days of final compaction.

Table 2
Min Curing Requirements before Placing Subsequent Courses¹

Untreated Material	Curing (Days)
PI ≤35	2
PI >35	5

1. Subject to approval. Proof rolling may be required as an indicator of adequate curing.

5. MEASUREMENT

- 5.1. **Lime.** When lime is furnished in trucks, the weight of lime will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at an approved location approved. Scales must meet the requirements of Item 520, "Weighing and Measuring Equipment."
- 5.1.1. **Commercial Lime Slurry.** Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.
- 5.1.2. **Quicklime.**
- 5.1.2.1. **Dry.** Lime will be measured by the ton (dry weight) of the quicklime.
- 5.1.2.2. **Slurry.** Lime slurry will be measured by the ton (dry weight) of the quicklime used to prepare the slurry multiplied by a conversion factor of 1.28 to determine the quantity of equivalent hydrated lime, which will be the basis of payment.
- 5.2. **Lime Treatment.** Lime treatment will be measured by the square yard of surface area. The dimensions for determining the surface areas are established by the widths shown on the plans and the lengths measured at placement.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for in accordance with Section 260.6.1., "Lime," and Section 260.6.2., "Lime Treatment."

Furnishing and delivering new base will be paid for in accordance with Section 247.6.2., "Flexible Base (Roadway Delivery)." Mixing, spreading, blading, shaping, compacting, and finishing new or existing base material will be paid for under Section 260.6.2., "Lime Treatment." Removal and disposal of existing asphalt concrete pavement will be paid for in conformance with pertinent Items or in accordance with Article 4.4., "Changes in the Work."

Sprinkling and rolling, except proof rolling, will not be paid for directly, but will be subsidiary to this Item, unless otherwise shown on the plans. When proof rolling is shown on the plans or directed by the Engineer, it will be paid for in accordance with Item 216.

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade or existing base will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade or existing base will be paid for in accordance with pertinent Items or Article 4.4., "Changes in the Work."

Where subgrade to be treated under this Contract has sulfates greater than 7,000 ppm, work will be paid for in accordance with Article 4.4., "Changes in the Work."

Asphalt used solely for curing will not be paid for directly, but will be subsidiary to this Item. Asphalt placed for curing and priming will be paid for under Item 310, "Prime Coat."

- 6.1. **Lime.** Lime will be paid for at the unit price bid for “Quicklime (Dry)” or “Commercial or Quicklime (Slurry).” This price is full compensation for materials, delivery, equipment, labor, tools, and incidentals.

Lime used for reworking a section in accordance with Section 260.4.7., “Reworking a Section,” will not be paid for directly, but will be subsidiary to this Item.

- 6.2. **Lime Treatment.** Lime treatment will be paid for at the unit price bid for “Lime Treatment (Existing Material),” “Lime Treatment (New Base),” or “Lime Treatment (Mixing Existing Material and New Base),” for the depth specified. No payment will be made for thickness or width exceeding that shown on the plans. This price is full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, applying lime, compacting, finishing, curing, curing materials, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals.

Item 300

Asphalts, Oils, and Emulsions



1. DESCRIPTION

Provide asphalt cements, cutback and emulsified asphalts, performance-graded asphalt binders, and other miscellaneous asphalt materials as shown on the plans.

2. MATERIALS

Provide asphalt materials that meet the stated requirements when tested in conformance with the referenced Department, AASHTO, and ASTM test methods. Use asphalt containing recycled materials only if the recycled components meet the requirements of Article 6.9., "Recycled Materials." Provide asphalt materials that the Department has preapproved for use in accordance with [Tex-545-C](#).

Inform the Department of all additives or modifiers included in the asphalt binder as part of the facility quality plan, as required by [Tex-545-C](#), and provide that information to Department personnel. The Department reserves the right to prohibit the use of any asphalt additive or modifier.

Limit the use of polyphosphoric acid to no more than 0.5% by weight of the asphalt binder.

The use of re-refined engine oil bottoms is prohibited.

Acronyms used in this Item are defined in Table 1.

Table 1
Acronyms

Acronym	Definition
Test Procedure Designations	
Tex	Department
T or R	AASHTO
D	ASTM
Polymer Modifier Designations	
P	polymer-modified
SBS	styrene-butadiene-styrene block co-polymer
TR	tire rubber modifier (obtained from ground truck and passenger vehicle post-consumer tires)
AC	asphalt cement
AE	asphalt emulsion
AE-P	asphalt emulsion prime
A-R	asphalt-rubber
ARA	emulsified asphalt recycling agent
C	cationic
CRM	crumb rubber modifier
CSS	cationic slow setting
EAP&T	emulsified asphalt prime and tack
EBL	emulsified bonding layer
FDR	full-depth reclamation
H-suffix	harder residue (lower penetration)
HA	hot-applied
HF	high float
HRSS	hard residue surface sealant
HY	high yield
MC	medium-curing

Acronym	Definition
MS	medium-setting
MSCR	multiple stress creep recovery
NT	non-tracking
PCE	prime, cure, and erosion control
PG	performance grade
RC	rapid-curing
RS	rapid-setting
S-suffix	stockpile usage
SCM	special-use cutback material
SS	slow-setting
SY	standard yield
TRAIL	tracking resistant asphalt interlayer

- 2.1. **Asphalt Cement.** Provide AC that is homogeneous, water-free, and non-foaming when heated to 347°F, and in accordance with Table 2.

Table 2
Asphalt Cement

Property	Test Procedure	Viscosity Grade			
		AC-0.6		AC-1.5	
		Min	Max	Min	Max
Viscosity 140°F, poise	T 202	40	80	100	200
275°F, poise		0.4	–	0.7	–
Penetration, 77°F, 100g, 5 sec.	T 49	350	–	250	–
Flash point, C.O.C., °F	T 48	425	–	425	–
Solubility, %	T 44	99.0	–	99.0	–
Spot test	Tex-509-C	Neg.		Neg.	
Tests on residue from RTFOT:	T 240				
Viscosity, 140°F, poise	T 202	–	400	–	1,000
Ductility, ¹ 77°F	T 51	100	–	100	–
5 cm/min., cm					

1. If AC-0.6 or AC-1.5 ductility at 77°F is less than 100 cm, material is acceptable if ductility at 60°F is more than 100 cm.

- 2.2. **Polymer-Modified Asphalt Cement.** Provide polymer-modified AC that is smooth, homogeneous, and meets the requirements shown in Table 3. Supply samples of the base AC and polymer additives if requested.

Table 3
Polymer-Modified Asphalt Cement

Property	Test Procedure	Polymer-Modified Viscosity Grade											
		AC-12-5TR		NT-HA ¹		AC-15P		AC-20XP		AC-10-2TR		AC-20-5TR	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Polymer		TR		–		SBS		SBS		TR		TR	
Polymer content, % (solids basis)	Tex-533-C or Tex-553-C	5.0	–	–	–	3.0	–	–	–	2.0	–	5.0	–
Dynamic shear, G*/sin δ, 82°C, 10 rad/s, kPa	T 315	–	–	1.0	–	–	–	–	–	–	–	–	–
Dynamic shear, G*/sin δ, 64°C, 10 rad/s, kPa	T 315	–	–	–	–	–	–	1.0	–	–	–	1.0	–
Dynamic shear, G*/sin δ, 58°C, 10 rad/s, kPa	T 315	1.0	–	–	–	–	–	–	–	1.0	–	–	–
Viscosity													
140°F, poise	T 202	1,200	–	–	–	1,500	–	2,000	–	1,000	–	2,000	–
275°F, poise	T 202	–	–	–	–	–	8.0	–	–	–	8.0	–	10.0
275°F, Pa-s	T 316	–	–	–	4.0	–	–	–	–	–	–	–	–
Penetration, 77°F, 100 g, 5 sec.	T 49	110	150	–	25	100	150	75	115	95	130	75	115
Elastic recovery, 50°F, %	Tex-539-C	55	–	–	–	55	–	55	–	30	–	55	–
Polymer separation	Tex-540-C	None		–		None		None		None		None	
Flash point, C.O.C., °F	T 48	425	–	425	–	425	–	425	–	425	–	425	–
Tests on residue from RTFOT aging and pressure aging:	T 240 and R 28												
Creep stiffness	T 313												
S, -18°C, Mpa		–	300	–	–	–	300	–	300	–	300	–	300
m-value, -18°C		0.300	–	–	–	0.300	–	0.300	–	0.300	–	0.300	–

1. This is a hot-applied TRAIL product.

- 2.3. **Cutback Asphalt.** Provide cutback asphalt that meets the requirements shown in Tables 4, 5, and 6 for the specified type and grade. Supply samples of the base AC and polymer additives if requested.

Table 4
Rapid-Curing Cutback Asphalt

Property	Test Procedure	Type-Grade	
		RC-250	
		Min	Max
Kinematic viscosity, 140°F, cSt	T 201	250	400
Water, %	D95	–	0.2
Flash point, T.O.C., °F	T 79	80	–
Distillation test:	T 78		
Distillate, percentage by volume of total distillate to 680°F			
to 437°F		40	75
to 500°F		65	90
to 600°F		85	–
Residue from distillation, volume %		70	–
Tests on distillation residue:			
Viscosity, 140°F, poise	T 202	600	2,400
Ductility, 5 cm/min., 77°F, cm	T 51	100	–
Solubility, %	T 44	99.0	–
Spot test	Tex-509-C	Neg.	

Table 5
Medium-Curing Cutback Asphalt

Property	Test Procedure	Type-Grade					
		MC-30		MC-800		MC-3000	
		Min	Max	Min	Max	Min	Max
Kinematic viscosity, 140°F, cSt	T 201	30	60	800	1,600	3,000	6,000
Water, %	D95	—	0.2	—	0.2	—	0.2
Flash point, T.O.C., °F	T 79	95	—	140	—	149	—
Distillation test:	T 78						
Distillate, percentage by volume of total distillate to 680°F							
to 437°F		—	35	—	—	—	—
to 500°F		30	75	—	40	—	15
to 600°F		75	95	45	85	15	75
Residue from distillation, volume %		50	—	75	—	80	—
Tests on distillation residue:							
Viscosity, 140°F, poise	T 202	300	1,200	300	1,200	300	1,200
Ductility, 5 cm/min., 77°F, cm	T 51	100	—	100	—	100	—
Solubility, %	T 44	99.0	—	99.0	—	99.0	—
Spot test	Tex-509-C	Neg.		Neg.		Neg.	

Table 6
Special-Use Cutback Asphalt

Property	Test Procedure	Type-Grade	
		SCM I	
		Min	Max
Kinematic viscosity, 140°F, cSt	T 201	500	1,000
Water, %	D95	—	0.2
Flash point, T.O.C., °F	T 79	175	—
Distillation test:	T 78		
Distillate, percentage by volume of total distillate to 680°F			
to 437°F		—	—
to 500°F		—	0.5
to 600°F		20	60
Residue from distillation, volume %		76	—
Tests on distillation residue:			
Penetration, 100 g, 5 sec., 77°F	T 49	180	—
Solubility, %	T 44	99.0	—

- 2.4. **Emulsified Asphalt.** Provide emulsified asphalt that is homogeneous, does not separate after thorough mixing, and meets the requirements for the specified type and grade shown in Tables 7, 8, 9, 10, and 10A–C.

Table 7
Emulsified Asphalt

Property	Test Procedure	Type-Grade							
		Rapid-Setting		Medium-Setting		Slow-Setting			
		HFRS-2		MS-2		SS-1		SS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	–	–	–	–	20	100	20	100
		150	400	100	300	–	–	–	–
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1	–	0.1
Miscibility	T 59	–		–		Pass		Pass	
Cement mixing, %	T 59	–	–	–	–	–	2.0	–	2.0
Demulsibility, 35 mL of 0.02 N CaCl ₂ , %	T 59	50	–	–	30	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	1	–	1
Freezing test, 3 cycles ¹	T 59	–		Pass		Pass		Pass	
Distillation test:	T 59								
Residue by distillation, % by wt.		65	–	65	–	60	–	60	–
Oil distillate, % by volume of emulsion		–	0.5	–	0.5	–	0.5	–	0.5
Tests on residue from distillation:									
Penetration, 77°F, 100 g, 5 sec.	T 49	100	140	90	160	90	160	40	100
Solubility, %	T 44	97.5	–	97.5	–	97.5	–	97.5	–
Ductility, 77°F, 5 cm/min., cm	T 51	100	–	100	–	100	–	80	–
Float test, 140°F, sec.	T 50	1,200	–	–	–	–	–	–	–

1. Applies only when the Engineer designates material for winter use.

Table 8
Cationic Emulsified Asphalt

Property	Test Procedure	Type-Grade							
		Rapid-Setting		Medium-Setting		Slow-Setting			
		CRS-2		CMS-2		CSS-1		CSS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	–	–	–	–	20	100	20	100
		150	400	100	350	–	–	–	–
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1	–	0.1
Cement mixing, %	T 59	–	–	–	–	–	0.2	–	0.2
Coating ability and water resistance:									
Dry aggregate/after spray	T 59	–	–	Good/Fair	–	–	–	–	–
Wet aggregate/after spray		–	–	Fair/Fair	–	–	–	–	–
Demulsibility, 35 mL of 0.8% Sodium dioctyl sulfosuccinate, %	T 59	70	–	–	–	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	1	–	1
Particle charge	T 59	Positive		Positive		Positive		Positive	
Distillation test:									
Residue by distillation, % by wt.	T 59	65	–	65	–	60	–	60	–
Oil distillate, % by volume of emulsion		–	0.5	–	7	–	0.5	–	0.5
Tests on residue from distillation:									
Penetration, 77°F, 100 g, 5 sec.	T 49	90	160	90	200	90	160	40	110
Solubility, %	T 44	97.5	–	97.5	–	97.5	–	97.5	–
Ductility, 77°F, 5 cm/min., cm	T 51	100	–	100	–	100	–	80	–

Table 9
Polymer-Modified Emulsified Asphalt

Property	Test Procedure	Type-Grade	
		Rapid-Setting HFRS-2P	
		Min	Max
Viscosity, Saybolt Furol 122°F, sec.	T 72	150	400
Sieve test, %	T 59	–	0.1
Demulsibility, 35 mL of 0.02 N CaCl ₂ , %	T 59	50	–
Storage stability, 1 day, %	T 59	–	1
Distillation test: ¹	T 59		
Residue by distillation, % by wt.		65	–
Oil distillate, % by volume of emulsion		–	0.5
Tests on residue from distillation:			
Polymer content, wt. % (solids basis)	Tex-533-C	3.0	–
Penetration, 77°F, 100 g, 5 sec.	T 49	90	140
Solubility, %	T 44	97.0	–
Viscosity, 140°F, poise	T 202	1,500	–
Float test, 140°F, sec.	T 50	1,200	–
Ductility, ² 39.2°F, 5 cm/min., cm	T 51	50	–
Elastic recovery, ² 50°F, %	Tex-539-C	55	–

- Exception to T 59: Bring the temperature on the lower thermometer slowly to 350 ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from the first application of heat.
- HFRS-2P must meet one of either the ductility or elastic recovery requirements.

Table 10
Polymer-Modified Cationic Emulsified Asphalt

Property	Test Procedure	Type-Grade											
		Rapid-Setting						Medium-Setting				Slow-Setting	
		CRS-2P		CHFRS-2P		CRS-2TR		CMS-1P ³		CMS-2P ³		CSS-1P	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	–	–	–	–	–	–	10	100	–	–	20	100
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1	–	0.1	–	0.1	–	0.1
Demulsibility, 35 ml of 0.8% sodium dioctyl sulfosuccinate, %	T 59	70	–	60	–	40	–	–	–	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	1	–	1	–	1	–	1
Particle charge	T 59	Positive		Positive		Positive		Positive		Positive		Positive	
Distillation test ¹ :	T 59												
Residue by distillation, % by weight		65	–	65	–	65	–	30	–	60	–	62	–
Oil distillate, % by volume of emulsion		–	0.5	–	0.5	–	3	–	0.5	–	0.5	–	0.5
Tests on residue from distillation:													
Polymer content, wt. % (solids basis)	Tex-533-C or Tex-553-C	3.0	–	3.0	–	5.0 ⁴	–	–	–	–	–	3.0	–
Penetration, 77°F, 100 g, 5 sec.	T 49	90	150	80	130	90	150	30	–	30	–	55	90
Viscosity, 140°F, poise	T 202	1,300	–	1,300	–	1,000	–	–	–	–	–	–	–
Solubility, %	T 44	97.0	–	95.0	–	98	–	–	–	–	–	97.0	–
Ductility, 77°F, 5 cm/min., cm	T 51	–	–	–	–	40	–	–	–	–	–	70	–
Float test, 140°F, sec.	T 50	–	–	1,800	–	–	–	–	–	–	–	–	–
Ductility, ² 39.2°F, 5 cm/min., cm	T 51	50	–	–	–	–	–	–	–	–	–	–	–
Elastic recovery, ² 50°F, %	Tex-539-C	55	–	55	–	–	–	–	–	–	–	–	–
Tests on residue from evaporative recovery:	R 78, Procedure B												
Nonrecoverable creep compliance of residue, 3.2 kPa, 52°C, kPa ⁻¹	T 350	–	–	–	–	–	–	–	2.0	–	4.0	–	–

- Exception to T 59: Bring the temperature on the lower thermometer slowly to 350 ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from the first application of heat.
- CRS-2P must meet one of either the ductility or elastic recovery requirements.
- With all precertification samples of CMS-1P or CMS-2P, submit certified test reports showing the type and percent of rejuvenator and/or latex added. Submit samples of these raw materials if requested by the Engineer.
- Modifier type is TR. Determined in accordance with [Tex-553-C](#).

Table 10A
Non-Tracking Tack Coat Emulsion¹

Property	Test Procedure	NT-HRE		NT-RRE		NT-SRE	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol, 77°F, sec.	T 72	15	–	15	–	10	100
Storage stability, 1 Day, %	T 59	–	1	–	1	–	1
Settlement, 5-day, %	T 59	–	5	–	5	–	5
Sieve test, %	T 59	–	0.30	–	0.30	–	0.1
Distillation test: ²	T 59						
Residue by distillation, % by wt.		50	–	58	–	50	–
Oil distillate, by volume of emulsion		–	1.0	–	1.0	–	1.0
Test on residue from distillation:							
Penetration, 77°F, 100 g, 5 sec.	T 49	–	20	15	45	40	90
Solubility, %	T 44	97.5	–	97.5	–	97.5	–
Dynamic shear, G*/sin(δ), 82°C, 10 rad/s, kPa	T 315	1.0	–	–	–	–	–

- These are emulsion-based TRAILs. Due to the hardness of the residue, these emulsions should be heated to 120–140°F prior to thorough mixing as the emulsion is being prepared for testing.
- Exception to T 59: Bring the temperature on the lower thermometer slowly to 350 ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from first application of heat.

Table 10B
Spray-Applied Underseal Membrane Polymer-Modified Emulsions

Property	Test Procedure	EBL	
		Min	Max
Viscosity @ 77°F, SSF	T 72	20	100
Storage Stability ¹ , %	T 59	—	1
Demulsibility ² Anionic emulsions — 35 ml of 0.02 N CaCl ₂ , % Cationic emulsions — 35 ml 0.8% sodium dioctyl sulfosuccinate, %	T 59	55	—
Sieve Test ³ , %	T 59	—	0.05
Distillation Test ⁴ Residue by distillation, % by wt. Oil portion of distillate, % by vol.	T 59	63 —	— 0.5
Test on Residue from Distillation Elastic Recovery @ 50°F, 50 mm/min., % Penetration @ 77°F, 100 g, 5 sec, 0.1 mm	Tex-539-C T 49	60 80	— 130

1. After standing undisturbed for 24 hr., the surface must be smooth, must not exhibit a white or milky colored substance, and must be a homogeneous color throughout.
2. Material must meet demulsibility test for emulsions.
3. May be required by the Engineer only when the emulsion cannot be easily applied in the field.
4. The temperature on the lower thermometer should be brought slowly to 350 ± 10°F and maintained at this temperature for 20 min. The total distillation should be completed in 60 ± 5 min. from the first application of heat.

Table 10C
Full-Depth Reclamation Emulsion

Property	Test Procedure	Standard Yield (FDR EM-SY)		High Yield (FDR EM-HY) ²	
		Min	Max	Min	Max
Viscosity Saybolt Furol @ 77°F, sec.	T 72	20	100	20	100
Sieve test, %	T 59	—	0.1	—	0.1
Cement mixing, %	T 59	—	2.0	—	2.0
% Storage stability, 1 day, %	T 59	—	1	—	1
Distillation test ¹ : Residue by distillation, % by wt. Oil portion of distillate, % by vol.	T 59	60 —	— 0.5	63 —	— 0.5
Test on residue from distillation: Penetration @ 77°F, dmm	T 49	40	95	120	—

1. The temperature on the lower thermometer should be brought slowly to 350 ± 10°F and maintained at this temperature for 20 min. The total distillation should be completed in 60 ± 5 min. from the first application of heat.
2. Provide a manufacturer's certificate of analysis (COA) with the type and percent of rejuvenator added.

- 2.5. **Specialty Emulsions.** Provide specialty emulsion that is either asphalt-based or resin-based and meets the requirements shown in Table 11 or Table 11A.

Table 11
Specialty Emulsions

Property	Test Procedure	Type-Grade					
		Medium-Setting				Slow-Setting	
		AE-P		EAP&T		PCE ¹	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	– 15	– 150	– –	– –	10 –	100 –
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1
Miscibility ²	T 59	–		Pass		Pass	
Demulsibility, 35 mL of 0.10 N CaCl ₂ , %	T 59	–	70	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	–
Particle size, ⁵ % by volume < 2.5 μm	Tex-238-F ³	–	–	90	–	90	–
Asphalt emulsion distillation to 500°F followed by Cutback asphalt distillation of residue to 680°F:	T 59 and T 78						
Residue after both distillations, % by wt.		40	–	–	–	–	–
Total oil distillate from both distillations, % by volume of emulsion		25	40	–	–	–	–
Residue by distillation, % by wt.	T 59	–	–	60	–	–	–
Residue by evaporation, ⁴ % by wt.	T 59	–	–	–	–	60	–
Tests on residue after all distillation(s):							
Viscosity, 140°F, poise	T 202	–	–	800	–	–	–
Kinematic viscosity, ⁵ 140°F, cSt	T 201	–	–	–	–	100	350
Flash point C.O.C., °F	T 48	–	–	–	–	400	–
Solubility, %	T 44	97.5	–	–	–	–	–
Float test, 122°F, sec.	T 50	50	200	–	–	–	–

- Supply with each shipment of PCE:
 - a copy of a lab report from an approved analytical lab, signed by a lab official, indicating the PCE formulation does not meet any characteristics of a Resource Conservation Recovery Act (RCRA) hazardous waste;
 - a certification from the producer that the formulation supplied does not differ from the one tested and that no listed RCRA hazardous wastes or Polychlorinated Biphenyls have been mixed with the product; and
 - a Safety Data Sheet.
- Exception to T 59: In dilution, use 350 mL of distilled or deionized water and a 1,000-mL beaker.
- Use [Tex-238-F](#), beginning at "Particle Size Analysis by Laser Diffraction," with distilled or deionized water as a medium and no dispersant, or use another approved method.
- Exception to T 59: Leave sample in the oven until foaming ceases, then cool and weigh.
- PCE must meet either the kinematic viscosity requirement or the particle size requirement.

Table 11A
Hard Residue Surface Sealant

Property	Test Procedure	HRSS	
		Min	Max
Viscosity, Krebs unit, 77°F, Krebs units	D 562	45	75
Softening point, °F	Tex-505-C ¹	250	–
Uniformity	D 2939	Pass ²	
Resistance to heat	D 2939	Pass ³	
Resistance to water	D 2939	Pass ⁴	
Wet flow, mm	D 2939	–	0
Resistance to Kerosene (optional) ⁵	D 2939	Pass ⁶	
Ultraviolet exposure, UVA-340, 0.77 W/m ² , 50°C chamber, 8 hr. UV lamp, 5 min. spray, 3 hr. 55 min. condensation, 1,000 hr. total exposure ⁷	G 154	Pass ⁸	
Abrasion loss, 1.6 mm thickness, liquid only, %	ISSA TB-100	–	1.0
Residue by evaporation, % by weight	D 2939	33	–
Tests on residue from evaporation:			
Penetration, 77°F, 100 g, 5 sec.	T 49	15	30
Flash point, Cleveland open cup, °F	T 48	500	–
Tests on base asphalt before emulsification			
Solubility, %	T 44	98	–

1. Cure the emulsion in the softening point ring in a 200 ± 5°F oven for 2 hr.
2. Product must be homogenous and show no separation or coagulation that cannot be overcome by moderate stirring.
3. No sagging or slippage of film beyond the initial reference line.
4. No blistering or re-emulsification.
5. Recommended for airport applications or where fuel resistance is desired.
6. No absorption of Kerosene into the clay tile past the sealer film. Note sealer surface condition and loss of adhesion.
7. Other exposure cycles with similar levels of irradiation and conditions may be used with Department approval.
8. No cracking, chipping, surface distortion, or loss of adhesion. No color fading or lightening.

2.6.

Diluted Emulsions. Provide emulsified asphalt that is homogeneous, does not separate after thorough mixing, and meets the requirements for the specified type and grade shown in Tables 12 and 12A, where the suffixes 50/50, 40/60, and 30/70 mean 50% emulsion diluted with 50% water; 40% emulsion diluted with 60% water, and 30% emulsion diluted with 70% water, respectively. For example, CSS-1H 40/60 means 40% CSS-1H diluted with 60% water and AE-P 30/70 means 30% AE-P diluted with 70% water.

Table 12
Cationic Diluted Emulsified Asphalt

Property	Test Procedure	Type-Grade					
		Diluted Slow-Setting					
		CSS-1H 50/50		CSS-1H 40/60		CSS-1H 30/70	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec.	T 72	Report only		Report only		Report only	
Distillation test							
Residue by distillation, % by wt.	T 59	30	–	24	–	18	–
Oil distillate, % by volume of emulsion		–	0.5	–	0.5	–	0.5
Tests on residue from distillation:							
Penetration, 77°F, 100 g, 5 sec.	T 49	40	110	40	110	40	110
Solubility, %	T 44	97.5	–	97.5	–	97.5	–
Ductility, 77°F, 5 cm/min., cm	T 51	80	–	80	–	80	–

Table 12A
Diluted Specialty Emulsions

Property	Test Procedure	Type-Grade Diluted Slow-Setting					
		AE-P 50/50		AE-P 40/60		AE-P 30/70	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 122°F, sec.	T 72	Report only		Report only		Report only	
Asphalt emulsion distillation to 500°F followed by cutback asphalt distillation of residue to 680°F: Residue after both distillations, % by wt. Total oil distillate from both distillations, % by volume of emulsion	T 59 and T 78	20 12.5	— 20	16 10.0	— 16	12 7.5	— 12
Tests on residue after all distillations:							
Solubility, % Float test, 122°F, sec.	T 44 T 50	97.5 50	— 200	97.5 50	— 200	97.5 50	— 200

- 2.7. **Recycling Agent.** Recycling agent and emulsified asphalt recycling agent (ARA) must meet the requirements shown in Table 13. Additionally, recycling agent and residue from ARA, when added in the specified proportions to the recycled asphalt, must meet the properties shown on the plans.

Table 13
Recycling Agent and Emulsified Asphalt Recycling Agent

Property	Test Procedure	Recycling Agent		ARA-1		ARA-1P	
		Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol, 77°F, sec.	T 72	—	—	15	100	15	110
Sieve test, %	T 59	—	—	—	0.1	—	0.1
Miscibility ¹	T 59	—		No coagulation		—	
Residue by evaporation ² , % by wt.	T 59	—	—	60	—	—	—
Distillation test ³ :	T 59						
Residue by distillation, % by wt.		—	—	—	—	60	65
Oil distillate, % by volume of emulsion		—	—	—	—	—	2
Penetration of distillation residue at 39.2°F, 100 g, 5 sec.	T 49	—	—	—	—	110	190
Tests on recycling agent or residue from evaporation:							
Flash point, C.O.C., °F	T 48	400	—	400	—	400	—
Kinematic viscosity	T 201						
140°F, cSt		75	200	75	200	—	—
275°F, cSt		—	10.0	—	10.0	—	—

- Exception to T 59: Use 0.02 N CaCl₂ solution in place of water.
- Exception to T 59: Maintain sample at 300°F until foaming ceases, then cool and weigh.
- Exception to T 59: Bring the temperature on the lower thermometer slowly to 350 ± 10°F. Maintain at this temperature for 20 min. Complete total distillation in 60 ± 5 min. from first application of heat.

- 2.8. **Crumb Rubber Modifier.** CRM consists of automobile and truck tires processed by ambient temperature grinding.

CRM must be:

- free of contaminants, including fabric, metal, and mineral and other non-rubber substances;
- free-flowing; and
- non-foaming when added to hot asphalt binder.

Ensure rubber gradation meets the requirements of the grades shown in Table 14 when tested in accordance with [Tex-200-F](#), Part I, using a 50-g sample.

Table 14
CRM Gradations

Sieve Size (% Passing)	Grade A		Grade B		Grade C		Grade D	Grade E
	Min	Max	Min	Max	Min	Max		
#8	100	—	—	—	—	—	As shown on the plans	As approved
#10	95	100	100	—	—	—		
#16	—	—	70	100	100	—		
#30	—	—	25	60	90	100		
#40	—	—	—	—	45	100		
#50	0	10	—	—	—	—		
#200	—	—	0	5	—	—		

- 2.9. **Crack Sealer.** Provide polymer-modified emulsified asphalt crack sealer meeting the requirements shown in Table 15. Provide rubber-asphalt crack sealer meeting the requirements shown in Table 16.

Table 15
Polymer-Modified Emulsified Asphalt Crack Sealer

Property	Test Procedure	Min	Max
Rotational viscosity, 77°F, cP	D2196, Method A	10,000	25,000
Sieve test, %	T 59	—	0.1
Storage stability, 1 day, %	T 59	—	1
Evaporation	Tex-543-C	65	—
Residue by evaporation, % by wt.			
Tests on residue from evaporation:			
Penetration, 77°F, 100 g, 5 sec.	T 49	35	75
Softening point, °F	T 53	140	—
Ductility, 39.2°F, 5 cm/min., cm	T 51	100	—

Table 16
Asphalt-Rubber Crack Sealer

Property	Test Procedure	Class A		Class B	
		Min	Max	Min	Max
CRM content, Grade A or Grade B, % by wt.	Tex-544-C	22	26	—	—
CRM content, Grade B, % by wt.	Tex-544-C	—	—	13	17
Virgin rubber content ¹ , % by wt.		—	—	2	—
Flash point ² , C.O.C., °F	T 48	400	—	400	—
Penetration ³ , 77°F, 150 g, 5 sec.	T 49	30	50	30	50
Penetration ³ , 32°F, 200 g, 60 sec.	T 49	12	—	12	—
Softening point, °F	T 53	—	—	170	—
Bond test, non-immersed, 0.5 in specimen, 50% extension, 3 cycles, 20°F ⁴	D5329	—		Pass	

1. Provide certification that the Min % virgin rubber was added.
2. Agitate the sealing compound using a 3/8–1/2-in. (9.5–12.7-mm) wide, square-end metal spatula to bring the material on the bottom of the cup to the surface (i.e., turn the material over) before passing the test flame over the cup. Start at one side of the thermometer, move around to the other, and then return to the starting point using 8–10 rapid circular strokes. Accomplish agitation in 3–4 sec. Pass the test flame over the cup immediately after stirring is completed.
3. Exception to T 49: Substitute the cone specified in D217 for the penetration needle.
4. Allow no crack in the crack-sealing materials or break in the bond between the sealer and the mortar blocks more than 1/4 in. deep for any specimen after completion of the test.

- 2.10. **Asphalt-Rubber Binders.** Provide A-R binders that are mixtures of asphalt binder and CRM that have been reacted at elevated temperatures. Provide A-R binders meeting D6114 and containing at least 15% CRM by weight. Provide Type I or Type II, containing CRM Grade C, for use in hot-mix aggregate mixtures. Provide Type II or Type III, containing CRM Grade B, for use in surface treatment binder. Ensure binder properties meet the requirements shown in Table 17.

Table 17
A-R Binders

Property	Test Procedure	Binder Type					
		Type I		Type II		Type III	
		Min	Max	Min	Max	Min	Max
Apparent viscosity, 347°F, cP	D2196, Method A	1,500	5,000	1,500	5,000	1,500	5,000
Penetration, 77°F, 100 g, 5 sec.	T 49	25	75	25	75	50	100
Penetration, 39.2°F, 200 g, 60 sec.	T 49	10	–	15	–	25	–
Softening point, °F	T 53	135	–	130	–	125	–
Resilience, 77°F, %	D5329	25	–	20	–	10	–
Flash point, C.O.C., °F	T 48	450	–	450	–	450	–
Tests on residue from RTFOT:	T 240						
Retained penetration ratio, 39.2°F, 200 g, 60 sec., % of original	T 49	75	–	75	–	75	–

- 2.11. **Performance-Graded Binders.** Provide PG binders that are smooth and homogeneous, show no separation when tested in accordance with [Tex-540-C](#), and meet the requirements shown in Table 18.

Separation testing is not required if:

- a modifier is introduced separately at the mix plant by injection in either the asphalt line or mixer,
- the binder is blended onsite in continuously agitated tanks, or
- binder acceptance is based on field samples taken from an in-line sampling port at the hot-mix plant after the addition of modifiers.

Table 18
Performance-Graded Binders

Property and Test Method	Performance Grade														
	PG 58			PG 64			PG 70			PG 76			PG 82		
	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34
Average 7-day Max pavement design temperature, °C ¹	58			64			70			76			82		
Min pavement design temperature, °C ¹	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34
Original Binder															
Flash point, T 48, Min, °C	230														
Viscosity, T 316 ^{2,3} : Max, 3.0 Pa-s, test temperature, °C	135														
Dynamic shear, T 315 ⁴ : G*/sin(δ), Min, 1.00 kPa, Max, 2.00 kPa ⁵ , Test temperature @ 10 rad/sec., °C	58			64			70			76			82		
Elastic recovery, D6084, 50°F, % Min ⁶	-	-	30	-	-	30	50	-	30	50	60	30	50	60	70
Rolling Thin Film Oven (RTFO) (T 240)															
Mass change, T 240, Max, %	1.0														
Dynamic shear, T 315 G*/sin(δ), Min, 2.20 kPa, Max, 5.00 kPa ⁵ , Test temperature @ 10 rad/sec., °C	58			64			70			76			82		
MSCR, T 350, recovery, 0.1 kPa, high PG temperature, % Min ⁶	-	-	20	-	-	20	30	-	20	30	40	20	30	40	50
Pressure Aging Vessel (PAV) Residue (R 28)															
PAV aging temperature, °C	100														
Dynamic shear, T 315 G*.sin (δ), Max, 5,000 kPa (Max, 6,000 kPa for δ ≥ 42°) Test temperature @ 10 rad/sec., °C	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19
Creep stiffness, T 313 ^{7,8} S, Max, 300 Mpa, m-value, Min, 0.300 Test temperature @ 60 sec., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24
Direct tension, T 314 ⁸ Failure strain, Min, 1.0% Test temperature @ 1.0 mm/min., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24

- Pavement temperatures are estimated from air temperatures using an algorithm contained in a Department-supplied computer program, may be provided by the Department, or may be obtained by following procedures outlined in AASHTO M 323 and R 25.
- This requirement may be waived at the Department's discretion if the supplier warrants that the asphalt binder can be adequately pumped, mixed, and compacted at temperatures that meet all applicable safety, environmental, and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
- Viscosity at 135°C is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. Contractors should be aware that variation could significantly impact their mixing and compaction operations. Contractors are therefore responsible for addressing any constructability issues that may arise.
- For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be substituted for dynamic shear measurements of G*/sin (δ) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational (T 316) viscometry.
- Max values for unaged and RTFO-aged dynamic shear apply only to materials used as substitute binders, as described in Item 341, "Dense-Graded Hot-Mix Asphalt," and Item 344, "Superpave Mixtures."
- Elastic recovery (D6084) is not required unless MSCR (T 350) is less than the Min % recovery. Elastic recovery will be used for the acceptance criteria in this instance.
- Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.
- If creep stiffness is below 300 Mpa, direct tension test is not required. If creep stiffness is between 300 and 600 Mpa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

3. EQUIPMENT

Provide all equipment necessary to transport, store, sample, heat, apply, and incorporate asphalts, oils, and emulsions.

4. CONSTRUCTION

- 4.1. **Typical Material Use.** Use materials shown in Table 19, unless otherwise determined by the Engineer.

Table 19
Typical Material Use

Material Application	Typically Used Materials
Hot-mixed, hot-laid asphalt mixtures	PG binders, A-R binder Types I and II
Surface treatment	PG 58-22, AC-15P, AC-20XP, AC-10-2TR, AC-20-5TR, HFRS-2, MS-2, CRS-2, CRS-2TR, CMS-2P, HFRS-2P, CRS-2P, CHFRS-2P, A-R binder Types II and III
Surface treatment (cool weather)	AC12-5TR, RC-250, MC-800, MC-3000, CMS-2P
Precoating	PG 58-22, PG 64-22, SS-1, SS-1H, CSS-1, CSS-1H
Tack coat	PG binders, SS-1H, CSS-1H, EAP&T, TRAIL, EBL
Fog seal	SS-1, SS-1H, CSS-1, CSS-1H, CSS-1H 50/50, CSS-1H 40/60, CSS-1H 30/70, CMS-1P
Hot-mixed, cold-laid asphalt mixtures	AC-0.6, AC-1.5, PG 58-22, CMS-2
Patching mix	MC-800, SCM I
Recycling	AC-0.6, AC-1.5, recycling agent, ARA-1, ARA-1P
Crack sealing	Polymer-modified AE crack sealant, asphalt-rubber crack sealers (Class A, Class B)
Microsurfacing	CSS-1P
Prime	MC-30, AE-P, AE-P 50/50, AE-P 40/60, AE-P 30/70, EAP&T, PCE
Curing membrane	SS-1, SS-1H, CSS-1, CSS-1H, PCE
Erosion control	SS-1, SS-1H, CSS-1, CSS-1H, PCE
FDR-foaming	PG 64-22, FDR EM-SY, FDR EM-HY

- 4.2. **Storage and Application Temperatures.** Use storage and application temperatures in accordance with Table 20. Store and apply materials at the lowest temperature yielding satisfactory results. Follow the manufacturer's instructions for any agitation requirements in storage. Manufacturer's instructions regarding recommended application and storage temperatures supersede those shown in Table 19.

Table 20
Storage and Application Temperatures

Type-Grade	Application		Storage Maximum (°F)
	Recommended Range (°F)	Maximum Allowable (°F)	
AC-0.6, AC-1.5	200–300	350	350
AC-15P, AC-20-5TR, AC12-5TR, and AC10-2TR	300–375	375	360
RC-250	125–180	200	200
MC-30, AE-P	70–150	175	175
MC-800, SCM I	175–260	275	275
MC-3000	225–275	290	290
HFRS-2, MS-2, CRS-2, HFRS-2P, CRS-2P, CMS-2, CRS-2TR	120–160	180	180
SS-1, SS-1H, CSS-1, CSS-1H, PCE, EAP&T, CSS-1P, recycling agent, emulsified recycling agent, polymer-modified AE crack sealant	50–130	140	140
PG binders	275–350	350	350
Asphalt-rubber crack sealers (Class A, Class B)	350–375	400	–
A-R binder Types I, II, and III	325–425	425	425

5. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to or are included in payment for other pertinent Items.

Item 301

Asphalt Antistripping Agents



1. DESCRIPTION

Furnish and incorporate all required asphalt antistripping agents in asphalt concrete paving mixtures and asphalt-stabilized base mixtures to meet moisture resistance testing requirements.

2. MATERIALS

2.1. **Lime.** Provide hydrated lime or commercial lime slurry in accordance with [DMS-6350](#), "Lime and Lime Slurry."

2.2. **Liquid Antistripping Agent.** Provide a liquid antistripping agent that is uniform and shows no evidence of crystallization, settling, or separation.

Ensure all liquid antistripping agents arrive in:

- properly labeled and unopened containers, as shipped from the manufacturer; or
- sealed tank trucks with an invoice to show contents and quantities.

Provide product information to the Engineer, including:

- Safety Data Sheet,
- specific gravity of the agent at the manufacturer's recommended addition temperature,
- manufacturer's recommended dosage range, and
- handling and storage instructions.

3. EQUIPMENT

Provide all equipment to store, handle, dispense, meter, and mix asphalt antistripping agents.

4. CONSTRUCTION

4.1. **Laboratory Design Evaluation and Production Mixture Verification.** Provide a laboratory mixture design and production mixture that meet moisture resistance requirements. Evaluate proposed asphalt pavement or base mixtures during design and production in conformance with the moisture resistance requirements in the asphalt mixture specification.

Governing specifications require the Contractor or Engineer to design the mixture, and the party performing the design is responsible for the moisture susceptibility evaluation. If the Contractor designs the mixture, the Engineer verifies compliance.

Determine the dosage needed to achieve the moisture resistance requirements during design if an antistripping agent is required. Use this addition rate in the production mixture.

Add between 0.5% and 2.0% of hydrated lime or commercial lime slurry solids by weight of the individual aggregate treated when using lime.

Add liquid antistripping agent, when used, to the binder, in conformance with the manufacturer's instructions. Do not exceed the manufacturer's maximum recommended dosage rate.

Stop production if the production mixture does not meet moisture resistance requirements and correct the problem.

- 4.2. **Addition of Antistripping Agents at the Mix Plant.** Connect the measuring device for the addition of the asphalt antistripping agent into the automatic plant controls to automatically adjust the supply to plant production and provide a consistent percentage in the mixture. Set automatic plant controls so that an interruption of asphalt antistripping agent's flow causes plant shutdown.
- 4.2.1. **Lime.** Incorporate lime in a manner that thoroughly and uniformly distributes lime onto the aggregate surface or into the mixture. Use metering equipment, as approved, to ensure the required quantity of lime is used.
- 4.2.1.1. **Hydrated Lime.** Add hydrated lime to the aggregate by one of the following methods, unless otherwise shown on the plans:
- mix in an approved pug mill mixer with damp aggregate containing water at least 2% above saturated surface dry conditions; or
 - add into the drum-mix plant immediately before asphalt binder addition or in the pug mill of the weigh-batch plant before asphalt binder addition. Dry mix aggregates and lime before adding asphalt binder when a weigh batch plant is used.
- 4.2.1.2. **Commercial Lime Slurry.** Add commercial lime slurry to the aggregate by one of the following methods unless otherwise shown on the plans:
- mix in a suitable pug mill mixer with the aggregate; or
 - mix with aggregate between the plant cold feeds and the dryer or mixing drum during mixture production.
- 4.2.2. **Liquid Antistripping Agent.** Incorporate liquid antistripping agent into the binder as follows:
- handle in conformance with the manufacturer's recommendations;
 - add at the manufacturer's recommended addition temperature;
 - add into the asphalt line by means of an in-line metering device, in accordance with Item 520, "Weighing and Measuring Equipment," and a blending device to disperse the agent; and
 - place the metering and blending devices in an approved location.

5. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to or included in payment quantity for other pertinent items.

Item 310

Prime Coat



1. DESCRIPTION

Prepare and treat existing or newly constructed surface with an asphalt binder or other specialty prime coat binder material. Apply blotter material as required.

2. MATERIALS

2.1. **Binder.** Use material of the type and grade shown on the plans in accordance with Item 300, "Asphalts, Oils, and Emulsions."

2.2. **Blotter.** Use either base course sweepings obtained from cleaning the base or native sand as blotter materials unless otherwise shown on the plans or approved.

3. EQUIPMENT

Provide applicable equipment in accordance with Article 316.3., "Equipment."

4. CONSTRUCTION

4.1. **General.** Apply the mixture when the air temperature is at or above 60°F, or above 50°F and rising. Measure the air temperature in the shade away from artificial heat. The Engineer will determine when weather conditions are suitable for application.

Do not permit traffic, hauling, or placement of subsequent courses over freshly constructed prime coats. Maintain the primed surface until placement of subsequent courses or acceptance of the work.

4.2. **Surface Preparation.** Prepare the surface by sweeping or other approved methods. Lightly sprinkle the surface with water before applying bituminous material, when directed, to control dust and ensure absorption.

4.3. **Application.**

4.3.1. **Binder.** The Engineer will select the application temperature within the limits recommended in Item 300, or by the material manufacturer. Apply material within 15°F of the selected temperature, but do not exceed the maximum allowable temperature.

Distribute the material smoothly and evenly at the rate selected by the Engineer. Roll the freshly applied prime coat using a pneumatic-tire roller to ensure penetration when directed.

4.3.2. **Blotter.** Spread blotter material before allowing traffic to use a primed surface. Apply blotter material to primed surface at the specified rate when "Prime Coat and Blotter" is shown on the plans as a bid item or as directed. Apply blotter to spot locations when "Prime Coat" is shown on the plans as a bid item or as directed to accommodate traffic movement through the work area. Remove blotter material before placing the surface. Dispose of blotter material in conformance with applicable state and federal requirements.

5. MEASUREMENT

This Item will be measured by the gallon of binder placed and accepted.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Prime Coat" or "Prime Coat and Blotter" of the type and grade of binder specified. This price is full compensation for cleaning and sprinkling the area to be primed; materials, including blotter material; and rolling, equipment, labor, tools, and incidentals.

Item 320

Equipment for Asphalt Concrete Pavement



1. DESCRIPTION

Provide equipment to produce, haul, place, compact, and core asphalt concrete pavement.

2. EQUIPMENT

Ensure weighing and measuring equipment complies with Item 520, "Weighing and Measuring Equipment." Synchronize equipment to produce a mixture meeting the required proportions.

2.1. Production Equipment. Provide:

- drum-mix type, weigh-batch, or modified weigh-batch mixing plants that ensure uniform, continuous production;
- automatic proportioning and measuring devices with interlock cutoff circuits that stop operations if the control system malfunctions;
- visible readouts indicating the weight or volume of asphalt and aggregate proportions;
- safe and accurate means to take required samples by inspection forces;
- permanent means to check the output of metering devices and to perform calibration and weight checks; and
- additive-feed systems to ensure a uniform, continuous material flow in the desired proportion.

2.1.1. Drum-Mix Plants. Provide a mixing plant that complies with the requirements below.

2.1.1.1. Aggregate Feed System. Provide:

- at least one cold aggregate bin for each stockpile of individual materials used to produce the mix;
- bins designed to prevent overflow of material;
- scalping screens or other approved methods to remove any oversized material, roots, or other objectionable materials;
- a feed system to ensure a uniform, continuous material flow in the desired proportion to the dryer;
- an integrated means for moisture compensation;
- belt scales, weigh box, or other approved devices to measure the weight of the combined aggregate; and
- cold aggregate bin flow indicators that automatically signal interrupted material flow.

2.1.1.2. Reclaimed Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS) Feed Systems. Provide at least one bin for each stockpile of RAP and RAS to weigh and feed the recycled material into the hot-mix plant.

2.1.1.3. Mineral Filler Feed System. Provide a closed system for mineral filler that maintains a constant supply with minimal loss of material through the exhaust system. Interlock the measuring device into the automatic plant controls to automatically adjust the supply of mineral filler to plant production and provide a consistent percentage to the mixture.

2.1.1.4. Heating, Drying, and Mixing Systems. Provide:

- a dryer or mixing system to agitate the aggregate during heating,
- a heating system that controls the temperature during production to prevent aggregate and asphalt binder damage,

- a heating system that completely burns fuel and leaves no residue, and
- a recording thermometer that continuously measures and records the mixture discharge temperature.

2.1.1.5. **Dust Collection System.** Provide a dust collection system to collect fines generated by the drying and mixing process and reintroduce them into the mixing drum.

2.1.1.6. **Asphalt Binder Equipment.** Supply equipment to heat binder to the required temperature. Equip the heating apparatus with a continuously recording thermometer located at the highest temperature point. Produce a 24-hr. chart of the recorded temperature. Place a device with automatic temperature compensation that accurately meters the binder in the line leading to the mixer.

Furnish a sampling port and locate in accordance with [Tex-500-C](#). Supply an additional sampling port between any additive blending device and mixer.

Supply an in-line viscosity-measuring device located between the blending unit and the mixing drum when asphalt-rubber (A-R) binder is specified. Provide a means to calibrate the meter onsite when an asphalt mass flow meter is used.

2.1.1.7. **Mixture Storage and Discharge.** Provide a surge-storage system to minimize interruptions during operations, unless otherwise approved. Furnish a gob hopper or other device to minimize segregation in the bin. Provide an automated system that weighs the mixture upon discharge and produces a ticket showing:

- date,
- project identification number,
- plant identification,
- mix identification,
- vehicle identification,
- total weight of the load,
- tare weight of the vehicle,
- weight of mixture in each load, and
- load number or sequential ticket number for the day.

2.1.1.8. **Truck Scales.** Provide standard platform scales at an approved location.

2.1.2. **Weigh-Batch Plants.** Provide a mixing plant that complies with Section 320.2.1.1., “Drum-Mix Plants,” except as required below.

2.1.2.1. **Screening and Proportioning.** Provide enough hot bins to separate the aggregate and to control proportioning of the mixture type specified. Supply bins that discard excessive and oversized material through overflow chutes. Provide safe access for Inspectors to obtain samples from the hot bins.

2.1.2.2. **Aggregate Weigh Box and Batching Scales.** Provide a weigh box and batching scales to hold and weigh a complete batch of aggregate. Provide an automatic proportioning system with low bin indicators that automatically stop when material level in any bin is not enough to complete the batch.

2.1.2.3. **Asphalt Binder Measuring System.** Provide bucket and scales with enough capacity to hold and weigh binder for one batch.

2.1.2.4. **Mixer.** Equip mixers with an adjustable automatic timer that controls the dry and wet mixing period and locks the discharge doors for the required mixing period. Furnish a pug mill with a mixing chamber large enough to prevent spillage.

2.1.3. **Modified Weigh-Batch Plants.** Provide a mixing plant that complies with Section 320.2.1.2., “Weigh-Batch Plants,” except as specifically described below.

2.1.3.1. **Aggregate Feeds.** Aggregate control is required at the cold feeds. Hot bin screens are not required.

- 2.1.3.2. **Surge Bins.** Provide one or more bins large enough to produce one complete batch of mixture.
- 2.2. **Hauling Equipment.** Provide trucks with enclosed sides to prevent asphalt mixture loss. Cover each load of mixture with waterproof tarpaulins when shown on the plans or required by the Engineer. Clean all truck beds before use to ensure the mixture is not contaminated. Coat the inside truck beds, when necessary, with an approved release agent from the Department's MPL.
- 2.3. **Placement and Compaction Equipment.** Provide equipment that does not damage underlying pavement. Comply with laws and regulations concerning overweight vehicles. Use other equipment that will consistently produce satisfactory results, when approved.
- 2.3.1. **Asphalt Paver.** Furnish a paver that will produce a finished surface that meets longitudinal and transverse profile, typical section, and placement requirements. Ensure the paver does not support the weight of any portion of hauling equipment other than the connection. Provide loading equipment that does not transmit vibrations or other motions to the paver that adversely affect the finished pavement quality. Equip the paver with an automatic, dual, longitudinal-grade control system and an automatic, transverse-grade control system.
- 2.3.1.1. **Tractor Unit.** Supply a tractor unit that can push or propel vehicles, dumping directly into the finishing machine to obtain the desired lines and grades to eliminate any hand finishing. Equip the unit with a hitch able to maintain contact between the hauling equipment's rear wheels and the finishing machine's pusher rollers while mixture is unloaded.
- 2.3.1.2. **Screed.** Provide a heated compacting screed that will produce a finished surface that meets longitudinal and transverse profile, typical section, and placement requirements. Screed extensions must provide the same compacting action and heating as the main unit unless otherwise approved.
- 2.3.1.3. **Grade Reference.** Provide a grade reference with enough support that the maximum deflection does not exceed 1/16 in. between supports. Ensure that the longitudinal controls can operate from any longitudinal grade reference, including a string line, ski, mobile reference, or joint matching shoes.
- 2.3.2. **Spray Paver.** Furnish a spray paver that will spray the membrane, apply the type and grade of mix shown on the plans, and level the surface of the pavement layer in a single pass. Configure the spray paver so that no equipment tires will drive through the membrane.
- 2.3.2.1. **Membrane Storage Tank and Distribution System.** Equip the spray paver with an insulated storage tank with a minimum capacity of 900 gal., unless otherwise approved. Provide a metered mechanical pressure sprayer on the spray paver to apply the membrane at the specified rate. Provide a readout device on the spray paver to monitor the membrane application rate.
- Unless otherwise directed, furnish a volumetric calibration and strap stick for the tank in accordance with [Tex-922-K](#), Part I. Calibrate the tank within the previous 5 yr. of the date first used on the project. The Engineer may verify calibration accuracy in accordance with [Tex-922-K](#), Part II.
- 2.3.3. **Material Transfer Devices.** Provide the specified type of device when shown on the plans. Ensure the devices provide a continuous, uniform mixture flow to the asphalt paver. Provide windrow pickup equipment, when used, constructed to pick up substantially all roadway mixture placed in the windrow.
- 2.3.4. **Remixing Equipment.** Provide equipment, when required, that includes a pug mill, variable pitch augers, or variable diameter augers operating under a storage unit with a minimum capacity of 8 ton.
- 2.3.5. **Motor Grader.** Provide a self-propelled grader, when allowed, with a blade length of at least 12 ft. and a wheelbase of at least 16 ft.
- 2.3.6. **Thermal Imaging System or Hand-Held Thermal Camera.** Provide a thermal imaging system or hand-held thermal camera meeting the requirements of [Tex-244-F](#).

- 2.3.7. **Rollers.** Provide rollers meeting the requirements of Item 210, "Rolling," for each type of roller required for compaction.
- 2.3.8. **Straightedges and Templates.** Furnish 10-ft. straightedges and other templates as required or approved.
- 2.4. **Field Laboratory.** Provide and maintain a Type D structure (hot-mix asphalt laboratory) unless otherwise shown on the plans in accordance with Item 504, "Field Office and Laboratory."
- 2.5. **Coring Equipment.** Provide equipment suitable to obtain a pavement specimen meeting the dimensions for testing when coring is required.

3. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

Item 341

Dense-Graded Hot-Mix Asphalt



1. DESCRIPTION

Construct a hot-mix asphalt (HMA) pavement layer composed of a compacted, dense-graded mixture of aggregate, asphalt binder, and additives mixed hot in a mixing plant. Payment adjustments will apply to HMA placed under this Specification unless the HMA is deemed exempt in accordance with Section 341.4.9.4., "Exempt Production."

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications.

Notify the Engineer of all material sources and before changing any material source or formulation. The Engineer will verify that the specification requirements are met and document all material source changes when the Contractor makes a source or formulation change. The Engineer may sample and test project materials anytime during the project to verify specification compliance in accordance with Item 6, "Control of Materials."

2.1. **Aggregate.** Furnish aggregates from sources that conform to the requirements shown in Table 1 and this Section. Aggregate requirements in this Section, including those shown in Table 1, may be modified or eliminated when shown on the plans. Additional aggregate requirements may be specified when shown on the plans. Provide aggregate stockpiles that meet the definitions in this Section for coarse, intermediate, or fine aggregate. Aggregate from reclaimed asphalt pavement (RAP) is not required to meet Table 1 requirements unless otherwise shown on the plans. Supply aggregates that meet the definitions in [Tex-100-E](#) for crushed gravel or crushed stone. The Engineer will designate the plant or the quarry as the sampling location. Provide samples from materials produced for the project. The Engineer will establish the Surface Aggregate Classification (SAC) and perform Los Angeles abrasion, magnesium sulfate soundness, and Micro-Deval tests. Perform all other aggregate quality tests shown in Table 1. Document all test results in the mixture design report. The Engineer may perform tests on independent or split samples to verify Contractor test results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis in accordance with [Tex-200-F](#), Part II.

2.1.1. **Coarse Aggregate.** Coarse aggregate stockpiles must have no more than 20% material passing the No. 8 sieve. Aggregates from sources listed in the Department's Bituminous Rated Source Quality Catalog (BRSQC) are preapproved for use. Use only the rated values for HMA listed in the BRSQC. Rated values for surface treatment (ST) do not apply to coarse aggregate sources used in HMA.

For sources not listed in the Department's BRSQC:

- build an individual stockpile for each material;
- request the Department test the stockpile for specification compliance;
- allow 30 calendar days for the Engineer to sample, test, and report results;
- use only when tested and approved; and
- once approved, do not add additional material to the stockpile unless otherwise allowed by the Engineer.

Provide coarse aggregate with at least the minimum SAC shown on the plans. SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. The SAC for sources in the Department's *Aggregate Quality Monitoring Program* (AQMP) ([Tex-499-A](#)) is listed in the BRSQC.

- 2.1.1.1. **Blending Class A and Class B Aggregates.** Class B aggregate meeting all other requirements shown in Table 1 may be blended with a Class A aggregate to meet requirements for Class A materials, unless otherwise shown on the plans. When blending Class A and Class B aggregates to meet a Class A requirement, ensure that at least 50% by weight, or volume if required, of the material retained on the No. 4 sieve comes from the Class A aggregate source, unless otherwise shown on the plans. Blend by volume if the bulk specific gravities of the Class A and Class B aggregates differ by more than 0.300. Coarse aggregate from RAP and recycled asphalt shingles (RAS) will be considered as Class B aggregate for blending purposes.

The Engineer may perform tests anytime during production, when the Contractor blends Class A and Class B aggregates to meet a Class A requirement. The Engineer will use the Department's mix design template, when electing to verify conformance, to calculate the percent of Class A aggregate retained on the No. 4 sieve by inputting the bin percentages shown from readouts in the control room at the time of production and stockpile gradations measured at the time of production. The Engineer may determine the gradations based on either washed or dry sieve analysis from samples obtained from individual aggregate cold feed bins or aggregate stockpiles. The Engineer may perform spot checks to verify the percent of Class A aggregate retained on the No. 4 sieve. The Engineer will use the gradations supplied by the Contractor in the mixture design report as an input for the template. A failing spot check will require confirmation with a stockpile gradation determined by the Engineer.

- 2.1.1.2. **Micro-Deval Abrasion.** The Engineer will perform at least one Micro-Deval abrasion test in accordance with [Tex-461-A](#) for each coarse aggregate source used in the mixture design that has a rated source soundness magnesium (RSSM) loss value greater than 15 as listed in the BRSQC. The Engineer will perform testing before the start of production and may perform additional testing anytime during production. The Engineer may obtain the coarse aggregate samples from each coarse aggregate source or may require the Contractor to obtain the samples. The Engineer may waive all Micro-Deval testing based on a satisfactory test history of the same aggregate source.

The Engineer will estimate the magnesium sulfate soundness loss for each coarse aggregate source, when tested, using the following formula:

$$Mg_{est.} = (RSSM)(MD_{act.}/RSMD)$$

where:

$Mg_{est.}$ = magnesium sulfate soundness loss

RSSM = rated source soundness magnesium

$MD_{act.}$ = actual Micro-Deval percent loss

RSMD = rated source Micro-Deval

When the estimated magnesium sulfate soundness loss is greater than the maximum magnesium sulfate soundness loss specified, the coarse aggregate source will not be allowed for use unless otherwise approved. The Engineer will consult the Materials and Tests Division, and additional testing may be required before granting approval.

- 2.1.2. **Intermediate Aggregate.** Aggregates not meeting the definition of coarse or fine aggregate will be defined as intermediate aggregate. Supply intermediate aggregates, when used, that are free of organic impurities. Supply intermediate aggregate from coarse aggregate sources, when used, that meet the requirements shown in Table 1, unless otherwise approved.

Test the stockpile if 10% or more of the stockpile is retained on the No. 4 sieve, and verify that it meets the requirements in Table 1 for crushed face count ([Tex-460-A](#)) and flat and elongated particles ([Tex-280-F](#)).

2.1.3.

Fine Aggregate. Fine aggregates consist of manufactured sands, screenings, and field sands. Fine aggregate stockpiles must meet the fine aggregate properties in accordance with Table 1 and the gradation requirements in accordance with Table 2. Supply fine aggregates that are free of organic impurities. The Engineer may test the fine aggregate in accordance with [Tex-408-A](#) to verify the material is free of organic impurities. Unless otherwise shown on the plans, at most 10% of the total aggregate may be field sand or other uncrushed fine aggregate. Use fine aggregate, except field sand, from coarse aggregate sources that meet the requirements shown in Table 1, unless otherwise approved.

Test the stockpile if 10% or more of the stockpile is retained on the No. 4 sieve and verify that it meets the requirements in Table 1 for crushed face count ([Tex-460-A](#)) and flat and elongated particles ([Tex-280-F](#)).

Table 1
Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate		
SAC	Tex-499-A (AQMP)	As shown on the plans
Deleterious material, %, Max	Tex-217-F , Part I	1.5
Decantation, %, Max	Tex-217-F , Part II	1.5
Micro-Deval abrasion, %	Tex-461-A	Note ¹
Los Angeles abrasion, %, Max	Tex-410-A	40
Magnesium sulfate soundness, 5 cycles, %, Max	Tex-411-A	30
Crushed face count, ² %, Min	Tex-460-A , Part I	85
Flat and elongated particles @ 5:1, %, Max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, Max	Tex-107-E	3
Sand equivalent, %, Min	Tex-203-F	45 ³
Organic impurities	Tex-408-A	Note ⁴

1. Used to estimate the magnesium sulfate soundness loss in accordance with Section 341.2.1.1.2., "Micro-Deval Abrasion."
2. Only applies to crushed gravel.
3. The Department may perform [Tex-252-F](#) on fine aggregates not meeting this minimum requirement. Fine aggregates with a methylene blue value of 10.0 mg/g or less may be used.
4. Optional test.

Table 2
Gradation Requirements for Fine Aggregate

Sieve Size	% Passing by Wt. Or Volume
3/8"	100
#8	70–100
#200	0–30

2.2.

Mineral Filler. Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Use no more than 2% hydrated lime or fly ash, unless otherwise shown on the plans. Use no more than 1% hydrated lime if a substitute binder is used, unless otherwise shown on the plans or allowed. Test all mineral fillers except hydrated lime and fly ash in accordance with [Tex-107-E](#) to ensure specification compliance. The plans may require or disallow specific mineral fillers. Provide mineral filler, when used, that:

- is dry enough, free-flowing, and free of clumps and foreign matter as determined by the Engineer;
- does not exceed 3% linear shrinkage when tested in accordance with [Tex-107-E](#); and
- meets the gradation requirements shown in Table 3, unless otherwise shown on the plans.

Table 3
Gradation Requirements for Mineral Filler

Sieve Size	% Passing by Wt. or Volume
#8	100
#200	55–100

- 2.3. **Baghouse Fines.** Fines collected by the baghouse or other dust-collecting equipment may be reintroduced into the mixing drum.
- 2.4. **Asphalt Binder.** Furnish the type and grade of performance-graded (PG) asphalt binder shown on the plans that meets the requirements of Item 300, "Asphalts, Oils, and Emulsions."
- 2.5. **Tack Coat.** Furnish CSS-1H, SS-1H, EBL, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder in accordance with Item 300. Specialized tack coat materials on the MPL for *Tracking Resistant Asphalt Interlayer* (TRAIL) will be allowed or required when shown on the plans. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use, unless required in conformance with the manufacturer's recommendation for approved TRAIL products on the MPL.
- 2.6. **Additives.** Use the type of additive specified when shown on the plans. Use the rate of additive specified in conformance with the manufacturer's recommendation. Additives that facilitate mixing and compaction or improve the quality of the mixture are allowed when approved. Provide the Engineer with documentation such as the bill of lading showing the quantity of additives used in the project unless otherwise directed.
- 2.6.1. **Lime and Liquid Antistripping Agent.** Lime or liquid antistripping agent is required when shown on the plans. When lime or a liquid antistripping agent is used, add in accordance with Item 301, "Asphalt Antistripping Agents." Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the lime into the drum.
- 2.6.2. **Warm-Mix Asphalt (WMA).** WMA is defined as HMA that is produced within a target temperature discharge range of 215°F and 275°F using approved WMA additives or processes from the MPL.
- WMA is allowed for use on all projects and is required when shown on the plans. When WMA is required, the maximum placement or target discharge temperature for WMA will be set at a value at or below 275°F.
- Department-approved WMA additives or processes may be used to facilitate mixing and compaction of HMA produced at target discharge temperatures above 275°F; however, such mixtures will not be defined as WMA.
- 2.6.3. **Compaction Aid.** Compaction aid is defined as a Department-approved chemical warm-mix additive, denoted as "chemical additive" on the MPL, that is used to facilitate mixing and compaction of HMA at a discharge temperature greater than 275°F.
- Compaction aid is allowed for use on all projects. Compaction aid is required when shown on the plans or as required in Section 341.4.7.1., "Weather Conditions."
- Warm-mix foaming processes, denoted as "foaming process" on the MPL, may be used to facilitate mixing and compaction of HMA at target discharge temperatures greater than 275°F; however, warm-mix foaming processes are not defined as a compaction aid.
- 2.7. **Recycled Materials.** Use of RAP and RAS is permitted unless otherwise shown on the plans. Use of RAS is restricted to only intermediate and base mixes unless otherwise shown on the plans. Do not exceed the maximum allowable percentages of RAP and RAS in accordance with Table 4. The allowable percentages in accordance with Table 4 may be decreased or increased when shown on the plans. Determine the asphalt binder content and gradation of the RAP and RAS stockpiles for mixture design purposes in accordance with [Tex-236-F](#), Part I. The Engineer may verify the asphalt binder content of the stockpiles anytime during production. Perform other tests on RAP and RAS when shown on the plans. Asphalt binder from RAP and

RAS is designated as recycled asphalt binder. Calculate and ensure that the ratio of the recycled asphalt binder to total binder does not exceed the percentages in accordance with Table 5 during mixture design and HMA production when RAP or RAS is used. Use a separate cold feed bin for each stockpile of RAP and RAS during HMA production. Surface, intermediate, and base mixes referenced in Table 4 and Table 5 are defined as follows, unless otherwise shown on the plans.

- **Surface.** The final HMA lift placed at the top of the pavement structure.
- **Intermediate.** Mixtures placed below an HMA surface mix and less than or equal to 8.0 in. below the riding surface.
- **Base.** Mixtures placed greater than 8.0 in. below the riding surface. Unless otherwise shown on the plans, mixtures used for bond breaker are defined as base mixtures.

2.7.1.

RAP. RAP is salvaged, milled, pulverized, broken, or crushed asphalt pavement. Fractionated RAP is defined as a stockpile that contains RAP material with at least 95.0% passing the 1/2-in. sieve, before burning in the ignition oven, unless otherwise approved. The Engineer may allow the Contractor to use an alternate to the 1/2-in. screen to fractionate the RAP.

Use of Contractor-owned RAP, including HMA plant waste, is permitted unless otherwise shown on the plans. Department-owned RAP stockpiles are available for the Contractor's use when the stockpile locations are shown on the plans. If Department-owned RAP is available for the Contractor's use, the Contractor may use Contractor-owned fractionated RAP and replace it with an equal quantity of Department-owned RAP. Department-owned RAP generated by required work on the Contract is available for the Contractor's use when shown on the plans. Perform any necessary tests to ensure Contractor- or Department-owned RAP is appropriate for use. The Department will not perform any tests or assume any liability for the quality of the Department-owned RAP unless otherwise shown on the plans. The Contractor will retain ownership of RAP generated on the project when shown on the plans.

Do not use Department- or Contractor-owned RAP contaminated with dirt or other objectionable materials. Do not use Department- or Contractor-owned RAP if the decantation value exceeds 5% and the plasticity index is greater than 8. Test the stockpiled RAP for decantation in accordance with [Tex-406-A](#), Part I. Determine the plasticity index in accordance with [Tex-106-E](#) if the decantation value exceeds 5%. The decantation and plasticity index requirements do not apply to RAP samples with asphalt removed by extraction or ignition.

Do not intermingle Contractor-owned RAP stockpiles with Department-owned RAP stockpiles. Remove unused Contractor-owned RAP material from the project site upon completion of the project. Return unused Department-owned RAP to the designated stockpile location.

Table 4
Max Allowable Amounts of RAP¹

Max Allowable Fractionated RAP (%)		
Surface	Intermediate	Base
20.0	30.0	35.0

1. Must also meet the recycled binder to total binder ratio shown in Table 5.

2.7.2.

RAS. RAS is defined as processed asphalt shingle material from manufacturing of asphalt roofing shingles or from re-roofing residential structures. Post-manufactured RAS is processed manufacturer's shingle scrap byproduct. Post-consumer RAS is processed shingle scrap removed from residential structures. Use of post-manufactured RAS or post-consumer RAS (tear-offs) is not permitted in surface mixtures unless otherwise shown on the plans. RAS may be used in intermediate and base mixtures unless otherwise shown on the plans. Up to 3% RAS may be used separately or as a replacement for fractionated RAP in accordance with Table 4 and Table 5. RAS may be used separately or in conjunction with RAP. Comply with all regulatory requirements stipulated for RAS by TCEQ.

Process the RAS by ambient grinding or granulating such that 100% of the particles pass the 3/8-in. sieve when tested in accordance with [Tex-200-F](#), Part I. Perform a sieve analysis on processed RAS material before extraction (or ignition) of the asphalt binder.

Add sand meeting the requirements of Table 1 and Table 2, or fine RAP, to RAS stockpiles if needed to keep the processed material workable. Any stockpile that contains RAS will be considered a RAS stockpile and be limited to no more than 3.0% of the HMA mixture in accordance with Table 4.

Certify compliance of the RAS with [DMS-11000](#), "Evaluating and Using Nonhazardous Recyclable Materials Guidelines." Treat RAS as an established nonhazardous recyclable material if it has not come into contact with any hazardous materials. Use RAS from shingle sources on the MPL. Remove all materials that are not part of the shingle, such as wood, paper, metal, plastic, and felt paper, before use. Determine the deleterious content of RAS material for mixture design purposes in accordance with [Tex-217-F](#), Part III. Do not use RAS if deleterious materials are more than 0.5% of the stockpiled RAS, unless otherwise approved. Submit a sample for approval before submitting the mixture design. The Department will perform the testing for deleterious material of RAS to determine specification compliance.

2.8.

Substitute Binders. No binder substitution will be allowed when shown on the plans. The Contractor may use a substitute PG binder shown in Table 5 instead of the PG binder originally specified, if using recycled materials, and if the substitute PG binder and mixture made with the substitute PG binder meet the following.

- The substitute binder meets the specification requirements for the substitute binder grade in accordance with Section 300.2.11., "Performance-Graded Binders."
- The mixture has less than 10.0 mm of rutting on the Hamburg wheel test ([Tex-242-F](#)) after the number of passes required for the originally specified binder. Use of substitute PG binders may be allowed only at the discretion of the Engineer if the Hamburg wheel test results are between 10.0 mm and 12.5 mm.

Table 5
Allowable PG Binders and Max Recycled Binder Ratios

Originally Specified PG Binder	Allowable Substitute PG Binder for Surface Mixes	Allowable Substitute PG Binder for Intermediate and Base Mixes	Maximum Ratio of Recycled Binder ¹ to Total Binder (%)		
			Surface	Intermediate	Base
76-22	70-22	70-22	15.0	25.0	30.0
70-22	Note ²	64-22	15.0	25.0	30.0
64-22	Note ²	Note ²	15.0	25.0	30.0
76-28	70-28	70-28	15.0	25.0	30.0
70-28	Note ²	64-28	15.0	25.0	30.0
64-28	Note ²	Note ²	15.0	25.0	30.0

1. Combined recycled binder from RAP and RAS. RAS is not permitted in surface mixtures unless otherwise shown on the plans.
2. No binder substitution is allowed.

3. EQUIPMENT

Provide required or necessary equipment in accordance with Item 320, "Equipment for Asphalt Concrete Pavement."

4. CONSTRUCTION

Produce, haul, place, and compact the specified paving mixture. In addition to tests required in accordance with the Specification, the Contractor may perform other QC tests as necessary. Anytime during the project, the Engineer may perform production and placement tests as necessary in accordance with Item 5, "Control of the Work." Schedule and participate in a mandatory pre-paving meeting with the Engineer on or before the first day of paving unless otherwise shown on the plans.

- 4.1. **Certification.** Personnel certified by the Department-approved HMA certification program must conduct all mixture designs, sampling, and testing in accordance with Table 6. Supply the Engineer with a list of certified personnel and copies of their current certificates before beginning production and when personnel changes are made. Provide a mixture design developed and signed by a Level 2-certified specialist. Provide Level 1A-certified specialists at the plant during production operations. Provide Level 1B-certified specialists to conduct placement tests. Provide Level AGG101-certified specialists for aggregate testing.

Table 6
Test Methods, Test Responsibility, and Min Certification Levels

Test Description	Test Method	Contractor	Engineer	Level ¹
Aggregate and Recycled Material Testing				
Sampling	Tex-221-F	✓	✓	1A/AGG101
Dry sieve	Tex-200-F, Part I	✓	✓	1A/AGG101
Washed sieve	Tex-200-F, Part II	✓	✓	1A/AGG101
Deleterious material	Tex-217-F, Part I and Part III	✓	✓	AGG101
Decantation	Tex-217-F, Part II	✓	✓	AGG101
Los Angeles abrasion	Tex-410-A	–	✓	Department
Magnesium sulfate soundness	Tex-411-A	–	✓	Department
Micro-Deval abrasion	Tex-461-A	–	✓	AGG101
Crushed face count	Tex-460-A	✓	✓	AGG101
Flat and elongated particles	Tex-280-F	✓	✓	AGG101
Linear shrinkage	Tex-107-E	✓	✓	AGG101
Sand equivalent	Tex-203-F	✓	✓	AGG101
Methylene blue test	Tex-252-F	–	✓	Department
Bulk-specific gravity	Tex-201-F	✓	✓	AGG101
Organic impurities	Tex-408-A	✓	✓	AGG101
Asphalt Binder and Tack Coat Sampling				
Asphalt binder sampling	Tex-500-C, Part II	✓	✓	1A/1B
Tack coat sampling	Tex-500-C, Part III	✓	✓	1A/1B
Mix Design and Verification				
Design and job-mix formula (JMF) changes	Tex-204-F	✓	✓	2
Mixing	Tex-205-F	✓	✓	2
Molding (Superpave gyratory compactor [SGC])	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Part I and Part VI	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Ignition oven correction factors ²	Tex-236-F, Part II	✓	✓	1A
Indirect tensile strength	Tex-226-F	✓	✓	1A
Hamburg wheel test	Tex-242-F	✓	✓	1A
Witnessing mixing of correction factors	Tex-236-F, Part III	–	✓	Department
Boil test	Tex-530-C	✓	✓	1A
Production Testing				
Selecting production random numbers	Tex-225-F, Part I	–	✓	1A
Mixture sampling	Tex-222-F	✓	✓	1A/1B
Molding (SGC)	Tex-241-F	✓	✓	1A
Laboratory-molded density	Tex-207-F, Part I and Part VI	✓	✓	1A
Rice gravity	Tex-227-F, Part II	✓	✓	1A
Gradation and asphalt binder content ²	Tex-236-F, Part I	✓	✓	1A
Control charts	Tex-233-F	✓	✓	1A
Moisture content	Tex-212-F, Part II	✓	✓	1A/AGG101
Hamburg wheel test	Tex-242-F	✓	✓	1A
Micro-Deval abrasion	Tex-461-A	–	✓	AGG101
Boil test	Tex-530-C	✓	✓	1A
Abson recovery	Tex-211-F	–	✓	Department

Test Description	Test Method	Contractor	Engineer	Level ¹
Placement Testing				
Selecting placement random numbers	Tex-225-F , Part II	–	✓	1B
Trimming roadway cores	Tex-251-F , Part I and Part II	✓	✓	1A/1B
In-place air voids	Tex-207-F , Part I and Part VI	✓	✓	1A
In-place density (nuclear method)	Tex-207-F , Part III	✓	–	1B
Establish rolling pattern	Tex-207-F , Part IV	✓	–	1B
Control charts	Tex-233-F	✓	✓	1A
Ride quality measurement	Tex-1001-S	✓	✓	Note ³
Segregation (density profile)	Tex-207-F , Part V	✓	✓	1B
Longitudinal joint density	Tex-207-F , Part VII	✓	✓	1B
Thermal profile	Tex-244-F	✓	–	1B
Shear bond strength test	Tex-249-F	–	✓	Department

1. Levels 1A, 1B, AGG101, and 2 are certification levels provided by the Hot Mix Asphalt Center certification program.
2. Refer to Section 341.4.9.2.3., “Production Testing,” for exceptions to using an ignition oven.
3. Profiler and operator are required to be certified at the Texas A&M Transportation Institute facility when surface test Type B is specified.

4.2.

Reporting and Responsibilities. Use Department-provided templates to record and calculate all test data, including mixture design, production and placement QC and QA, control charts, thermal profiles, segregation density profiles, and longitudinal joint density. Obtain the current version of the templates from the Department’s website or from the Engineer. The Engineer and the Contractor will provide any available test results to the other party when requested. The maximum allowable time for the Contractor and Engineer to exchange test data is as shown in Table 7, unless otherwise approved. The Engineer and the Contractor will immediately report to the other party any test result that requires suspension of production or placement, or a payment adjustment less than 1.000, or that fails to meet the specification requirements. Record and electronically submit all test results and pertinent information on Department-provided templates.

Subsequent sublots placed after test results are available to the Contractor, which require suspension of operations, may be considered unauthorized work. Unauthorized work will be accepted or rejected at the discretion of the Engineer in accordance with Article 5.3., “Conformity with Plans, Specifications, and Special Provisions.”

Table 7
Reporting Schedule

Reporting Schedule			
Description	Reported By	Reported To	To Be Reported Within
Production Quality Control			
Gradation ¹	Contractor	Engineer	1 working day of completion of the subplot
Asphalt binder content ¹			
Laboratory-molded density ²			
Moisture content ³			
Boil test ⁴			
Production Quality Assurance			
Gradation ³	Engineer	Contractor	1 working day of completion of the subplot
Asphalt binder content ³			
Laboratory-molded density ¹			
Hamburg wheel test ⁵			
Boil test ⁴			
Binder tests ⁵			
Placement Quality Control			
In-place air voids ²	Contractor	Engineer	1 working day of completion of the lot
Segregation ¹			
Longitudinal joint density ¹			
Thermal profile ¹			

Description	Reported By	Reported To	To Be Reported Within
Placement Quality Assurance			
In-place air voids ¹	Engineer	Contractor	1 working day after receiving the trimmed cores ⁶
Segregation ³			1 working day of completion of the lot
Longitudinal joint density ³			
Thermal profile ³			
Aging ratio ⁵			5 working days after receiving the cores
Shear bond strength test ⁵			
Payment adjustment summary	Engineer	Contractor	2 working days of performing all required tests and receiving Contractor test data

1. These tests are required on every sublot.
2. Optional test. When performed on split samples, report the results as soon as they become available.
3. To be performed at the frequency shown in Table 16 or as shown on the plans.
4. When shown on the plans.
5. To be reported as soon as the results become available.
6. Two days are allowed if cores cannot be dried to constant weight within 1 day.

The Engineer will use the Department-provided template to calculate all payment adjustment factors for the lot. Sublot samples may be discarded after the Engineer and Contractor sign off on the payment adjustment summary documentation for the lot.

Use the procedures described in [Tex-233-F](#) to plot the results of all QC and QA testing. Update the control charts as soon as test results for each sublot become available. Make the control charts readily accessible at the field laboratory. The Engineer may suspend production for failure to update control charts.

- 4.3. **Quality Control Plan (QCP).** Develop and follow the QCP in detail. Obtain approval for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP before the mandatory pre-paving meeting. Receive approval of the QCP before beginning production. Include the following items in the QCP.

- 4.3.1. **Project Personnel.** For project personnel, include:

- a list of individuals responsible for QC with authority to take corrective action,
- current contact information for each individual listed, and
- current copies of certification documents for individuals performing specified QC functions.

- 4.3.2. **Material Delivery and Storage.** For material delivery and storage, include:

- the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;
- aggregate stockpiling procedures to avoid contamination and segregation;
- frequency, type, and timing of aggregate stockpile testing to assure conformance with material requirements before mixture production; and
- procedure for monitoring the quality and variability of asphalt binder.

- 4.3.3. **Production.** For production, include:

- loader operation procedures to avoid contamination in cold bins;
- procedures for calibrating and controlling cold feeds;
- procedures to eliminate debris or oversized material;
- procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, RAP, RAS, lime, liquid antistriper, compaction aid, foaming process, and WMA);

- procedures for reporting job control test results; and
- procedures to avoid segregation and drain-down in the silo.

4.3.4. **Loading and Transporting.** For loading and transporting, include:

- type and application method for release agents, and
- truck-loading procedures to avoid segregation.

4.3.5. **Placement and Compaction.** For placement and compaction, include:

- proposed agenda for mandatory pre-paving meeting, including date and location;
- proposed paving plan (e.g., production rate, paving widths, joint offsets, and lift thicknesses);
- type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;
- procedures for the transfer of mixture into the paver while avoiding physical and thermal segregation and preventing material spillage;
- process to balance production, delivery, paving, and compaction to achieve continuous placement operations and good ride quality;
- paver operations (e.g., speed, operation of wings, and height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and
- procedures to construct quality longitudinal and transverse joints.

4.4. **Mixture Design.**

4.4.1. **Design Requirements.** Use the dense-graded design procedure provided in [Tex-204-F](#), unless otherwise shown on the plans. Design the mixture to meet the requirements shown in Tables 1, 2, 3, 4, 5, 8, 9, and 10.

Design the mixture using an SGC, and 50 gyrations as the design number of gyrations (N_{design}). Use a target laboratory-molded density of 96.0% to design the mixture; however, adjustments can be made to the N_{design} value as shown in Table 9. The N_{design} level may be reduced to at least 35 gyrations at the Contractor's discretion.

Use a Department-approved laboratory on the MPL to perform the Hamburg wheel test and provide results with the mixture design, or provide the laboratory mixture and request that the Department perform the Hamburg wheel test. Upon receiving the sample from the Contractor, the Engineer will be allowed 10 working days to provide the Contractor with Hamburg wheel test results on the laboratory mixture design.

The Engineer will provide the mixture design when shown on the plans. The Contractor may submit a new mixture design anytime during the project. The Engineer will verify and approve all mixture designs (JMF1) before the Contractor can begin production.

Provide the Engineer with a mixture design report using the Department-provided template. Include the following items in the report:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- the binder source and optimum design asphalt content;
- asphalt binder content and aggregate gradation of RAP and RAS stockpiles;
- the N_{design} level used on the SGC;
- results of all applicable tests;
- the mixing and molding temperatures;
- the signature of the Level 2 person or persons who performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

Table 8
Master Gradation Limits (% Passing by Wt. or Volume) and Void in Mineral Aggregate (VMA) Requirements

Sieve Size	DG-B Fine Base	DG-C Coarse Surface	DG-D Fine Surface	DG-F Fine Mixture
2"	—	—	—	—
1-1/2"	100.0 ¹	—	—	—
1"	98.0–100.0	100.0 ¹	—	—
3/4"	84.0–98.0	95.0–100.0	100.0 ¹	—
1/2"	—	—	98.0–100.0	100.0 ¹
3/8"	60.0–80.0	70.0–85.0	85.0–100.0	98.0–100.0
#4	40.0–60.0	43.0–63.0	50.0–70.0	70.0–90.0
#8	29.0–43.0	32.0–44.0	35.0–46.0	38.0–48.0
#30	13.0–28.0	14.0–28.0	15.0–29.0	12.0–27.0
#50	6.0–20.0	7.0–21.0	7.0–20.0	6.0–19.0
#200	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0
Design (VMA), % Min				
—	13.0	14.0	15.0	16.0
Production (Plant-Produced) (VMA), % Min				
—	12.5	13.5	14.5	15.5

1. Defined as Max sieve size. No tolerance allowed.

Table 9
Laboratory Mixture Design Properties

Mixture Property	Test Method	Requirement
Target laboratory-molded density, %	Tex-207-F	96.0
Design gyrations (N _{design})	Tex-241-F	50 ¹
Indirect tensile strength (dry), psi	Tex-226-F	85–200 ²
Boil test ³	Tex-530-C	—

- Adjust within a range of 35–100 gyrations when shown on the plans, in accordance with the specification, or when mutually agreed between the Engineer and Contractor.
- The Engineer may allow the indirect tensile test strength to exceed 200 psi if the corresponding Hamburg wheel rut depth is >2.5 mm and <12.5 mm.
- When shown on the plans. Used to establish baseline for comparison to production results.

Table 10
Hamburg Wheel Test Requirements

High-Temperature Binder Grade	Test Method	Min # of Passes at 12.5-mm ¹ Rut Depth, Tested at 50°C
PG 64 or lower	Tex-242-F	10,000 ²
PG 70		15,000 ³
PG 76 or higher		20,000

- The Hamburg wheel test will have a minimum rut depth of 2.5 mm.
- May be decreased to at least 5,000 passes when shown on the plans.
- May be decreased to at least 10,000 passes when shown on the plans.

4.4.2.

Job-Mix Formula Approval. The JMF is the combined aggregate gradation, N_{design} level, and target asphalt percentage used to establish target values for hot-mix production. JMF1 is the original laboratory mixture design used to produce the trial batch. When WMA is used, JMF1 may be designed and submitted to the Engineer without including the WMA additive, foaming process, or compaction aid. When WMA or a compaction aid is used, document the additive or process used and recommended rate in the JMF1 submittal. The Engineer and the Contractor will verify JMF1 based on plant-produced mixture from the trial batch, unless otherwise approved. The Engineer may accept an existing mixture design previously used on a Department project and may waive the trial batch to verify JMF1. The Department may require the Contractor to reimburse the Department for verification tests if more than two trial batches per design are required.

4.4.2.1. **Contractor's Responsibilities.**

- 4.4.2.1.1. **Providing Superpave Gyratory Compactor.** Provide an SGC in accordance with Item 504, "Field Office and Laboratory," and make the SGC available to the Engineer for use in molding production samples.
- 4.4.2.1.2. **Gyratory Compactor Correlation Factors.** Use [Tex-206-F](#), Part II, to perform a gyratory compactor correlation when the Engineer uses a different SGC. Apply the correlation factor to all subsequent production test results.
- 4.4.2.1.3. **Submitting JMF1.** Furnish a mix design report (JMF1) with representative samples of all component materials and request approval to produce the trial batch. Provide approximately 25 lb. of the design mixture if opting to have the Department perform the Hamburg wheel test on the laboratory mixture, and request that the Department perform the test.
- 4.4.2.1.4. **Supplying Aggregates.** Provide approximately 40 lb. of each aggregate stockpile unless otherwise directed.
- 4.4.2.1.5. **Supplying Asphalt.** Provide at least 1 gal. of the asphalt material and enough quantities of any additives proposed for use.
- 4.4.2.1.6. **Ignition Oven Correction Factors.** Notify the Engineer before performing [Tex-236-F](#), Part II. Allow the Engineer to witness the mixing of ignition oven correction factor sample. Determine the aggregate and asphalt correction factors from the ignition oven in accordance with [Tex-236-F](#), Part II.
- If the Engineer witnesses the mixing of the ignition oven correction factor samples, provide the Engineer with identically prepared samples of the mixtures before the trial batch production, including all additives (except water), and blank samples used to determine the correction factors for the ignition oven used for QA testing during production.
- Correction factors established from a previously approved mixture design may be used for the current mixture design if the mixture design and ignition oven are the same as previously used, unless otherwise directed. Correction factors must be performed every 12 mo.
- 4.4.2.1.7. **Boil Test.** When shown on the plans, perform the test and retain the tested sample from [Tex-530-C](#) until completion of the project or as directed. Use this sample for comparison purposes during production.
- 4.4.2.1.8. **Trial Batch Production.** Provide a plant-produced trial batch upon receiving conditional approval of JMF1 and authorization to produce a trial batch. If applicable, include the WMA additive, foaming process, or compaction aid for verification testing of JMF1 and development of JMF2. Produce a trial batch mixture that meets the requirements shown in Tables 4, 5, and 11. The Engineer may accept test results from recent production of the same mixture instead of a new trial batch.
- 4.4.2.1.9. **Trial Batch Production Equipment.** Use only equipment and materials proposed for use on the project to produce the trial batch.
- 4.4.2.1.10. **Trial Batch Quantity.** Produce enough quantity of the trial batch to ensure that the mixture meets the specification requirements.
- 4.4.2.1.11. **Number of Trial Batches.** Produce trial batches as necessary to obtain a mixture that meets the specification requirements.
- 4.4.2.1.12. **Trial Batch Sampling.** Obtain a representative sample of the trial batch and split it into three equal portions in accordance with [Tex-222-F](#). Label these portions as "Contractor," "Engineer," and "Referee." Deliver samples to the appropriate laboratory as directed.
- 4.4.2.1.13. **Trial Batch Testing.** Test the trial batch to ensure the mixture produced using the proposed JMF1 meets the mixture requirements shown in Table 11. Ensure the trial batch mixture is also in compliance with the

Hamburg wheel requirement shown in Table 10. Use a Department-approved laboratory listed on the MPL to perform the Hamburg wheel test on the trial batch mixture, or request that the Department perform the Hamburg wheel test. Provide approximately 25 lb. of the trial batch mixture if opting to have the Department perform the Hamburg wheel test, and request that the Department perform the test. Upon receiving the sample from the Contractor, the Engineer will be allowed 10 working days to provide the Contractor with Hamburg wheel test results on the trial batch. Provide the Engineer with a copy of the trial batch test results.

- 4.4.2.1.14. **Development of JMF2.** After the Engineer grants full approval of JMF1, evaluate the trial batch test results, determine the optimum mixture proportions, and submit as JMF2. Adjust the asphalt binder content or gradation to achieve the specified target laboratory-molded density. The asphalt binder content established for JMF2 is not required to be within any tolerance of the optimum asphalt binder content established for JMF1; however, mixture produced using JMF2 must meet the VMA requirements for production shown in Table 8. If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform [Tex-226-F](#) on Lot 1 production to confirm the indirect tensile strength does not exceed 200 psi. Verify that JMF2 meets the mixture requirements shown in Table 4 and Table 5.
- 4.4.2.1.15. **Mixture Production.** Use JMF2 to produce Lot 1 in accordance with Section 341.4.9.3.1.1., “Lot 1 Placement,” after receiving approval for JMF2 and a passing Hamburg wheel result on the trial batch from a laboratory listed on the MPL. Once JMF2 is approved, and without receiving the results from the Department’s Hamburg wheel test on the trial batch, the Contractor may proceed to Lot 1 production at their own risk.
- Notify the Engineer if electing to proceed without Hamburg wheel test results from the trial batch. Note that the Engineer may require up to the entire subplot of any mixture failing the Hamburg wheel test to be removed and replaced at the Contractor’s expense.
- 4.4.2.1.16. **Development of JMF3.** Evaluate the test results from Lot 1, determine the optimum mixture proportions, and submit as JMF3 for use in Lot 2.
- 4.4.2.1.17. **JMF Adjustments.** If JMF adjustments are necessary to achieve the specified requirements, make the adjustments before beginning a new lot. The adjusted JMF must:
- be provided to the Engineer in writing before the start of a new lot,
 - be numbered in sequence to the previous JMF,
 - meet the mixture requirements in accordance with Table 4 and Table 5,
 - meet the master gradation limits in accordance with Table 8, and
 - be within the operational tolerances of JMF2 in accordance with Table 11.
- 4.4.2.1.18. **Requesting Referee Testing.** Use referee testing, if needed, in accordance with Section 341.4.9.1., “Referee Testing,” to resolve testing differences with the Engineer.

Table 11
Operational Tolerances

Description	Test Method	Allowable Difference Between JMF2 and JMF1 Target ¹	Allowable Difference Between Current JMF and JMF2 ²	Allowable Difference Between Contractor and Engineer ³
Individual % retained on #8 sieve and larger	Tex-200-F or Tex-236-F	Must be Within Master Gradation Limits in Table 8	±5.04	±5.0
Individual % retained on sieves smaller than #8 and larger than #200			±3.04	±3.0
% passing the #200 sieve			±2.04	±1.6
Asphalt binder content, %	Tex-236-F	±0.5	±0.3	±0.3
Laboratory-molded density, %	Tex-207-F	±1.0	±1.0	±1.0
In-place air voids, %		—	—	±1.0
Laboratory-molded bulk specific gravity		—	—	±0.020
VMA, %, Min	Tex-204-F	Note ⁵	Note ⁵	—
Theoretical maximum specific (Rice) gravity	Tex-227-F	—	—	±0.020

1. JMF1 is the approved laboratory mixture design used for producing the trial batch. JMF2 is the approved mixture design developed from the trial batch used to produce Lot 1.
2. Current JMF is JMF3 or higher. JMF3 is the approved mixture design used to produce Lot 2.
3. Contractor may request referee testing when values exceed these tolerances.
4. When within these tolerances, mixture production gradations may fall outside the master gradation limits; however, the % passing the #200 will be considered out of tolerance when outside the master gradation limits.
5. Verify that Table 8 requirements are met for VMA.

4.4.2.2. **Engineer's Responsibilities.**

4.4.2.2.1. **Superpave Gyratory Compactor.** The Engineer will use a Department SGC, calibrated in accordance with [Tex-241-F](#), to mold samples for laboratory mixture design verification. For molding trial batch and production specimens, the Engineer will use the Contractor-provided SGC at the field laboratory or provide and use a Department SGC at an alternate location.

4.4.2.2.2. **Conditional Approval of JMF1 and Authorizing Trial Batch.** The Engineer will review and verify conformance with the following information within 2 working days of receipt:

- the Contractor's mix design report (JMF1);
- the Contractor-provided Hamburg wheel test results;
- all required materials including aggregates, asphalt, additives, and recycled materials; and
- the mixture specifications.

The Engineer will grant the Contractor conditional approval of JMF1 if the information provided on the paper copy of JMF1 indicates that the Contractor's mixture design meets the specifications. When the Contractor does not provide Hamburg wheel test results with laboratory mixture design, 10 working days are allowed for conditional approval of JMF1. The Engineer will base full approval of JMF1 on the test results on mixture from the trial batch.

Unless waived, the Engineer will determine the Micro-Deval abrasion loss in accordance with Section 341.2.1.1.2., "Micro-Deval Abrasion." If the Engineer's test results are pending after 2 working days, conditional approval of JMF1 will still be granted within 2 working days of receiving JMF1. When the Engineer's test results become available, they will be used for specification compliance.

The Contractor is authorized to produce a trial batch after the Engineer grants conditional approval of JMF1.

4.4.2.2.3. **Hamburg Wheel Testing of JMF1.** If the Contractor requests the option to have the Department perform the Hamburg wheel test on the laboratory mixture, the Engineer will mold samples in accordance with [Tex-242-F](#) to verify compliance with the Hamburg wheel test requirement shown in Table 10. Upon receiving the sample from the Contractor, the Engineer will be allowed 10 working days to provide the Contractor with Hamburg wheel test results on the laboratory mixture design.

- 4.4.2.2.4. **Ignition Oven Correction Factors.** The Engineer will determine ignition oven correction factors by one of the following options.
- Witness the mixing of ignition oven correction factor samples by the Contractor in accordance with [Tex-236-F](#), Part III. The Engineer will use the identically prepared samples provided by the Contractor to determine the aggregate and asphalt correction factors for the ignition oven in accordance with [Tex-236-F](#), Part II.
 - If the Engineer does not witness the mixing of ignition oven correction factor samples, the Engineer will prepare the samples to determine the aggregate and asphalt correction factors for the ignition oven in accordance with [Tex-236-F](#), Part II. Notify the Contractor before performing [Tex-236-F](#), Part II. Allow the Contractor to witness the Engineer performing [Tex-236-F](#), Part II.

Correction factors must be performed every 12 mo. to be used for QA testing during production.

- 4.4.2.2.5. **Testing the Trial Batch.** Within 1 full working day, the Engineer will sample and test the trial batch to ensure that the mixture meets the requirements shown in Table 11. If the Contractor requests the option to have the Department perform the Hamburg wheel test on the trial batch mixture, the Engineer will mold samples in accordance with [Tex-242-F](#) to verify compliance with the Hamburg wheel test requirement shown in Table 10.

The Engineer will have the option to perform the following tests on the trial batch.

- [Tex-226-F](#), to verify that the indirect tensile strength meets the requirement shown in Table 9.
- [Tex-530-C](#), to retain and use for comparison purposes during production.

- 4.4.2.2.6. **Full Approval of JMF1.** The Engineer will grant full approval of JMF1 and authorize the Contractor to proceed with developing JMF2 if the Engineer's results for the trial batch meet the requirements shown in Tables 8, 9, and 10. The Engineer will notify the Contractor that an additional trial batch is required if the trial batch does not meet these requirements.

- 4.4.2.2.7. **Approval of JMF2.** The Engineer will approve JMF2 within 1 working day if the mixture meets the requirements shown in Table 5 and Table 8. The asphalt binder content established for JMF2 is not required to be within any tolerance of the optimum asphalt binder content established for JMF1; however, mixture produced using JMF2 must meet the VMA requirements shown in Table 8. If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform [Tex-226-F](#) on Lot 1 production to confirm the indirect tensile strength does not exceed 200 psi.

- 4.4.2.2.8. **Approval of Lot 1 Production.** The Engineer will authorize the Contractor to proceed with JMF2 for Lot 1 production after a passing Hamburg wheel test result on the trial batch is achieved from a laboratory listed on the MPL. The Contractor may proceed at their own risk with Lot 1 production without the results from the Hamburg wheel test on the trial batch.

If the Department-approved laboratory's sample from the trial batch fails the Hamburg wheel test, the Engineer will suspend production until further Hamburg wheel tests meet the specified values. The Engineer may require up to the entire subplot of any mixture failing the Hamburg wheel test be removed and replaced at the Contractor's expense.

- 4.4.2.2.9. **Approval of JMF3 and Subsequent JMF Changes.** JMF3 and subsequent JMF changes are approved if they meet the mixture requirements shown in Table 4 and Table 5, and the master gradation limits shown in Table 8, and they are within the operational tolerances of JMF2 shown in Table 11. The addition of a WMA additive to facilitate mixing or as a compaction aid does not require a new laboratory mixture design or trial batch. Current JMF changes that exceed the operational tolerances of JMF2 in accordance with Table 11 may require a new laboratory mixture design, trial batch, or both.

- 4.5. **Production Operations.** Perform a new trial batch when the plant or plant location is changed. All source changes for asphalt will require a passing Hamburg wheel test result from a laboratory listed on the MPL.

The Contractor may proceed at their own risk with Lot 1 production without the results from the Hamburg wheel test on the trial batch. All aggregate source changes will require a new laboratory mixture design and trial batch. Take corrective action and receive approval to proceed after any production suspension for noncompliance with the specification. Submit a new mix design and perform a new trial batch when the asphalt binder content of:

- any RAP stockpile used in the mix is more than 0.5% higher than the value shown in the mixture design report, or
- RAS stockpile used in the mix is more than 2.0% higher than the value shown in the mixture design report.

4.5.1. **Storage and Heating of Materials.** Do not heat the asphalt binder above the temperatures specified in Item 300, or outside the manufacturer's recommended values. Provide the Engineer with daily records of asphalt binder and HMA discharge temperatures (in legible and discernible increments) in accordance with Item 320, unless otherwise directed. Do not store mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr. unless otherwise approved.

4.5.2. **Mixing and Discharge of Materials.** Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed the maximum production temperatures shown in Table 12. The Department will not pay for or allow placement of any mixture produced above the maximum production temperatures shown in Table 12.

Table 12
Max Production Temperature

High-Temperature Binder Grade ¹	Max Production Temperature (°F)
PG 64	325 ²
PG 70	335 ²
PG 76	345 ²

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The Max production temperature of WMA is 275°F.

Produce WMA within the target discharge temperature range of 215–275°F when WMA is required. Take corrective action anytime the discharge temperature of the WMA exceeds the target discharge range. The Engineer may suspend production operations if the Contractor's corrective action is not successful at controlling the production temperature within the target discharge range. Note that when WMA is produced, it may be necessary to adjust burners to ensure complete combustion such that no burner fuel residue remains in the mixture.

Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. Determine the moisture content, if requested, by oven-drying in accordance with [Tex-212-F](#), Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck and perform the test promptly.

4.6. **Hauling Operations.** Clean all truck beds before use to ensure that mixture is not contaminated. Use a release agent listed on the MPL to coat the inside bed of the truck when necessary. Do not use diesel or any release agent not listed on the MPL.

Use equipment for hauling as defined in Section 341.4.7.3.3., "Hauling Equipment." Use other hauling equipment only when allowed.

4.7. **Placement Operations.** Collect haul tickets from each load of mixture delivered to the project and provide the Department's copy to the Engineer approximately every hour, or as directed. Use a handheld thermal camera or infrared thermometer, when a thermal imaging system is not used, to measure and record the internal temperature of the mixture as discharged from the truck or material transfer device (MTD) before or

as the mix enters the paver. Measure the mixture temperature at a minimum frequency of one per ten trucks, or as approved. Include an approximate station number or Global Positioning System coordinates of the location where the temperature was taken on each ticket. Ensure the mixture meets the temperature requirements shown in Table 12. Calculate the daily yield and cumulative yield for the specified lift and provide to the Engineer at the end of paving operations for each day unless otherwise directed. The Engineer may suspend production if the Contractor fails to produce and provide haul tickets and yield calculations by the end of paving operations for each day.

Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. Offset longitudinal joints of successive courses of hot mix by at least 6 in. Place mixture so that longitudinal joints on the surface course coincide within 6 in. of lane lines, are not placed in the wheel path, or will not be covered with pavement markings, or as directed. Ensure that all finished surfaces will drain properly. Place the mixture at the rate or thickness shown on the plans. The Engineer will use the guidelines shown in Table 13 to determine the compacted lift thickness of each layer when multiple lifts are required. The thickness determined is based on the rate of 110 lb. per square yard for each inch of pavement, unless otherwise shown on the plans.

Table 13
Compacted Lift Thickness and Required Core Height

Mixture Type	Compacted Lift Thickness Guidelines		Min Untrimmed Core Height Eligible for Testing (in.)
	Min (in.)	Max (in.)	
DG-B	2.50	5.00	1.75
DG-C	2.00	4.00	1.50
DG-D	1.50	3.00	1.25
DG-F	1.25	2.50	1.25

4.7.1.

Weather Conditions.

4.7.1.1.

When Using a Thermal Imaging System. Place mixture when the roadway surface is dry and the roadway surface temperature is at or above the temperatures shown in Table 14A, unless otherwise approved or as shown on the plans. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer. Provide output data from the thermal imaging system to demonstrate to the Engineer that no recurring severe thermal segregation exists in accordance with Section 341.4.7.3.1.2., “Thermal Imaging System.”

Table 14A
Min Pavement Surface Temperatures

High-Temperature Binder Grade ¹	Min Pavement Surface Temperatures (°F)	
	Subsurface Layers	Surface Layers
PG 64	35	40
PG 70	45 ²	50 ²
PG 76	45 ²	50 ²

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The Contractor may pave at temperatures 10°F lower than these values when a chemical WMA additive is used as a compaction aid in the mixture or when using WMA.

4.7.1.2.

When Not Using a Thermal Imaging System. When using a thermal camera instead of the thermal imaging system, place mixture when the roadway surface temperature is at or above the temperatures shown in Table 14B, unless otherwise approved or as shown on the plans. Measure the roadway surface temperature using a handheld thermal camera or infrared thermometer. The Engineer may allow mixture placement to begin before the roadway surface reaches the required temperature if conditions are such that the roadway surface will reach the required temperature within 2 hr. of beginning placement operations. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable as determined by the Engineer.

Table 14B
Min Pavement Surface Temperatures

High-Temperature Binder Grade ¹	Min Pavement Surface Temperatures (°F)	
	Subsurface Layers	Surface Layers
PG 64	45	50
PG 70	55 ²	60 ²
PG 76	60 ²	60 ²

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The Contractor may pave at temperatures 10°F lower than these values when a chemical WMA additive is used as a compaction aid in the mixture, when using WMA, or when using a paving process with equipment that eliminates thermal segregation. In such cases, for each subplot and in the presence of the Engineer, use a handheld thermal camera operated in accordance with [Tex-244-F](#) to demonstrate to the satisfaction of the Engineer that the uncompacted mat has no more than 10°F of thermal segregation.

4.7.2. **Tack Coat.**

4.7.2.1. **Application.** Clean the surface before placing the tack coat. The Engineer will set the rate between 0.04 and 0.10 gal. of residual asphalt per square yard of surface area. Apply a uniform tack coat at the specified rate unless otherwise directed. Apply the tack coat in a uniform manner to avoid streaks and other irregular patterns. Apply the tack coat to all surfaces that will come in contact with the subsequent HMA placement, unless otherwise directed. Apply adequate overlap of the tack coat in the longitudinal direction during placement of the mat to ensure bond of adjacent mats, unless otherwise directed. Allow adequate time for emulsion to break completely before placing any material. Prevent splattering of tack coat when placed adjacent to curb, gutter, and structures. Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use, unless required in conformance with the manufacturer's recommendation for approved TRAIL product use, or when shown on the plans.

4.7.2.2. **Sampling.** The Engineer will obtain at least one sample of the tack coat binder per project per source in accordance with [Tex-500-C](#), Part III, and test it to verify compliance with Item 300. The Engineer will notify the Contractor when the sampling will occur and will witness the collection of the sample from the asphalt distributor immediately before use. Label the can with the corresponding lot and subplot numbers, producer, producer facility location, grade, district, date sampled, all applicable bills of lading (if available), and project information, including highway and control-section-job (CSJ) number. For emulsions, the Engineer may test as often as necessary to ensure the residual of the emulsion is greater than or equal to the specification requirement in Item 300.

4.7.3. **Lay-Down Operations.** Use the placement temperatures shown in Table 15 to establish the minimum placement temperature of the mixture delivered to the paving operation.

Table 15
Min Mixture Placement Temperature

High-Temperature Binder Grade¹	Min Placement Temperature^{2,3,4} (°F)
PG 64	260
PG 70	270
PG 76	280

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
2. The mixture temperature must be measured using a handheld thermal camera or infrared thermometer immediately before entering MTD or paver.
3. Min placement temperatures may be reduced 20°F if using a chemical WMA additive as a compaction aid, MTD with remixing capabilities, or paver hopper insert with remixing capabilities.
4. When using WMA, the minimum placement temperature is 215°F.

4.7.3.1. **Thermal Profile.** Use a handheld thermal camera or a thermal imaging system to obtain a continuous thermal profile in accordance with [Tex-244-F](#). Thermal profiles are not applicable in areas described in Section 341.4.9.3.1.4., "Miscellaneous Areas."

4.7.3.1.1. **Thermal Segregation.**

4.7.3.1.1.1. **Moderate.** Any areas that have a temperature differential greater than 25°F, but not exceeding 50°F.

4.7.3.1.1.2. **Severe.** Any areas that have a temperature differential greater than 50°F.

4.7.3.1.2. **Thermal Imaging System.** Review the output results when a thermal imaging system is used, and provide the automated report described in [Tex-244-F](#) to the Engineer daily, unless otherwise directed. Modify the paving process as necessary to eliminate any recurring (moderate or severe) thermal segregation identified by the thermal imaging system.

The Engineer may suspend paving operations if the Contractor cannot successfully modify the paving process to eliminate recurring severe thermal segregation. Density profiles are not required and not applicable when using a thermal imaging system.

Provide the Engineer with electronic copies of all daily data files that can be used with the thermal imaging system software to generate temperature profile plots daily or as requested.

4.7.3.1.3. **Thermal Camera.** Provide the Engineer with the thermal profile of every subplot within 1 working day of the completion of each lot. When requested by the Engineer, provide the thermal images generated using the thermal camera. Report the results of each thermal profile in accordance with Section 341.4.2., "Reporting and Responsibilities." The Engineer will use a handheld thermal camera to obtain a thermal profile at least once per project.

Take immediate corrective action to eliminate recurring moderate thermal segregation when a handheld thermal camera is used.

Suspend operations and take immediate corrective action to eliminate severe thermal segregation unless otherwise directed. Resume operations when the Engineer determines that subsequent production will meet the requirements of this Section. No production or placement payment adjustments greater than 1.000 will be paid for any subplot that contains severe thermal segregation. Evaluate areas with severe thermal segregation by performing density profiles in accordance with Section 341.4.9.3.3.3., "Segregation (Density Profile)." Remove and replace the material in any areas that have severe thermal segregation and a failing result for segregation (density profile), unless otherwise directed. The subplot in question may receive a production and placement payment adjustment greater than 1.000, if applicable, when the defective material is successfully removed and replaced.

- 4.7.3.2. **Windrow Operations.** Operate windrow pickup equipment so that when hot mix is placed in windrows, substantially all the mixture deposited on the roadbed is picked up and loaded into the paver.
- 4.7.3.3. **Hauling Equipment.** Use belly dump, live-bottom, or end dump trucks to haul and transfer mixture. Except for paving miscellaneous areas, end dump trucks are allowed only when used in conjunction with an MTD with remixing capability or when a thermal imaging system is used, unless otherwise approved.
- 4.7.3.4. **Screed Heaters.** Turn off screed heaters to prevent overheating of the mat if the paver stops for more than 5 min. The Engineer may evaluate the suspect area in accordance with Section 341.4.9.3.3.5., "Recovered Asphalt Dynamic Shear Rheometer (DSR)," if the screed heater remains on for more than 5 min. while the paver is stopped.
- 4.8. **Compaction.** Compact the pavement uniformly to contain between 3.8% and 8.5% in-place air voids. Take immediate corrective action to bring the operation within 3.8% and 8.5% when the in-place air voids exceed the range of these tolerances. The Engineer will allow paving to resume when the proposed corrective action is likely to yield between 3.8% and 8.5% in-place air voids.
- Obtain cores in areas placed under exempt production, as directed, at locations determined by the Engineer. The Engineer may test these cores and suspend operations or require removal and replacement if the in-place air voids are less than 2.7% or more than 9.9%. Areas defined in Section 341.4.9.3.1.4., "Miscellaneous Areas," are not subject to in-place air void determination.
- Furnish the type, size, and number of rollers necessary to ensure desired compaction. Use additional rollers as required to remove any roller marks. Use only water or an approved release agent on rollers, tamps, and other compaction equipment unless otherwise directed.
- Use the control strip method shown in [Tex-207-E](#), Part IV, on the first day of production to establish the rolling pattern that will produce the desired in-place air voids, unless otherwise directed.
- Use tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not allow thorough compaction using rollers. The Engineer may require rolling using a trench roller on widened areas, in trenches, and in other limited areas.
- Complete all compaction operations using breakdown rollers before the pavement temperature drops below 180°F, unless otherwise allowed. Compaction using a pneumatic or light finish roller operated in static mode is allowed for pavement temperatures above 160°F.
- Allow the compacted pavement to cool to 160°F or lower before opening to traffic, unless otherwise directed. Sprinkle the finished mat with water or limewater, when directed, to expedite opening the roadway to traffic.
- 4.9. **Acceptance Plan.** Payment adjustments for the material will be in accordance with Article 341.6., "Payment."
- Sample and test the hot mix on a lot and subplot basis. Suspend production if the production payment factor shown in Section 341.6.1., "Production Payment Adjustment Factors," or the placement payment factor shown in Section 341.6.2., "Placement Payment Adjustment Factors," for two consecutive lots is below 1.000. Resume production once test results or other information indicates to the satisfaction of the Engineer that the next material produced or placed will result in payment factors of at least 1.000.
- 4.9.1. **Referee Testing.** The Materials and Tests Division is the referee laboratory. The Contractor may request referee testing if a "remove and replace" condition is determined based on the Engineer's test results, or if the differences between Contractor and Engineer test results exceed the maximum allowable difference in accordance with Table 11 and the differences cannot be resolved. The Contractor may also request referee testing if the Engineer's test results require suspension of production and the Contractor's test results are within specification limits. Make the request within 5 working days after receiving test results and cores from the Engineer. Referee tests will be performed only on the subplot in question and only for the tests in question. Allow 10 working days from the time the referee laboratory receives the samples for test results to be

reported. The Department may require the Contractor to reimburse the Department for referee tests if more than three referee tests per project are required and the Engineer's test results are closer to the referee test results than the Contractor's test results.

The Materials and Tests Division will determine the laboratory-molded density based on the molded specific gravity and the maximum theoretical specific gravity of the referee sample. The in-place air voids will be determined based on the bulk specific gravity of the cores, as determined by the referee laboratory, and the Engineer's average maximum theoretical specific gravity for the lot. Except for "remove and replace" conditions, referee test results are final and will establish payment adjustment factors for the subplot in question. The Contractor may decline referee testing and accept the Engineer's test results when the placement payment adjustment factor for any subplot results in a "remove and replace" condition. Placement sublots subject to be removed and replaced will be further evaluated in accordance with Section 341.6.2.2., "Placement Sublots Subject to Removal and Replacement."

4.9.2. **Production Acceptance.**

4.9.2.1. **Production Lot.** A production lot consists of four equal sublots. The default quantity for Lot 1 is 1,000 ton; however, when requested by the Contractor, the Engineer may increase the quantity for Lot 1 to no more than 4,000 ton. The Engineer will select subsequent lot sizes based on the anticipated daily production such that approximately three-four sublots are produced each day. The lot size will be between 1,000 ton and 4,000 ton. The Engineer may change the lot size before the Contractor begins any lot.

If the optimum asphalt binder content for JMF2 is more than 0.5% lower than the optimum asphalt binder content for JMF1, the Engineer may perform or require the Contractor to perform [Tex-226-F](#) on Lot 1 to confirm the indirect tensile strength does not exceed 200 psi. Take corrective action to bring the mixture within specification compliance if the indirect tensile strength exceeds 200 psi, unless otherwise directed.

4.9.2.1.1. **Incomplete Production Lots.** If a lot is begun but cannot be completed, such as on the last day of production or in other circumstances deemed appropriate, the Engineer may close the lot. Adjust the payment for the incomplete lot in accordance with Section 341.6.1., "Production Payment Adjustment Factors." Close all lots within 5 working days unless otherwise allowed.

4.9.2.2. **Production Sampling.**

4.9.2.2.1. **Mixture Sampling.** The Engineer will perform or witness the sampling of production sublots from trucks at the plant in accordance with [Tex-222-F](#). The sampler will split each sample into three equal portions in accordance with [Tex-200-F](#) and label these portions as "Contractor," "Engineer," and "Referee." The Engineer will perform or witness the sample splitting and take immediate possession of the samples labeled "Engineer" and "Referee." The Engineer will maintain the custody of the samples labeled "Engineer" and "Referee" until the Department's testing is completed.

4.9.2.2.1.1. **Random Sample.** At the beginning of the project, the Engineer will select random numbers for all production sublots. Determine sample locations in accordance with [Tex-225-F](#). Take one sample for each subplot at the randomly selected location. The Engineer will perform or witness the sampling of production sublots.

4.9.2.2.1.2. **Blind Sample.** For one subplot per lot, the Engineer will sample, split, and test a "blind" production sample instead of the random sample collected by the Contractor. The location of the Engineer's "blind" sample will not be disclosed to the Contractor before sampling. The Engineer's "blind" sample may be randomly selected in accordance with [Tex-225-F](#) for any subplot or selected at the discretion of the Engineer. The Engineer may sample and test an additional blind sample when the random sampling process does not result in obtaining a sample.

For one subplot per lot, the Contractor must obtain from the Engineer a "blind" production sample collected by the Engineer. If desired, the Contractor may witness the collection of blind samples. Test either the "blind" or the random sample; however, referee testing for the subplot (if applicable) will be based on a comparison of results from the "blind" sample.

- 4.9.2.2.2. **Asphalt Binder Sampling.** The Engineer will witness the Contractor obtain a 1-qt. sample of the asphalt binder for each lot of mixture produced. The Contractor will notify the Engineer when the sampling will occur. Obtain the sample at approximately the same time the mixture random sample is obtained. Sample from a port located immediately upstream from the mixing drum or pug mill and upstream from the introduction of any additives in accordance with [Tex-500-C](#), Part II. Label the can with the corresponding lot and subplot numbers, producer name, producer facility, grade, District, date sampled, all applicable bills of lading (if available), and project information, including highway and CSJ number. The Engineer will retain these samples for 1 yr. The Engineer may also obtain independent samples. If obtaining an independent asphalt binder sample and upon request of the Contractor, the Engineer will split a sample of the asphalt binder with the Contractor.

At least once per project, the Engineer will collect split samples of each binder grade and source used. The Engineer will submit one split sample to the Materials and Tests Division to verify compliance with Item 300, and will retain the other split sample for 1 yr.

- 4.9.2.3. **Production Testing.** The Contractor and Engineer must perform production tests shown in Table 16. The Contractor has the option to verify the Engineer's test results on split samples provided by the Engineer. Determine compliance with operational tolerances shown in Table 11 for all sublots.

Take immediate corrective action if the Engineer's laboratory-molded density on any subplot is less than 95.0% or greater than 97.0% to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor's corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

The Engineer may allow alternate methods for determining the asphalt binder content and aggregate gradation if the aggregate mineralogy is such that [Tex-236-F](#), Part I does not yield reliable results. Provide evidence that results from [Tex-236-F](#), Part I are not reliable before requesting permission to use an alternate method unless otherwise directed. Use the applicable test procedure as directed if an alternate test method is allowed.

Table 16
Production and Placement Testing Frequency

Description	Test Method	Min Contractor Testing Frequency	Min Engineer Testing Frequency
Individual % retained on #8 sieve and larger	Tex-200-F or Tex-236-F	1 per subplot	1 per 12 sublots ¹
Individual % retained on sieves smaller than #8 and larger than #200			
% passing #200 sieve			
Laboratory-molded density	Tex-207-F	–	1 per subplot ¹
Laboratory-molded bulk specific gravity			
In-place air voids			
VMA	Tex-204-F		
Segregation (density profile)	Tex-207-F , Part V	1 per subplot ²	1 per project
Longitudinal joint density	Tex-207-F , Part VII	1 per subplot ³	1 per project
Moisture content	Tex-212-F , Part II	When directed	1 per project
Theoretical maximum specific (Rice) gravity	Tex-227-F	–	1 per subplot ¹
Asphalt binder content	Tex-236-F	1 per subplot	1 per lot ¹
Thermal profile	Tex-244-F	1 per subplot ²	1 per project
Hamburg wheel test	Tex-242-F	–	
Deleterious in RAS ⁴	Tex-217-F , Part III	–	
Asphalt binder sampling and testing ^{4,5}	Tex-500-C , Part II	–	
Tack coat sampling and testing	Tex-500-C , Part III	–	
Boil test ⁶	Tex-530-C	1 per lot	
Shear bond strength test ⁷	Tex-249-F	–	

- For production defined in Section 341.4.9.4., “Exempt Production,” the Engineer will perform one test per day if 100 ton or more is produced. For exempt production, no testing is required when < 100 ton is produced.
- To be performed in the presence of the Engineer when not using the thermal imaging system, unless otherwise approved.
- To be performed in the presence of the Engineer.
- Testing performed by the Materials and Tests Division or designated laboratory.
- Sampling performed by the Contractor. The Engineer will witness sampling and retain the samples for 1 yr.
- When shown on the plans.
- Testing performed by the Materials and Tests Division or District for informational purposes on a sample obtained by the Contractor within the first four lots of the project.

4.9.2.4. **Operational Tolerances.** Control the production process within the operational tolerances shown in Table 11. When production is suspended, the Engineer will allow production to resume when test results or other information indicates the next mixture produced will be within the operational tolerances.

4.9.2.4.1. **Gradation.** Suspend operation and take corrective action if any aggregate is retained on the maximum sieve size shown in Table 8. A subplot is defined as out of tolerance if either the Engineer's or the Contractor's test results are out of operational tolerance. Suspend production when test results for gradation exceed the operational tolerances shown in Table 11 for three consecutive sublots on the same sieve or four consecutive sublots on any sieve, unless otherwise directed. The consecutive sublots may be from more than one lot.

4.9.2.4.2. **Asphalt Binder Content.** A subplot is defined as out of operational tolerance if either the Engineer's or the Contractor's test results exceed the values shown in Table 11. No production or placement payment adjustments greater than 1.000 will be paid for any subplot that is out of operational tolerance for asphalt binder content. Suspend production and shipment of the mixture if the Engineer's or the Contractor's asphalt binder content deviates from the current JMF by more than 0.5% for any subplot.

4.9.2.4.3. **VMAs.** The Engineer will determine the VMA for every subplot. For sublots when the Engineer does not determine asphalt binder content, the Engineer will use the asphalt binder content results from QC testing performed by the Contractor to determine VMA.

Take immediate corrective action if the VMA value for any subplot is less than the minimum VMA requirement for production shown in Table 8. Suspend production and shipment of the mixture if the Engineer's VMA

results on two consecutive sublots are below the minimum VMA requirement for production shown in Table 8. No production or placement payment adjustments greater than 1.000 will be paid for any subplot that does not meet the minimum VMA requirement for production shown in Table 8 based on the Engineer's VMA determination.

Suspend production and shipment of the mixture if the Engineer's VMA result is more than 0.5% below the minimum VMA requirement for production shown in Table 8. In addition to suspending production, the Engineer may require removal and replacement or may allow the subplot to be left in place without payment.

- 4.9.2.4.4. **Hamburg Wheel Test.** The Engineer may perform a Hamburg wheel test on plant-produced mixture anytime during production. Suspend production until further Hamburg wheel tests meet the specified values when the production samples fail the Hamburg wheel test criteria shown in Table 10. The Engineer may require up to the entire subplot of any mixture failing the Hamburg wheel test to be removed and replaced at the Contractor's expense.

If the Department-approved laboratory's Hamburg wheel test on plant-produced mixture results in a "remove and replace" condition, the Contractor may request that the Materials and Tests Division determine the final disposition of the material in question by re-testing the failing material.

- 4.9.2.5. **Individual Loads of Hot Mix.** The Engineer may reject individual truckloads of hot mix. When a load of hot mix is rejected for reasons other than temperature, contamination, or excessive uncoated particles, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances shown in Table 11, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load.

- 4.9.3. **Placement Acceptance.**

- 4.9.3.1. **Placement Lot.** A placement lot consists of four placement sublots. A placement subplot consists of the area placed during a production subplot.

- 4.9.3.1.1. **Lot 1 Placement.** Placement payment adjustments greater than 1.000 for Lot 1 will be in accordance with Section 341.6.2., "Placement Payment Adjustment Factors"; however, no placement adjustment less than 1.000 will be assessed for any subplot placed in Lot 1 when the in-place air voids are greater than or equal to 2.7% and less than or equal to 9.9%. Remove and replace any subplot with in-place air voids less than 2.7% or greater than 9.9%.

- 4.9.3.1.2. **Incomplete Placement Lots.** An incomplete placement lot consists of the area placed as described in Section 341.4.9.2.1.1., "Incomplete Production Lots," excluding areas defined in Section 341.4.9.3.1.4., "Miscellaneous Areas." Placement sampling is required if the random sample plan for production resulted in a sample being obtained from an incomplete production subplot.

- 4.9.3.1.3. **Shoulders, Ramps, Etc.** Shoulders, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are subject to in-place air void determination and payment adjustments unless shown on the plans as not eligible for in-place air void determination. Intersections may be considered miscellaneous areas when determined by the Engineer.

- 4.9.3.1.4. **Miscellaneous Areas.** Miscellaneous areas include areas that typically involve significant handwork or discontinuous paving operations, such as temporary detours, driveways, mailbox turnouts, crossovers, gores, spot level-up areas, pavement repair sections less than 300 ft., and other similar areas. Temporary detours are subject to in-place air void determination when shown on the plans. Miscellaneous areas also include level-ups and thin overlays when the layer thickness shown on the plans is less than the minimum untrimmed core height eligible for testing in accordance with Table 13. The specified layer thickness is based on the rate of 110 lb. per square yard for each inch of pavement unless another rate is shown on the plans. When "Level Up" is listed as part of the bid item description, a payment adjustment factor of 1.000 will be assigned for all placement sublots as described in Article 341.6., "Payment." Miscellaneous areas are not eligible for random placement sampling locations. Compact miscellaneous areas in accordance with

Section 341.4.8., "Compaction." Miscellaneous areas are not subject to in-place air void determination, thermal profiles testing, segregation (density profiles), or longitudinal joint density evaluations.

- 4.9.3.2. **Placement Sampling.** The Engineer will select random numbers for all placement sublots at the beginning of the project. The Engineer will provide the Contractor with the placement random numbers only immediately after the subplot is completed. Mark the roadway location at the completion of each subplot and record the station number. Determine one random sample location for each placement subplot in accordance with [Tex-225-F](#). Adjust the random sample location by no more than necessary to achieve a 2-ft. clearance if the location is within 2 ft. of a joint or pavement edge.

Shoulders, ramps, intersections, acceleration lanes, deceleration lanes, and turn lanes are always eligible for selection as a random sample location; however, if a random sample location falls on one of these areas and the area is shown on the plans as not subject to in-place air void determination, cores will not be taken for the subplot and a 1.000 pay factor will be assigned to that subplot.

Provide the equipment and means to obtain and trim roadway cores onsite. Onsite is defined as in close proximity to where the cores are taken. Obtain the cores within 1 working day of the time the placement subplot is completed, unless otherwise approved. Obtain two 6-in. diameter cores side-by-side from within 1 ft. of the random location provided for the placement subplot. Mark the cores for identification, measure and record the untrimmed core height, and provide the information to the Engineer. The Engineer will witness the coring operation and measurement of the core thickness. Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. Take corrective action if an adequate bond does not exist between the current and underlying layer to ensure that an adequate bond will be achieved during subsequent placement operations.

Trim the cores immediately after obtaining them from the roadway in accordance with [Tex-251-F](#) if the core heights meet the minimum untrimmed value in accordance with Table 13. Trim the cores onsite in the presence of the Engineer. Use a permanent marker or paint pen to record the lot and subplot numbers on each core, as well as the designation as Core A or Core B. The Engineer may require additional information to be marked on the core and may choose to sign or initial the core. The Engineer will take custody of the cores immediately after witnessing the trimming of the cores and will retain custody of the cores until the Department's testing is completed. Before turning the trimmed cores over to the Engineer, the Contractor may wrap the trimmed cores or secure them in a manner that will reduce the risk of possible damage occurring during transport by the Engineer. After testing, the Engineer will return the cores to the Contractor.

The Engineer may have the cores transported back to the Department's laboratory at the HMA plant via the Contractor's haul truck or other designated vehicle. In such cases where the cores will be out of the Engineer's possession during transport, the Engineer will use Department-provided security bags and the Protocol for Roadway Core Custody located on the Department's website to provide a secure means and process that protect the integrity of the cores during transport.

Decide whether to include the pair of cores in the air void determination for that subplot if the core height before trimming is less than the minimum untrimmed value shown in Table 13. Trim the cores in accordance with [Tex-251-F](#) before delivering to the Engineer if electing to have the cores included in the air void determination. If electing to not have the cores included in air void determination, inform the Engineer of the decision, and deliver untrimmed cores to the Engineer. The placement pay factor for the subplot will be 1.000 if cores will not be included in air void determination.

Instead of the Contractor trimming the cores onsite immediately after coring, the Engineer and the Contractor may mutually agree to have the trimming operations performed at an alternate location, such as a field laboratory or other similar location. In such cases, the Engineer will take possession of the cores immediately after they are obtained from the roadway and will retain custody of the cores until testing is completed. Either the Department or Contractor representative may perform trimming of the cores. The Engineer will witness all trimming operations in cases where the Contractor representative performs the trimming operation.

Dry the core holes and tack the sides and bottom immediately after obtaining the cores. Fill the hole with the same type of mixture and properly compact the mixture. Repair core holes using other methods when approved.

- 4.9.3.3. **Placement Testing.** Perform placement tests in accordance with Table 16. After the Engineer returns the cores, the Contractor may test the cores to verify the Engineer's test results for in-place air voids. The allowable differences between the Contractor's and Engineer's test results are shown in Table 11.

- 4.9.3.3.1. **In-Place Air Voids.** The Engineer will measure in-place air voids in accordance with [Tex-207-F](#) and [Tex-227-F](#). Before drying to a constant weight, cores may be pre-dried using a CoreDry or similar vacuum device to remove excess moisture. The Engineer will average the values obtained for all sublots in the production lot to determine the theoretical maximum specific gravity. The Engineer will use the average air void content for in-place air voids.

The Engineer will use the vacuum method to seal the core if required in accordance with [Tex-207-F](#). The Engineer will use the test results from the unsealed core to determine the placement payment adjustment factor if the sealed core yields a higher specific gravity than the unsealed core. After determining the in-place air void content, the Engineer will return the cores and provide test results to the Contractor.

- 4.9.3.3.2. **Informational Shear Bond Strength Testing.** The Engineer will select one random subplot within the first four lots of the project for shear bond strength testing. Obtain full-depth cores in accordance with [Tex-249-F](#) unless the HMA is being placed directly on concrete pavement. Label the cores with lot and subplot numbers and provide to the Engineer. Inspector must use pertinent Department form to document the CSJ number, producer of the tack coat, mix type, and shot rate. The Engineer will ship the cores to the Materials and Tests Division or District laboratory for shear bond strength testing. Results from these tests will not be used for specification compliance.

- 4.9.3.3.3. **Segregation (Density Profile).** Test for segregation using density profiles in accordance with [Tex-207-F](#), Part V. Density profiles are not required and are not applicable when using a thermal imaging system. Density profiles are not applicable in areas described in Section 341.4.9.3.1.4., "Miscellaneous Areas."

Perform at least one density profile per subplot. Perform additional density profiles when any of the following conditions occur, unless otherwise approved:

- areas that are identified by either the Contractor or the Engineer with severe thermal segregation,
- any visibly segregated areas that exist,
- the paver stops due to lack of material being delivered to the paving operations and the temperature of the uncompacted mat before the initial breakdown rolling is less than the temperatures shown in Table 17.

Table 17
Min Uncompacted Mat Temperature Requiring Segregation Profile¹

High-Temperature Binder Grade²	Min Temperature of Uncompacted Mat Allowed Before Initial Breakdown Rolling^{3,4,5} (°F)
PG 64	<250
PG 70	<260
PG 76	<270

1. Applicable only to paver stops that occur due to lack of material being delivered to the paving operations and when not using a thermal imaging system.
2. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.
3. The surface of the uncompacted mat must be measured using a handheld thermal camera or infrared thermometer.
4. Min uncompacted mat temperature requiring a segregation profile may be reduced 20°F if using a chemical WMA additive as a compaction aid, MTD with remixing capabilities, or paver hopper insert with remixing capabilities.
5. When using WMA, the Min uncompacted mat temperature requiring a segregation profile is 215°F.

Provide the Engineer with the density profile of every subplot in the lot within 1 working day of the completion of each lot. Report the results of each density profile in accordance with Section 341.4.2., "Reporting and Responsibilities."

The density profile is considered failing if it exceeds the tolerances shown in Table 18. When a thermal imaging system is not used, the Engineer will measure the density profile at least once per project. The Engineer's density profile results will be used when available. The Engineer may require the Contractor to remove and replace the area in question if the area fails the density profile and has surface irregularities as defined in Section 341.4.9.3.3.6., "Irregularities." The subplot in question may receive a production and placement payment adjustment greater than 1.000, if applicable, when the defective material is successfully removed and replaced.

Investigate density profile failures and take corrective actions during production and placement to eliminate the segregation. Suspend production if two consecutive density profiles fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

Table 18
Segregation (Density Profile) Acceptance Criteria

Mixture Type	Max Allowable Density Range (highest to lowest, pcf)	Max Allowable Density Range (average to lowest, pcf)
DG-B	8.0	5.0
DG-C, DG-D, and DG-F	6.0	3.0

4.9.3.3.4. **Longitudinal Joint Density.**

4.9.3.3.4.1. **Informational Tests.** Perform joint density evaluations while establishing the rolling pattern and verify that the joint density is no more than 3.0 pcf below the density taken at or near the center of the mat. Adjust the rolling pattern, if needed, to achieve the desired joint density. Perform additional joint density evaluations, at least once per subplot, unless otherwise directed.

4.9.3.3.4.2. **Record Tests.** Perform a joint density evaluation for each subplot at each pavement edge that is or will become a longitudinal joint. Joint density evaluations are not applicable in areas described in Section 341.4.9.3.1.4., "Miscellaneous Areas." Determine the joint density in accordance with [Tex-207-F](#), Part VII. Record the joint density information and submit results on Department forms to the Engineer. The evaluation is considered failing if the joint density is more than 3.0 pcf below the density taken at the core random sample location and the correlated joint density is less than 90.0%. The Engineer will make independent joint density verification at least once per project and may make independent joint density

verifications at the random sample locations. The Engineer's joint density test results will be used when available.

Provide the Engineer with the joint density of every subplot in the lot within 1 working day of the completion of each lot. Report the results of each joint density in accordance with Section 341.4.2., "Reporting and Responsibilities."

Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if the evaluations on two consecutive sublots fail, unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

- 4.9.3.3.5. **Recovered Asphalt Dynamic Shear Rheometer (DSR).** The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Materials and Tests Division. The aging ratio is the DSR value of the extracted binder divided by the DSR value of the original unaged binder. Obtain DSR values in accordance with AASHTO T 315 at the specified high-temperature PG of the asphalt. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores in accordance with [Tex-211-F](#).

- 4.9.3.3.6. **Irregularities.** Identify and correct irregularities, including segregation, rutting, raveling, flushing, fat spots, mat slippage, irregular color, irregular texture, roller marks, gouges, streaks, uncoated aggregate particles, or broken aggregate particles. The Engineer may also identify irregularities, and in such cases, the Engineer will promptly notify the Contractor. If the Engineer determines that the irregularity will adversely affect pavement performance, the Engineer may require the Contractor to remove and replace (at the Contractor's expense) areas of the pavement that contain irregularities. The Engineer may also require the Contractor to remove and replace (at the Contractor's expense) areas where the mixture does not bond to the existing pavement.

If irregularities are detected, the Engineer may require the Contractor to immediately suspend operations or may allow the Contractor to continue operations for no more than 1 day while the Contractor is taking appropriate corrective action.

- 4.9.4. **Exempt Production.** The mixture may be deemed as exempt production when mutually agreed upon between the Engineer and the Contractor, or when shown on the plans. Exempt production may be used for the following conditions.
- Anticipated daily production is less than 500 ton.
 - Total production for the project is less than 5,000 ton.
 - Pavement repair sections are equal to or greater than 300 ft. For pavement repair sections less than 300 ft., refer to Section 341.4.9.3.1.4., "Miscellaneous Areas."

Exempt production is not eligible for referee testing. For exempt production, the Contractor is relieved of all production and placement QC and QA sampling and testing requirements, except for coring operations when required by the Engineer. When mutually agreed upon between the Engineer and the Contractor, production sampling will be allowed at the point of delivery. When 100 ton or more per day is produced, the Engineer must perform acceptance tests for production and placement in accordance with Table 16. If the specification requirements listed below are met, the production and placement pay factors are 1.000:

- produce, haul, place, and compact the mixture in compliance with the specification and as directed;
- control mixture production to yield a laboratory-molded density that is within $\pm 1.0\%$ of the target laboratory-molded density as tested by the Engineer;
- compact the mixture in accordance with Section 341.4.8., "Compaction;"
- when a thermal imaging system is not used, the Engineer may perform segregation (density profiles) and thermal profiles in accordance with the specification; and
- all other specification requirements.

- 4.9.5. **Ride Quality.** Measure ride quality in accordance with Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

5. MEASUREMENT

- 5.1. **Dense-Graded HMA.** Hot mix will be measured by the ton of composite hot mix, which includes asphalt, aggregate, and additives. Measure the weight on scales in accordance with Item 520, "Weighing and Measuring Equipment."
- 5.2. **Tack Coat.** Tack coat will be measured at the applied temperature by strapping the tank before and after road application and determining the net volume in gallons from the calibrated distributor. The Engineer will witness all strapping operations for volume determination. All tack, including emulsions, will be measured by the gallon applied.

The Engineer may allow the use of a metering device to determine asphalt volume used and application rate if the device is accurate within 1.5% of the strapped volume.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under Section 341.5.1., "Dense-Graded HMA," will be paid for at the unit price bid for "Dense-Graded Hot-Mix Asphalt" of the mixture type, SAC, and binder specified. These prices are full compensation for surface preparation, materials, placement, equipment, labor, tools, and incidentals.

The work performed and materials furnished in accordance with this Item and measured as provided under Section 341.5.2., "Tack Coat," will be paid for at the unit price bid for "Tack Coat" of the tack coat provided. These prices are full compensation for materials, placement, equipment, labor, tools, and incidentals. Payment adjustments will be applied as determined in accordance with this Item; however, a payment adjustment factor of 1.000 will be assigned for all placement sublots for level-ups only when "Level Up" is listed as part of the bid item description. A payment adjustment factor of 1.000 will be assigned to all production and placement sublots when "Exempt" is listed as part of the bid item description, and all testing requirements are met.

Payment for each subplot, including applicable payment adjustments greater than 1.000, will be paid only for sublots when the Contractor supplies the Engineer with the required documentation for production and placement QC and QA, thermal profiles, segregation density profiles, and longitudinal joint densities in accordance with Section 341.4.2., "Reporting and Responsibilities." When a thermal imaging system is used, documentation is not required for segregation density profiles on individual sublots; however, the thermal imaging system automated reports described in [Tex-244-F](#) are required.

Trial batches will not be paid for unless they are included in pavement work approved by the Department.

Payment adjustment for ride quality will be determined in accordance with Item 585.

- 6.1. **Production Payment Adjustment Factors.** The production payment adjustment factor is based on the laboratory-molded density using the Engineer's test results. The bulk specific gravities of the samples from each subplot will be divided by the Engineer's maximum theoretical specific gravity for the subplot. The individual sample densities for the subplot will be averaged to determine the production payment adjustment factor in accordance with Table 19 for each subplot, using the deviation from the target laboratory-molded density in accordance with Table 9. The production payment adjustment factor for completed lots will be the average of the payment adjustment factors for the four sublots sampled within that lot.

Table 19
Production Payment Adjustment Factors for Laboratory-Molded Density¹

Absolute Deviation from Target Laboratory-Molded Density	Production Payment Adjustment Factor (Target Laboratory-Molded Density)
0.0	1.050
0.1	1.050
0.2	1.050
0.3	1.044
0.4	1.038
0.5	1.031
0.6	1.025
0.7	1.019
0.8	1.013
0.9	1.006
1.0	1.000
1.1	0.965
1.2	0.930
1.3	0.895
1.4	0.860
1.5	0.825
1.6	0.790
1.7	0.755
1.8	0.720
>1.8	Remove and replace

1. If the Engineer's laboratory-molded density on any subplot is <95.0% or >97.0%, take immediate corrective action to bring the mixture within these tolerances. The Engineer may suspend operations if the Contractor's corrective actions do not produce acceptable results. The Engineer will allow production to resume when the proposed corrective action is likely to yield acceptable results.

- 6.1.1. **Payment for Incomplete Production Lots.** Production payment adjustments for incomplete lots, described under Section 341.4.9.2.1.1., "Incomplete Production Lots," will be calculated using the average production payment factors from all sublots sampled.

A production payment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any samples within the first subplot.

- 6.1.2. **Production Sublots Subject to Removal and Replacement.** If after referee testing the laboratory-molded density for any subplot results in a "remove and replace" condition as shown in Table 19, the Engineer may require removal and replacement or may allow the subplot to be left in place without payment. The Engineer may also accept the subplot in accordance with Section 5.3.1., "Acceptance of Defective or Unauthorized Work." Replacement material meeting the requirements of this Item will be paid for in accordance with this Section.

- 6.2. **Placement Payment Adjustment Factors.** The placement payment adjustment factor is based on in-place air voids using the Engineer's test results. The bulk specific gravities of the cores from each subplot will be divided by the Engineer's average maximum theoretical specific gravity for the lot. The individual core densities for the subplot will be averaged to determine the placement payment adjustment factor in accordance with Table 20 for each subplot that requires in-place air void measurement. A placement payment adjustment factor of 1.000 will be assigned to the entire subplot when the random sample location falls in an area shown on the plans as not subject to in-place air void determination. A placement payment adjustment factor of 1.000 will be assigned to quantities placed in areas described in Section 341.4.9.3.1.4., "Miscellaneous Areas." The placement payment adjustment factor for completed lots will be the average of the placement payment adjustment factors for up to four sublots within that lot.

Table 20
Placement Payment Adjustment Factors for In-Place Air Voids

In-Place Air Voids	Placement Pay Adjustment Factor	In-Place Air Voids	Placement Payment Adjustment Factor
<2.7	Remove and replace	6.4	1.042
2.7	0.710	6.5	1.040
2.8	0.740	6.6	1.038
2.9	0.770	6.7	1.036
3.0	0.800	6.8	1.034
3.1	0.830	6.9	1.032
3.2	0.860	7.0	1.030
3.3	0.890	7.1	1.028
3.4	0.920	7.2	1.026
3.5	0.950	7.3	1.024
3.6	0.980	7.4	1.022
3.7	0.998	7.5	1.020
3.8	1.002	7.6	1.018
3.9	1.006	7.7	1.016
4.0	1.010	7.8	1.014
4.1	1.014	7.9	1.012
4.2	1.018	8.0	1.010
4.3	1.022	8.1	1.008
4.4	1.026	8.2	1.006
4.5	1.030	8.3	1.004
4.6	1.034	8.4	1.002
4.7	1.038	8.5	1.000
4.8	1.042	8.6	0.998
4.9	1.046	8.7	0.996
5.0	1.050	8.8	0.994
5.1	1.050	8.9	0.992
5.2	1.050	9.0	0.990
5.3	1.050	9.1	0.960
5.4	1.050	9.2	0.930
5.5	1.050	9.3	0.900
5.6	1.050	9.4	0.870
5.7	1.050	9.5	0.840
5.8	1.050	9.6	0.810
5.9	1.050	9.7	0.780
6.0	1.050	9.8	0.750
6.1	1.048	9.9	0.720
6.2	1.046	>9.9	Remove and replace
6.3	1.044	—	—

- 6.2.1. **Payment for Incomplete Placement Lots.** Payment adjustments for incomplete placement lots described under Section 341.4.9.3.1.2., “Incomplete Placement Lots,” will be calculated using the average of the placement payment factors from all sublots sampled and sublots where the random location falls in an area shown on the plans as not eligible for in-place air void determination.

If the random sampling plan results in production samples, but not in placement samples, the random core location and placement adjustment factor for the subplot will be determined by applying the placement random number to the length of the subplot placed.

If the random sampling plan results in placement samples, but not in production samples, no placement adjustment factor will apply for that subplot placed.

A placement payment adjustment factor of 1.000 will be assigned to any lot when the random sampling plan did not result in collection of any production samples.

- 6.2.2. **Placement Sublots Subject to Removal and Replacement.** If after referee testing the placement payment adjustment factor for any subplot results in a “remove and replace” condition as shown in Table 20, the

Engineer will choose the location of two cores to be taken within 3 ft. of the original failing core location. The Contractor must obtain the cores in the presence of the Engineer. The Engineer will take immediate possession of the untrimmed cores and submit the untrimmed cores to the Materials and Tests Division, where they will be trimmed, if necessary, and tested for bulk specific gravity within 10 working days of receipt.

The bulk specific gravity of each core from each subplot will be divided by the Engineer's average maximum theoretical specific gravity for the lot. The individual core densities for the subplot will be averaged to determine the new payment adjustment factor of the subplot in question. If the new payment adjustment factor is 0.720 or greater, the new payment adjustment factor will apply to that subplot. If the new payment adjustment factor is less than 0.720, no payment will be made for the subplot. Remove and replace the failing subplot, or the Engineer may allow the subplot to be left in place without payment. The Engineer may also accept the subplot in accordance with Section 5.3.1., "Acceptance of Defective or Unauthorized Work." Replacement material meeting the requirements of this Item will be paid for in accordance with this Section.

- 6.3. **Total Adjusted Pay (TAP) Calculation.** TAP will be based on the applicable payment adjustment factors for production and placement for each lot.

$$TAP = (A+B)/2$$

where:

$A = \text{Bid price} \times \text{production lot quantity} \times \text{average payment adjustment factor for the production lot}$

$B = \text{Bid price} \times \text{placement lot quantity} \times \text{average payment adjustment factor for the placement lot} + (\text{bid price} \times \text{quantity placed in miscellaneous areas} \times 1.000)$

Production lot quantity = Quantity actually placed - quantity left in place without payment

Placement lot quantity = Quantity actually placed - quantity left in place without payment - quantity placed in miscellaneous areas

Item 354

Planing and Texturing Pavement



1. DESCRIPTION

Plane, or plane and texture, existing asphalt concrete pavement, asphalt-stabilized base, or concrete pavement.

2. EQUIPMENT

The Engineer may require demonstration of the equipment's capabilities.

2.1. **Planing Machine.** Use planing machines that:

- have a minimum 6-ft. cutting width except for work areas less than 6 ft. wide;
- are self-propelled with enough power, traction, and stability to maintain an accurate depth of cut and slope;
- can cut in one continuous operation: 4 in. of asphalt concrete pavement, 1 in. of concrete pavement, or a combination of 2 in. of asphalt concrete pavement and 1/2 in. of concrete pavement;
- use dual longitudinal controls capable of operating on both sides automatically from any longitudinal grade reference, which includes string line, ski, mobile string line, or matching shoe;
- use transverse controls with an automatic system to control cross slope at a given rate;
- use integral loading and reclaiming devices to allow cutting, removal, and discharge of the material into a truck in one operation; and
- include devices to control dust created by the cutting action.

2.2. **Manual System.** Use a manual system that can achieve a uniform depth of cut, flush to all inlets, valve covers, manholes, and other appurtenances within the paved area. Use of a manual system is allowed for areas restricted to self-propelled access and for detail pavement removal.

2.3. **Sweeper.** Use a street sweeper to remove cuttings and debris from the planed or textured pavement unless otherwise approved. Equip the sweeper with a water tank, a dust control spray assembly, both a pick-up and a gutter broom, and a debris hopper.

3. CONSTRUCTION

3.1. **Grade Reference.** Place grade reference points at maximum intervals of 50 ft. in accordance with Item 5, "Control of the Work," when required. Use the control points to set the grade reference. Support the grade reference so the maximum deflection does not exceed 1/16 in. between supports.

3.2. **Planing and Texturing.** Vary the speed of the machine to leave a grid or other pattern type with discontinuous longitudinal reach. Remove the pavement surface for the length, depth, and width shown on the typical section and to the established line and grades. Remove pavement to vertical lines adjacent to curbs, gutters, inlets, manholes, or other obstructions. Do not damage appurtenances or underlying pavement. Provide a planed surface that has a uniform textured appearance and riding surface. Surface should be free of gouges, continuous longitudinal grooves, ridges, oil film, and other imperfections of workmanship. Leave a uniform surface of concrete pavement free of asphalt materials when removing an asphalt concrete pavement overlay.

Provide a minimum texture depth of not less than 0.05 in. when an overlay on the planed pavement is not required. Stop planing operations when surface texture depth is not sufficient. Never damage armor joints and other appurtenances.

Provide a pavement surface that, after planing, has a smooth riding quality and is true to the established line, grade, and cross-section. Provide a pavement surface that does not vary more than 1/8 in. in 10 ft. Evaluate this criterion using a 10-ft. straightedge placed parallel to the centerline of the roadway. Deviations will be measured from the top of the texture. Correct any point in the surface not meeting this requirement.

Sweep pavement and gutter. Leave pavement and curb clean.

- 3.3. **Edge Treatments.** Slope vertical or near vertical longitudinal faces in the pavement surface for areas under traffic in conformance with the requirements on the plans at the end of the day. Taper transverse faces to provide an acceptable ride.

- 3.4. **Salvaged Materials.** The Contractor will retain ownership of planed materials unless otherwise shown on the plans. Stockpile salvaged materials at locations shown on the plans. Prepare the stockpile site by removing vegetation and trash and providing proper drainage. Keep salvaged paving material free of contamination during its removal, transportation, and storage. Place different types or qualities of salvaged asphalt paving material into separate stockpiles. Dispose of unsalvageable material in conformance with applicable federal, state, and local regulations.

4. MEASUREMENT

This Item will be measured by the square yard of surface area for each pavement type, including asphalt concrete pavement and concrete pavement. Measurement will be based on the depth shown for each bid item, within the limits shown on the plans, regardless of the number of passes required. Only one bid item for each pavement type will apply to any one location.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Planing and Texturing Asphalt Concrete Pavement," "Planing and Texturing Concrete Pavement," "Planing Asphalt Concrete Pavement," or "Planing Concrete Pavement" of the depths specified.

The planing of concrete pavement to remove all asphalt concrete pavement in accordance with Article 354.3., "Construction," will be subsidiary to the planing of asphalt concrete pavement of the depth shown on the plans.

This price is full compensation for removing all material to the depth shown; texturing the pavement surface when texturing is shown in the bid item description; loading, hauling, and unloading; stockpiling or disposing of material; sweeping; tapering or sloping longitudinal or transverse joints in accordance with Section 354.3.3., "Edge Treatments"; and equipment, labor, tools, and incidentals. Demonstration work to receive approval for use of equipment will not be paid for unless work is performed in accordance with the Contract and is accepted.

Item 400

Excavation and Backfill for Structures



1. DESCRIPTION

Excavate for placement and construction of structures and backfill structures. Cut and restore pavement.

2. MATERIALS

Use materials that meet the requirements of the following.

- Item 401, "Flowable Backfill"
- Item 421, "Hydraulic Cement Concrete"
- [DMS-4600](#), "Hydraulic Cement"

3. CONSTRUCTION

3.1. Excavation.

- 3.1.1. **General.** Excavate to the lines and grades shown on the plans or as directed. Provide slopes, benching, sheeting, bracing, pumping, and bailing as necessary to maintain the stability and safety of excavations up to 5 ft. deep. Excavation protection for excavations deeper than 5 ft. is governed by Item 402, "Trench Excavation Protection," and Item 403, "Temporary Special Shoring." Use satisfactory excavated material as backfill or as embankment fill in accordance with Item 132, "Embankment." Dispose of material not incorporated into the final project off the right of way in conformance with federal, state, and local regulations.

Keep any topsoil that has been removed separate, and replace it, as nearly as feasible, in its original position when excavating for installation of structures across private property or beyond the limits of the embankment. Restore the area to an acceptable condition.

Excavate drilled shafts in accordance with Item 416, "Drilled Shaft Foundations."

- 3.1.1.1. **Obstructions.** Remove obstructions to the proposed construction, including trees and other vegetation, debris, and structures, over the width of the excavation to a depth of 1 ft. below the bottom of excavation. Remove as required to clear the new structure and plug in an approved manner if abandoned storm drains, sewers, or other drainage systems are encountered. Restore the bottom of the excavation to grade by backfilling after removing obstructions in accordance with this Item. Dispose of surplus materials in conformance with federal, state, and local regulations.

- 3.1.1.2. **Excavation in Streets.** Cut pavement and base to neat lines when structures are installed in streets, highways, or other paved areas. Restore pavement structure after completion of excavation and backfilling.

Maintain and control traffic in accordance with the approved traffic control plan and the TMUTCD.

- 3.1.1.3. **Utilities.** Comply with the requirements of Article 7.15., "Responsibility for Damage Claims." Conduct work with minimum disturbance of existing utilities, and coordinate work in or near utilities with the utility owners. Inform utility owners before work begins, allowing them enough time to identify, locate, reroute, or make other adjustments to utility lines.

Avoid cutting or damaging underground utility lines that are to remain in place. Promptly notify the utility company if damage occurs. Provide temporary flumes across the excavation while open if an active sanitary

sewer line is damaged during excavation and restore the lines when backfilling has progressed to the original bedding lines of the cut sewer.

- 3.1.1.4. **De-Watering.** Construct or place structures in the presence of water only if approved. Place precast members, pipe, and concrete only on a dry, firm surface. Remove water by bailing, pumping, well point installation, deep wells, underdrains, or other approved method.

Remove standing water in a manner that does not allow water movement through or alongside concrete being placed if structures are approved for placement in the presence of water. Pump or bail only from a suitable sump separated from the concrete work while placing structural concrete or for a period of at least 36 hr. thereafter. Pump or bail during placement of seal concrete only to the extent necessary to maintain a static head of water within the cofferdam. Pump or bail to de-water inside a sealed cofferdam only after the seal has aged at least 36 hr.

Place a stabilizing material in the bottom of the excavation if the bottom cannot be de-watered to the point the subgrade is free of mud or it is difficult to keep reinforcing steel clean. Use flexible base, cement-stabilized base or backfill, lean concrete, or other approved stabilizing material. Provide concrete with at least 275 lb. of cement per cubic yard, if lean concrete is used, and place to a minimum depth of 3 in. Stabilizing material placed for the convenience of the Contractor will be at the Contractor's expense.

- 3.1.2. **Bridge Foundations and Retaining Walls.** Do not disturb material below the bottom of footing grade. Do not backfill to compensate for excavation that has extended below grade. Fill the area with concrete at the time the footing is placed if excavation occurs below the proposed footing grade. Additional concrete placed will be at the Contractor's expense.

Take core samples to determine the character of the supporting materials if requested. Provide an intact sample adequate to judge the character of the founding material. Take these cores when the excavation is close to completion. Cores should be approximately 5 ft. deeper than the proposed founding grade.

Remove loose material if the founding stratum is rock or other hard material, and clean and cut it to a firm surface that is level, stepped, or serrated, as directed. Clean out soft seams, and fill with concrete when the footing is placed.

Place the foundation once the Engineer has inspected the excavation and authorized changes have been made to provide a uniform bearing condition if the material at the footing grade of a retaining wall, bridge bent, or pier is a mixture of compressible and incompressible material.

- 3.1.3. **Cofferdams.** The term "cofferdam" designates any temporary or removable structure constructed to hold surrounding earth, water, or both out of the excavation whether the structure is formed of soil, timber, steel, concrete, or a combination of these. Use pumping wells or well points for de-watering cofferdams if required.

Submit details and design calculations for sheet pile or other types of cofferdams requiring structural members bearing the seal, signature, and date of a licensed professional engineer for review before constructing the cofferdam. The Department reserves the right to reject designs. Design structural systems to comply with the *AASHTO Standard Specifications for Highway Bridges* or *AASHTO LRFD Bridge Design Specifications*. Interior dimensions of cofferdams must provide enough clearance for the construction, inspection, and removal of required forms and, if necessary, enough room to allow pumping outside the forms. Extend sheet pile cofferdams well below the bottom of the footings and make concrete seals as well-braced and watertight as practicable.

Use Class E concrete for foundation seals unless otherwise specified. Place concrete foundation seals in accordance with Item 420, "Concrete Substructures." Seals placed for the convenience of the Contractor will be at the Contractor's expense.

Make the excavation deep enough to allow for swelling of the material at the base of the excavation during pile-driving operations when the Engineer judges it to be impractical to de-water inside a cofferdam and a concrete seal is to be placed around piling driven within the cofferdam. Remove swelling material to the

bottom of the seal grade after driving the piling. Remove the foundation material to exact footing grades where it is possible to de-water inside the cofferdam without placing a seal after driving piling. Do not backfill a foundation to compensate for excavation that has been extended below grade; fill such areas below grade with concrete at the time the seals or footings are placed.

Remove cofferdams after completing the substructure without disturbing or damaging the structure unless otherwise provided.

- 3.1.4. **Culverts and Storm Drains.** When the design requires special bedding conditions for culverts or storm drains, an excavation diagram will be shown on the plans. Do not exceed these limits of excavation.

Construct pipe structures in an open cut with vertical sides extending to a point 1 ft. above the pipe unless otherwise shown on the plans. When site conditions or the plans do not prohibit sloping the cut, the excavation may be stepped or laid back to a stable slope beginning 1 ft. above the pipe. Maintain the stability of the excavation throughout the construction period.

Construct the embankment for pipe to be installed in fill above natural ground to an elevation at least 1 ft. above the top of the pipe, and then excavate for the pipe.

- 3.1.4.1. **Unstable Material.** Remove the material to a depth of no more than 2 ft. below the grade of the structure when unstable soil is encountered at established footing grade, unless the Engineer authorizes additional depth. Replace soil removed with stable material in uniform layers no greater than 8 in. deep (loose measurement). Each layer must have enough moisture to be compacted by rolling or tamping as required to provide a stable foundation for the structure.

Use special materials such as flexible base, cement-stabilized base, cement-stabilized backfill, or other approved material when it is not feasible to construct a stable foundation as outlined above.

- 3.1.4.2. **Incompressible Material.** Remove the incompressible material to 6 in. below the footing grade, backfill with an approved compressible material, and compact in accordance with Section 400.3.3., "Backfill," if rock, part rock, or other incompressible material is encountered at established footing grade while placing prefabricated elements.

- 3.2. **Shaping and Bedding.**

- 3.2.1. **General.** Place at least 2 in. of fine granular material for precast box sections on the base of the excavation before placing the box sections. Use bedding as shown in Figure 1 for pipe installations. Use Class C bedding unless otherwise shown on the plans. The Engineer may require the use of a template to secure reasonably accurate shaping of the foundation material. Undercut the excavation at least 4 in. where cement-stabilized backfill is shown on the plans and backfill with stabilized material to support the pipe or box at the required grade.

B_c - Outside diameter or horizontal dimension
 D - Inside diameter of pipe
 d - Min. bedding material below pipe

D	d
$\leq 27"$	3"
30" to 60"	4"
$\geq 66"$	6"

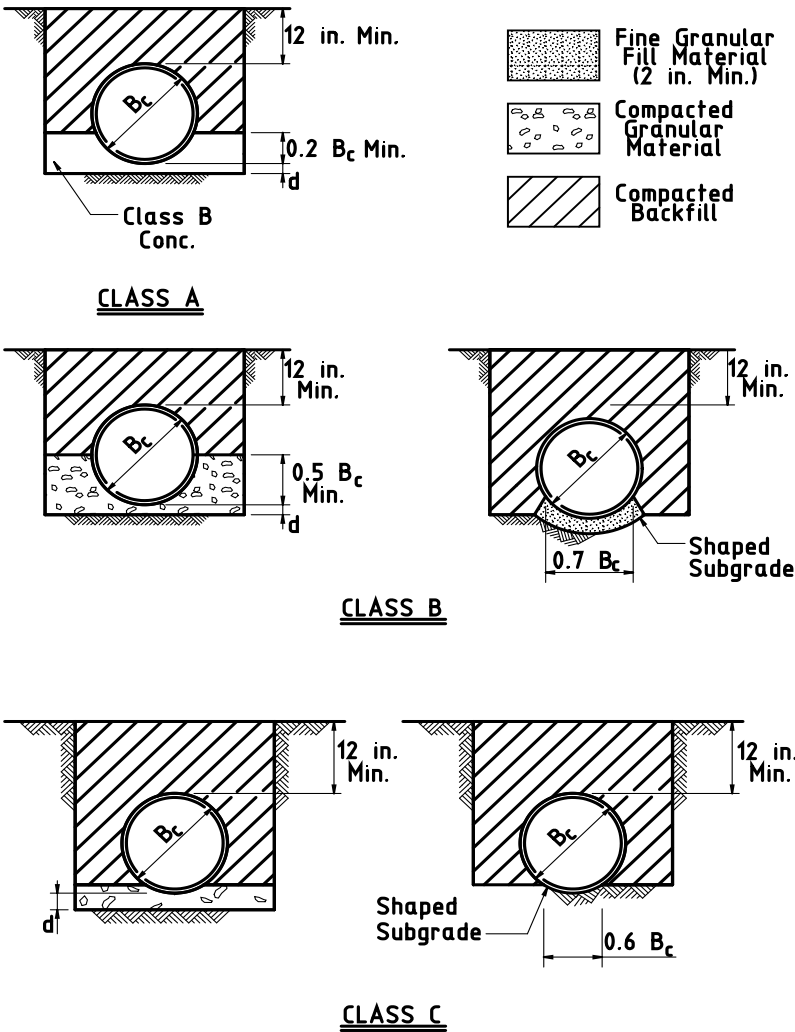


Figure 1
Bedding Diagrams

- 3.2.2. **Optional Shaping and Bedding for Precast Concrete Pipe.** For precast concrete pipe, the beddings in accordance with ASTM C1479 are permissible.
- 3.3. **Backfill.**
- 3.3.1. **General.** Backfill the excavation after placement of the permanent structure as soon as practical. Use backfill free of stones large enough to interfere with compaction; large or frozen lumps that will not break down readily under compaction; and wood or other extraneous material. Obtain backfill material from excavation or from other sources.

Place backfill in layers no greater than 10 in. deep (loose measurement) in areas not supporting a completed roadbed, retaining wall, or embankment. Place backfill in uniform layers no greater than 8 in. deep (loose measurement) in areas supporting a portion of a roadbed, retaining wall, or embankment. Compact each

layer to meet the density requirements of the roadbed, retaining wall, or embankment material, or as shown on the plans.

Bring each layer of backfill material to the moisture content needed to obtain the required density. Use mechanical tamps or rammers to compact the backfill. Rollers may be used to compact backfill if feasible.

Cohesionless materials may be used for backfilling. Use cohesionless materials that conform to the requirements shown in Table 1.

Table 1
Cohesionless Material Gradation Limits

Sieve Size	Percent Retained
3"	0
#10	Note 1
#200	90–100

- No. 10 sieve requirements are 0–30% retained when used as aggregate for cement-stabilized backfill.

Compact cohesionless materials using vibratory equipment, water ponding, or a combination of both.

3.3.2. **Bridge Foundations, Retaining Walls, Manholes and Inlets, and Box Culverts.** Place backfill against the structure only after the concrete has reached the design strength required in Item 421.

Backfill retaining walls with material meeting the requirements of Item 423, "Retaining Walls." Backfill around bridge foundations, manholes and inlets, and culverts using material with particles no more than 4 in. in greatest dimension and a gradation that permits thorough compaction. Use rock or gravel mixed with soil if the percentage of fines is enough to fill all voids and ensure a uniform and thoroughly compacted mass of proper density.

Use mechanical tamps and rammers to avoid damage to the structure where backfill material is being placed too close to the structure to permit compaction with blading and rolling equipment.

Avoid wedging action of backfill against structures. Step or serrate slopes bounding the excavation to prevent such action. Place backfill uniformly around bridge foundations. Place backfill equally and in uniform layers along both sides of manholes and inlets and culverts.

The Engineer may require backfilling of structures excavated into hard, erosion-resistant material, and subject to erosive forces, with stone or lean concrete.

Box culverts may be opened to traffic as soon as enough backfill and embankment have been placed over the top to protect culverts against damage from heavy construction equipment. Repair damage to culvert caused by construction traffic at no additional expense to the Department.

3.3.3. **Pipe.** Bring backfill material to the proper moisture condition after installing bedding and pipe as required and place it equally along both sides of the pipe in uniform layers no greater than 8 in. deep (loose measurement). Compact each lift mechanically. Thoroughly compact materials placed under the haunches of the pipe to prevent damage or displacement of the pipe. Place backfill in this manner to the top-of-pipe elevation. Place and compact backfill above the top of the pipe in accordance with Section 400.3.3.1., "General."

The Engineer may reject backfill material containing more than 20% by weight of material retained on a 3-in. sieve with large lumps not easily broken down or that cannot be spread in loose layers. Material excavated by trenching machine must generally meet the requirements of this Section as long as large stones are not present.

Place and compact additional material where pipe extends beyond the toe of slope of the embankment and the depth of cover provided by backfill to the original ground level is less than the minimum required by the specifications for the type of pipe involved, until the minimum cover has been provided.

- 3.3.4. **Cement-Stabilized Backfill.** Backfill the excavation to the elevations shown with cement-stabilized backfill when shown on the plans. Use cement-stabilized backfill that contains aggregate conforming to the gradation limits shown in Table 1, water, and at least 7% hydraulic cement based on the dry weight of the aggregate, in accordance with [Tex-120-E](#).

Place cement-stabilized backfill equally along the sides of structures to prevent strain on or displacement of the structure. Fill voids when placing cement-stabilized backfill. Use hand-operated tampers, if necessary, to fill voids. Compact the mixture using density control unless otherwise shown on the plans. Place and compact the backfill within 2 hr. of mixing.

- 3.3.5. **Flowable Backfill.** Backfill the excavation with flowable backfill to the elevations indicated when shown on the plans. Prevent the structure from being displaced during the placement of the flowable fill, and prevent flowable fill from entering manholes and inlets, culverts, and drainage structures.

4. MEASUREMENT

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

- 4.1. **Structural Excavation.** Unless shown on the plans as a pay item, structural excavation quantities shown are for information purposes only.

When structural excavation is specified as a pay item, structural excavation for pipe headwalls, inlets, manholes, culvert or storm drain extensions less than 15 ft. long, bridge abutments, retaining walls, and side road and private entrance pipe culverts will not be measured. No allowance will be made for variance from plans quantity incurred by an alternate bid.

When specified as a pay item, structural excavation will be measured by the cubic yard as computed by the average end areas method or as shown on the plans. Excavation diagrams shown on the plans take precedence over the provisions of this Article.

- 4.1.1. **Boundaries of Measurement.**

- 4.1.1.1. **Pipe.**

- 4.1.1.1.1. **Pipe up to 42 Inches.** For pipe up to 42 in. nominal or equivalent diameter, no material outside vertical planes 1 ft. beyond and parallel to the horizontal projection of the outside surfaces of the pipe will be included.

- 4.1.1.1.2. **Pipe Larger than 42 Inches.** For pipes larger than 42 in. nominal or equivalent diameter, no material outside vertical planes located 2 ft. beyond and parallel to the horizontal projection of the outside surfaces of the pipe will be included.

Quantities for excavation in fill above natural ground include 1 ft. above the top of the pipe regardless of the height of completed fill. Excavation for pipe will be measured between the extreme ends of the completed structure, including end appurtenances as shown on the plans and from centerline to centerline of structures such as inlets and manholes.

- 4.1.1.2. **Footings, Walls, Boxes, and Other Excavation.** No material outside vertical planes 1 ft. beyond and parallel to the edges of the footings or outside walls will be included, whether a cofferdam or shoring is used. When plans provide the option of cast-in-place or precast boxes, measurement will be based on the cast-in-place option.

Where excavation in addition to that allowed for the footings is required for other portions of the structure, measurement for the additional excavation will be limited laterally by vertical planes 1 ft. beyond the face of the member and parallel to it, and vertically to a depth of 1 ft. below the bottom of the member.

- 4.1.1.3. **Excavation near Roadways and Channels.** At structure sites other than culverts and pipe excavations, the measurement of structural excavation will include only material below or outside the limits of the completed road or channel excavation. Roadway and channel excavation will be paid under Item 110, "Excavation." For culverts except side road and private entrance culverts, excavation within the limits of the structure and below or outside the limits of the completed roadway excavation will be measured as structural excavation.
- 4.1.2. **Falsework.** No measurement will be made for excavation necessary for placing forms or falsework that exceed the limits given in Section 400.4.1.1., "Boundaries of Measurement."
- 4.1.3. **Swelling.** Measurement will not include materials removed below footing grades to compensate for anticipated swelling due to pile driving, nor will it include material required to be removed due to swelling beyond the specified limits during pile-driving operations.
- 4.1.4. **Cave-Ins.** Measurement will not include additional volume caused by slips, slides, cave-ins, silting, or fill material resulting from the action of the elements or the Contractor's operation.
- 4.1.5. **Undercut.** Where rock or other incompressible or unstable material is undercut to provide a suitable foundation for pipe or box sections, such material below grade directed to be removed will be measured for payment.
- 4.1.6. **Grade Change.** Additional measurement will be made of the volume of excavation involved in the lowering or raising of the elevation of a footing, foundation, or structure unit, when such grade change is authorized.
- 4.2. **Cement-Stabilized Backfill.** Cement-stabilized backfill will be measured by the cubic yard as shown on the plans.
- 4.3. **Cutting and Restoring Pavement.** Cutting and restoring pavement will be measured by the square yard as shown on the plans. Excavation below pavement or base will be measured as structural excavation of the pertinent type.

5. PAYMENT

- 5.1. **Structural Excavation.** Unless specified as a pay item, structural excavation and backfill performed, and material furnished in accordance with this Item will not be paid for directly, but will be subsidiary to pertinent Items.

When structural excavation is specified as a pay item, the excavation and backfill work performed, and materials furnished will be paid for at the unit price bid for "Structural Excavation," "Structural Excavation (Box)," "Structural Excavation (Pipe)," and "Structural Excavation (Bridge)." This price includes concrete to compensate for excavation that has extended below grade for bridge foundations and retaining walls, and backfilling and compacting areas that were removed as part of structural excavation.

Cofferdams or other measures necessary for supporting excavations less than 5 ft. deep will not be measured or paid for directly, but will be subsidiary to the Contract.

Foundation seal concrete for cofferdams, when required, will be paid for as provided in the pertinent Items. If no direct method of payment is provided in the Contract, the work will be measured and paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method." Seal placed for the convenience of the Contractor will not be paid for.

Unless otherwise provided, stone or lean concrete backfill around structures as provided for in Section 400.3.3.2., "Bridge Foundations, Retaining Walls, Manholes and Inlets, and Box Culverts," will be

measured and paid for as extra work in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

When structural excavation is specified as a pay item, a partial payment of 50% of the bid price will be made for structural excavation completed to the satisfaction of the Engineer but not backfilled. The remaining amount will be paid upon completion of backfilling. When the Contractor elects to excavate beyond plan requirements, no measurement will be made of the additional volume.

- 5.2. **Removal and Replacement of Unsuitable or Incompressible Material.** Removal and replacement of material will be paid for if directed. Removal and replacement of material or placement of special material made necessary by the softening of founding material due to the Contractor's sequence of work or operation will be at the Contractor's expense. Special material used or additional excavation made for the Contractor's convenience will not be paid for.

- 5.2.1. **Structural Excavation as a Pay Item.** Where special materials are not required or specified, payment for the removal and replacement of unstable or incompressible material will be made at a price equal to 200% of the unit price bid per cubic yard for "Structural Excavation." When the Contractor elects to remove and replace material deeper than directed, no measurement will be made on that portion below the directed elevation. This price is full compensation for removing the unstable or incompressible material; furnishing, hauling, placing, and compacting suitable replacement material; and equipment, labor, tools, and incidentals.

When shown on the plans or when directed, for the use of special materials such as flexible base, cement-stabilized base, cement-stabilized backfill, or other special material, payment for excavation below footing grades will be made at the unit price bid for "Structural Excavation." Payment for furnishing, hauling, placing, and compacting the flexible base, cement-stabilized base, cement-stabilized backfill, or other special materials will be made at the unit price bid for these items in the Contract, or, if the required material is not a bid item, in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

- 5.2.2. **Structural Excavation Not a Pay Item.** Where special materials for backfill are not required or specified, payment for the authorized removal and replacement of unstable or incompressible material will be measured and paid for at \$18 per cubic yard of material removed. This price is full compensation for removing the unstable or incompressible material; furnishing, hauling, placing, and compacting suitable replacement material; and equipment, labor, tools, and incidentals.

When shown on the plans or when directed, for the use of special materials such as flexible base, cement-stabilized base, cement-stabilized backfill, or other special material, excavation below the footing grades will be paid for at \$12 per cubic yard. Payment for furnishing, hauling, placing, and compacting the flexible base, cement-stabilized base, cement-stabilized backfill, or other special materials will be made at the unit price bid for these items, or, if the required material is not a bid item, in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

- 5.3. **Lowering of a Structure Foundation.** If the Engineer requires a structure foundation to be lowered to an elevation below the grade shown on the plans, overexcavation will be paid for in accordance with Table 2.

Table 2
Payment for Required Overexcavation

Variance of Revised Footing Grade from Plan Grade	Payment Terms	Variance of Revised Footing Grade from Plan Grade
	"Structural Excavation" is a Bid Item	"Structural Excavation" is Not a Bid Item
Up to and including 5 ft.	Unit price equal to 115% of unit price bid for "Structural Excavation"	\$12 per cubic yard
Over 5 ft. up to 10 ft.	Unit price equal to 125% of unit price bid for "Structural Excavation"	\$15 per cubic yard
Over 10 ft.	In accordance with Article 9.7., "Payment for Extra Work and Force Account Method."	

- 5.4. **Cement-Stabilized Backfill.** Cement-stabilized backfill will be paid for at the unit price bid for "Cement-Stabilized Backfill."

- 5.5. **Cutting and Restoring Pavement.** Cutting and restoring pavement will be paid for at the unit price bid for "Cutting and Restoring Pavement" of the type specified.

Work done to repair damage to base or pavement incurred outside the limits shown on the plans, or the limits authorized, will not be measured for payment.

The unit prices bid are full compensation for excavation, including removing obstructions and plugging drainage systems; bedding and backfilling, including placing, sprinkling, and compaction of material; soundings; cleaning and filling seams; constructing and removing cofferdams; de-watering, sheeting, or bracing excavations up to and including 5 ft. deep; pumps; drills; explosives; disposition of surplus material; cutting pavement and base to neat lines; and materials, hauling, equipment, labor, tools, and incidentals.

Flowable backfill will be paid for in accordance with Item 401. Protection methods for open excavations deeper than 5 ft. will be measured and paid for as required in accordance with Item 402 or Item 403.

Item 401

Flowable Backfill



1. DESCRIPTION

Furnish and place flowable backfill for trench, hole, or other void.

2. MATERIALS

Use materials from prequalified sources listed on the Department website. Use materials from non-listed sources only when tested and approved before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources. Do not combine approved material with unapproved material.

- 2.1. **Cement.** Furnish cement in accordance with [DMS-4600](#), "Hydraulic Cement."
- 2.2. **Fly Ash.** Furnish fly ash in accordance with [DMS-4610](#), "Coal Ash."
- 2.3. **Chemical Admixtures.** Furnish chemical admixtures in accordance with [DMS-4640](#), "Chemical Admixtures for Concrete." Use specialty type admixtures to enhance the flowability, reduce shrinkage, and reduce segregation by maintaining solids in suspension when necessary. Use and proportion all admixtures in conformance with the manufacturer's recommendations.
- 2.4. **Fine Aggregate.** Provide fine aggregate that will stay in suspension in the mortar to the extent required for proper flow and that meets the gradation requirements shown in Table 1.

Table 1
Aggregate Gradation Chart

Sieve Size	Percent Passing
3/4"	100
#200	0–30

Test fine aggregate gradation in accordance with [Tex-401-A](#).

Plasticity index must not exceed six when tested in accordance with [Tex-106-E](#).

- 2.5. **Mixing Water.** Use mixing water in accordance with Item 421, "Hydraulic Cement Concrete."

3. CONSTRUCTION

Submit a construction method and plan, including mix design, for approval. Provide a means of filling the entire void area and be able to demonstrate this has been accomplished. Prevent the movement of any inserted structure from its designated location. Remove and replace or correct the problem if voids are found in the fill or any of the requirements are not met as shown on the plans, without additional cost to the Department.

Furnish a mix meeting the requirements shown in Table 2, unless otherwise shown on the plans.

Table 2
Flowable Fill Mix Design Requirements

Property	Excavatable	Non-Excavatable	Test Method
28-day compressive strength ¹ , psi	80–200	> 200	ASTM D4832
Consistency ² , Min diameter, in.		8	ASTM D6103
Unit weight, pcf	90–125	100 to 145	ASTM D6023
Air content, %	10–30	5 to 15	ASTM D6023

1. Average of two specimens.
2. Mixture must not segregate.

Mix the flowable fill using a central-mixed concrete plant, ready-mix concrete truck, pug mill, or other approved method.

Furnish all labor, equipment, tools, containers, and molds required for sampling, making, transporting, curing, removing, and disposing of test specimens. Furnish test molds meeting the requirements of [Tex-447-A](#). Transport, strip, and cure the test specimens as scheduled at the designated location. Cure test specimens in accordance with [Tex-447-A](#). The Engineer will sample, make, and test all specimens. Dispose of used, broken specimens in an approved location and manner. The frequency of job-control testing will be at the direction of the Engineer.

4. MEASUREMENT

This Item will be measured by the cubic yard of material placed. Measurement will not include additional volume caused by slips, slides, or cave-ins resulting from the Contractor's operations.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Flowable Backfill." This price is full compensation for furnishing, hauling, and placing materials and for equipment, tools, labor, and incidentals.

Item 402
Trench Excavation Protection



1.	DESCRIPTION Furnish and place excavation protection for trenches 5 ft. or greater in depth for pipe, box culvert, electrical or telephone conduit, duct, or other utility installation.
2.	CONSTRUCTION Provide vertical or sloped cuts, benches, shields, support systems, or other systems providing the necessary protection in accordance with OSHA Standards and Interpretations, 29 CFR Part 1926, Subpart P, "Excavations."
3.	MEASUREMENT This Item will be measured by the foot along the long axis of the trench where the depth of trench exceeds 5 ft. This measurement includes all required trench protection, including trench ends.
4.	PAYMENT The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Trench Excavation Protection." This price is full compensation for excavation and backfill required for excavation protection; furnishing, placing, and removing shoring, sheeting, or bracing; de-watering or diversion of water; jacking and jack removal; and equipment, labor, materials, tools, and incidentals.

Item 403

Temporary Special Shoring



1. DESCRIPTION

Furnish and install temporary shoring to hold the surrounding earth, water, or both out of the work area.

2. MATERIALS

Furnish new or used materials. Furnish materials that meet the requirements of Item 410, "Soil Nail Anchors," or Item 411, "Rock Nail Anchors," when using temporary nailed walls (rock or soil).

3. CONSTRUCTION

The Contractor is responsible for the temporary special shoring design unless complete details are shown on the plans. Submit details and design calculations bearing the seal and signature of a licensed professional engineer before constructing the shoring. The Department reserves the right to reject designs. Design the shoring to comply with OSHA Standards and Interpretations, 29 CFR Part 1926, Subpart P, "Excavations." Design structural systems to comply with AASHTO *Standard Specifications for Highway Bridges* or AASHTO *LRFD Bridge Design Specifications*. Design shoring subject to railroad loading to comply with the AREMA *Manual for Railway Engineering* and any additional requirements of the railway being supported.

Provide vertical or sloped cuts, benches, shields, support systems, or other systems to provide the necessary protection in accordance with the approved design. Construct temporary nailed walls (rock or soil), when used, in accordance with Item 410 or Item 411.

4. MEASUREMENT

This Item will be measured by the square foot of surface area of a vertical plane at the face of the shoring between the top of the ground being supported and the minimum protection grade line shown on the plans. If no minimum protection grade is shown on the plans, the lowest required excavated elevation will be used. Shoring projecting above the level of the ground being supported will not be measured. When excavation techniques (e.g., sloped cuts or benching) are used to provide the necessary protection, the surface area for payment will be calculated based on the area described by a vertical plane adjacent to the structure.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Special Shoring." This price is full compensation for excavation and backfill; furnishing, placing, and removing shoring, sheeting, or bracing; de-watering or diversion of water; jacking and jack removal; and equipment, labor, materials, tools, and incidentals.

No payment will be made for special shoring made necessary by the selection of an optional design or sequence of work that creates the need for shoring.

Item 416

Drilled Shaft Foundations



1. DESCRIPTION

Construct foundations consisting of reinforced or non-reinforced concrete drilled shafts.

2. MATERIALS

Use materials that meet the requirements of the following Items.

- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 448, "Structural Field Welding"

Use concrete for drilled shafts that meets the requirements shown in Table 1 unless otherwise shown on the plans.

Table 1
Concrete for Drilled Shafts

Drilled Shaft Type	Concrete
Non-reinforced	Class A
Reinforced	Class C
Slurry and underwater concrete placement	Class SS

Use coarse aggregate Grade 4, 5, or 6 for drilled shaft concrete in reinforced drilled shafts. Grade 2 or Grade 3 may be used if the shaft is dry and reinforcing steel has a 5 in. minimum clear spacing.

Use a water-reducing, retarding admixture in accordance with [DMS-4640](#), "Chemical Admixtures for Concrete," in all concrete when using casing that will be pulled or when placing shafts under water or under slurry.

Use concrete with slump that meets the requirements shown in Table 2 as determined in accordance with [Tex-415-A](#).

Table 2
Slump Requirements

Placement Type	Min Acceptable Placement Slump (in.)	Recommended Design and Placement Slump (in.)	Max Acceptable Placement Slump (in.)
Dry	5-1/2	6-1/2	7-1/2
Underwater and under slurry	7	8	9

Perform a slump loss test in accordance with [Tex-430-A](#) before beginning work when casing is to be pulled or concrete is to be placed underwater or under slurry. Provide concrete that will maintain a slump of at least 4 in. throughout the entire anticipated time of concrete placement. Time of concrete placement is in accordance with Section 416.3.6., "Concrete," and Section 416.3.7., "Additional Requirements for Slurry Displacement or Underwater Concrete Placement Methods." Note the temperature of the concrete mix at the beginning of the slump loss test. Place the concrete if its temperature at the time of placement into the drilled shaft is no more than 10°F higher than the slump loss test temperature. Use ice or other concrete-cooling ingredients to lower concrete temperature or run additional slump loss tests at the higher temperatures. Slump loss testing will be waived if anticipated time of concrete placement is less than 90 min.

Use mineral drilling slurry that meets the requirements shown in Table 3, as determined in accordance with [Tex-130-E](#). Determine pH of slurry in accordance with [Tex-128-E](#) or using pH paper strips.

Table 3
Mineral Slurry Requirements

Before Introduction into Excavation			Sampled from Bottom of Excavation Before Concreting		
Specific Gravity	Sand Content	pH	Specific Gravity	Viscosity (sec.)	Sand Content
≤1.10	≤1%	8–11	≤1.15	≤45	≤4%

Use mineral slurry consisting of processed bentonite or attapulgite clays mixed with clean fresh water. Do not use partially hydrolyzed polyacrylamide (PHPA) polymeric slurry or any other fluid composed primarily of a polymer solution.

If approved, water may be used as the drilling fluid. In this case, all the provisions shown in Table 3 must be met, except that the maximum specific gravity is not to exceed 1.12.

Sample slurry from the bottom of the hole, before placing concrete, and test it in accordance with [Tex-130-E](#). Use a pump or air lift to remove slurry that does not meet the requirements shown in Table 3 while adding fresh clean slurry to the top of the hole to maintain the slurry level. Continue this operation until the slurry sampled from the bottom of the hole meets the requirements.

3. CONSTRUCTION

Submit drilled shaft installation plan for review no later than 1 mo. before drilled shaft construction. Include the following in the plan:

- name and experience record of the drilled shaft superintendent who will be in charge of drilled shaft operations for the project;
- list of proposed equipment to be used, including cranes, drills, augers, bailing buckets, final cleaning equipment, de-sanding equipment, slurry pumps, core-sampling equipment, tremies or concrete pumps, and casing;
- details of overall construction operation sequence and the sequence of shaft construction in bents or groups;
- details of shaft excavation methods;
- when the use of slurry is anticipated, details of the slurry mix design and its suitability for the subsurface conditions at the construction site, mixing and storage methods, maintenance methods, and disposal procedures;
- details of methods to clean the shaft excavation;
- details of reinforcement placement, including support and centralization methods;
- details of concrete placement, including proposed operational procedures for free-fall, tremie, or pumping methods; and
- details of casing installation and removal methods.

The installation plan will be reviewed for conformance with the plans, specifications, and special provisions. The Contractor will be notified within 14 days of receipt of the installation plan of any additional information required or changes necessary to meet the Contract requirements. All procedural approvals will be subject to trial in the field and will not relieve the Contractor of the responsibility to satisfactorily complete the work as shown on the plans and in conformance with specifications.

Place the shaft to within the following tolerances.

- Vertical plumbness: 1 in. per 10 ft. of depth
- Center of shaft located under column: 1 in. of horizontal plan position

- Center of shaft located under footing: 3 in. of horizontal plan position

Complete the embankment at bridge ends before installing drilled shafts that pass through the fill. Refer to Item 423, "Retaining Walls," for provisions for drilled shafts passing through the structural volume of retaining walls.

- 3.1. **Excavation.** The plans indicate the expected depths and elevations for encountering satisfactory bearing material. Excavate as required for the shafts through all materials encountered to the dimensions and elevations shown on the plans or required by the site conditions. Removal of man-made obstructions not shown on the plans will be paid for in accordance with Article 9.7., "Payment for Extra Work and Force Account Method." Adjust the bottom of the shaft or alter the foundation if satisfactory founding material is not encountered at plan elevation, as approved, to satisfactorily comply with design requirements. Blasting is not allowed for excavations.

Stop drilling if caving conditions are encountered and adopt a construction method that stabilizes the shaft walls.

Do not excavate a shaft within two shaft diameters (clear) of an open shaft excavation, or one in which concrete has been placed in the preceding 24 hr.

Dispose of material excavated from shafts and not incorporated into the finished project as shown on the plans and in conformance with federal, state, and local laws.

Provide suitable access, lighting, and equipment for proper inspection of the completed excavation and checking of the dimensions and alignment of shaft excavation.

- 3.2. **Core Holes.** Take cores to determine the character of the supporting materials if directed. Use a method that will result in recovery of an intact sample adequate for judging the character of the founding material. Such cores should be at least 5 ft. deeper than the proposed founding grade or a depth equal to the diameter of the shaft, whichever is greater. Take these cores when the excavation is complete.

- 3.3. **Casing.** Use casing when necessary to prevent caving of the material, excluding groundwater, when slurry is used for hole stabilization, or when required in conformance with the Contractor's safety plan. Provide casing with an outside diameter not less than the specified diameter of the shaft. The portion of shaft below the casing may be as much as 2 in. smaller than the specified shaft diameter. No extra compensation will be made for concrete required to fill an oversized casing or oversized excavation. Use casing strong enough to withstand handling stresses and pressures of concrete and of the surrounding earth or water, and that is watertight, smooth, clean, and free of accumulations of hardened concrete.

Use construction methods that result in a minimal amount of disturbed soil trapped outside the casing. This does not apply to temporary undersized casings used to protect workers inside shafts or to drilled shafts designed for point bearing only.

Leave casing in place only if authorized or shown on the plans. Extract casing only after placing the concrete to an appropriate level. Always maintain enough concrete in the casing to counteract soil and water pressure. Rotate or move the casing up or down a few inches if necessary before and during concrete placement to facilitate extraction of the casing.

- 3.4. **Requirements for Slurry Displacement Method.** When soil conditions warrant, use the slurry displacement method to construct drilled shafts, unless otherwise shown on the plans. Use this method to support the sides of the excavation with processed mineral slurry that is then displaced by concrete to form a continuous concrete shaft.

Install surface casing to at least 10 ft. below existing ground before introducing slurry. Do not use casing other than surface casing. Do not use surface casing longer than 20 ft. without approval. Do not extract the surface casing until after placing the concrete.

Pre-mix slurry in a reservoir with enough capacity to fill the excavation and for recovery of the slurry during concrete placement. Do not mix slurry in the shaft excavation or other hole. Allow adequate time for hydration of the slurry before introduction into the excavation.

Maintain a head of slurry in the shaft excavation at or near ground level or higher, as necessary, to counteract groundwater pressure during and after drilling.

Use an air lift or proper size cleanout bucket, just before placing reinforcing steel, to remove any material that may have fallen from the sides of the excavation or accumulated on the bottom after the completion of drilling. Use a cleanout bucket if material is too large to be picked up using an air lift.

Re-process the hole using the auger as directed if concrete placement is not started within 4 hr. of the completion of the shaft excavation. Then clean the bottom using an air lift or cleanout bucket and check the slurry at the bottom of the hole for compliance with slurry requirements in accordance with Article 416.2., "Materials."

Agitate the congealed slurry to liquefaction if the slurry forms a gel before concrete placement, and whenever directed.

Recover and dispose of all slurry as approved, and in conformance with all federal, state, and local laws. Do not discharge slurry into or in close proximity to streams or other bodies of water.

- 3.5. **Reinforcing Steel.** Completely assemble the cage of reinforcing steel and place it as a unit immediately before concrete placement. The cage consists of longitudinal bars and lateral reinforcement (spiral reinforcement, lateral ties, or horizontal bands). Connect individual segments with couplers or by lapping steel as approved if overhead obstacles prevent placement of the cage as a single unit.

Extend the reinforcing steel cage as follows if the shaft is lengthened beyond plan length, unless directed otherwise.

- Extend the cage to the bottom for shafts supporting structures other than bridges.
- Extend the cage to 25 ft. or to the bottom, whichever is shorter, for bridge shafts with plan lengths less than 25 ft.
- Do not extend the cage for bridge shafts with plan lengths at least 25 ft. that are lengthened less than 33% of plan length.
- Extend the cage as directed for bridge shafts with plan lengths at least 25 ft. that are lengthened more than 33% of plan length.

If the cage does not reach the bottom of the shaft, it may be suspended, or a portion of the longitudinal steel may be extended to support the cage on the bottom of the shaft. Bars used to extend or support the cage may be lap spliced or welded by a qualified welder. Place the extension at the bottom of the shaft.

Tie spiral reinforcement to the longitudinal bars at a spacing no more than 24 in., or as required for a stable cage. Ensure lateral reinforcement is not welded to longitudinal bars unless otherwise shown on the plans.

Center the reinforcing steel cage in the excavation using approved "roller"-type centering devices unless otherwise approved. Use concrete or plastic chairs to keep the reinforcing cage off the bottom of the hole. Use centering devices starting at 1.5 ft. off from the bottom of the cage and spaced vertically at intervals not exceeding 10 ft. Use at least three centering devices per level at a spacing not to exceed 30 in. Flat or crescent-shaped centralizers ("sleds") are not allowed.

Support or hold down the cage to control vertical displacement during concrete placement or extraction of the casing. Use support that is concentric with the cage to prevent racking and distortion of the steel.

Check the elevation of the top of the steel cage before and after concrete placement or after casing extraction when casing is used. Downward movement of the steel up to 6 in. per 20 ft. of shaft length and upward movement of the steel up to 6 in. total are acceptable.

Maintain the minimum length of steel required for lap with column steel. Use dowel bars if the proper lap length is provided both into the shaft and into the column. Locate and tie all dowel bars into the cage before placing concrete.

Locate and tie anchor bolts when required before placement of concrete. Use templates or other devices to assure accurate placement of anchor bolts.

- 3.6. **Concrete.** Perform all work in accordance with Item 420, "Concrete Substructures." Provide concrete with maximum placement temperatures as shown in Table 4. Provide thermal analysis to show, and temperature-recording devices to verify, maximum concrete core temperature requirements are met in accordance with Section 420.4.7.14, "Mass Placements," for shafts with diameter exceeding 7 ft. Instrument the first shaft for each size shaft exceeding 7 ft. diameter, and as directed if results do not meet specifications and when the concrete mix design changes.

Table 4
Max Concrete Placing Temperature

Shaft Size	Mix Design Options 1–5	Mix Design Options 6–8
Diameter <5 ft.	95°F	95°F
5 ft. ≤ diameter ≤ 7 ft.	95°F	85°F
7 ft. < diameter	85°F	75°F

Form portions of drilled shaft that project above natural ground.

Remove loose material and accumulated seep water from the bottom of the excavation before placing concrete. No more than 3 in. of water should be present within the base of the excavation at the time of concrete placement. The rate of inflow should be confirmed by observation to be less than 12 in. per hour. Place concrete using underwater placement methods if seepage exceeds the tolerable levels cited above.

Place concrete as soon as possible after all excavation is complete and reinforcing steel is placed. Provide workable concrete that does not require vibrating or rodding. Vibrate formed portions of drilled shafts.

Place concrete continuously for the entire length of the shaft. Limit free fall of concrete to 25 ft. for dry shafts of 24-in. or smaller diameter. Use a suitable tube or tremie to prevent segregation of materials. Use a tube or tremie in sections to provide proper discharge and permit raising as the placement progresses. For dry shafts more than 24-in. diameter, concrete may be allowed to free fall an unlimited distance if it does not strike the reinforcing cage or sides of the hole during placement. Provide a hopper with a minimum 3-ft. long drop-tube at the top of the shaft to direct concrete vertically down the center of the shaft when free fall is used. Do not use a shovel or other means to simply deflect the concrete discharge from the truck.

Always maintain enough head of concrete for cased shafts above the bottom of the casing to overcome hydrostatic pressure. Extract casing at a slow, uniform rate with the pull in line with the axis of the shaft. Monitor the concrete level in the casing during extraction. Stop the extraction and add concrete to the casing as required to ensure a completely full hole upon casing removal. The elapsed time from the mixing of the first concrete placed into the cased portion of the shaft until the completion of extraction of the casing must not exceed the time for which the concrete maintains a slump of more than 4 in. in accordance with Article 416.2., "Materials." Modify the concrete mix, the construction procedures, or both for subsequent shafts if the elapsed time is exceeded.

Cure the top surface and treat any construction joint area in accordance with Item 420.

- 3.7. **Additional Requirements for Slurry Displacement or Underwater Concrete Placement Methods.** Place concrete on the same day the shaft is excavated and as soon as possible after all excavation is complete

and reinforcing steel is placed. Rework the hole by overdrilling a minimum 1/2 in. on all sides on the same day that concrete is placed when drilling of a hole is performed on multiple days if approved. Use an air lift or cleanout bucket of the proper size to clean the bottom of the excavation before placing the reinforcing steel cage and concrete. Place concrete through a closed tremie or pump it to the bottom of the excavation. The minimum tremie diameter will be at least six times the maximum size of aggregate used in the concrete mix, but not less than 10 in. Initially seal the tremie or pump line to positively separate the concrete from the slurry or water. Place concrete continuously from the beginning of placement until the shaft is completed. Always keep the tremie full of concrete and well submerged in the previously placed concrete if using a tremie. Raise the tremie as necessary to maintain the free flow of concrete and the stability of any casing used. Always keep the discharge tube submerged in the previously placed concrete if using a pump. Place additional concrete to ensure the removal of any contaminated concrete at the top of the shaft. Allow the top portion of concrete to flush completely from the hole at the completion of the pour until there is no evidence of slurry or water contamination. Do not attempt to remove this concrete using shovels, pumps, or other means. Level the top of shaft with hand tools as necessary.

Use a sump or other approved method to channel displaced fluid and concrete away from the shaft excavation. Recover slurry and dispose of it as approved. Do not discharge displaced fluids into or near streams or other bodies of water. Provide a collar or other means of capturing slurry and the top portion of concrete flushed from the shaft for pours over water.

Remove the tube, reseal it at the bottom, penetrate with the tube into the concrete already placed by at least 5 ft., and recharge it before continuing if concrete placement is interrupted due to withdrawal of the submerged end of the tremie or pump discharge tube before completion. If this condition exists, notify the Engineer and note the elevation and circumstances related to the loss of seal on the drilled shaft log.

The elapsed time from the mixing of the first concrete placed until the completion of concrete placement, including extraction of the casing, must not exceed the time for which the concrete maintains a slump of more than 4 in. in accordance with Article 416.2., "Materials." Modify the concrete mix, the construction procedures, or both for subsequent shafts if the elapsed time is exceeded.

- 3.8. **Test Load.** Load test shafts, if required, in accordance with Item 405, "Foundation Load Test."
- 3.9. **Trial Shaft.** When required on the plans, construct trial shafts to the depth and diameter shown on the plans. Trial shafts include drilling the hole, placement of the rebar cage (unless otherwise stated), and placement of the concrete. When trial shafts are required, delay start of production shafts until successful completion of trial shafts.

4. MEASUREMENT

- 4.1. **Drilled Shaft.** Drilled shaft foundations will be measured by the foot to the bottom of the shaft.
 - 4.1.1. **Interior Bents and Piers.** Shafts will be measured from a point approximately 6 in. below the finished earthwork elevation at the center of each shaft, unless specific elevations or dimensions are shown on the plans or unless otherwise directed to meet unusual conditions. The bent height shown on the plans is for estimating purposes only and does not control the top-of-shaft measurement.
 - 4.1.2. **Abutment Bents and Retaining Walls.** Shafts will be measured from the bottom of footing or cap elevation.
 - 4.1.3. **Other Non-Bridge Structures.** Shafts, including trial shafts, will be measured from the top of the shaft.
- 4.2. **Core Hole.** Core holes will be measured by each core hole drilled.

5. PAYMENT

The unit prices bid for the various classifications of drilled shafts are full compensation for excavation; furnishing, placing, and removing casing; furnishing, processing, and recovering slurry; furnishing and

placing reinforcing steel; pumping; furnishing and placing concrete, including additional concrete required to fill an oversize casing or oversize excavation; conducting slump loss tests; backfilling; disposing of cuttings and slurry; and materials, tools, equipment, labor, and incidentals.

When the bottom of a drilled shaft is placed at an elevation below plan grade, no direct payment will be made for extra reinforcement placed to support the cage. The extra reinforcement will be subsidiary to the unit price bid per foot of shaft. No extra payment will be made for casings left in place, unless specified on the plans.

No payment will be made for "Drilled Shaft" until the concrete has been placed.

- 5.1. **Drilled Shaft.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Drilled Shaft," "Drilled Shaft (Non-Reinforced)," "Drilled Shaft (Sign Mounts)," "Drilled Shaft (High Mast Pole)," "Drilled Shaft (Roadway Illumination Pole)," or "Drilled Shaft (Traffic Signal Pole)" of the specified diameter, subject to the limitations for overruns authorized by the Engineer in accordance with Section 416.5.1.1., "Overrun."

- 5.1.1. **Overrun.** Payment for individual completed shaft lengths up to and including 5 ft. more than the maximum plan length shaft, in accordance with Section 416.5.1.2., "Maximum Plan Length Shaft," will be made at the unit price bid per foot of the specified diameter.

Payment for the portion of individual completed shaft length more than 5 ft. and up to and including 15 ft. more than the maximum plan length shaft, in accordance with this Item, will be made at a unit price equal to 115% of the unit price bid per foot of the specified diameter.

Payment for the portion of individual completed shaft length greater than 15 ft. more than the maximum plan length shaft, in accordance with Section 416.5.1.2., "Maximum Plan Length Shaft," will be made at a unit price equal to 125% of the unit price bid per foot of the specified diameter.

- 5.1.2. **Maximum Plan Length Shaft.** Payment described in the previous Sections is subject to the following provisions for extra depth drilling.
- For bridge structures, the maximum plan length shaft is the maximum length shaft, regardless of diameter, for any drilled shaft on that specific bridge.
 - For retaining walls, the maximum plan length shaft is the maximum length shaft, regardless of diameter, for any drilled shaft on that specific retaining wall.
 - For overhead sign structures, the maximum plan length shaft is the maximum length shaft, regardless of diameter, for any overhead sign structures included in the Contract.
 - For high mast illumination poles, the maximum plan length shaft is the maximum length shaft, regardless of diameter, for any high mast illumination pole included in the Contract.
 - For roadway illumination poles, the maximum plan length shaft is the maximum length shaft, regardless of diameter, for any roadway illumination pole included in the Contract.
 - For traffic signal poles, the maximum plan length shaft is the maximum length shaft, regardless of diameter, for any traffic signal pole included in the Contract.

- 5.2. **Core Hole.** Core holes will be paid at \$200 each.

Item 420

Concrete Substructures



1. DESCRIPTION

Construct concrete substructures including footings, columns, caps, abutments, piers, culverts, other bridge substructure elements, and other concrete structures as indicated.

2. MATERIALS

- 2.1. **Concrete.** Provide concrete in accordance with Item 421, "Hydraulic Cement Concrete." Provide the class of concrete for each type of structure or unit as shown on the plans or in conformance with pertinent governing specifications.
- 2.2. **Grout or Mortar.** Provide grout for dowelling anchors or precast connections in accordance with [DMS-4675](#), "Cementitious Grouts and Mortars for Miscellaneous Applications."
- 2.3. **Latex Curing Materials.** Provide an acrylic-polymer latex admixture (acrylic resin emulsion in accordance with [DMS-4640](#), "Chemical Admixtures for Concrete") suitable for producing polymer-modified concrete or mortar. Do not allow latex to freeze.
- 2.4. **Reinforcing Steel.** Provide reinforcing steel in accordance with Item 440, "Reinforcement for Concrete."
- 2.5. **Expansion Joint Material.** Provide materials in accordance with [DMS-6310](#), "Joint Sealants and Fillers."
- Provide preformed fiber expansion joint material that conforms to the dimensions shown on the plans.
 - Provide preformed bituminous fiber material unless otherwise specified.
 - Provide asphalt board that conforms to dimensions shown on the plans.
 - Provide re-bonded neoprene filler that conforms to the dimensions shown on the plans.
- 2.6. **Waterstop.** Provide rubber or polyvinyl chloride (PVC) waterstops in accordance with [DMS-6160](#), "Water Stops, Nylon-Reinforced Neoprene Sheet, and Elastomeric Pads," unless otherwise shown on the plans.
- 2.7. **Curing Materials.** Provide membrane curing compounds in accordance with [DMS-4650](#), "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

Provide cotton mats that consist of a filling material of cotton "bat" or "bats" (at least 12 oz. per square yard) completely covered with unsized cloth (at least 6 oz. per square yard) stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 in., or tuft both longitudinally and transversely at intervals less than 3 in. Provide cotton mats that are free of tears and in good general condition. Provide a flap at least 6 in. wide consisting of two thicknesses of the covering and extending along one side of the mat.

Provide polyethylene sheeting that is at least 4 mils thick and free of visible defects. Provide only clear or opaque white sheeting when the ambient temperature during curing exceeds 90°F or when applicable to control temperature during mass pours.

Provide burlap-polyethylene mats made of burlap impregnated on one side with a film of opaque white pigmented polyethylene, free of visible defects. Provide laminated mats that have at least one layer of an impervious material such as polyethylene, vinyl plastic, or other acceptable material (either as a solid sheet or impregnated into another fabric) and are free of visible defects.

Provide burlap material that complies with AASHTO M 182, Class 3 (10 oz. per square yard) with the following additions.

- Manila hemp may also be used to make burlap.
- Do not use burlap fabricated from bags.
- Do not use burlap containing any water-soluble ingredient that will retard the setting time of concrete.

Provide used burlap that complies with the requirements stated above and that has only been used previously for curing concrete. "Like new" cleanliness is not expected, but contamination with any substance foreign to the concrete curing process, such as grease or oil, will be cause for rejection.

- 2.8. **Epoxy.** Provide epoxy materials in accordance with [DMS-6100](#), "Epoxies and Adhesives," unless otherwise specified.

3. EQUIPMENT

- 3.1. **Transporting and Placing Equipment.** Use appropriate transporting and placing equipment such as buckets, chutes, buggies, belt conveyors, pumps, or other equipment as necessary. Ensure concrete is not transported or conveyed by equipment made of aluminum.

Use tremies to control the fall of concrete or for underwater placement. Use tremies that are watertight and of large enough diameter to allow the placement of the concrete but less than 14 in. in diameter. Construct the tremie so the bottom can be sealed and opened once the tremie has been fully charged with concrete for underwater placements.

Use pumps with lines at least 5 in. inside diameter (ID) where Grade 2 or smaller coarse aggregate is used, and at least 8 in. ID for Grade 1 coarse aggregate.

- 3.2. **Vibrators.** Use immersion-type vibrators for consolidation of concrete. Provide at least one standby vibrator for emergency use. Furnish vibrator head covered by a rubberized or elastomeric cover when used near epoxy coated reinforcing steel.

- 3.3. **Temperature Recording Equipment.** Use strip chart temperature-recording devices, recording maturity meters in accordance with [Tex-426-A](#), or other approved devices that are accurate to within $\pm 2^{\circ}\text{F}$ within the range of 32–212°F for mass concrete operations, for cold weather placements, and as otherwise specified.

- 3.4. **Artificial Heating Equipment.** Use artificial heating equipment as necessary for maintaining the concrete temperatures in accordance with Section 420.4.7.11., "Placing Concrete in Cold Weather."

- 3.5. **Spraying Equipment.** Use mechanically powered pressure sprayers, either air or airless, with appropriate atomizing nozzles for the application of membrane curing. Use hand-pressurized spray equipment with two or three fan-spray nozzles if approved. Ensure the spray from each nozzle overlaps the spray from adjacent nozzles by approximately 50%.

- 3.6. **Concrete Testing Equipment.** Provide testing equipment for use by the Engineer in accordance with Section 421.3.3., "Testing Equipment."

4. CONSTRUCTION

Obtain approval for proposed construction methods before starting work. Approval of construction methods and equipment does not relieve the Contractor's responsibility for safety or correctness of methods, adequacy of equipment, or completion of work in full accordance with the Contract.

Unless otherwise shown on the plans, it is the Contractor's option to perform testing on structural concrete (structural classes of concrete are identified as shown in Table 8 of Section 421.4.1., "Classification of Concrete Mix Designs") to determine the in-situ strength to address the schedule restrictions in accordance

with Section 420.4.1., "Schedule Restrictions." The Engineer may require the Contractor to perform this testing for concrete placed in cold weather. Make enough test specimens for Contractor-performed testing to ensure strength requirements are met for the operations listed in Section 420.4.1., "Schedule Restrictions." Make at least one set of test specimens for each element cast each day. Cure these specimens under the same conditions as the portion of the structure involved for all stages of construction. Ensure safe handling, curing, and storage of all test specimens. Provide testing personnel, and sample and test the hardened concrete in accordance with Section 421.4.8., "Sampling and Testing of Concrete." The maturity method, [Tex-426-A](#), may be used for in-situ strength determination for schedule restrictions if approved. Coring will not be allowed for in-situ strength determination for schedule restrictions. Provide the Engineer the opportunity to witness all testing operations. Report all test results to the Engineer.

If the Contractor does not wish to perform schedule restriction testing, the Engineer's 7-day lab-cured tests, performed in accordance with Article 421.5., "Acceptance of Concrete," will be used for schedule restriction determinations. The Engineer may require additional time for strength gain to account for field curing conditions such as cold weather.

- 4.1. **Schedule Restrictions.** Construct and open completed structures to traffic with the following limitations unless otherwise shown on the plans.

- 4.1.1. **Setting Forms.** Attain at least 2,500 psi compressive strength before erecting forms on concrete footings supported by piling or drilled shafts, or on individual drilled shafts. Erect forms on spread footings and culvert footings after the footing concrete has aged at least 2 curing days in accordance with Section 420.4.10., "Curing Concrete." Place concrete only after the forms and reinforcing steel have been inspected by the Engineer.

Support tie beam or cap forms by falsework on previously placed tie beams only if the tie beam concrete has attained a compressive strength of 2,500 psi and the member is properly supported to eliminate stresses not provided for in the design. Maintain curing as required until completion of the curing period.

Place superstructure forms or falsework on the substructure only if the substructure concrete has attained a compressive strength of 3,000 psi.

- 4.1.2. **Removal of Forms and Falsework.** Keep in place weight-supporting forms and falsework for bridge components and culvert slabs until the concrete has attained a compressive strength of 2,500 psi in accordance with Section 420.4.11., "Removal of Forms and Falsework." Keep all forms for mass placements in place for 4 days following concrete placement unless otherwise approved based on the outcome of the heat control plan in accordance with Section 420.4.7.14., "Mass Placements."

- 4.1.3. **Placement of Superstructure Members.** Erect or place superstructure members or precast substructure members only after the substructure concrete has attained a compressive strength of 3,000 psi.

- 4.1.4. **Opening to Traffic.** Direct traffic culverts may be opened to construction traffic when the design strength specified in Section 421.4.1., "Classification of Concrete Mix Designs," has been attained if curing is maintained. Obtain approval before opening direct traffic culverts to the traveling public. Open other noncritical structural and nonstructural concrete for service upon the completion of curing unless otherwise specified or directed.

- 4.1.5. **Post-Tensioned Construction.** Ensure strength requirements shown on the plans for structural elements designed to be post-tensioned are met for stressing and staged loading of structural elements.

- 4.1.6. **Backfilling.** Backfill in accordance with Section 400.3.3., "Backfill."

- 4.2. **Plans for Falsework and Forms.** Submit plans for falsework and forms for the following items: vertical forms for piers and single column bents; load supporting forms for caps and tie-beams; form attachments for bridges to be widened; and other items as indicated or directed. Provide design calculations when requested. Show all essential details of proposed forms, falsework, and bracing. Have a licensed professional engineer design, seal, and sign these plans. Department approval is not required, except as shown in Table 1 of

Item 5, "Control of the Work," when forms or falsework are located such that public safety can be affected, but the Department reserves the right to request modifications to the plans. The Contractor is responsible for the adequacy of these plans. Design job-fabricated formwork assuming a weight of 150 pcf for concrete, and include a live-load allowance of 50 psf of horizontal surface of the form. Do not exceed 125% of the allowable stresses used by the Department for the design of structures.

- 4.3. **Falsework.** Design and construct falsework to safely carry the maximum anticipated loads, including wind loads, and to provide the necessary rigidity. Consult AASHTO's *Guide Design Specifications for Bridge Temporary Works* and *Construction Handbook for Bridge Temporary Works* for falsework and shoring information not indicated below. Submit details in accordance with Section 420.4.2., "Plans for Falsework and Forms."

Design job-fabricated falsework assuming a weight of 150 pcf for concrete, and include a minimum live-load allowance of 50 psf of horizontal surface of the form. Do not exceed 125% of the allowable stresses used by the Department for the design of structures.

Do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction for commercially produced structural units used in falsework. Include a minimum live-load allowance of 35 psf of horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide timber that is sound, in good condition, and free of defects that would impair its strength. Provide timber that meets or exceeds the species, size, and grade requirements shown on the submitted falsework plans.

Provide wedges made of hardwood or metal in pairs to adjust falsework to desired elevations to ensure even bearing. Do not use wedges to compensate for incorrectly cut bearing surfaces.

Use sills or grillages large enough to support the superimposed load without settlement. Take precautions to prevent settling of the supporting material unless the sills or grillages are founded on solid rock, shale, or other hard materials.

Place falsework that cannot be founded on a satisfactory spread footing on piling or drilled shafts with enough bearing capacity to support the superimposed load without settlement. Drive falsework piling to the required resistance determined by the applicable formula in Item 404, "Driving Piling." Design drilled shafts for falsework to carry the superimposed load using both skin friction and point bearing.

Weld in accordance with Item 448, "Structural Field Welding." Securely brace each falsework bent to provide the stiffness required, and securely fasten the bracing to each pile or column it crosses.

Remove falsework when it is no longer required or as shown on the submitted falsework plan. Pull or cut off foundations for falsework at least 2 ft. below finished ground level. Completely remove falsework, piling, or drilled shafts in a stream, lake, or bay to the approved limits to prevent obstruction to the waterway.

- 4.4. **Forms.** Submit formwork plans in accordance with Section 420.4.2., "Plans for Falsework and Forms."

- 4.4.1. **General.** Provide forms of either timber or metal except where otherwise specified or permitted.

Design forms for the pressure exerted by a liquid weighing 150 pcf. Take the rate of concrete placement into consideration in determining the depth of the equivalent liquid. Include a minimum live-load allowance of 50 psf of horizontal surface for job-fabricated forms. Do not exceed 125% of the Department's allowable stresses for the design of structures.

Do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction for commercially produced structural units used for forms. Include a minimum live-load allowance of 35 psf of

horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide steel forms for round columns unless otherwise approved. Refer to Item 427, "Surface Finishes for Concrete," for additional requirements for off-the-form finishes.

Provide commercial form liners for imprinting a pattern or texture on the concrete surface as shown on the plans and in accordance with Section 427.4.3.5., "Form Liner Finish."

Provide forming systems that are practically mortar-tight, rigidly braced, and strong enough to prevent bulging between supports, and maintain them to the proper line and grade during concrete placement. Maintain forms in a manner that prevents warping and shrinkage. Do not allow offsets at form joints to exceed 1/16 in.

Use only material that is inert, non-biodegradable, and nonabsorptive for forms to be left in place.

Construct all forms to permit their removal without marring or damaging the concrete. Clean all forms and footing areas of any extraneous matter before placing concrete. Provide openings in forms if needed for the removal of laitance or foreign matter.

Treat the facing of all forms with bond-breaking coating of composition that will not discolor or injuriously affect the concrete surface. Take care to prevent coating of the reinforcing steel.

Complete all preparatory work before requesting permission to place concrete.

Cease placement if the forms show signs of bulging or sagging at any stage of the placement, and remove the portion of the concrete causing this condition immediately as directed. Reset the forms and securely brace them against further movement before continuing the placement.

4.4.2.

Timber Forms. Provide properly seasoned, good-quality lumber that is free of imperfections that would affect its strength or impair the finished surface of the concrete. Provide timber or lumber that meets or exceeds the requirements for species and grade shown on the submitted formwork plans.

Maintain forms or form lumber that will be reused so it stays clean and in good condition. Do not use any lumber that is split, warped, bulged, or marred, or that has defects in any way that will produce inferior work. Promptly remove such lumber from the work.

Provide form lining for all formed surfaces except:

- the inside of culvert barrels, inlets, manholes, and box girders;
- surfaces that are subsequently covered by backfill material or are completely enclosed; and
- any surface formed by a single finished board or by plywood.

Provide form lining of an approved type such as 5/8" asonite or plywood. Do not provide thin membrane sheeting such as polyethylene sheets for form lining.

Use plywood at least 3/4 in. thick. Place the grain of the face plies on plywood forms parallel to the span between the supporting studs or joists unless otherwise shown on the submitted form drawings.

Use plywood for forming surfaces that remain exposed that meets the requirements for B-B Plyform Class I or Class II Exterior of the U.S. Department of Commerce Voluntary Product Standard PS 1.

Space studs and joists so the facing form material remains in true alignment under the imposed loads.

Space wales closely enough to hold forms securely to the designated lines, scabbed at least 4 ft. on each side of joints to provide continuity. Place a row of wales near the bottom of each placement.

Place facing material with parallel and square joints, securely fastened to supporting studs.

Place forms with the form panels symmetrical (long dimensions set in the same direction) for surfaces exposed to view and receiving only an ordinary surface finish in accordance with Section 420.4.13., "Ordinary Surface Finish." Make horizontal joints continuous.

Make molding for chamfer strips or other uses of materials of a grade that will not split when nailed and can be maintained to a true line without warping. Dress wood molding on all faces. Fill forms at all sharp corners and edges with triangular chamfer strips measuring 3/4 in. on the sides unless otherwise shown on the plans.

Use metal form ties of an approved type or a satisfactory substitute of a type that permits ease of removal of the metal to hold forms in place. Cut back wire ties at least 1/2 in. from the face of the concrete.

Use devices to hold metal ties in place that can develop the strength of the tie and adjust to allow for proper alignment.

Entirely remove metal and wooden spreaders that separate the forms as the concrete is being placed.

Provide adequate cleanout openings for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

- 4.4.3. **Metal Forms.** Requirements for timber forms regarding design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse, and wetting also apply to metal forms, except metal forms do not require lining unless as specifically shown on the plans.

Use form metal thick enough to maintain the true shape without warping or bulging. Countersink all bolt and rivet heads on the facing sides. Design clamps, pins, or other connecting devices to hold the forms rigidly together and to allow removal without damage to the concrete. Use metal forms that present a smooth surface and line up properly. Keep metal free of rust, grease, and other foreign materials.

- 4.5. **Drains.** Install and construct weep holes and roadway drains as shown on the plans.

- 4.6. **Placing Reinforcement and Post-Tensioning.** Place reinforcement in accordance with Item 440. Do not weld reinforcing steel supports to other reinforcing steel except where shown on the plans.

Place post-tensioning ducts, anchorages, and other hardware in conformance with the approved prestressing details and in accordance with Item 426, "Post-Tensioning." Keep ducts free of obstructions until all post-tensioning operations are complete.

- 4.7. **Placing Concrete.** Give the Engineer sufficient advance notice before placing concrete in any unit of the structure to permit the inspection of forms, reinforcing steel placement, and other preparations.

Do not place concrete when impending weather conditions would impair the quality of the finished work. Place concrete in early morning or at night or adjust the placement schedule for more favorable weather when conditions of wind, humidity, and temperature are such that concrete cannot be placed without the potential for weather-related distress.

Adequately illuminate the entire placement site as approved when mixing, placing, and finishing concrete in non-daylight hours.

Furnish adequate shelter to protect the concrete against damage from rainfall or freezing temperatures in accordance with this Item if changes in weather conditions require protective measures after work starts. Continue operations during rainfall only if approved. Use protective coverings for the material stockpiles. Cover aggregate stockpiles only to the extent necessary to control the moisture conditions in the aggregates.

Allow at least 1 curing day after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.

- 4.7.1. **Placing Temperature.** Place concrete in accordance with the following temperature limits for the classes of concrete defined in Section 421.4.1., "Classification of Concrete Mix Designs."
- Place Class C, F, H, K, or SS concrete only when its temperature at time of placement is between 50°F and 95°F. Increase the minimum placement temperature to 60°F if slag cement is used in the concrete.
 - Place Class S concrete, used in this Item only as indicated for culvert top slabs, only when its temperature is between 50°F and 85°F. Increase the minimum placement temperature to 60°F if slag cement is used in the concrete.
 - Place Class A, B, and D concrete only when its temperature at the time of placement is greater than 50°F.
 - Place mass concrete in accordance with Section 420.4.7.14., "Mass Placements," only when its temperature at the time of placement is between 50°F and 75°F.
- 4.7.2. **Transporting Time.** Begin the discharge of concrete delivered in truck mixers within the times shown in Table 14 of Item 421.
- 4.7.3. **Workability of Concrete.** Place concrete with a slump as specified in Section 421.4.2.5., "Slump." Water may be added to the concrete before discharging any concrete from the truck to adjust for low slump, provided that the maximum mix design water-cement ratio is not exceeded. Mix concrete in accordance with Section 421.4.6., "Mixing and Delivering Concrete," after introduction of any additional water or chemical admixtures. Do not add water or chemical admixtures after any concrete has been discharged.
- 4.7.4. **Transporting Concrete.** Transport concrete by buckets, chutes, buggies, belt conveyors, pumps, or other methods.
- Protect concrete transported by conveyors from sun and wind to prevent loss of slump and workability. Shade or wrap with wet burlap pipes through which concrete is pumped as necessary to prevent loss of slump and workability.
- Arrange and use chutes, troughs, conveyors, or pipes so the concrete ingredients will not be separated. Terminate such equipment in vertical downspouts when necessary to prevent segregation. Extend open troughs and chutes, if necessary, down inside the forms or through holes left in the forms.
- Keep all transporting equipment clean and free of hardened concrete coatings. Discharge water used for cleaning clear of the concrete.
- 4.7.5. **Preparation of Surfaces.** Thoroughly wet all forms and hardened concrete on which concrete is to be placed before placing concrete on them. Remove any remaining puddles of excess water before placing concrete. Provide surfaces that are in a moist, saturated surface-dry (SSD) condition when concrete is placed on them.
- Ensure the subgrade or foundation is moist before placing concrete on grade. Lightly sprinkle the subgrade if dry.
- 4.7.6. **Expansion Joints.** Construct joints and devices to provide for expansion and contraction as shown on the plans.
- Use light wire or nails to anchor any preformed fiber joint material to the concrete on one side of the joint.
- Ensure finished joints conform to the plans with the concrete sections completely separated by the specified opening or joint material.

Remove all concrete within the joint opening soon after form removal and again where necessary after surface finishing to ensure full effectiveness of the joint.

- 4.7.7. **Construction Joints.** A construction joint is the joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set. Monolithic placement means the manner and sequence of concrete placing do not create a construction joint.

Make construction joints of the type and at the locations shown on the plans. Additional joints in other members are not permitted without approval. Place authorized additional joints using details equivalent to those shown on the plans for joints in similar locations.

Make construction joints square and normal to the forms unless otherwise required. Use bulkheads in the forms for all vertical joints.

Thoroughly roughen the top surface of a concrete placement terminating at a horizontal construction joint as soon as practical after initial set is attained.

Thoroughly clean the hardened concrete surface of all loose material, laitance, dirt, and foreign matter, and saturate it with water. Remove all free water and moisten the surface before concrete or bonding grout is placed against it. Ensure the surface of the existing concrete is in an SSD condition just before placing subsequent concrete. Wet the existing concrete by ponding water on the surface for 24 hr. before placing subsequent concrete. Use high-pressure water blasting if ponding is not possible to achieve SSD conditions 15–30 min. before placing the concrete. An SSD condition is achieved when the surface remains damp when exposed to sunlight for 15 min.

Draw forms tight against the existing concrete to avoid mortar loss and offsets at joints.

Bonding agents are not required unless indicated otherwise. Coat the joint surface with bonding mortar, grout, epoxy, or other material if a bonding agent is required as shown on the plans. Provide Type V epoxy in accordance with [DMS-6100](#) for bonding fresh concrete to hardened concrete. Place the bonding epoxy on a clean, dry surface, and place the fresh concrete while the epoxy is still tacky. Place bonding mortar or grout on a surface that is SSD and place the concrete before the bonding mortar or grout dries. Place other bonding agents in conformance with the manufacturer's recommendations.

- 4.7.8. **Handling and Placing.** Minimize segregation of the concrete and displacement of the reinforcement when handling and placing concrete. Produce a uniform, dense compact mass.

Ensure concrete free falls no more than 5 ft. except in the case of drilled shafts, thin walls such as in culverts, or as allowed in conformance with other Items. Remove any hardened concrete splatter ahead of the plastic concrete.

Fill each part of the forms by depositing concrete as near to its final position as possible. Do not deposit large quantities of concrete at one point and run or move the concrete along to fill the forms.

Deposit concrete in the forms in layers of suitable depth but no more than 36 in. deep unless otherwise permitted.

Avoid cold joints in a monolithic placement. Sequence successive layers or adjacent portions of concrete so they can be vibrated into a homogeneous mass with the previously placed concrete before it sets. Allow no more than 1 hr. to elapse between adjacent or successive placements of concrete when re-vibration of the concrete is shown on the plans, except as otherwise allowed by an approved placing procedure. This time limit may be extended by 1/2 hr. if the concrete contains at least the minimum recommended dosage of a Type B or Type D admixture.

- 4.7.9. **Consolidation.** Carefully consolidate concrete and flush mortar to the form surfaces using immersion-type vibrators. Do not use vibrators that operate by attachment to forms or reinforcement except where approved on steel forms.

Vibrate the concrete immediately after deposit. Systematically space points of vibration to ensure complete consolidation and thorough working of the concrete around the reinforcement and embedded fixtures, and into the corners and angles of the forms. Insert the vibrators vertically where possible. Vibrate the entire depth of each lift, allowing the vibrator to penetrate several inches into the preceding lift. Do not use the vibrator to move the concrete to other locations in the forms. Do not drag the vibrator through the concrete. Thoroughly consolidate concrete along construction joints by operating the vibrator along and close to but not against the joint surface. Continue the vibration until the concrete surrounding reinforcements and fixtures is completely consolidated. Hand-spade or rod the concrete if necessary to ensure flushing of mortar to the surface of all forms.

- 4.7.10. **Installation of Dowels and Anchor Bolts.** When shown on the plans, provide an Adhesive Anchor Installer certified by ACI. Install dowels and anchor bolts by casting them in place or by grouting with grout, epoxy, or epoxy mortar unless specified otherwise. Form or drill holes for grouting. Follow the manufacturer's recommended installation procedures for pre-packaged grout or epoxy anchor systems. Test anchors if required on the plans or in conformance with other Items.

Drill holes for anchor bolts to accommodate the bolt embedment required by the plans. Make holes for dowels at least 12 in. deep unless otherwise shown on the plans. Make the hole diameter at least twice the dowel or bolt diameter, but not exceeding the dowel or bolt diameter plus 1-1/2 in. when using cementitious grout or epoxy mortar. Make the hole diameter 1/16–1/4 in. greater than the dowel or bolt diameter when using neat epoxy unless specified otherwise by the epoxy manufacturer.

Thoroughly clean holes of all loose material, oil, grease, or other bond-breaking substance, and blow them clean with filtered compressed air. Use a wire brush followed by oil-free compressed air to remove all loose material from the holes, repeating as necessary until no more material is removed. Ensure holes are in a surface-dry condition when epoxy-type materials are used and in a surface-moist condition when cementitious grout is used. Develop and demonstrate for approval a procedure for cleaning and preparing the holes for installation of the dowels and anchor bolts. Completely fill the void between the hole and dowel or bolt with grouting material. Follow exactly the requirements for cleaning in conformance with the product specifications for pre-packaged systems.

Provide hydraulic cement grout for cast-in-place or grouted systems in accordance with [DMS-4675](#). Provide a Type III epoxy in accordance with [DMS-6100](#) when neat epoxy is used for anchor bolts or dowels. Provide Type VIII epoxy in accordance with [DMS-6100](#) when an epoxy grout is used. Provide grout, epoxy, or epoxy mortar as the binding agent unless otherwise shown on the plans.

Provide other anchor systems as required on the plans.

- 4.7.11. **Placing Concrete in Cold Weather.** Protect concrete placed under weather conditions where weather may adversely affect results. Permission given by the Engineer for placing during cold weather does not relieve the Contractor of responsibility for producing concrete equal in quality to that placed under normal conditions. Remove and replace concrete as directed at the Contractor's expense if it is determined unsatisfactory due to poor conditions.

Do not place concrete in contact with any material coated with frost or with a temperature of 32°F or lower. Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Place concrete when the ambient temperature in the shade is at least 35°F and rising or above 40°F.

Provide and install recording thermometers, maturity meters, or other suitable temperature-measuring devices to verify all concrete is effectively protected as follows.

- Maintain the temperature at all surfaces of concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, top slabs of non-direct traffic culverts, and other similar formed concrete at or above 40°F for 72 hr. from the time of placement.
- Maintain the temperature of all other concrete, including the bottom slabs (footings) of culverts, placed on or in the ground above 32°F for 72 hr. from the time of placement.

Use additional covering, insulated forms, or other means and, if necessary, supplement the covering with artificial heating. Avoid applying heat directly to concrete surfaces. Cure in accordance with Section 420.4.10., "Curing Concrete," during this period until all requirements for curing have been satisfied.

Have all necessary heating and covering material ready for use before permission is granted to begin placement when impending weather conditions indicate the possible need for temperature protection.

- 4.7.12. **Placing Concrete in Hot Weather.** Keep the concrete at or below the maximum temperature at time of placement in accordance with Section 420.4.7.1., "Placing Temperature." Sprinkle and shade aggregate stockpiles or use ice, liquid nitrogen systems, or other approved methods as necessary to control the concrete temperature.

- 4.7.13. **Placing Concrete in Water.** Deposit concrete in water only when shown on the plans or with approval. Make forms or cofferdams tight enough to prevent any water current passing through the space in which the concrete is being deposited. Do not pump water during the concrete placing or until the concrete has set for at least 36 hr.

Place the concrete using a tremie or pump, or use another approved method, and do not allow it to fall freely through the water or disturb it after it is placed. Keep the concrete surface level during placement.

Support the tremie or operate the pump so it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow. Keep the lower end of the tremie or pump hose submerged in the concrete. Use continuous placing operations until the work is complete.

Design the concrete mix in accordance with Item 421 with a minimum cement content of 650 lb. per cubic yard for concrete to be placed under water. Include an anti-washout admixture in the mix design as necessary to produce a satisfactory finished product.

- 4.7.14. **Mass Placements.** Develop and obtain approval for a heat control plan for monolithic placements designated on the plans as mass concrete to ensure the following during the heat dissipation period:
- the temperature differential between the central core of the placement and the exposed concrete surface does not exceed 35°F and
 - the temperature at the central core of the placement does not exceed 160°F.

Use the ConcreteWorks© software available from the Department, or another approved method in accordance with ACI 207, "Mass Concrete," to develop the heat control plan. The Department will make available technical assistance on the use of ConcreteWorks©. Develop the heat control plan using historical temperature ranges for the anticipated time of the mass placement. Re-create the plan if the work schedule shifts by more than one month.

The heat control plan may include a combination of the following elements:

- selection of concrete ingredients including aggregates, gradation, and cement types, to minimize heat of hydration;
- use of ice or other concrete cooling ingredients;
- use of liquid nitrogen dosing systems;
- controlling rate or time of concrete placement;
- use of insulation or supplemental external heat to control heat loss;
- use of supplementary cementing materials;

- use of a cooling system to control the core temperature; or
- vary the duration for which formwork remains in place.

Furnish and install two pairs of temperature-recording devices, maturity meters, or other approved equivalent devices. Install devices to measure the surface temperature no more than 3 in. from the surface. Install devices to measure the core temperature half the least dimension from the nearest surface near the point of maximum predicted heat. Use these devices to simultaneously measure the temperature of the concrete at the core and the surface. Maintain temperature control methods for 4 days unless otherwise approved in conformance with the submitted heat control plan. Do not use maturity meters to predict strength of mass concrete. Revise the heat control plan as necessary to maintain the temperature limitations shown above.

If the core temperature exceeds 160°F, the mass concrete element will be subject to review and acceptance by the Engineer using forensic analyses to determine its potential reduction in service life or performance. Proceed with subsequent construction on the affected element only when notified regarding acceptance. Repair any resulting cracking if the temperature differential between the central core of the placement and the nearest concrete surface exceeds 35°F at no expense to the Department and revise the heat control plan as necessary to prevent further occurrences.

- 4.7.15. **Placing Concrete in Foundation and Substructure.** Do not place concrete in footings until the depth and character of the foundation have been inspected and permission has been given to proceed.

Place concrete footings upon seal concrete after the cofferdams are free of water and the seal concrete is cleaned. Perform any necessary pumping or bailing during the concreting from a suitable sump located outside the forms.

Construct or adjust all temporary wales or braces inside cofferdams as the work proceeds to prevent unauthorized construction joints.

Omit forms when footings can be placed in a dry excavation without the use of cofferdams, if approved, and fill the entire excavation with concrete to the elevation of the top of footing.

Place concrete in columns monolithically between construction joints unless otherwise directed. Columns and caps or tie beams supported on them may be placed in the same operation or separately. Allow for settlement and shrinkage of the column concrete, if placed in the same operation, by placing it to the lower level of the cap or tie beam, and delay placement between 1 hr. and 2 hr. before proceeding with the cap or tie beam placement.

- 4.7.16. **Placing Concrete in Box Culverts.** Allow between 1 hr. and 2 hr. to elapse where the top slab and walls are placed monolithically in culverts more than 4 ft. in clear height before placing the top slab to allow for settlement and shrinkage in the wall concrete.

Accurately finish the footing slab at the proper time to provide a smooth, uniform surface. Finish top slabs that carry direct traffic in accordance with Item 422, "Concrete Superstructures." Give top slabs of fill-type culverts a float finish.

- 4.8. **Extending Existing Substructures.** Verify pertinent dimensions and elevations of the existing structure before ordering any required materials.

- 4.8.1. **Removal.** Remove portions of the existing structure to the lines and dimensions shown on the plans or as directed. Dispose of these materials as shown on the plans or as directed. Repair any portion of the remaining structure damaged by the construction.

Do not use explosives to remove portions of the existing structure unless approved in writing. Do not use a demolition ball, other swinging weight, or impact equipment unless shown on the plans. Use pneumatic or hydraulic tools for final removal of concrete at the "break" line. Use removal equipment, as approved, that will not damage the remaining concrete.

- 4.8.2. **Reuse of Removed Portions of Structure.** Detach and remove all portions of the old structure that are to be incorporated into the extended structure to the lines and details as shown on the plans or as directed. Move the unit to be reused to the new location specified using approved methods. Place the reinforcement and extension concrete as shown on the plans.
- 4.8.3. **Splicing Reinforcing Steel.** Splice new reinforcing bars to exposed bars in the existing structure using lap splices in accordance with Item 440, unless otherwise shown on the plans. The new reinforcing steel does not need to be tied to the existing steel where spacing or elevation does not match that of the existing steel, provided the lap length is attained. Weld in accordance with Item 448 when welded splices are permitted. Install any required dowels in accordance with Section 420.4.7.10., "Installation of Dowels and Anchor Bolts."
- 4.8.4. **Concrete Preparation.** Roughen and clean concrete surfaces that are in contact with new construction before placing forms. Prepare these construction joint surfaces in accordance with Section 420.4.7.7., "Construction Joints."
- 4.9. **Treatment and Finishing of Horizontal Surfaces.** Strike off to grade and finish all unformed upper surfaces. Do not use mortar topping for surfaces constructed under this Section.

Float the surface with a suitable float after the concrete has been struck off.

Slope the tops of caps and piers between bearing areas from the center slightly toward the edge, and slope the tops of abutment and transition bent caps from the backwall to the edge, as directed, so water drains from the surface. Give the concrete a smooth trowel finish. Construct bearing areas for steel units in accordance with Section 441.3.11.6., "Bearing and Anchorage Devices." Give the bearing area under the expansion ends of concrete slabs and slab and girder spans a steel-trowel finish to the exact grades required. Give bearing areas under elastomeric bearing pads or nonreinforced bearing seat buildups a textured, wood float finish. Do not allow the bearing area to vary from a level plane more than 1/16 in. in all directions.

Cast bearing seat buildups or pedestals for concrete units integrally with the cap or a construction joint. Provide a latex-based mortar, an epoxy mortar, or an approved proprietary bearing mortar for bearing seat buildups cast with a construction joint. Mix mortars in conformance with the manufacturer's recommendations. Construct pedestals of Class C concrete, reinforced as shown on the plans or as indicated in Figure 1 and Figure 2. The Engineer of Record will design pedestals higher than 12 in.

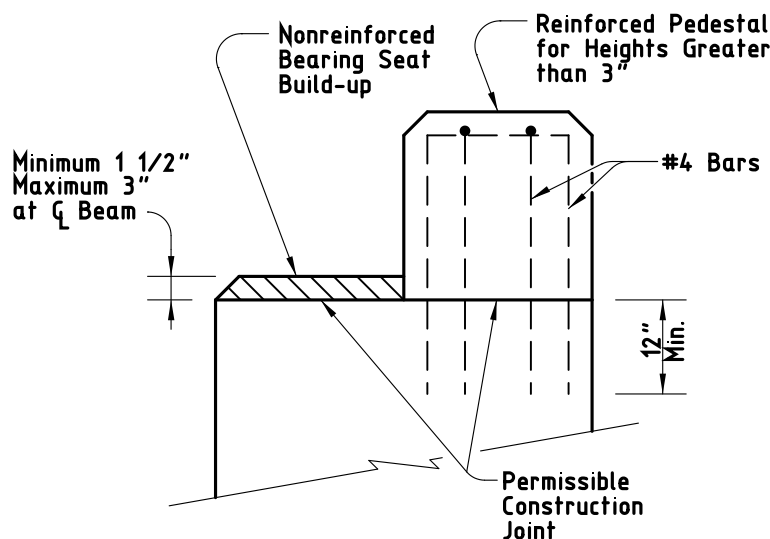


Figure 1
Section Through Bearing Seat Buildups

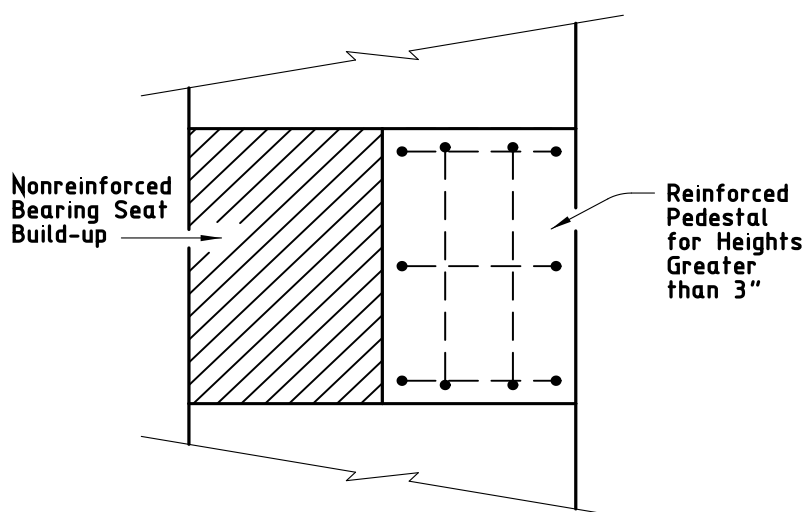


Figure 2
Plan View of Bearing Seat Buildups

- 4.10. **Curing Concrete.** Obtain approval of the proposed curing methods, equipment, and materials before placing concrete. The Engineer may require the same curing methods for like portions of a single structure. Inadequate curing or facilities may delay all concrete placements on the project until remedial action is taken.

A curing day is a calendar day when the temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hr. or, on colder days if the temperature of all surfaces of the concrete is maintained above 40°F, for the entire 24 hr. The required curing period begins when all concrete has attained its initial set unless specified otherwise. [Tex-440-A](#) may be used to determine when the concrete has attained its initial set.

Cure all concrete for 4 consecutive days except as allowed for the curing options listed below. Use form or membrane curing for vertical surfaces unless otherwise approved. Use only water curing for horizontal surfaces of high-performance concrete (HPC) or mass concrete. Use water or membrane curing for horizontal or unformed surfaces for all other concrete.

Use one of the following curing options for vertical surfaces, unless specified otherwise.

- Form cure for 48 hr. after placement.
- Form cure for 12 hr. after placement followed by membrane curing.
- For HPC, form cure for 48 hr. after placement followed by membrane curing.
- For mass concrete, form cure in conformance with the heat control plan followed by membrane curing if forms are removed before 4 days.

Apply membrane curing, if used, within 2 hr. of form removal.

Use only water curing in accordance with this Section for the top surface of any concrete unit upon which concrete is to be placed and bonded at a later interval (e.g., stub walls, caps with backwalls, and risers).

Cure all other concrete in conformance with the pertinent Items. Use the following methods for curing concrete in accordance with this Item.

- 4.10.1. **Form Curing.** When forms are left in intimate contact with the concrete, other curing methods are not required except for exposed surfaces and for cold weather protection. Use another approved curing method if forms are removed before the 4-day required curing period.

- 4.10.2. **Water Curing.** Keep all exposed surfaces of the concrete wet continuously for the required curing time. Use water curing in accordance with concrete mixing water in Section 421.2.5., "Water." Do not use seawater or water that stains or leaves an unsightly residue.
- 4.10.2.1. **Blankets.** Keep the concrete continuously wet by maintaining wet cotton or burlap mats in direct contact with the concrete for the required curing time. Weight the mats adequately to provide continuous contact with all concrete. Cover surfaces that cannot be cured by direct contact with mats, forming an enclosure well anchored to the forms or ground so outside air cannot enter the enclosure. Provide sufficient moisture inside the enclosure to keep all surfaces of the concrete wet.
- 4.10.2.2. **Water Spray.** Overlap sprays or sprinklers to keep all unformed surfaces continuously wet.
- 4.10.2.3. **Ponding.** Cover the surfaces with at least 2 in. of clean granular material, always kept wet, or at least 1 in. of deep water. Use a dam to retain the water or saturated granular material.
- 4.10.3. **Membrane Curing.** Choose either Type 1-D or Type 2 membrane-curing compound unless otherwise shown on the plans. Use the same type of curing compound on an individual member.
- Apply membrane curing just after free moisture has disappeared at a rate of approximately 180 sq. ft. per gallon. Do not spray curing compound on projecting reinforcing steel or concrete that will later form a construction joint. Do not apply membrane curing to dry surfaces. Dampen formed surfaces and surfaces that have been given a first rub, so they are moist at the time of application of the membrane.
- Leave the film unbroken for the minimum curing period specified when membrane is used for complete curing. Correct damaged membrane immediately by reapplication of membrane. Polyethylene sheeting, burlap-polyethylene mats, or laminated mats in close contact with the concrete surfaces are equivalent to membrane curing.
- 4.11. **Removal of Forms and Falsework.** Remove forms for vertical surfaces after the concrete has aged at least 12 hr. after initial set, provided the removal can be done without damage to the concrete, unless otherwise directed. Keep forms for mass placements in place for 4 days following concrete placement unless otherwise approved based on the outcome of the heat control plan in accordance with Section 420.4.7.14., "Mass Placements."
- Leave in place weight-supporting forms and falsework spanning more than 1 ft. for all bridge components and culvert slabs except as directed otherwise until the concrete has attained a compressive strength of 2,500 psi. Remove forms for other structural components as necessary.
- Remove inside forms (walls and top slabs) for box culverts and sewers after concrete has attained a compressive strength of 1,800 psi if an approved overhead support system is used to transfer the weight of the top slab to the walls of the box culvert or sewer before removal of the support provided by the forms.
- Forms or parts of forms may be removed only if constructed to permit removal without disturbing forms or falsework required to be left in place for a longer period on other portions of the structure.
- Remove all metal appliances used inside forms for alignment to a depth of at least 1/2 in. from the concrete surface. Make the appliances so metal may be removed without undue chipping or spalling of the concrete, and so it leaves a smooth opening in the concrete surface when removed. Do not burn off rods, bolts, or ties.
- Remove all forms and falsework unless otherwise directed.
- 4.12. **Defective Work.** Repair defective work as soon as possible. Remove and replace at the expense of the Contractor any defect that cannot be repaired to the satisfaction of the Engineer.

- 4.13. **Ordinary Surface Finish.** Apply an ordinary surface finish to all concrete surfaces. Provide surfaces with uniform appearance. Address defects and surface irregularities not consistent with the intent of the expected finish by the following:
- Chip away all loose or broken material to sound concrete where porous, spalled, or honeycombed areas are visible after form removal.
 - Repair spalls in accordance with the *Concrete Repair Manual* available on the Department's website.
 - Clean and fill holes or spalls caused by the removal of metal appliances used inside forms, with latex grout, cement grout, or epoxy grout as approved. Do not blend the patch with the surrounding concrete.
 - Remove all fins, rust staining, runs, drips, or mortar from surfaces that will be exposed. Smooth all form marks and chamfer edges by grinding or dry-rubbing.
 - Ensure all repairs are dense, well-bonded, and properly cured. Finish exposed large repairs to blend with the surrounding concrete where a higher class of finish is not specified.

Apply an ordinary surface finish as the final finish to the following exposed surfaces unless specified otherwise:

- inside and top of inlets,
- inside and top of manholes,
- inside of sewer appurtenances, and
- inside of culvert barrels.

Form marks and chamfer edges do not need to be smoothed for the inside of culvert barrels.

5. MEASUREMENT

This Item will be measured by the cubic yard, square yard, foot, square foot, or each structure.

- 5.1. **General.** Concrete quantities will be based on the dimensions shown on the plans or those established in writing by the Engineer.

In determining quantities, no deductions will be made for chamfers less than 2 in. or for embedded portions of steel or prestressed concrete beams, piling, anchor bolts, reinforcing steel, drains, weep holes, junction boxes, electrical or telephone conduit, ducts and voids for prestressed tendons, or embedded portions of light fixtures.

Variation in concrete headwall quantity incurred when an alternate bid for pipe is permitted will not be cause for payment adjustment.

Quantities revised by a change in design, measured as specified, will be increased or decreased and included for payment.

- 5.2. **Plans Quantity.** Structure elements shown in Table 1 and measured by the cubic yard are plans quantity measurement items. The quantity to be paid for plans quantity items is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

No adjustment will be made for footings or other in-ground elements where the Contractor has been allowed to place concrete in an excavation without forms.

Table 1
Plans Quantity Payment
(Cubic Yard Measurement Only)

Culverts and culvert wing walls	Abutments
Headwalls for pipe	Footings
Retaining walls	Pile bent caps
Inlets and manholes	Post-tensioned elements

Note—Other elements, including pier and bent concrete, may be paid for as “plans quantity” when shown on the plans.

- 5.3. **Measured in Place.** Items not paid for as “plans quantity” will be measured in place.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for the class of concrete and element identified and by the special designation when appropriate. This price is full compensation for furnishing, hauling, and mixing concrete materials; furnishing, bending, fabricating, splicing, welding, and placing the required reinforcement; clips, blocks, metal spacers, ties, wire, or other materials used for fastening reinforcement in place; placing, finishing, and curing concrete; mass placement controls; applying ordinary surface finish; installing bridge identification numbers; furnishing and placing drains, metal flashing strips, and expansion joint material; excavation; subgrade preparation; and forms and falsework, and for equipment, labor, tools, and incidentals.

Price will be adjusted in accordance with Article 421.6., “Measurement and Payment,” when required to address non-compliance of project acceptance testing.

Design and installation of foundations for falsework are at the Contractor’s expense.

In addition to the work described above, for extending structures the unit prices bid for the various classifications of concrete shown are full compensation for removing and disposing of, if necessary, the designated portion of the existing structure; removing, stockpiling if necessary, and replacing headwall units for reuse; cleaning, bending, and cutting of exposed reinforcing steel; splicing of new reinforcing steel to existing reinforcing steel; installation of dowels; and cleaning and preparing existing concrete surfaces.

Item 421

Hydraulic Cement Concrete



1. DESCRIPTION

Furnish hydraulic cement concrete for concrete pavements, concrete structures, and other concrete construction.

2. MATERIALS

Use materials from prequalified sources listed on the Department website. Provide aggregates from sources listed in the Department's Concrete Rated Source Quality Catalog (CRSQC). Use materials from non-listed sources only when tested and approved before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources. Do not combine approved material with unapproved material.

2.1. **Cement.** Furnish cement in accordance with [DMS-4600](#), "Hydraulic Cement."

2.2. **Supplementary Cementitious Materials (SCMs).**

- **Coal Ash.** Furnish sources of fly ash, modified fly ash (MFA), harvested coal ash (HCA), and ground bottom ash (GBA) in accordance with [DMS-4610](#), "Coal Ash."
- **Slag Cement.** Furnish slag cement in accordance with [DMS-4620](#), "Slag Cement."
- **Silica Fume.** Furnish silica fume in accordance with [DMS-4630](#), "Silica Fume."
- **Natural Pozzolans.** Furnish natural pozzolans in accordance with [DMS-4635](#), "Natural Pozzolans."

2.3. **Cementitious Material.** Cementitious materials are the cement and SCMs used in concrete.

2.4. **Chemical Admixtures.** Furnish admixtures in accordance with [DMS-4640](#), "Chemical Admixtures for Concrete."

2.5. **Water.** Furnish mixing and curing water that is free of oils, acids, organic matter, or other deleterious substances. Water from municipal supplies approved by the Texas Department of Health will not require testing. Provide test reports showing compliance with Table 1 before use when using water from other sources.

Water that is a blend of concrete wash water and other acceptable water sources, certified by the concrete producer as complying with the requirements shown in Table 1 and Table 2, may be used as mix water. Test the blended water weekly for 4 weeks for compliance with Table 1 and Table 2 or provide previous test results. Then test every month for compliance. Provide water test results upon request.

Do not use mix water that has an adverse effect on the air-entraining agent, on any other chemical admixture, or on strength or time of set of the concrete. Use mixing and curing water free of iron and other impurities that may cause staining or discoloration when using white hydraulic cement.

Table 1
Chemical Limits for Mix Water

Contaminant	Test Method	Max Concentration (ppm or mg/L)
Chloride (Cl)	ASTM C114 ¹	
Prestressed concrete		500
Bridge decks & superstructure		500
All other concrete		1,000
Sulfate (SO ₄)	ASTM C114 ¹	2,000
Alkalis (Na ₂ O + 0.658K ₂ O)	ASTM C114 ¹	600
Total solids	ASTM C1603	50,000

1. ASTM C114 includes reference and alternative test methods to measure the concentration of chlorides, sulfates, and alkalis in solutions prepared from dissolving cementitious materials. Use the applicable Test Methods in C114 to measure these constituents. The laboratory performing these tests is not required to conform to the method qualification requirements of Test Methods C114. Alternative instrumental and wet chemistry methods not listed in Test Methods C114 that measure the concentration of these chemical species in solution are permitted. When alternative methods are used, the test method used will be included in the report.

Table 2
Acceptance Criteria for Questionable Water Supplies

Property	Test Method	Limits
Compressive strength, Min % control at 7 days	ASTM C31, ASTM C39 ^{1,2}	90
Time of set, deviation from control, h:min.	ASTM C403	From 1:00 early to 1:30 later

1. Base comparisons on fixed proportions and the same volume of test water compared to the control mix using 100% potable water or distilled water.
2. Base comparisons on sets consisting of at least two standard specimens made from a composite sample.

2.6.

Aggregate.

2.6.1.

Coarse Aggregate. Provide coarse aggregate consisting of durable particles of gravel, crushed blast furnace slag, recycled crushed hydraulic cement concrete, crushed stone, or combinations that are free of frozen material and injurious amounts of salt, alkali, vegetable matter, or other objectionable material, either free or as an adherent coating. Provide coarse aggregate of uniform quality throughout.

Provide coarse aggregate with the requirements shown in Table 3 unless otherwise shown on the plans.

Table 3
Coarse Aggregate Requirements

Description	Test Method	Limit
Weight of clay lumps, % Max	Tex-413-A	0.25
Weight of shale, % Max		1.0
Weight of laminate and friable particle, % Max		5.0
L.A. abrasion wear, % Max	Tex-410-A	40
5-cycle magnesium sulfate soundness, ^{1,2} non-air-entrained concrete, % Max	Tex-411-A	25
5-cycle magnesium sulfate soundness, ^{1,3} air-entrained concrete, % Max		18
Loss by decantation, % Max	Tex-406-A	1.5

1. Recycled crushed hydraulic cement concrete is not subject to 5-cycle magnesium sulfate soundness requirements.
2. Allowed when air-entrained concrete is used at the Contractor's option.
3. Only when air-entrained concrete is required by the plans.

Increase the loss by decantation limit to 3.0% for all classes of concrete and 5.0% for Class A, B, and P if the material finer than the No. 200 sieve is determined to be at least 85% calcium carbonate in accordance with [Tex-406-A](#), Part III, in the case of coarse aggregates made primarily from crushing stone, unless otherwise shown on the plans. Provide test results upon request.

Provide coarse aggregate or combination of aggregates conforming to the gradation requirements shown in Table 4 when tested in accordance with [Tex-401-A](#) unless otherwise specified.

Table 4
Coarse Aggregate Gradation Chart

Aggregate Grade No. ¹	Maximum Nominal Size	Percent Passing on Each Sieve								
		2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	#4	#8
1	2"	100	80–100	50–85	–	20–40	–	–	0–10	–
2	1-1/2"	–	100	95–100	–	35–70	–	10–30	0–10	–
3	1-1/2"	–	100	95–100	–	60–90	25–60	–	0–10	–
4 (57)	1"	–	–	100	95–100	–	25–60	–	0–10	0–5
5 (67)	3/4"	–	–	–	100	90–100	–	20–55	0–10	0–5
6 (7)	1/2"	–	–	–	–	100	90–100	40–70	0–15	0–5
7	3/8"	–	–	–	–	–	100	70–95	0–25	–
8	3/8"	–	–	–	–	–	100	95–100	20–65	0–10

1. Corresponding ASTM C33 gradation shown in parentheses.

2.6.2.

Fine Aggregate. Provide fine aggregate consisting of clean, hard, durable particles of natural, manufactured sand; recycled crushed hydraulic cement concrete; slag; lightweight aggregate; or a combination thereof. Provide fine aggregate free of frozen material and injurious amounts of salt, alkali, vegetable matter, or other objectionable material.

Provide fine aggregates in accordance with Table 5 unless otherwise shown on the plans.

Table 5
Fine Aggregate Requirements

Description	Test Method	Limit
Weight of clay lumps, % Max	Tex-413-A	0.50
Organic impurities ¹	Tex-408-A	Color not darker than standard
Sand equivalent, Min	Tex-203-F	80
Fineness modulus	Tex-402-A	2.3–3.1

1. Only when air-entrained concrete is specified.

Provide fine aggregate or combinations of aggregates conforming to the gradation requirements shown in Table 6 when tested in accordance with [Tex-401-A](#) unless otherwise specified.

Table 6
Fine Aggregate Gradation Chart (Grade 1)

Sieve Size	% Passing
3/8"	100
#4	95–100
#8	80–100
#16	50–85
#30	25–65
#50	10–35 ¹
#100	0–10
#200	0–3 ²

1. 6–35 when sand equivalent value is greater than 85.
2. 0–6 for manufactured sand.

2.6.3.

Intermediate Aggregate. Provide intermediate aggregate consisting of clean, hard, durable particles of natural, manufactured sand; slag; recycled crushed hydraulic cement concrete; lightweight aggregate; or a combination thereof when optimized aggregate gradation (OAG) concrete is specified or when used at the Contractor's option. Provide intermediate aggregate free of frozen material and injurious amounts of salt, alkali, vegetable matter, or other objectionable material.

Provide intermediate aggregate in accordance with Table 7.

Table 7
Intermediate Aggregate Requirements

Description	Test Method	Limit
Weight of clay lumps, % Max	Tex-413-A	0.50
L.A. abrasion wear, ¹ % Max	Tex-410-A	40
5-cycle magnesium sulfate soundness, ^{1,2,3} non-air-entrained concrete, % Max	Tex-411-A	25
5-cycle magnesium sulfate soundness, ^{1,2,4} air-entrained concrete, % Max		18
Organic impurities ⁵	Tex-408-A	Color not darker than standard
Loss by decantation, ¹ % Max	Tex-406-A	1.5

1. Applies only to the portion retained on the No. 4 sieve, if more than 30% of the intermediate aggregate is retained on the No. 4 sieve.
2. Recycled crushed hydraulic cement concrete is not subject to 5-cycle magnesium sulfate soundness requirements.
3. Allowed when air-entrained concrete is used at the Contractor's option.
4. Only when air-entrained concrete is required by the plans.
5. Applies only to the portion passing the 3/8-in. sieve, if more than 30% of the intermediate aggregate is passing the 3/8-in. sieve.

For the portion retained on the No. 4 sieve, if more than 30% of the intermediate aggregate is retained on the No. 4 sieve, and in the case of aggregates made mainly from crushing stone, unless otherwise shown on the plans, the loss by decantation may be increased to 3.0% for all classes of concrete and 5.0% for Class A, B, and P if the material finer than the No. 200 sieve is determined to be at least 85% calcium carbonate in accordance with [Tex-406-A](#), Part III. Provide test results upon request.

- 2.7. **Mortar and Grout.** Furnish pre-packaged grouts in accordance with [DMS-4675](#), "Cementitious Grouts and Mortars for Miscellaneous Applications," when specified for applications other than post-tension grouting.

When grouting or mortaring stone riprap is shown on the plans, provide mortar and grout consisting of one part hydraulic cement, two parts sand, and sufficient water to provide the desired consistency. Other mix proportions allowed as approved. Provide mortar with a consistency such that the mortar can be easily handled and spread by trowel. Provide grout of a consistency that will flow into and completely fill all voids.

Section 421.4.2.6., "Mix Design Options," does not apply for mortar and grout.

- 2.8. **Storage of Materials.**

- 2.8.1. **Cement and Supplementary Cementitious Materials.** Store all cement and supplementary cementitious materials in weatherproof enclosures that will protect the materials from dampness or absorption of moisture.

When permitted, small quantities of packaged cementitious material may be stored in the open, on a raised platform, and under waterproof covering for up to 48 hr.

- 2.8.2. **Aggregates.** Handle and store concrete aggregates in a manner that prevents contamination by foreign materials. Clear and level the sites for the stockpiles of all vegetation if the aggregates are stored on the ground, and do not use the bottom 6-in. layer of aggregate without cleaning the aggregate before use.

Maintain separate stockpiles and prevent intermixing when conditions require the use of two or more grades of coarse aggregates. Separate the stockpiles using physical barriers where space is limited. Store aggregates from different sources in different stockpiles unless the Engineer authorizes pre-blending of the aggregates. Minimize segregation in stockpiles. Remix and test stockpiles when segregation is apparent.

Sprinkle stockpiles to control moisture and temperature as necessary. Maintain reasonably uniform moisture content in aggregate stockpiles.

- 2.8.3. **Chemical Admixtures.** Store admixtures in conformance with manufacturer's recommendations in tanks that are clearly labeled and prevent admixtures from freezing.

3. EQUIPMENT

- 3.1. **Concrete Plants and Mixing Equipment.** Except for volumetric stationary plant or truck (auger) mixers, each plant and truck mixer must be certified by NRMCA or have an inspection report signed and sealed by a licensed professional engineer showing concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C94. A new certification or signed and sealed report is required every time a plant is moved. Plants with a licensed professional engineer's inspection require re-inspection every 2 yr. Provide a copy of the certification or the signed and sealed inspection report to the Engineer. Remove equipment or facilities from service until corrected when they fail to meet specification requirements.

When allowed as shown on the plans or by the Engineer, for concrete classes not identified as structural concrete in Table 8 or for Class C concrete not used for bridge-class structures, the Engineer may inspect and approve all plants and trucks instead of NRMCA or non-Department engineer-sealed certifications. The criteria and frequency of Engineer approval of plants and trucks are the same used for NRMCA certification.

Inspect and furnish inspection reports of the condition of blades and fins and their percent wear from the original manufacturer's design for all mixing and agitating equipment annually. Repair mixing equipment exhibiting 10% or more wear before use. If an inspection within 12 mo. is not practical, a 2-mo. grace period (for a maximum of 14 mo. between inspections) is permitted.

- 3.1.1. **Scales.** Check all scales before beginning of operations, after each move, or whenever their accuracy or adequacy is questioned, and at least once every 6 mo. Immediately correct deficiencies, and recalibrate. Provide a record of calibration showing scales in compliance with ASTM C94 requirements. Check batching accuracy of volumetric water batching devices at least every 90 days. Check batching accuracy of chemical admixture dispensing devices at least every 6 mo. Perform daily checks as necessary to ensure measuring accuracy. Check electronic aggregate moisture probes at least every 90 days in accordance with [Tex-409-A](#), and be accurate to within 1.0% of the actual moisture content.

- 3.1.2. **Volumetric Mixers.** Provide volumetric mixers with rating plates defining the capacity and the performance of the mixer in accordance with the Volumetric Mixer Manufacturers Bureau or equivalent. Provide volumetric mixers that comply with ASTM C685. Provide test data showing mixers meet the uniformity test requirements in accordance with [Tex-472-A](#).

Unless allowed on the plans or by the Engineer, volumetric truck (auger) mixers may not supply classes of concrete identified as structural concrete in Table 8.

- 3.1.3. **Agitators and Truck and Stationary Mixers.** Provide stationary and truck mixers capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and capable of discharging the concrete so that the requirements of [Tex-472-A](#) are met.

Perform concrete uniformity tests on mixers or agitators in accordance with [Tex-472-A](#) as directed, to resolve issues of mix uniformity and mixer performance.

Perform the mixer or agitator uniformity test at the full rated capacity of the equipment. Remove all equipment that fails the uniformity test from service.

Inspect and maintain mixers and agitators. Keep them free of concrete buildup, and repair or replace worn or damaged blades or fins.

Ensure all mixers have a plate affixed showing manufacturer's recommended operating speed and rated capacity for mixing and agitating.

Truck mixers with automated water and chemical admixture measurement and slump and slump flow monitoring equipment meeting the requirement of ASTM C94 will be allowed. Provide data every 6 mo. substantiating the accuracy of slump, slump flow, temperature, water, and chemical admixture measurements. The slump measured by the automated system must be within 1 in. of the slump measured

in accordance with [Tex-415-A](#). The concrete temperature measured by the automated system must be within 1°F of concrete temperature measured in accordance with [Tex-422-A](#). The Engineer will not use the automated measurements for acceptance.

- 3.2. **Hauling Equipment.** Provide hauling equipment capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and discharging the concrete with a satisfactory degree of uniformity.

Provide equipment with smooth, mortar-tight metal containers equipped with gates that prevent accidental discharge of the concrete when using non-agitating equipment for transporting concrete.

Maintain hauling equipment clean and free of built-up concrete.

- 3.3. **Testing Equipment.** Provide strength-testing equipment when required in accordance with the Contract controlling test unless shown otherwise. Provide calibration records of strength-testing equipment to the Engineer within 1 week after each calibration. Furnish and maintain the following in conformance with the pertinent test procedure unless otherwise shown on the plans or specified.

- Test molds
- Curing facilities
- Maturity meters if used
- Wheelbarrow or other container acceptable for the sampling of the concrete

4. CONSTRUCTION

- 4.1. **Classification of Concrete Mix Designs.** Provide classes of concrete meeting the requirements shown in Table 8.

A higher-strength class of concrete with equal or lower water-to-cementitious material (w/cm) ratio may be substituted for the specified class of concrete when approved.

- 4.2. **Mix Design Proportioning.** Furnish mix designs using ACI 211, [Tex-470-A](#), or other approved procedures for the classes of concrete shown in Table 8 unless a design method is shown on the plans. Perform mix design proportioning by absolute volume method unless otherwise approved. Perform cement replacement using equivalent weight method unless otherwise approved.

Do not exceed the maximum w/cm ratio shown in Table 8 when designing the mixture.

- 4.2.1. **Cementitious Materials.** Do not exceed 700 lb. of cementitious material per cubic yard of concrete unless otherwise specified or approved.

- Use cement of the same type and from the same source for monolithic placements, unless otherwise approved.
- Do not use SCMs when white hydraulic cement is specified.

- 4.2.2. **Aggregates.** Recycled crushed hydraulic cement concrete may be used as a coarse or fine aggregate in Class A, B, E, and P concrete. Limit recycled crushed concrete fine aggregate to at most 20% of the fine aggregate.

Use light-colored aggregates when white hydraulic cement is specified.

Table 8
Concrete Classes

Class of Concrete	Design Strength ¹ , Min f'_c (psi)	Max w/cm Ratio	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Use ²
A	3,000	0.60	I, II, I/II, IL, IP, IS, IT, V	1, 2, 4, and 7	When the cementitious material content does not exceed 520 lb./cu. yd., any coal ash or natural pozzolan listed in the MPL may be used at a cement replacement of 20%–50%.	Curb, gutter, curb and gutter, concrete retards, sidewalks, driveways, backup walls, anchors, non-reinforced drilled shafts
B	2,000	0.60			Limit the alkali loading to 4.0 lb./cu. yd. or less when using Option 7.	Riprap, traffic signal controller foundations, small roadside signs, anchors
C ³	3,600	0.45	I, II, I/II, IP, IL, IS, IT, V	1–8	N/A	Drilled shafts, bridge substructure, traffic rail, culverts except top slab of direct traffic culverts, headwalls, wing walls, inlets, manholes, traffic barrier
E	3,000	0.50	I, II, I/II, IL, IP, IS, IT, V	1–8	When the cementitious material content does not exceed 520 lb./cu. yd., any coal ash or natural pozzolan listed on the MPLs may be used at a cement replacement of 20%–50%.	Seal concrete
F ³	Note ⁴	0.45			Limit the alkali loading to 4.0 lb./cu. yd. or less when using Option 7.	
H ³	Note ⁴	0.45	I, II, I/II, III, IP, IL, IS, IT, V	1–4, 8	N/A	Railroad structures; occasionally for bridge piers, columns, bents, post-tension members
					Mix design Options 1–8 allowed for cast-in-place concrete and the following precast elements unless otherwise shown on the plans. ■ Bridge deck panels ■ Retaining wall systems ■ Coping ■ Sound walls ■ Wall columns ■ Traffic rail ■ Traffic barrier ■ Long/arch-span culverts ■ Precast concrete products in accordance with Item 462, 464, and 465 Do not use Type III cement in mass placement concrete.	Precast concrete, post-tension members
S ³	4,000	0.45	I, II, I/II, IP, IL, IS, IT, V	1–8	N/A	Bridge slabs, top slabs of direct traffic culverts, approach slabs
P	See Item 360, "Concrete Pavement."	0.50	I, II, I/II, IL, IP, IS, IT, V	1–8	When the cementitious material content does not exceed 520 lb./cu. yd., any coal ash or natural pozzolan on the MPLs may be used at a cement replacement of 20%–50%.	Concrete pavement
CO ³	4,600	0.40	I, II, I/II, IP, IL, IS,	1–8	N/A	Bridge deck concrete overlay
LMC ³	4,000	0.40				Latex-modified concrete overlay

Class of Concrete	Design Strength ¹ , Min f' _c (psi)	Max w/cm Ratio	Cement Types	Mix Design Options	Exceptions to Mix Design Options	General Use ²
SS ³	3,600	0.45		1–8	Use a minimum cementitious material content of 658 lb./cu. yd. of concrete. Limit the alkali loading to 4.0 lb. per cubic yard or less when using Option 7.	Slurry displacement shafts, underwater drilled shafts
K ³	Note ⁴	0.40	I, II, I/II, III, IP, IL, IS, IT, V	1–8	N/A	Bridge repair
HES	Note ⁴	0.45	I, IL, II, I/II, III	N/A	Mix design options do not apply. Limit of 700 lb. of cementitious material per cubic yard is not pertinent.	Concrete pavement, concrete pavement repair
"X" (HPC) ^{3,5,6}	Note ⁷	0.45	I, II, I/II, III, IP, IL, IS, IT, V	1–4, and 8	N/A	N/A
"X" (SRC) ^{3,5,6}	Note ⁷	0.45	I/II, II, IP, IL (MS or HS), IS, IT (MS or HS), V	1–4, and 7	When using coal ash, use only coal ashes allowed for SRC in accordance with the coal ash MPL. Type III-MS may be used where allowed. Type I, Type IL, and Type III cements may be used when natural pozzolans are used or when coal ashes allowed for SRC in accordance with the coal ash MPL are used, and with a Max w/cm of 0.40. Use Option 7 for precast concrete where allowed.	N/A

1. Design strength must be attained within 56 days.
2. For information only.
3. Structural concrete classes.
4. As shown on the plans or specified.
5. "X" denotes class of concrete as shown on the plans or specified.
6. (HPC): High Performance Concrete, (SRC): Sulfate Resistant Concrete.
7. Same as class of concrete as shown on the plans.

4.2.2.1. **Coarse Aggregate.** Use Grade 2 or 3 coarse aggregate for Class P concrete. Use Grade 8 aggregate in extruded curbs unless otherwise approved. Unless otherwise specified, do not use Grade 1 aggregate in drilled shafts. Use coarse aggregate grades for all other classes of concrete with a maximum nominal size no larger than:

- 1/5 the narrowest dimension between sides of forms;
- 1/3 the depth of slabs;
- 2/3 the minimum clear spacing between individual reinforcing bars or wire, bundles of bars, individual tendons, bundles of tendons, or ducts for cast-in-place concrete; or
- 3/4 the minimum clear spacing between individual reinforcing bars or wires, bundles of bars, individual tendons, bundled tendons, or ducts for precast concrete.

4.2.2.2. **Fine Aggregate.** Use fine aggregate with an acid insoluble residue of at least 60% by weight when tested in accordance with [Tex-612-J](#) in all concrete subject to direct traffic.

Use the following equation to determine whether the aggregate combination meets the acid insoluble residue requirement when blending fine aggregate or using an intermediate aggregate.

$$\frac{(A_1 \times P_1) + (A_2 \times P_2) + (A_{ia} \times P_{ia})}{100} \geq 60\%$$

where:

A_1 = acid insoluble (%) of fine aggregate 1

A_2 = acid insoluble (%) of fine aggregate 2

A_{ia} = acid insoluble (%) of intermediate aggregate passing the 3/8 in. sieve

P_1 = percent by weight of fine aggregate 1 of the fine aggregate blend

P_2 = percent by weight of fine aggregate 2 of the fine aggregate blend

P_{ia} = percent by weight of intermediate aggregate passing the 3/8-in. sieve

Alternatively to the above equation, blend fine aggregate with a Micro-Deval loss of less than 12%, when tested in accordance with [Tex-461-A](#), with at least 40% of a fine aggregate with an acid insoluble residue of at least 60%.

Use the following equation to determine whether the aggregate combination meets the sand equivalency requirement when blending fine aggregate or using an intermediate aggregate.

$$\frac{(SE_1 \times P_1) + (SE_2 \times P_2) + (SE_{ia} \times P_{ia})}{100} \geq 80\%$$

where:

SE_1 = sand equivalency (%) of fine aggregate 1

SE_2 = sand equivalency (%) of fine aggregate 2

SE_{ia} = sand equivalency (%) of intermediate aggregate passing the 3/8 in. sieve

P_1 = percent by weight of fine aggregate 1 of the fine aggregate blend

P_2 = percent by weight of fine aggregate 2 of the fine aggregate blend

P_{ia} = percent by weight of intermediate aggregate passing the 3/8-in. sieve

- 4.2.3. **Chemical Admixtures.** Do not use Type C, E, F, or G admixtures in Class S bridge deck concrete. Do not use chemical admixtures containing calcium chloride in any concrete.

Use a 30% calcium nitrite solution when a corrosion-inhibiting admixture is required. Dose the admixture at the rate of gallons of admixture per cubic yard of concrete shown on the plans. Use set retarding admixtures, as needed, to control setting time to ensure concrete containing corrosion inhibiting admixtures remains workable for the entire duration of the concrete placement. Perform setting time testing and slump loss tests during trial batch testing.

- 4.2.4. **Air Entrainment.** When air-entrained concrete is shown on the plans, target an entrained air content of 4.0% for Class P concrete and 5.5% for all other classes of concrete. Use an approved air-entraining admixture when air-entrained concrete is specified, or when an air-entraining admixture is used at the Contractor's option. Unless otherwise shown on the plans, acceptance of concrete loads will be based on a tolerance of $\pm 1.5\%$ from the target air content. If the air content is more than 1.5 but less than 3.0% above the target air, the concrete may be accepted based on strength tests. For specified concrete strengths above 5,000 psi, a reduction of 1% entrained air content is permitted.

- 4.2.5. **Slump.** Provide concrete with a slump in accordance with Table 9 unless otherwise specified. When approved, the slump of a given concrete mix may be increased above the values shown in Table 9 using chemical admixtures, provided the admixture-treated concrete has the same or lower w/cm ratio and does not exhibit segregation or excessive bleeding. Request approval to exceed the slump limits shown in Table 9 sufficiently in advance for proper evaluation by the Engineer.

Table 9
Placement Slump Requirements

General Use	Placement Slump Range (in.)
Walls (>9 in. thick), caps, columns, piers	3–7
Bridge slabs, top slabs of direct traffic culverts, approach slabs, concrete overlays	3–6
Latex-modified concrete for bridge deck overlays	3–8
Inlets, manholes, walls (<9 in. thick), bridge railing, culverts, concrete traffic barrier, concrete pavement (formed)	4–6
Precast concrete	4–9
Underwater concrete placements	6–8-1/2
Drilled shafts, slurry displaced, underwater drilled shafts	See Item 416, "Drilled Shaft Foundations"
Curb, gutter, curb and gutter, concrete retards, sidewalk, driveways, seal concrete, anchors, riprap, small roadside sign foundations, concrete pavement repair, concrete repair	As approved

4.2.6. Mix Design Options.

4.2.6.1. Option 1. Replace cement with at least the minimum dosage listed on the MPL for the coal ash or natural pozzolan used in the mixture. Conduct Option 8 testing to determine the minimum replacement dosage as listed on the MPL. Do not replace more than 50% of the cement. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

4.2.6.2. Option 2. Replace 35–50% of the cement with slag cement. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

4.2.6.3. Option 3. Replace 35–50% of the cement with a combination of coal ash, slag cement, MFA, natural pozzolan, or at least 3% silica fume; however, no more than 10% may be silica fume. Up to 70% of the cement may be replaced when concrete is used for mass concrete placements.

4.2.6.4. Option 4. Use Type IP, IS, or IT cement as allowed in Table 8 for each class of concrete. When replacing blended cements with additional SCMs, the replacement limits in Option 3 will apply to the final cementitious mixture. When using fly ash or natural pozzolans not having a minimum dosage listed on the MPL in the final cementitious mixture, perform Option 8 testing.

4.2.6.5. Option 5. Option 5 is left intentionally blank.

4.2.6.6. Option 6. Use a lithium nitrate admixture at a minimum dosage determined by testing conducted in accordance with [Tex-471-A](#). Before use of the mix, provide an annual certified test report signed and sealed by a licensed professional engineer, from a laboratory on the MPL, certified by the Materials and Tests Division (MTD) as being capable of testing in accordance with [Tex-471-A](#).

4.2.6.7. Option 7. Ensure the total alkali contribution from the cement in the concrete does not exceed 3.5 lb. per cubic yard of concrete when using hydraulic cement not containing SCMs calculated as follows.

$$\text{lb. alkali per cu. yd.} = \frac{(\text{lb. cement per cu. yd.}) \times (\% \text{ Na}_2\text{O equivalent in cement})}{100}$$

In the above calculation, use the maximum cement alkali content reported on the cement mill certificate.

4.2.6.8. Option 8. Use Table 10 when deviating from Options 1–3 or when required by the coal ash MPL. Perform required testing annually and submit results to the Engineer. Laboratories performing ASTM C1260, C1567, and C1293 testing must be listed on the Department's MPL. Before use of the mix, provide a certified test report signed and sealed by a licensed professional engineer demonstrating the proposed mixture conforms to the requirements of Table 10.

Provide a certified test report signed and sealed by a licensed professional engineer, when high-performance concrete (HPC) is required, and less than 20% of the cement is replaced with SCMs, demonstrating ASTM C1202 test results indicate the permeability of the concrete is less than 1,500 coulombs tested immediately after either of the following curing schedules.

- Moisture cure specimens 56 days at 73°F.
- Moisture cure specimens 7 days at 73°F followed by 21 days at 100°F.

Table 10
Option 8 Testing and Mix Design Requirements

Scenario	ASTM C1260 Result		Testing Requirements for Mix Design Materials or Prescriptive Mix Design Options ¹
	Mix Design Fine Aggregate	Mix Design Coarse Aggregate	
A	>0.10%	>0.10%	Determine the dosage of SCMs needed to limit the 14-day expansion of each aggregate ¹ to <0.10% when tested individually in accordance with ASTM C1567.
B	≤0.10%	≤0.10%	Use the minimum replacement listed in the coal ash MPL, or When Option 8 is listed on the MPL, use at least 40% coal ash with a maximum CaO ² content of 25%, or Use any ternary combination that replaces 35–50% of cement.
	≤0.10%	ASTM C1293 1 yr. Expansion ≤0.04%	Use a minimum of 20% of any coal ash; or Use any ternary combination that replaces 20–50% of cement.
C	≤0.10%	>0.10%	Determine the dosage of SCMs needed to limit the 14-day expansion of course and intermediate ¹ aggregate to <0.10% when tested individually in accordance with ASTM C1567.
D	>0.10%	≤0.10%	Use the minimum replacement listed in the coal ash MPL, or When Option 8 is listed in the MPL, use a minimum of 40% coal ash with a maximum CaO ² content of 25%, or Use any ternary combination that replaces 35% to 50% of cement.
	> 0.10%	ASTM C1293 1 yr. Expansion ≤ 0.04%	Determine the dosage of SCMs needed to limit the 14-day expansion of each fine aggregate to <0.10% when individually tested in accordance with ASTM C1567.

1. Intermediate size aggregates will fall under the requirements of mix design coarse aggregate.
2. Average the CaO content from the previous ten values as listed on the test certificate.

4.2.7. **Optimized Aggregate Gradation (OAG) Concrete.** The gradation requirements shown in Table 4 and Table 6 do not apply when OAG concrete is specified or used by the Contractor, unless otherwise shown on the plans.

The fineness modulus for fine aggregate shown in Table 5 does not apply when OAG concrete is used. Establish the optimized aggregate gradation in accordance with [Tex-470-A](#). Use at least 420 lb. per cubic yard of cementitious material when OAG concrete is used unless otherwise approved.

Make necessary adjustments to individual aggregate stockpile proportions during OAG concrete production when the gradation deviates more than 2% from the optimized gradation requirements.

4.2.8. **Self-Consolidating Concrete (SCC).** Provide SCC meeting the requirements shown in Table 11 when approved for use in precast concrete. Use concrete with a slump flow that can be placed without vibration and will not segregate or excessively bleed.

Request approval to exceed the slump flow limits sufficiently in advance for proper evaluation by the Engineer.

Table 11
Mix Design Requirements for SCC

Tests	Test Method	Acceptable Limits
Slump flow for precast concrete	ASTM C1611	22–27 ¹
T ₅₀ , sec.	ASTM C1611	2–7
VSI rating	ASTM C1611	0 or 1
Passing ability, in.	ASTM C1621	≤2
Segregation column, %	ASTM C1610	≤10
Bleeding, %	ASTM C232	≤2.5

1. These slump flow limits are generally acceptable for most applications. However, slump flow limits may be adjusted during mix design approval process and when approved.

- 4.3. **Concrete Trial Batches.** Perform trial batches when required by the plans, or when previous satisfactory field data is not available. Submit previous satisfactory field data to the Engineer showing the proposed mix design conforms to specification requirements when trial batches are not required and before concrete is placed. Trial batch test results will be reported to the Contractor and the concrete supplier. Trial batches are not required for Class A, B, or E concrete unless establishing target values as described below.

Perform trial batches for all self-consolidating concrete mix designs.

Make all trial batches using the proposed ingredients in a mixer that is representative of the mixers to be used on the project when required. Make the batch size at least 50% of the mixer's rated capacity. Alternatively, use an AASHTO-accredited laboratory to perform laboratory trial batches using all the proposed ingredients. Perform fresh concrete tests for air content and slump, and make, cure, and test strength specimens for compliance with specification requirements. Test at least one set of design strength specimens, consisting of two specimens per set, at 7-day, 28-day, and at least one additional age unless otherwise directed. Before placing, provide the Engineer the option of witnessing trial batches, including the testing of the concrete. If not provided this option, the Engineer may require additional trial batches, including testing, before the concrete is placed.

Trial batches for precast concrete will be performed in accordance with [Tex-703-I](#) to show proposed mix design meets the requirements of the pertinent class of concrete, or Table 11 when SCC is used.

Establish a compressive strength target value in accordance with [Tex-427-A](#) for each Class A, B, and E concrete.

When changes are made to the type, brand, or source of aggregates, cement, SCM, water, or chemical admixtures, submit previous satisfactory field data, data from a new trial batch, or other evidence showing the change will not adversely affect the relevant properties of the concrete. Submit the data for approval before making changes to the mix design. A change in vendor does not necessarily constitute a change in materials or source. The Engineer may waive new trial batches when there is a prior record of satisfactory performance with the ingredients. During concrete production, dosage changes of chemical admixtures used in the trial batches will not require a re-evaluation of the mix design.

The Contractor has the option of performing trial batches in conjunction with concrete placements except for SCC mixtures, when new trial batches are required during the course of the project. If the concrete fails to meet any requirement, the Engineer will determine acceptability and payment adjustments. Establishing target strength for Class A, B, and E concrete may be conducted during these placements.

Establish the strength–maturity relationship in accordance with [Tex-426-A](#) when the maturity method is specified or permitted. When using the maturity method, any changes in any of the ingredients, including changes in proportions, will require the development of a new strength–maturity relationship for the mix.

- 4.3.1. **Mix Design of Record.** Once a trial batch or previously satisfactory field data substantiates the mix design, the proportions and mixing methods used become the mix design of record. Do not exceed mix design w/cm ratio.

4.4. Production Testing.

- 4.4.1. **Aggregate Moisture Testing.** Determine moisture content in accordance with [Tex-409-A](#) or [Tex-425-A](#) for coarse, intermediate, and fine aggregates at least twice per week, when there is an apparent change, or for new shipments of aggregate. When aggregate hoppers or storage bins are equipped with properly maintained electronic moisture probes for continuous moisture determination, moisture tests in accordance with [Tex-409-A](#) or [Tex-425-A](#) are not required.

When producing SCC, and when aggregate hoppers or storage bins are not equipped with electronic moisture probes, determine the moisture content of the aggregates before producing the first concrete batch each day. Thereafter, determine the moisture content every 4 hr. or when there is an apparent change while SCC is being produced.

- 4.4.2. **Aggregate Gradation Testing.** Perform a sieve analysis in accordance with [Tex-401-A](#) on each stockpile used in the blend at least 1 day before producing OAG concrete. Perform sieve analysis on each stockpile after every 10,000 cu. yd. of Class P OAG concrete produced, and every 1,000 cu. yd. for all other structural-class concrete. Provide sieve analysis data to the Engineer.

4.5. Measurement of Materials.

- 4.5.1. **Non-Volumetric Mixers.** Measure aggregates by weight. Correct batch weight measurements for aggregate moisture content. Measure mixing water, consisting of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures, by volume or weight. Measure ice by weight. Measure cement and SCMs in a hopper and on a separate scale from those used for other materials. When measuring by cumulative weight, measure the cement first and ensure the cement meets the cement tolerance shown in Table 12 before measuring the SCMs. Measure concrete chemical admixtures by weight or volume. Measure batch materials within the tolerances shown in Table 12.

Table 12
Mix Design Batching Tolerances—Non-Volumetric Mixers

Material	Tolerance (%)
Cement, wt.	-1 to +3
SCM, wt.	-1 to +3
Cement + SCM (cumulative weighing), wt.	-1 to +3
Water, wt. or volume	±3 ¹
Fine aggregate, wt.	±2
Coarse aggregate, wt.	±2
Fine + coarse aggregate (cumulative weighing), wt.	±1
Chemical admixtures, wt. or volume	±3

1. Allowable deviation from target weight, not including water withheld or moisture in the aggregate. The Engineer will verify the w/cm ratio is within specified limits.

Ensure the quantity measured, when measuring cementitious materials at less than 30% of scale capacity, is accurate to no less than the required amount and no more than 4% in excess. Ensure the cumulative quantity, when measuring aggregates in a cumulative weigh batcher at less than 30% of the scale capacity, is measured accurately to ±0.3% of scale capacity or ±3% of the required cumulative weight, whichever is less.

Measure cement in number of bags under special circumstances when approved. Use the weights specified on the packaging. Weighing bags of cement is not required. Ensure fractional bags are not used except for small hand-mixed batches of approximately 5 cu. ft. or less and when an approved method of volumetric or weight measurement is used.

- 4.5.2. **Volumetric Mixers.** Provide an accurate method of measuring all ingredients by volume and calibrate equipment to assure correct measurement of materials within the specified tolerances. Base tolerances on volume-weight relationship established by calibration and measure the various ingredients within the tolerances shown in Table 13. Correct batch measurements for aggregate moisture content.

Table 13
Mix Design Batching Tolerances—Volumetric Mixers

Material	Tolerance
Cement, wt. %	0 to +4
SCM, wt. %	0 to +4
Fine aggregate, wt. %	±2
Coarse aggregate, wt. %	±2
Admixtures, wt. or volume %	±3
Water, wt. or volume %	±1

4.6. **Mixing and Delivering Concrete.**

- 4.6.1. **Mixing Concrete.** Operate mixers and agitators within the limits of the rated capacity and speed of rotation for mixing and agitation as designated by the manufacturer of the equipment. Provide concrete in a thoroughly mixed and uniform mass with a satisfactory degree of uniformity when tested in accordance with [Tex-472-A](#).

Do not top-load new concrete onto returned concrete.

Adjust mixing times and batching operations as necessary when the concrete contains silica fume to ensure the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix will be verified by MTD using cylinders made from trial batches. Make necessary changes to the batching operations, if uniform dispersion is not achieved, until uniform and complete dispersion of the silica fume is achieved.

Mix concrete by hand methods or in a small motor-driven mixer when permitted, for small placements of less than 2 cu. yd. For such placements, proportion the mix by volume or weight.

- 4.6.2. **Delivering Concrete.** Deliver concrete to the project in a thoroughly mixed and uniform mass, and discharge the concrete with a satisfactory degree of uniformity. Conduct testing in accordance with [Tex-472-A](#) when there is a reason to suspect the uniformity of concrete and as directed.

Maintain concrete delivery and placement rates sufficient to prevent cold joints.

Adding chemical admixtures or the portion of water withheld is permitted only at the jobsite, under the supervision of the Engineer, to adjust the slump or slump flow of the concrete. Do not add water or chemical admixtures to the batch after more than an amount needed to conduct slump testing has been discharged. Turn the drum or blades at least 30 additional revolutions at mixing speed to ensure thorough and uniform mixing of the concrete. When this water is added, do not exceed the approved mix design w/cm ratio.

When truck mixers are equipped with automated water or chemical admixture measurement and slump or slump flow monitoring equipment, the addition of water or chemical admixtures during transit is allowed. Reports generated by this equipment must be submitted to the Engineer daily.

Before unloading, furnish the delivery ticket for the batch of concrete containing the information required in accordance with ASTM C94. The Engineer will verify all required information is provided on the delivery tickets. The Engineer may suspend concrete operations until the corrective actions are implemented if delivery tickets do not provide the required information. The Engineer will verify the design w/cm ratio is not exceeded.

An electronic ticket delivery system (e-ticketing) may be used instead of printed tickets. The use of e-ticketing will require written approval. At minimum, the system will:

- provide electronic, real-time e-tickets meeting the requirements above;
- automatically generate e-tickets using software and hardware fully integrated with the batch plant scales used to weigh the material;

- be able to record all water and chemical admixture additions performed at the jobsite or in transit when allowed;
- provide the ability to associate fresh concrete test results with each e-ticket;
- be designed in such a way that data input cannot be altered by the Contractor or the Engineer;
- provide the Engineer access to the e-ticketing data in real-time using a web-based or app-based system compatible with iOS; and
- provide offline capabilities to prevent data loss if power or connectivity is lost.

The Engineer may discontinue use of the e-ticketing and require printed tickets as needed if the e-ticketing system fails to meet the above requirements.

Begin the discharge of concrete delivered in truck mixers within the times shown in Table 14. Concrete delivered after these times and concrete that has not begun to discharge within these times will be rejected. The discharge times shown in Table 14 may be extended provided slump loss testing is conducted in accordance with [Tex-430-A](#) to show concrete will maintain the minimum required slump for the requested discharge time extension. Extended discharge times will be allowed when the concrete temperature at time of discharge is no more than 10°F higher than the slump loss test concrete temperature.

Table 14
Concrete Discharge Times for Truck Mixers

Fresh Concrete Temperature, °F	Max Time After Batching for Concrete Not Containing Type B or D Admixtures, min.	Max Time After Batching for Concrete Containing Type B or D Admixtures, ¹ min.
90 and above	45	75
75 ≤ T < 90	60	90
T < 75	90	120

1. Concrete must contain at least the minimum manufacturer's recommended dosage of Type B or D admixture.

- 4.7. **Placing, Finishing, and Curing Concrete.** Place, finish, and cure concrete in conformance with the pertinent Items.
- 4.8. **Sampling and Testing of Concrete.** Unless otherwise specified, all fresh and hardened concrete is subject to testing as follows.
 - 4.8.1. **Certification of Testing Personnel.** Contractor personnel performing testing must be either ACI-certified or qualified by a Department-recognized equivalent written and performance testing program for the tests being performed. Personnel performing these tests are subject to Department approval. Use of a commercial laboratory is permitted at the Contractor's option.
 - 4.8.2. **Fresh Concrete.** Provide safe access and assistance to the Engineer during sampling. Fresh concrete will be sampled for testing at the point of discharge from the delivery equipment or end of belt conveyors.
 - 4.8.3. **Testing Concrete.** The Engineer, unless specified in other Items or shown on the plans, will test the fresh and hardened concrete in accordance with the following methods.
 - **Slump.** [Tex-415-A](#)
 - **Air Content.** [Tex-414-A](#) or [Tex-416-A](#), only when air-entrained concrete is shown on the plans
 - **Temperature.** [Tex-422-A](#)
 - **Making and Curing Strength Specimens.** [Tex-447-A](#)
 - **Compressive Strength.** [Tex-418-A](#)
 - **Flexural Strength.** [Tex-448-A](#)
 - **Maturity.** [Tex-426-A](#)

Flexural strength and maturity specimens will not be made unless specified in other Items or shown on the plans.

Concrete with slump less than minimum required after all addition of water withheld will be rejected, unless otherwise allowed by the Engineer. Concrete with slump exceeding maximum allowed may be used at the Contractor's option. If used, Engineer will make, test, and evaluate strength specimens in accordance with Article 421.5., "Acceptance of Concrete." Acceptance of concrete not meeting air content or temperature requirements will be determined by Engineer. Fresh concrete exhibiting segregation and excessive bleeding will be rejected.

- 4.8.3.1. **Strength Specimen Handling.** After strength test specimens are molded, protect and cure in conformance with pertinent test methods. When necessary, deliver Contractor-molded specimens to curing facilities, remove specimens from their molds, and place specimens in curing tanks within 24–48 hr. after molding, in conformance with pertinent test methods. The Engineer will deliver Department-molded specimens to curing facilities, remove specimens from their molds, and place specimens in curing tanks within 24–48 hr. after molding, in conformance with pertinent test methods.

5. ACCEPTANCE OF CONCRETE

The Engineer will sample and test the fresh and hardened concrete for acceptance. The test results will be reported to the Contractor and the concrete supplier. Investigate the quality of the materials, the concrete production operations, and other possible problem areas to determine the cause for any concrete that fails to meet the required strengths as specified below. Take necessary actions to correct the problem, including redesign of the concrete mix. The Engineer may suspend all concrete operations under the pertinent Items if the Contractor is unable to identify, document, and correct the cause of the low strengths in a timely manner. Resume concrete operations only after obtaining approval for any proposed corrective actions. Concrete failing to meet the required strength as specified below will be evaluated in accordance with Article 421.6., "Measurement and Payment."

- 5.1. **Structural Class of Concrete.** For concrete classes identified as structural concrete shown in Table 8, the Engineer will make and test 7-day and 28-day specimens, and, if necessary, 56-day specimens. The Engineer will base acceptance on attaining the design strength shown in Table 8 or design strength shown on the plans.
- 5.2. **Class P and Class High Early Strength (HES).** The Engineer will base acceptance in accordance with Item 360 and Item 361, "Repair of Concrete Pavement."
- 5.3. **All Other Classes of Concrete.** For concrete classes not identified as structural concrete in Table 8, the Engineer will make and test 7-day specimens. The Engineer will base acceptance on attaining design strength or attaining the 7-day target value established in accordance with [Tex-427-A](#).

6. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

The following procedure will be used to evaluate concrete where one or more project acceptance test specimens fail to meet the required design strength specified in this Item or shown on the plans.

- The concrete for a given placement will be considered structurally adequate and accepted at full price if the average of 28-day or 56-day set of specimens made at the time of placement meets the required design strength, provided no single specimen test result is less than 85% of the required design strength.
- The Engineer will perform a structural review of the concrete to determine its adequacy to remain in service if the average 28-day or 56-day set of specimens made at the time of placement is less than the required design strength or if any single specimen test result is less than 85% of the required design strength. If the concrete is determined to be structurally adequate, the Engineer will determine the limits of the payment adjustment using the formula below.

- If the in situ concrete strength is needed for the structural review, take cores at locations designated by the Engineer in accordance with [Tex-424-A](#). The Engineer will test the cores. The coring and testing will be at the Contractor's expense.
- If all the tested cores meet the required design strength, the concrete will be paid for at full price.
- If any of the tested cores do not meet the required design strength, but the average strength attained is determined to be structurally adequate, the Engineer will determine the limits of the payment adjustment using the following formula.

$$A = B_p \left[-5.37 \left(\frac{S_a}{S_s} \right)^2 + 11.69 \left(\frac{S_a}{S_s} \right) - 5.32 \right]$$

where:

A = Amount to be paid per unit of measure for the entire placement in question.

S_a = Actual average strength from cylinders or cores. Use values from cores, if taken.

S_s = Minimum required strength (specified).

B_p = Unit bid price.

- If the structural review determines the concrete is not adequate to remain in service, the Engineer will determine the limits of the concrete to be removed.
- The decision to reject structurally inadequate concrete or to apply the payment adjustment factor will be made no later than 7 days after 28-day or 56-day design strength specimens, or cores, if taken, are tested.

Item 422

Concrete Superstructures



1. DESCRIPTION

Construct reinforced concrete bridge slabs, decks, flat slabs, slab and girder units (pan formed), approach slabs, or other bridge superstructure elements as specified.

2. MATERIALS

2.1. **Concrete.** Provide concrete in accordance with Item 421, "Hydraulic Cement Concrete." Provide Class S or Class S (HPC) concrete for all cast-in-place concrete unless otherwise shown on the plans. Provide the class of concrete for precast components shown on the plans or in conformance with governing Items.

2.2. **Reinforcing Steel.** Provide reinforcing steel in accordance with Item 440, "Reinforcement for Concrete."

2.3. **Structural Grout.** Provide grout in accordance with [DMS-4675](#), "Cementitious Grouts and Mortars for Miscellaneous Applications," or as shown on the plans.

2.4. **Expansion Joint Material.** Provide materials in accordance with [DMS-6310](#), "Joint Sealants and Fillers."

- Provide preformed bituminous fiber expansion joint material unless specified otherwise.
- Provide a Class 4, 5, or 7 low-modulus silicone sealant unless otherwise directed.
- Provide asphalt board that conforms to dimensions shown on the plans.
- Provide re-bonded neoprene filler that conforms to the dimensions shown on the plans.

2.5. **Foam Bedding Strips for Prestressed Concrete Panels.** Use extruded polystyrene in accordance with ASTM C578, Type VI (40-psi compressive strength) or as specified.

Provide a manufacturer's certification or data sheet stating the foam meets these requirements. Use an adhesive or bonding agent compatible with polystyrene as recommended by the polystyrene manufacturer.

2.6. **Evaporation Retardants.** Provide evaporation retardants in accordance with [DMS-4650](#), "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

2.7. **Curing Materials.** Provide membrane curing compounds in accordance with [DMS-4650](#).

Provide cotton mats that consist of a filling material of cotton "bat" or "bats" (at least 12 oz. per square yard) completely covered with unsized cloth (at least 6 oz. per square yard) stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 in., or tuft both longitudinally and transversely at intervals less than 3 in. Provide cotton mats that are free of tears and in good general condition. Provide a flap at least 6 in. wide consisting of two thicknesses of the covering and extending along one side of the mat.

Provide polyethylene sheeting that is at least 4 mils thick and free of visible defects. Provide opaque white sheeting when the ambient temperature during curing exceeds 90°F.

Provide burlap-polyethylene mats made from burlap impregnated on one side with a film of opaque white-pigmented polyethylene, free of visible defects. Provide laminated mats that have at least one layer of an impervious material such as polyethylene, vinyl plastic, or other acceptable material (either as a solid sheet or impregnated into another fabric) and are free of visible defects.

Provide burlap material that complies with AASHTO M 182, Class 3 (10 oz. per square yard) with the following additions.

- Manila hemp may also be used to make burlap.
- Do not use burlap fabricated from bags.
- Do not use burlap containing any water-soluble ingredient that will retard the setting time of concrete.

Provide used burlap complying with the requirements stated above, and that only has been used previously for curing concrete. "Like new" cleanliness is not expected, but contamination with any substance foreign to the concrete curing process, such as grease or oil, will be cause for rejection.

- 2.8. **Epoxy.** Provide epoxy materials in accordance with [DMS-6100](#), "Epoxyes and Adhesives," unless otherwise specified.

3. EQUIPMENT

- 3.1. **Fogging Equipment.** Use fogging equipment that can apply water in a fine mist, not a spray. Produce the fog using equipment that pumps water or water and air under high pressure through a suitable atomizing nozzle. Use hand-held mechanical equipment portable enough to use in the direction of any prevailing wind and adaptable for intermittent use to prevent excessive wetting of the concrete.

- 3.2. **Transporting and Placing Equipment.** Use appropriate transporting and placing equipment such as buckets, chutes, buggies, belt conveyors, pumps, or other equipment as necessary. Do not transport or convey concrete by equipment made of aluminum. Use carts with pneumatic tires for carting or wheeling concrete over newly placed slabs.

Use tremies that are watertight to control the fall of concrete and of large enough diameter to allow the placement of the concrete but less than 14 in. in diameter.

Use pumps with lines at least 5 in. inside diameter (ID) where Grade 2 or smaller coarse aggregate is used and at least 8 in. ID for Grade 1 coarse aggregate.

- 3.3. **Vibrators.** Use immersion-type vibrators for consolidation of concrete. Provide at least two standby vibrators for emergency use. Furnish vibrator head covered by a rubberized or elastomeric cover when used near epoxy-coated reinforcing steel.

- 3.4. **Screeds and Work Bridges for Bridge Slabs.** Use a self-propelled transverse screed or a mechanical longitudinal screed for bridge slabs. Use transverse screeds that can follow the skew of the bridge for skews greater than 15° unless otherwise approved. Equip transverse screeds with a pan float and skew kit. Manually operated screeding equipment may be used if approved for top slabs of culverts, small placements, or unusual conditions. Use screeds that are rigid and heavy enough to hold true to shape and have sufficient adjustments to provide for the required camber or section. Equip the screeds, except those of the roller drum type, with metal cutting edges.

Use sufficient work bridges for finishing operations for bridge slabs. Mount a carpet drag to a work bridge or a movable support system that can vary the area of carpet in contact with the concrete. Use carpet pieces long enough to cover the entire width of the placement. Splice or overlap the carpet as necessary. Ensure enough carpet is in contact longitudinally with the concrete being placed to provide the desired surface finish. Use artificial grass-type carpeting with a molded polyethylene pile face with a blade length between 5/8 and 1 in. and minimum weight of 70 oz. per square yard. Ensure the carpet has a strong, durable backing not subject to rot and the facing is adequately bonded to the backing to withstand the intended use. A burlap drag, attached to the pan float on a transverse screed, may be used instead of the carpet drag.

- 3.5. **Temperature Recording Equipment.** Use strip chart temperature-recording devices, recording maturity meters in accordance with [Tex-426-A](#), or other approved devices that are accurate within $\pm 2^{\circ}\text{F}$ within the range of 32–212°F.

- 3.6. **Artificial Heating Equipment.** Use artificial heating equipment as necessary for maintaining the concrete temperatures in accordance with Section 422.4.6.11., "Placing Concrete in Cold Weather."
- 3.7. **Sawing Equipment.** Use sawing equipment capable of cutting grooves in completed bridge slabs and top slabs of direct traffic culverts. Provide grooves that are 1/8–3/16 in. deep, nominally 1/8 in. wide, and spaced at 1 in. Use sawing equipment capable of cutting grooves in hardened concrete within 18 in. of the barrier rail or curb.
- 3.8. **Spraying Equipment.** Use mechanically powered pressure sprayers with appropriate atomizing nozzles for the application of membrane curing. Mechanically driven spraying equipment, adaptable to the rail system used by the screeds, may be used for applying membrane curing to bridge slabs. Use hand-pressurized spray equipment with two or three fan-spray nozzles if approved. Ensure the spray from each nozzle overlaps the spray from adjacent nozzles by approximately 50%.
- 3.9. **Concrete Testing Equipment.** Provide testing equipment for the Engineer's use in accordance with Section 421.3.3., "Testing Equipment."

4. CONSTRUCTION

Obtain approval for proposed construction methods before starting work. Approval of construction methods and equipment does not relieve the Contractor's responsibility for safety or correctness of methods, adequacy of equipment, or completion of work in full accordance with the Contract. Attend the preconstruction (pre-pour) meetings for bridge slabs conducted by the Engineer. Provide and obtain approval for proposed finishing methods, interim curing methods, and final curing methods.

Unless otherwise shown on the plans, it is the Contractor's option to perform testing on structural concrete (structural classes of concrete are identified in Table 8 of Section 421.4.1., "Classification of Concrete Mix Designs") to determine the in situ strength to address the schedule restrictions listed below. The Engineer may require the Contractor to perform this testing for concrete placed in cold weather. Make enough test specimens for Contractor-performed testing to ensure strength requirements are met for the operations listed below. Make at least one set of test specimens for each element cast each day. Cure these specimens under the same conditions as the portion of the structure involved for all stages of construction. Ensure safe handling, curing, and storage of all test specimens. Provide testing personnel, and sample and test the hardened concrete in accordance with Section 421.4.8., "Sampling and Testing of Concrete." The maturity method, [Tex-426-A](#), may be used for in-situ strength determination for schedule restrictions if approved. Coring will not be allowed for in-situ strength determination for schedule restrictions. Provide the Engineer the opportunity to witness all testing operations. Report all test results to the Engineer.

If the Contractor does not wish to perform schedule restriction testing, the Engineer's 7-day lab-cured tests, performed in accordance with Article 421.5., "Acceptance of Concrete," will be used for schedule restriction determinations. The Engineer may require additional time for strength gain to account for field curing conditions such as cold weather.

- 4.1. **Schedule Restrictions and Inspection Hold-Points.**
- 4.1.1. **Placement of Superstructure Members.** Place or cast superstructure members after the substructure concrete has attained a compressive strength of 3,000 psi.
- 4.1.2. **Longitudinal Screeding of Bridge Slabs.** Place a longitudinal screed directly on previously placed concrete slabs to check and grade an adjacent slab only after the previously placed slab has aged at least 24 hr. Place and screed the concrete after the previously placed slabs have aged at least 48 hr. Maintain curing of the previously placed slabs during placement.
- 4.1.3. **Staged Placement of Bridge Slabs on Continuous Steel Units.** Ensure the previously placed concrete attains a compressive strength of 3,000 psi when staged placement of a slab is required or used before

placing the next stage placement. Multiple stages may be placed in a single day if approved by the Engineer of Record.

- 4.1.4. **Storage of Materials on Structure.** Obtain approval to store materials on completed portions of a structure once a compressive strength of 3,000 psi has been attained. Maintain proper curing if materials will be stored on structures before completion of curing.
- 4.1.5. **Placement of Equipment and Machinery.** Do not place erection equipment or machinery on the structure until the concrete has attained the design strength specified in Section 421.4.1., "Classification of Concrete Mix Designs," unless otherwise approved.
- 4.1.6. **Carting of Concrete.** Cart, wheel, or pump concrete over completed slabs after the completed concrete has attained a compressive strength of 3,000 psi. Maintain curing during these operations.
- 4.1.7. **Placing Bridge Rails.** Reinforcing steel and concrete for bridge rails may be placed on bridge slabs once the slab concrete has attained a compressive strength of 3,000 psi. Ensure the slab concrete has attained its design strength specified in Section 421.4.1., "Classification of Concrete Mix Designs," before placing railing concrete if slipforming methods are used for railing concrete.
- 4.1.8. **Opening to Construction Traffic.** Bridges may be opened to all construction traffic when the design strength specified in Section 421.4.1., "Classification of Concrete Mix Designs," has been attained if curing is maintained. Avoid crossing bridges at high speeds until railing concrete, if present, has attained a compressive strength of 3,000 psi.
- 4.1.9. **Opening to Full Traffic.** Bridges may be opened to the traveling public when the design strength specified in Section 421.4.1., "Classification of Concrete Mix Designs," has been attained for all structural elements, including railing subject to impact from traffic and when curing has been completed for all slabs. Obtain approval before opening bridges to the traveling public.
- 4.1.10. **Inspection Hold-Points.** Notify the Engineer of progress of work and when work is complete before beginning the next stage of work.
 - Beam erection and bracing
 - Formwork, including setting of precast panels
 - Placing reinforcing steel
 - Screed dry run and pre-pour clear cover checks
 - Attend pre-pour meeting conducted by the Engineer
 - Post-curing crack inspection

- 4.2. **Forms.** Submit forming plans for decks or slabs on beams or girders, overhangs, cast-in-place spans, and bracing systems for girders when the overhang exceeds 3 ft. 6 in. Submit similar plans for other units of the superstructure as directed. Show all essential details of proposed forms and bracing. Have a licensed professional engineer design, seal, and sign these plans. Department approval is not required, but the Department reserves the right to request modifications to the plans. The Contractor is responsible for the adequacy of these plans.

Design job-fabricated formwork assuming a weight of 150 pcf for concrete, and include a minimum live load allowance of 50 psf of horizontal surface of the form. Do not exceed 125% of the allowable stresses used by the Department for the design of structures.

Use conventional forms, permanent metal deck forms, or prestressed concrete panels for slabs on beams or girders unless specified otherwise. Use permanent metal deck forms or conventional forms for thickened slabs, diaphragms, or other regions as shown on the plans where prestressed concrete panels are not used. Provide prestressed concrete panels as shown on the plans and in accordance with Item 424, "Precast Concrete Structural Members (Fabrication)." Provide copies of the precast panel layout drawings from the panel fabricator.

Use only material that is inert, nonbiodegradable, and nonabsorptive for forms to be left in place.

Overhang form supports that transmit a horizontal force to a steel girder or beam or to a prestressed concrete beam are permitted provided a satisfactory structural analysis has been made of the effect on the girder or beam as shown on the submitted formwork plans.

Use beam bracing as shown on the plans when overhang brackets are used on prestressed concrete beam spans with slab overhangs not exceeding 3 ft. 6 in. Provide and design additional support or bracing for the outside beams regardless of the type of beam used for spans with overhangs exceeding this amount.

Attachment of forms or screed supports for bridge slabs to steel I-beams or girders may be by welding subject to the following requirements.

- Do not weld to tension flanges or to areas indicated on the plans.
- Weld in accordance with Item 448, "Structural Field Welding."

When setting forms of any type, consider:

- deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram,
- differential beam or girder deflections due to skew angles and the use of certain stay-in-place slab forming systems, and
- deflection of the forming system due to the wet concrete.

Securely stake forms to line and grade and maintain in position for bridge approach slabs. Rigidly attach inside forms for curbs to the outside forms.

Construct all forms to permit their removal without marring or damaging the concrete. Clean all forms and footing areas of any extraneous matter before placing concrete. Provide openings in forms if needed for the removal of laitance or foreign matter.

Treat the facing of all forms with bond-breaking coating of composition that will not discolor or injuriously affect the concrete surface. Take care to prevent coating of the reinforcing steel.

Complete all preparatory work before placing concrete.

- 4.2.1. **Precast Panels.** Profile each beam to determine the actual camber or sag of the beams before placing panels. Adjust the profile grade line, panel elevation, and bearing seat elevations as needed to obtain the required cover over the slab reinforcement and slab thickness while maintaining ride quality. Make adjustments over suitable increments when a profile grade line adjustment is necessary, depending on span lengths, so the revised grade line will produce a uniform profile and good riding qualities. Obtain approval for the grade adjustments before placement. Consider actual beam camber in adjacent spans or slab placements when adjusting the grade line. Inspect each panel before being placed for cracks and other damage. Refer to Section 424.4.3.1., "Defects and Breakage," for rejection criteria due to cracking and other damage.
- 4.2.2. **Permanent Metal Decking.** Submit signed and sealed design calculations in addition to the required formwork drawings. Design and install formwork as shown on the plans and formwork drawings. The plans will govern in cases where the plans and the formwork drawings conflict.
- 4.2.3. **Conventional Forms.** Provide properly seasoned good-quality lumber free of imperfections that would affect its strength or impair the finished surface of the concrete. Provide timber or lumber that meets or exceeds the requirements for species and grade shown on the submitted formwork plans.

Maintain forms or form lumber that will be reused so that it stays clean and in good condition. Do not use any lumber that is split, warped, bulged, or marred or that has any defect that will produce inferior work; remove such lumber from the work.

Use plywood at least 3/4 in. thick. Use plywood for forming surfaces that remain exposed that meets the requirements for B-B Plyform Class I or Class II Exterior of the U.S. Department of Commerce Voluntary Product Standard PS 1.

Space studs and joists so that the facing form material remains in true alignment under the imposed loads.

Place forms with the form panels symmetrically (long dimensions set in the same direction) for surfaces exposed to view and receiving only an ordinary surface finish as defined in Section 420.4.13., "Ordinary Surface Finish." Make horizontal joints continuous.

Make molding for chamfer strips or other uses of materials of a grade that will not split when nailed and can be maintained to a true line without warping. Dress wood molding on all faces. Fill forms at all sharp corners and edges with triangular chamfer strips measuring 3/4 in. on the sides unless otherwise shown on the plans.

- 4.3. **Placing Reinforcement.** Place reinforcement as provided in Item 440. Do not weld reinforcing steel supports to I-beams or girders or to reinforcing steel except as shown on the plans.
- 4.4. **Drains.** Install and construct weep holes and roadway drains as shown on the plans.
- 4.5. **Extending Existing Slabs.** Verify pertinent dimensions and elevations of the existing structure before ordering any required materials.
- 4.5.1. **Removal.** Remove portions of the existing structure to the lines and dimensions shown on the plans or as directed. Dispose of these materials as shown on the plans or as directed. Remove any metal railing without damaging it, and stack it neatly on the right of way at locations that do not interfere with traffic or construction or at locations shown on the plans. All removed metal railing remains the property of the Department unless otherwise shown on the plans. Repair any portion of the remaining structure damaged as a result of the construction. Do not use explosives to remove portions of the existing structure unless approved in writing. Do not use a demolition ball, other swinging weight, or impact equipment unless shown on the plans. Use pneumatic or hydraulic tools for final removal of concrete at the "break" line. Use removal equipment, as approved, that will not damage the remaining concrete.
- 4.5.2. **Reuse of Removed Portions of Structure.** Detach and remove all portions of the old structure that are to be incorporated into the extended structure to the lines and details as shown on the plans or as directed. Move the unit to be reused to the new location specified using approved methods. Place the reinforcement and extension concrete as shown on the plans.
- 4.5.3. **Breaking Back Bridge Slabs.** Saw the top surface of the slab for bridge slabs and direct traffic slabs of box culverts along the "break" line to a depth of 1/2 in. before breaking back. Do not cut the reinforcement at the "break" line. Sever the concrete at the "break" line. Do not damage the remaining reinforcement within one lap length of the "break" line during removal of the designated portion of the existing structure.
- 4.5.4. **Splicing Reinforcing Steel.** Splice new reinforcing bars to exposed bars in the existing structure using lap splices in accordance with Item 440 unless otherwise shown on the plans. The new reinforcing steel does not need to be tied to the existing steel where spacing or elevation does not match that of the existing steel, provided the lap length is attained. Weld in accordance with Item 448 when welded splices are permitted. Install any required dowels in accordance with Section 422.4.6.10., "Installation of Dowels and Anchor Bolts."
- 4.5.5. **Concrete Preparation.** Roughen and clean concrete surfaces that are in contact with new construction before the placing of forms. Prepare these construction joint surfaces in accordance with Section 422.4.6.7., "Construction Joints."
- 4.6. **Placing Concrete.** Do not place concrete unless approval is obtained for the hold-point inspections in accordance with Section 422.4.1.10., "Inspection Hold-Points," and the pre-pour meeting has been conducted. Give the Engineer sufficient advance notice before placing concrete in any unit of the structure to permit the final inspection of forms, reinforcing steel placement, and other preparations. Obtain approval for

proposed curing methods based on forecast weather conditions for the expected duration of the pour and use the evaporation rate nomograph as mentioned below to determine the required curing options.

Follow the sequence of placing concrete shown on the plans or specified.

Do not place concrete when impending weather conditions would impair the quality of the finished work. Place concrete in early morning or at night or adjust the placement schedule for more favorable weather if conditions of wind, humidity, and temperature are such that concrete cannot be placed without the potential for plastic shrinkage cracking. Consult the evaporation rate nomograph in PCA's *Design and Control of Concrete Mixtures* or the evaporation rate spreadsheet available on the Department's website for shrinkage cracking potential. Adequately illuminate the entire placement site when mixing, placing, and finishing concrete in non-daylight hours as approved.

Furnish adequate shelter to protect the concrete against damage from rainfall or from freezing temperatures in accordance with this Item if changes in weather conditions require protective measures after work starts. Continue operations during rainfall only if approved. Use protective coverings for the material stockpiles. Cover aggregate stockpiles only to the extent necessary to control the moisture conditions in the aggregates.

Allow at least 1 curing day after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.

- 4.6.1. **Placing Temperature.** Place superstructure concrete only when its temperature at the time of placement is between 50 and 85°F. Increase the minimum placement temperature to 60°F if slag cement is used in the concrete.
- 4.6.2. **Transporting Time.** Begin the discharge of concrete delivered in truck mixers within the times shown in Table 14 of Item 421.
- 4.6.3. **Workability of Concrete.** Place concrete with a slump as specified in Section 421.4.2.5., "Slump." Placing concrete with slump exceeding maximum specified may result in bridge deck cracking and be subject to Section 422.4.10., "Defective Work." Water may be added to the concrete before discharging any concrete from the truck to adjust for low slump, provided the maximum mix design water-cement ratio is not exceeded. Mix concrete after introduction of any additional water or chemical admixtures in accordance with Section 421.4.6., "Mixing and Delivering Concrete." Do not add water or chemical admixtures after any concrete has been discharged.
- 4.6.4. **Transporting Concrete.** Use a method and equipment capable of maintaining the rate of placement shown on the plans or required by this Item to transport concrete to the forms. Transport concrete by buckets, chutes, buggies, belt conveyors, pumps, or other methods.

Protect concrete transported by conveyors from sun and wind to prevent loss of slump and workability. Shade or wrap with wet burlap pipes through which concrete is pumped as necessary to prevent loss of slump and workability.

Arrange and use chutes, troughs, conveyors, or pipes so the concrete ingredients will not be separated. Terminate such equipment in vertical downspouts, when necessary, to prevent segregation. Extend open troughs and chutes, if necessary, down inside the forms or through holes left in the forms.

Keep all transporting equipment clean and free of hardened concrete coatings. Discharge water used for cleaning clear of the concrete.
- 4.6.5. **Preparation of Surfaces.** Thoroughly wet all forms, prestressed concrete panels, T-beams, slab beams, and concrete box beams on which concrete is to be placed before placing concrete on them. Remove free water from the surface or beam lines before placing concrete. Provide surfaces that are in a moist, saturated surface-dry (SSD) condition when concrete is placed on them. Ensure the surface of the existing concrete is in an SSD condition just before placing subsequent concrete. Prewet the existing concrete by ponding water on the surface for 24 hr. before placing subsequent concrete. Use high-pressure water blasting to achieve

SSD conditions 15–30 min. before placing the concrete if ponding is not possible. An SSD condition is achieved when the surface remains damp when exposed to sunlight for 15 min.

Ensure the subgrade or foundation is moist before placing concrete for bridge approach slabs.

- 4.6.6. **Expansion Joints.** Construct joints and devices to provide for expansion and contraction as shown on the plans and in accordance with this Section and Item 454, "Bridge Expansion Joints."

Prevent bridging of concrete or mortar around expansion joint material in bearings and expansion joints.

Use forms adaptable to loosening or early removal in construction of all open joints and joints to be filled with expansion joint material. Loosen these forms as soon as possible after final concrete set to permit free movement of the span without requiring full form removal and avoid expansion or contraction damage to the adjacent concrete.

Ensure that finished joints conform to the plan details with the concrete sections completely separated by the specified opening or joint material.

Remove all concrete within the joint opening soon after form removal and again where necessary after surface finishing to ensure full effectiveness of the expansion joint.

- 4.6.7. **Construction Joints.** A construction joint is formed by placing plastic concrete in direct contact with concrete that has attained its initial set. Monolithic placement means the manner and sequence of concrete placing do not create a construction joint.

Make construction joints of the type and at the locations shown on the plans. Do not make joints in bridge slabs not shown on the plans unless approved. Additional joints in other members are not permitted without approval. Place authorized additional joints using details equivalent to those shown on the plans for joints in similar locations.

Make construction joints square and normal to the forms unless otherwise required. Use bulkheads in the forms for all vertical joints.

Thoroughly clean the hardened concrete surface of all loose material, laitance, dirt, and foreign matter, and saturate it with water. Remove all free water and moisten the surface before concrete or bonding grout is placed against it. Ensure the surface of the existing concrete is in an SSD condition just before placing subsequent concrete. Prewet the existing concrete by ponding water on the surface for 24 hr. before placing subsequent concrete. Use high-pressure water blasting to achieve SSD conditions 15–30 min. before placing the concrete if ponding is not possible. An SSD condition is achieved when the surface remains damp when exposed to sunlight for 15 min.

Draw forms tight against the existing concrete to avoid mortar loss and offsets at joints.

Bonding agents are not required unless specified otherwise. Coat the joint surface with bonding mortar, grout, epoxy, or other material as shown on the plans or in conformance with other Items if a bonding agent is required. Provide Type V epoxy in accordance with [DMS-6100](#) for bonding fresh concrete to hardened concrete. Place the bonding epoxy on a clean, dry surface, and place the fresh concrete while the epoxy is still tacky. Place bonding mortar or grout on a surface that is SSD and place the concrete before the bonding mortar or grout dries. Place other bonding agents in conformance with the manufacturer's recommendations.

- 4.6.8. **Handling and Placing.** Minimize segregation of the concrete and displacement of the reinforcement when handling and placing concrete. Produce a uniform, dense, compact mass.

Do not allow concrete to free-fall more than 5 ft. Remove any hardened concrete splatter ahead of the plastic concrete.

Fill each part of the forms by depositing concrete as near its final position as possible. Do not deposit large quantities at one point and run or work the concrete along the forms.

Avoid cold joints in a monolithic placement. Sequence successive layers or adjacent portions of concrete so they can be vibrated into a homogeneous mass with the previously placed concrete before it sets.

- 4.6.9. **Consolidation.** Carefully consolidate concrete and flush mortar to the form surfaces using immersion type vibrators. Do not use vibrators that operate by attachment to forms or reinforcement except where approved on steel forms.

Vibrate the concrete immediately after deposit. Systematically space points of vibration to ensure complete consolidation and thorough working of the concrete around the reinforcement and embedded fixtures, and into the corners and angles of the forms. Insert the vibrator vertically where possible, except for slabs where it may be inserted in a sloping or horizontal position. Vibrate the entire depth of each lift, allowing the vibrator to penetrate several inches into the preceding lift. Do not use the vibrator to move the concrete to other locations in the forms. Do not drag the vibrator through the concrete. Thoroughly consolidate concrete along construction joints by operating the vibrator along and close to but not against the joint surface. Continue the vibration until the concrete surrounding reinforcements and fixtures is completely consolidated. Hand-spade or rod the concrete if necessary to ensure flushing of mortar to the surface of all forms. Concentrate vibration efforts along the beam lines when precast concrete panels are used for deck construction.

- 4.6.10. **Installation of Dowels and Anchor Bolts.** Install dowels and anchor bolts by casting them in place or by grouting with grout, epoxy, or epoxy mortar unless specified otherwise. Form or drill holes for grouting. Use only epoxy when installing horizontal dowels into the edges of slabs. Follow the manufacturer's recommended installation procedures for pre-packaged grout or epoxy anchor systems. Test anchors if required on the plans or by other Items.

Drill holes for anchor bolts to accommodate the bolt embedment required by the plans. Make holes for dowels at least 12 in. deep unless otherwise shown on the plans. Make the hole diameter at least twice the dowel or bolt diameter, but the hole need not exceed the dowel or bolt diameter plus 1-1/2 in. when using cementitious grout or epoxy mortar. Make the hole diameter 1/16–1/4 in. greater than the dowel or bolt diameter when using neat epoxy, unless specified otherwise by the epoxy manufacturer.

Thoroughly clean holes of all loose material, oil, grease, or other bond-breaking substance, and blow them clean with filtered compressed air. Use a wire brush followed by oil-free compressed air to remove all loose material from the holes, repeating as necessary until no more material is removed. Ensure holes are in a surface-dry condition when epoxy type materials are used and in a surface-moist condition when cementitious grout is used. Develop and demonstrate for approval a procedure for cleaning and preparing the holes for installation of the dowels and anchor bolts. Completely fill the void between the hole and dowel or bolt with grouting material. Follow exactly the requirements for cleaning in conformance with the product specifications for pre-packaged systems.

Provide a Type III epoxy in accordance with [DMS-6100](#) when neat epoxy is used for anchor bolts or dowels. Provide Type VIII epoxy in accordance with [DMS-6100](#) when an epoxy grout is used. Provide grout, epoxy, or epoxy mortar as the binding agent unless otherwise shown on the plans.

Provide other anchor systems as shown on the plans.

- 4.6.11. **Placing Concrete in Cold Weather.** Protect concrete placed under weather conditions where weather may adversely affect results. Permission given by the Engineer for placing during cold weather does not relieve the Contractor of responsibility for producing concrete equal in quality to that placed under normal conditions. If concrete placed under poor conditions is unsatisfactory, remove and replace it as directed at Contractor's expense.

Do not place concrete in contact with any material coated with frost or with a temperature of 32°F or lower. Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless

approved. Place concrete when the ambient temperature in the shade is at least 35°F and rising or above 40°F.

Provide and install recording thermometers, maturity meters, or other suitable temperature measuring devices to verify all concrete is effectively protected. Maintain the temperature of the top surface of bridge slabs and top slabs of direct traffic culverts at 50°F or above for 72 hr. from the time of placement and above 40°F for an additional 72 hr.

Use additional covering, insulated forms, or other means and, if necessary, supplement the covering with artificial heating. Avoid applying heat directly to concrete surfaces. Cure as specified in Section 422.4.8., "Final Curing," during this period until all requirements for curing have been satisfied.

Have on hand all necessary heating and covering material, ready for use, before permission is granted to begin placement when impending weather conditions indicate the possible need for temperature protection. Distress caused by concrete drying out as a result of delayed set and strength gain associated with cold weather are a result of the Contractor's actions and are subject to repair in accordance with Section 422.4.10., "Defective Work."

- 4.6.12. **Placing Concrete in Hot Weather.** Use an approved Type B or Type D set retarding agent in all concrete for superstructures and top slabs of direct traffic culverts, except concrete containing slag cement, when the temperature of the air is above 85°F, unless otherwise directed.

Keep the concrete at or below the maximum temperature at time of placement as specified above. Sprinkle and shade aggregate stockpiles or use ice, liquid nitrogen systems, or other approved methods as necessary to control the concrete temperature.

- 4.6.13. **Placing Concrete in Superstructure.** Place simple span bridge slabs without transverse construction joints by using either a self-propelled transverse finishing machine or a mechanical longitudinal screed unless otherwise shown on the plans. Use of manually operated screeding equipment may be permitted for small placements or for unusual conditions such as narrow widening, variable cross-slopes, or transitions. Support the screed adequately on a header or rail system stable enough to withstand the longitudinal or lateral thrust of the equipment. Adjust the profile grade line as necessary to account for variations in beam camber and other factors to obtain the required slab thickness and concrete cover over the slab reinforcement. Set beams and verify their surface elevations in a sufficient number of spans so that when adjustment is necessary, the profile grade line can be adjusted over suitable increments to produce a smooth riding surface. Take dead load deflection into account in setting the grades of headers and rail systems. Use construction joints when required or permitted for slab placements on steel or prestressed concrete beams, as shown on the plans. Release falsework under the spans before placing concrete on steel girder or truss spans, and swing the spans free on their permanent supports.

Provide additional camber to offset the initial and final deflections of the span as shown on the plans for concrete flat slab, concrete slab, and girder spans cast in place on falsework. Provide camber of approximately 3/8 in. for 30-ft. spans and 1/2 in. for 40-ft. spans to offset initial and final deflections for concrete slab and girder spans using pan forms, unless otherwise directed. Provide a camber of 1/8 in. for 10-ft. spans but no more than 1/2 in. for concrete flat slab, concrete slab, and girder spans not using pan forms when dead load deflection is not shown on the plans.

Provide a camber of 1/4 in. in addition to deflection for slabs without vertical curvature on steel or prestressed concrete beams. Provide camber for specified vertical curvature and transverse slopes.

Make one or more passes with the screed over the bridge slab segment before placing concrete on it to ensure proper operation and maintenance of grades and clearances. Use an approved system of checking to detect any vertical movement of the forms or falsework. Maintain forms for the bottom surface of concrete slabs, girders, and overhangs to the required vertical alignment during concrete placing.

Level, strike off, and screed the surface while carrying a slight excess of concrete ahead of the screed to fill all low spots as soon as the concrete has been placed and vibrated in a section wide enough to permit

working. Move longitudinal screeds across the concrete with a saw-like motion while their ends rest on headers or templates set true to the roadway grade or on the adjacent finished slab. Move transverse screeds longitudinally approximately 1/5 of the drum length for each complete out-and-back pass of the carriage. Scream the surface of the concrete enough times and at intervals to produce a uniform surface true to grade and free of voids.

Fog unformed surfaces of slab concrete in bridge slabs and in top slabs of direct traffic culverts from the time of initial strike-off of the concrete until finishing is completed and required interim curing is in place. Do not use fogging to add finishing water, and do not work moisture from the fog spray into the fresh concrete.

Retard the concrete for simple spans only if necessary to complete finishing operations or as required by this Section. Bring the top of curb and sidewalk section to the correct camber and alignment when filling curb forms and finish them in accordance with this Item.

- 4.6.13.1. **Transverse Screeding.** Install rails for transverse finishing machines that are supported from the beams or girders so the supports may be removed without damage to the slab. Prevent bonding between removable supports and the concrete in an acceptable manner. Do not allow rail support parts that remain embedded in the slab to project above the upper mat of reinforcing steel. Rail or screed supports attached to I-beams or girders are subject to the requirements of this Item. Place concrete at a minimum rate of 30 ft. of bridge slab per hour for transverse screeding unless otherwise shown on the plans. Deposit concrete parallel to the skew of the bridge so all girders are loaded uniformly along their length. Deposit slab concrete between the exterior beam and adjacent beam before placing concrete in the overhang portion of the slab. Furnish personnel and equipment capable of placing, finishing, and curing the slab at an acceptable rate to ensure compliance with the specifications. Place concrete in transverse strips. Start placement at the lowest end on profile grades greater than 1-1/2%.

At the Contractor's option, attach a pan drag and either a carpet or burlap drag to the screed assembly to float and provide surface micro-texture in one operation. Adjust the contact pressure of the pan drag to smooth high spots and fill any depressions left by the screed. Adjust the weight or position of the carpet or burlap drag to produce a smooth sandy micro-texture without blemishes, marks, or scratches deeper than 1/16 in. Fill screed rail support holes and holes from the Engineer's depth checks for slab thickness and reinforcing cover with concrete and finish them to match the rest of the slab.

- 4.6.13.2. **Longitudinal Screeding.** Use of temporary intermediate headers will be permitted for placements over 50 ft. long if the rate of placement is rapid enough to prevent a cold joint and if these headers are designed for easy removal to permit satisfactory consolidation and finish of the concrete at their locations, unless otherwise shown on the plans. Deposit slab concrete between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab. Place concrete in longitudinal strips starting at a point in the center of the segment adjacent to one side, except as this Section specifies, and complete the strip by placing uniformly in both directions toward the ends. Start placing at the lowest end for spans on a profile grade of 1-1/2% or more. Use strips wide enough that the concrete within each strip remains plastic until placement of the adjacent strip. Place the concrete in proper sequence to be monolithic with the adjacent longitudinal strips of the slabs where monolithic curb construction is specified.

- 4.6.13.3. **Placements on Continuous Steel Units.** Place slabs on continuous steel units in a single, continuous operation without transverse construction joints using a self-propelled transverse finishing machine or a mechanical longitudinal screed, unless otherwise shown on the plans. Retard the initial set of the concrete sufficiently to ensure concrete remains plastic in at least three spans immediately preceding the slab being placed. Use construction joints, when required for slab placements on steel beams or girders, as shown on the plans. Ensure the previously placed concrete attains a compressive strength of 3,000 psi when staged placement of a slab is required on the plans before placing the next stage concrete. Multiple stages may be placed in a single day if approved. Use an approved placing sequence that will not overstress any of the supporting members where plans permit staged placing without specifying a particular order of placement.

- 4.6.13.4. **Slab and Girder Units.** Place girders, slab, curbs of slab, and girder spans monolithically unless otherwise shown on the plans. Fill concrete girder stems first and place the slab concrete within the time limits specified in this Item. Place concrete in the stems for a short distance if using a transverse screed, and then place the

concrete in transverse strips. Fill the outside girder stem first, beginning at the low end or side, if using a longitudinal screed, and continue placement in longitudinal strips.

- 4.7. **Finish and Interim Curing of Bridge Slabs.** Obtain approval of the proposed interim curing methods, equipment, and materials at the pre-pour meeting before placing concrete. Consider forecast weather conditions to determine the interim curing methods to use.

Use work bridges or other suitable facilities to perform all finishing operations and to provide access, if necessary, for the Engineer to check measurements for slab thickness and reinforcement cover.

Work the screeded surface to a smooth finish using a long-handled wood or metal float, or hand-float it from work bridges over the slab. Floating may not be necessary if the pan float attached to a transverse screed produces an acceptable finish. Avoid overworking the surface of the concrete. Avoid use of finish water.

Perform sufficient checks, witnessed by the Engineer, using a long-handled 10-ft. straightedge on the plastic concrete to ensure the final surface will be within specified tolerances. Make the check with the straightedge parallel to the centerline. Lap each pass half over the preceding pass. Remove all high spots and fill and float all depressions more than 1/16 in. deep with fresh concrete. Continue checking and floating until the surface is true to grade and free of depressions, high spots, voids, or rough spots. Fill screed-rail support holes with concrete and finish them to match the top of the slab.

Provide a uniform micro-texture using a carpet drag, burlap drag, or broom finish. Finish the surface to a smooth sandy texture without blemishes, marks, or scratches deeper than 1/16 in. Apply the surface texturing using a work bridge or platform immediately after completing the straightedge checks. Draw the carpet or burlap drag longitudinally along the concrete surface, adjusting the surface contact area or pressure to provide a satisfactory coarsely textured surface. A broom finish may be performed using a fine-bristle broom transversely. For bridge approach slabs, the carpet drag, burlap drag, or broom finish may be applied either longitudinally or transversely.

Evaporation protection is required if the evaporation rate exceeds 0.10 lb. per square foot per hour in accordance with the *Evaporation Calculation for Concrete Worksheet* as shown on the Department's website, in accordance with the evaporation rate nomograph in PCA's *Design and Control of Concrete Mixtures*, or if shown on the plans.

- 4.7.1. **Evaporation Protection.** Use one of the following methods for evaporation protection.

- 4.7.1.1. **Evaporation Retardant.** Coat the concrete surface immediately after the carpet or burlap drag, or broom finish with a single application of evaporation retardant at a rate recommended by the manufacturer. Do not allow more than 10 min. to elapse between the texturing at any location and application of evaporation retardant. The evaporation retardant may be applied using the same work bridge used for surface texturing. Do not work the concrete surface once the evaporation retardant has been applied.

- 4.7.1.2. **Wet Burlap.** Place pre-wet burlap no more than 10 ft. behind the finishing operation. A work bridge may be required to avoid marring the surface. Ensure the wet burlap covers the entire surface. Use sprayers, hoses, sprinklers, or other similar methods to keep the burlap continuously wetted until application of the final curing.

- 4.7.2. **Interim Curing.** Apply interim curing using one of the following options after applying the evaporation protection (if needed).

- 4.7.2.1. **Membrane Cure.** Apply membrane interim curing at a rate of approximately 180 sq. ft. per gallon. Apply before the water sheen disappears but do not place over standing water. Fog as necessary to maintain the wet sheen. Do not spray membrane curing on a dry surface.

- 4.7.2.2. **Wet Burlap.** Place pre-wet burlap no more than 10 ft. behind the finishing operation. Burlap used for evaporation protection will also be considered as the interim curing.

- 4.8. **Final Curing.** Obtain approval of the proposed curing methods, equipment, and materials at the pre-pour meeting before placing concrete. Inadequate curing or facilities may delay all concrete placements on the project until remedial action is taken. Apply final curing as soon as possible after interim curing without damaging the surface finish. Check the adequacy of the curing each day of the curing period. Take corrective action or modify the curing methods as needed to maintain a moist concrete surface.

A curing day is a calendar day when the temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hr. or, on colder days, if the temperature of all surfaces of the concrete is maintained above 40°F, for the entire 24 hr. The required curing period begins when all concrete has attained its initial set. [Tex-440-A](#) may be used to determine when the concrete has attained its initial set.

Cure all superstructure concrete according to the following, unless otherwise shown on the plans:

- Concrete using Type I or Type III cement: 8 days
- Concrete using Type I/II or Type II cement: 10 days
- Concrete with any type of supplementary cementing materials: 10 days

Place polyethylene sheeting, burlap-polyethylene blankets, laminated mats, or insulating curing mats in direct contact with the slab when the air temperature is expected to drop below 40°F during the first 72 hr. of the curing period. Weigh down these curing materials using dry mats to maintain direct contact with the concrete and provide insulation against cold weather. Supplemental heating or insulation may be required in cold and wet weather if the insulating cotton mats become wet or the concrete drops below the specified curing temperature. Avoid applying heat directly to concrete surfaces.

Use one of the following water curing methods for final curing. Keep all exposed surfaces of the concrete wet continuously for the required curing time. Use water for curing that meets the requirements for concrete mixing water in accordance with Section 421.2.5., "Water." Do not use seawater or water that stains or leaves an unsightly residue.

- 4.8.1. **Cotton Mats.** Keep the concrete continuously wet by maintaining wet cotton mats in direct contact with the concrete for the required curing time. Weight the mats adequately to provide continuous contact with all concrete. Cover surfaces that cannot be cured by direct contact with mats, forming an enclosure well anchored to the forms or ground so outside air cannot enter the enclosure. Provide sufficient moisture inside the enclosure to keep all surfaces of the concrete wet. Use of soaker hoses and plastic covering is acceptable provided the concrete surface remains continuously wet for the required curing duration.
- 4.8.2. **Burlap Mats.** The burlap used for interim curing may also be used for final curing if kept continuously wetted and completely covered with plastic sheeting. Overlap plastic sheeting and weigh down sufficiently so air cannot enter underneath the plastic.
- 4.8.3. **Burlap-Polyethylene Mats.** Place these mats over soaker hoses or by other similar methods to keep the concrete surface wetted for the duration of the curing period. Overlap the mats and weight down sufficiently so air cannot enter underneath the mats.
- 4.9. **Removal of Forms and Falsework.** Forms for vertical surfaces may be removed after the concrete has aged 12 hr. after initial set, provided the removal can be executed without damage to the concrete, unless otherwise directed.

Remove forms for inside curb faces and for bridge rails whenever removal can be executed without damage to the curb or railing.

Leave in place weight-supporting forms and falsework spanning more than 1 ft., except as directed otherwise, until the concrete has attained a compressive strength of 2,500 psi. Remove forms for other structural components as necessary.

Forms or parts of forms may be removed only if constructed to permit removal without disturbing forms or falsework required to be left in place for a longer period on other portions of the structure.

Remove all metal appliances used inside forms for alignment to a depth of at least 1/2 in. from the concrete surface. Make the appliances so that metal may be removed without undue chipping or spalling of the concrete, and so that it leaves a smooth opening in the concrete surface when removed. Do not burn off rods, bolts, or ties.

Remove all forms and falsework unless otherwise directed.

Apply an ordinary surface finish as the final finish to the bottom of bridge slabs between girders or beams, and vertical and bottom surfaces of interior concrete beams or girders, unless otherwise noted.

Form marks and chamfer edges do not need to be smoothed for the bottom of bridge slabs between girders or beams. Remove all fins, runs, drips, or mortar from surfaces that will be exposed.

- 4.10. **Defective Work.** The Contractor is responsible for the ride quality of the finished bridge slab. The Engineer will use a 10-ft. straightedge (1/8 in. in 10 ft.) to verify ride quality and determine locations where corrections are needed. Submit a plan for approval to produce a ride of acceptable quality if the Engineer determines the ride quality is unacceptable. Make all corrections for ride before saw-cutting grooves.

Repair defective work as soon as possible. Remove and replace at the expense of the Contractor any defect that cannot be repaired to the satisfaction of the Engineer.

The Engineer will inspect the deck or slab for plastic shrinkage and settlement cracking after completion of final curing and within 5 days after curing mats are removed. Seal any noted shrinkage cracks attributable to Contractor placing, curing, and finishing practices as well as transverse cracks over interior bents in continuous units using gravity feed crack repair as directed in accordance with Item 780, "Concrete Crack Repair," at no cost to the Department.

- 4.11. **Final Surface Texture.** Saw-cut grooves in the hardened concrete of bridge slabs, bridge approach slabs, and direct traffic culverts to produce the final texturing after completion of the required curing period, unless otherwise specified. Cut grooves parallel to the structure centerline, unless otherwise shown on plans. Cut grooves along the slab within 18 in. of the barrier rail, curb, or median divider. Adjust groove cutting at skewed metal expansion joints in bridge slabs so all grooves end within 6 in. of the joint, measured perpendicular to the centerline of the metal joint. Leave no ungrooved surface wider than 6 in. adjacent to either side of the joint. Cut grooves continuously across construction joints or other joints in the concrete less than 1/2 in. wide. Apply the same procedure described above where barrier rails, curbs, or median dividers are not parallel to the structure centerline to maintain the 18-in. maximum dimension from the end of the grooves to the gutter line. Cut grooves continuously across formed concrete joints. Provide either a carpet drag or broom finish for micro-texture when saw-cut grooves are not required on the plans. In this case, ensure an adequate and consistent micro-texture is achieved by applying enough weight to the carpet and keeping the carpet or broom from getting plugged with grout. For surfaces that do not have adequate texture, the Engineer may require corrective action including diamond grinding or shot blasting.

Give a carpet drag, burlap drag, or broom finish to all concrete surfaces to be overlaid when the plans call for a concrete overlay (CO) to be placed on the slab (new construction). Saw-grooving is not required in this case. Provide an average texture depth for the finish of approximately 0.035 in. with no individual test falling below 0.020 in., unless otherwise shown on the plans, when tested in accordance with [Tex-436-A](#). Revise finishing procedures to produce the desired texture if the texture depth falls below what is intended.

Give all concrete surfaces to be covered a lightly textured broom or carpet drag finish when the plans require an asphalt seal, with or without overlay, on the slab (new construction). Provide an average texture depth of approximately 0.025 in. when tested in accordance with [Tex-436-A](#).

5. MEASUREMENT

Reinforced concrete slabs or decks on girders, beams, slab beams, double-T beams, or box beams placed under this Item will be measured by the square foot of slab surface area using the nominal dimensions and

configuration shown on the plans. Transverse measurement will be made from outer edge of slab to outer edge of slab (including raised median and sidewalk sections). Longitudinal measurement will be made between ends of units or spans. Diaphragms, haunch concrete, reinforcement, and optional steel diaphragms will be considered as a portion of the slab unless otherwise shown on the plans. An estimated quantity for the haunch between the slab and beams will be included for the Contractor's information only. No measurement will be made during construction for variation in the amount of haunch concrete due to variations in camber of the beams.

Approach slabs and cast-in-place superstructure elements including flat slabs, slab and girder units (pan formed), and shear keys will be measured by the cubic yard. For slab and girder spans using pan forms, a quantity will be included for the screed setting required to provide proper camber in the roadway surface after form removal.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustment of quantities is required.

The quantities of concrete and reinforcing steel shown on the plans are based on a conventionally formed slab. These quantities include amounts for concrete diaphragms, brackets and other required attachments, and haunch concrete when required, based on the profile grade, theoretical camber, and dead load deflection of the beams. No additional measurement will be made for concrete or reinforcing steel due to a variation in camber of the beams from theoretical camber, or for additional quantities required by optional methods of forming.

Additional concrete that may be required by an adjustment of the profile grade line during construction, to ensure proper slab thickness, will not be measured for payment.

6. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for the various superstructure elements specified. This price is full compensation for furnishing, hauling, mixing, placing, curing, and finishing concrete; furnishing and placing reinforcing steel; grouting and pointing; furnishing and placing drains and expansion joint material (except where specifically furnished under another item); furnishing and placing metal flashing strips; forms (removable and permanent) and falsework; prestressed concrete panels; furnishing and placing concrete and reinforcement for raised medians, sidewalks, sign mounts, luminaire brackets, and other concrete appurtenances; removing designated portions of existing slab; cleaning, bending, and cutting exposed existing reinforcing steel; welding reinforcing steel; doweling; cleaning and preparing concrete surfaces; and equipment, labor, tools, and incidentals.

Price will be adjusted in accordance with Article 421.6., "Measurement and Payment," when required to address non-compliance of project acceptance testing.

Diaphragm concrete will not be paid for directly, but will be subsidiary to the slab unless otherwise shown on the plans.

Structural steel, anchor bolts, armor joints, sealed expansion joints, rail (including the concrete parapet portion), and concrete median barrier will be measured and paid for in conformance with pertinent bid items.

In addition to the work described above, for extending structures the unit price bid is full compensation for removing and disposing of the designated portion of the existing structure; removing, stockpiling, and replacing headwall units for reuse; cleaning, bending, and cutting of exposed reinforcing steel; splicing or welding of new reinforcing steel to existing reinforcing steel; installation of dowels; and cleaning and preparing existing concrete surfaces.

Item 423

Retaining Walls



1. DESCRIPTION

Furnish, construct, and install retaining walls.

2. MATERIALS

2.1. **General.** Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 445, "Galvanizing"
- Item 458, "Waterproofing Membranes for Structures"
- Item 556, "Pipe Underdrains"

Use concrete for retaining walls that conforms to the requirements of Table 1 unless otherwise shown on the plans.

Table 1
Concrete for Retaining Walls

Application	Concrete
Cast-in-place, non-reinforced	Class A
Cast-in-place, reinforced	Class C
Precast	Class H, $f_c = 4,000$ psi

Furnish concrete for machine-made concrete block units in accordance with ASTM C90, Class 1, Type II, except the minimum 28-day compressive strength must be 4,000 psi with maximum moisture absorption of 7%.

Provide Type 1 filter fabric in accordance with [DMS-6200](#), "Filter Fabric." Provide filter fabric rated as UV-resistant when used as part of the exposed facing for a temporary wall.

Joint fillers, pads, waterstops, and other incidental materials must be as shown on the plans or approved by the Engineer.

Epoxy coat all steel used in concrete panels and coping including connectors, dowels, stirrups, and reinforcing steel when the plans call for epoxy coating of steel earth reinforcements.

Construct permanent retaining walls approved for use in accordance with [DMS-4800](#), "Proprietary Earth Retaining Wall System," and on the Approved System List for Concrete Block Retaining Walls Systems and Mechanically Stabilized Earth Panel Type Systems.

2.2. **Definitions.** This Item uses the following terms.

- **Permanent Wall.** A retaining wall with a design service life of 75 yr. All walls are presumed to be permanent walls unless otherwise shown on the plans.
- **Temporary Wall.** A retaining wall so designated by description, with a design service life of 3 yr.
- **Mechanically Stabilized Earth (MSE) Wall.** A wall consisting of a volume of select backfill with tensile earth reinforcement elements distributed throughout. Permanent MSE walls use a precast concrete

panel as a facing element. Provide the approved MSE panel type systems in accordance with [DMS-4800](#). Temporary MSE walls use welded wire fabric with filter fabric backing as a facing element.

- **Concrete Block Wall.** A retaining wall that uses machine-made, precast concrete block units as facing elements. The walls may use a volume of select fill with tensile earth reinforcements distributed throughout, or may use only the facing unit and unit fill weight for support. Provide the approved concrete block retaining wall systems in accordance with [DMS-4800](#).

2.3. **Fabrication.**

2.3.1. **Cast-in-Place.** Execute work in accordance with Item 420.

2.3.2. **Formed Precast.** Execute work in accordance with Item 424, "Precast Concrete Structural Members (Fabrication)."

2.3.3. **Machine-Made Precast.** Furnish machine-made concrete block units in accordance with ASTM C90, sampled and tested in accordance with ASTM C140. Furnish units with molded dimensions within 1/8 in. of specified dimensions, except height must be within 1/16 in.

2.4. **Backfill.**

2.4.1. **Non-Select.** Furnish non-select backfill for walls other than temporary and permanent MSE and concrete block walls as shown on the plans. Non-select fill will be in accordance with Item 132, "Embankment," of the type shown on the plans. Provide material with a maximum plasticity index of 30 if no type is specified, as determined in accordance with [Tex-106-E](#).

2.4.2. **Select.** Select backfill is required in specific areas of permanent and temporary MSE and concrete block-type retaining walls. Provide select backfill that is free of organic or otherwise deleterious materials and that conforms to the gradation limits shown in Table 2, as determined in accordance with [Tex-401-A](#).

Provide backfill that does not contain shale, caliche, or other soft, poor-durability coarse aggregate particles. Reclaimed asphalt pavement is not allowed. Manufactured sand is allowed for temporary walls with a service life of 3 yr. or less. Test each source of backfill for durability and soundness in accordance with [Tex-411-A](#), five-cycle magnesium sulfate soundness. Backfill material with a maximum five-cycle soundness loss exceeding 25% will be rejected. Alternately, [Tex-461-A](#) Micro-Deval abrasion may be used if the corresponding results show loss is not greater than 20%; otherwise [Tex-411-A](#) governs aggregate verification.

Type AS, BS, and DS particles larger than 1/4 in. must be angular or completely crushed. Provide mechanically crushed gravel or stone backfill. Gravel from each aggregate source will have at least 95% two or more mechanically induced crushed faces, as determined in accordance with [Tex-460-A](#), Part I. Rounded rock or rounded gravel is not allowed. Natural sand meeting the requirements of this Section is permitted for use.

Table 2
Select Backfill Gradation Limits

Type	Sieve Size	Percent Retained
AS	3"	0
	1/2"	50–100
	#4	See Note
	#40	85–100
	#200	95–100
BS	3"	0
	#4	See Note
	#40	40–100
	#200	85–100
CS	3"	0
	#4	See Note
	#200	75–100
DS	3"	0
	3/8"	85–100
	#200	95–100

Note—Use No. 4 sieve for determination of rock backfill in accordance with Section 2.4., "Backfill."

When the backfill gradation results in 85% or more material retained on the No. 4 sieve, the backfill will be considered rock backfill. All Type DS backfill is considered rock backfill.

In addition to the requirements for Type CS select fill, the plasticity index in accordance with [Tex-106-E](#) may not exceed six.

Furnish Type BS backfill for permanent walls; Type CS backfill for temporary walls; and Type DS backfill for areas of walls subject to inundation unless otherwise shown on the plans, or below the 100-year flood elevation as shown on the plans.

Furnish backfill meeting the requirements of this Section but with a maximum particle size of 3/4 in. when nonmetallic or epoxy coated earth reinforcements are used.

- 2.4.3. **Drainage Aggregate for Concrete Block Wall.** Use drainage aggregate to fill the void within concrete block units and in the zone 1 ft. behind the units. Provide drainage aggregate that is free of organic or otherwise deleterious materials and that conforms to the gradation limits shown in Table 3 as determined in accordance with [Tex-110-E](#).

Table 3
Drainage Aggregate Gradation Limits

Sieve Size	Percent Retained
1"	0
3/4"	25–50
1/2"	50–100
#4	75–100

- 2.4.4. **Cement-Stabilized Backfill.** Use cement-stabilized backfill when required or as approved. Stabilize Type CS backfill with 5% hydraulic cement by dry weight of the backfill material. Use a stationary plant to thoroughly mix the backfill material, cement, and water. Place and compact the backfill within 2 hr. of mixing. Provide special drainage provisions when cement-stabilized backfill is used, as shown on the plans.
- 2.4.5. **Electrochemical.** Provide backfill meeting the following additional requirements for permanent retaining wall systems using galvanized metallic earth reinforcements.
- The pH is between 5.5 and 10.0 as determined in accordance with [Tex-128-E](#).
 - Resistivity is more than 3,000 ohms centimeter (ohm-cm) as determined in accordance with [Tex-129-E](#).

- Material with resistivity between 1,500 and 3,000 ohm-cm may be used if the chloride content is less than 100 parts per million (ppm) and the sulfate content is less than 200 ppm as determined in accordance with [Tex-620-J](#).

Perform electrochemical testing on the raw, unstabilized backfill material when cement-stabilized backfill is used.

- 2.5. **Earth Reinforcements.** Furnish earth reinforcements that meet the design requirements. Galvanize or epoxy coat all steel elements for permanent walls in contact with soil. Epoxy coat in accordance with Item 440, except provide a minimum 18-mil coating thickness. Epoxy coat the reinforcing only when shown on the plans or as approved. Use connection hardware that is likewise nonmetallic or epoxy coated when using nonmetallic or epoxy coated earth reinforcements.

3. CONSTRUCTION

- 3.1. **General.** Construct retaining walls as shown on the plans and the approved working drawings, and in accordance with the following Items.

- Item 110, "Excavation"
- Item 132, "Embankment"
- Item 400, "Excavation and Backfill for Structures"
- Item 420, "Concrete Substructures"
- Item 458, "Waterproofing Membranes for Structures"
- Item 556, "Pipe Underdrains"

Construct required piling or drilled shafts in conformance with the pertinent specification.

- 3.2. **Options.** When optional design details are shown on the plans, the Contractor is required to use the same facing design within an area of continuous retaining walls.

Provide drawings for review indicating the proposed design arrangement when proposing the use of two or more systems.

- 3.3. **Submittals.** When proprietary wall systems are used for permanent or temporary walls, submit working drawings including casting drawings, construction drawings, and design calculations bearing the seal of a licensed professional engineer for review and approval in accordance with the Department's *Guide to Shop Drawing Submittals* process. Upon completion of construction, submit a set of reproducible as-built drawings.

- 3.3.1. **Casting Drawings.** Include all information necessary for casting wall elements, including railing and coping when prefabricated. Show shape and dimensions of panels; size, quantity, and details of the reinforcing steel; quantity, type, size, and details of connection and lifting hardware; and additional necessary details.

- 3.3.2. **Construction Drawings.** Include a numbered panel layout showing horizontal and vertical alignment of the walls as well as the existing and proposed ground lines. Include all information needed to erect the walls, including the proposed leveling pad elevations; the type and details of the soil reinforcing system (if applicable); the details and manufacturer of all pads, fillers, and filter fabric; the limits and dimensions of structural backfill; details necessary to incorporate coping, railing, inlets, drainage, and electrical conduit; and additional necessary details.

Leveling pad elevations may vary from the elevations shown on the plans. Provide at least 1 ft. of cover from the top of the leveling pad to finished grade unless a different minimum cover or a specified minimum leveling pad elevation is shown.

- 3.3.3. **Design Calculations.** Include calculations covering the range of heights and loading conditions on the project. Calculations for both internal and external stability as shown on the plans will be required. Include a

summary of all design parameters used; material types, strength values, and assumed allowables; loads and loading combinations; and factor-of-safety parameters.

3.4.

Permanent MSE Walls. Grade the foundation for the structure level to a width equal to or exceeding the length of the reinforcing system. Perform proof rolling on retaining wall foundation area to identify any loose, soft, or unsuitable materials in accordance with Item 216, "Proof Rolling." Material not meeting a maximum rut depth of 1 in. per pass of pneumatic tire roller should continue to be rolled or removed and replaced with suitable material. Pneumatic tire rolling will be waived for portions of wall with a reinforcement length of 8 ft.; for these conditions, proof rolling will be required using a smooth-wheeled vibratory roller or other approved roller.

Place drilled shafts and piling located within the MSE volume before construction of the wall. Place any required pipe underdrain before construction of the wall. Complete MSE wall construction before construction of abutment caps and abutment wing walls. Completion of walls and abutment should be in conjunction with project phasing or allow for completion of walls that meets the proper placement and compaction at abutments.

Place the concrete leveling pad as shown on the construction drawings. Provide a wood float finish and wait at least 24 hr. before beginning panel erection. No curing or strength testing of the leveling pad concrete is required.

Shim the first row of panels as necessary to achieve correct alignment. Use plastic shims or other material that will not deteriorate. Remove and replace the leveling pad or provide a grout level-up as directed if the required shim height exceeds 1 in.

Place filter fabric behind the wall along the joint between the leveling pad and the panels. Grout areas where filter fabric spans more than 6 in. at leveling pad steps.

Place and compact fill material over the leveling pad to an elevation even with or above the surrounding ground after backfilling the first row of panels. Do not allow water to accumulate and stand at the base of the wall.

Place filter fabric behind all wall joints and at the intersection of retaining walls with other structures, including riprap. Cover joints at least 6 in. on each side and use adhesive to hold the filter fabric in place.

Exercise care while lifting, setting, and aligning panels to prevent damage to the panels. Discontinue any operation that results in chipping, spalling, or cracking of panels. Remove and replace damaged panels, or repair as approved.

Provide external bracing for the initial row of panels. Use wooden wedges, clamps, or other means necessary to maintain position and stability of panels during placement and compaction of backfill. Remove wooden wedges as soon as the panel or coping above the wedged element is erected and backfilled. Remove all wedges after completing the wall.

Review plumbness and position of each row of panels before placing the subsequent row. Remove and rebuild any portion of the wall that is out of tolerance. Modify panel batter and bracing, and backfill material, placement, and compaction methods as required to maintain wall tolerances.

Construct walls to a local vertical and horizontal alignment tolerance of 3/4 in. when measured along a 10-ft. straightedge relative to vertical and horizontal wall control line. Construct walls to an overall vertical tolerance (plumbness from top to bottom) of 1/2 in. per 10 ft. of wall height. Construct walls so the maximum offset at any panel joint is between 3/8 in. and 3/4 in. and no joint is open to the extent the filter fabric is visible from the front of the wall.

Place backfill to closely follow the erection of each row of panels. Place the select and embankment backfill to the same elevation where possible, and operate the compaction equipment over the interface. Do not

create a continuous, distinct, vertical joint between the select and embankment backfill. Complete the embankment after construction of the retaining wall.

Maintain the stability of the interface area between the existing ground and the select fill when building a wall against existing ground. Remove and recompact any material that loosens, caves, or fails.

Compact backfill to provide at least 95% of density determined in accordance with [Tex-114-E](#). Field density determination will be made in accordance with [Tex-115-E](#).

Sprinkle backfill as required to ensure adequate uniformly distributed moisture in each lift before and during compaction. Place fill in lifts of 8 in. or less (loose measurement). Place fill in a manner that avoids segregation of the fill. Decrease the lift thickness if necessary to obtain the required compaction. Use hand-operated or walk-behind compaction equipment in the 3-ft. wide strip adjacent to the wall panels. Do not displace panels or distort or damage the reinforcement system during compaction. Modify backfill material, placement, and compaction methods as necessary to meet density requirements while maintaining wall tolerances.

Place rock backfill or material the Engineer determines too coarse for density testing in accordance with Section 132.3.4.1., "Ordinary Compaction."

Place and compact the backfill to the reinforcement level, at each earth reinforcement level, before placing the reinforcement. Place earth reinforcements perpendicular to the face of the wall. Remove slack in connections before placing backfill. Pre-tension each layer of reinforcement to remove slack before placing backfill for systems using nonmetallic earth reinforcements. Use devices capable of mechanically applying and holding the required force. Do not operate tracked equipment directly on any reinforcement.

Cover the rock backfill with filter fabric before placing the 2 ft. of backfill immediately below the pavement structure or top of wall when rock backfill is used. Overlap the fabric at least 18 in. at splices, and extend it past the edge of the rock backfill at least 18 in. Use backfill that contains sufficient fines to fill the voids in a compacted state above the filter fabric. Place a horizontal layer of filter fabric as specified above when transitioning from rock backfill to finer grained backfill anywhere within the wall volume.

Prevent surface water or rainwater from damaging the retaining walls during construction. Shape the backfill to prevent water from ponding or flowing on the backfill or against the wall face. Remove and replace any portion of the retaining wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

- 3.5. **Temporary MSE Walls.** Provide a facing system rigid enough to maintain a smooth and straight wall face both during and after construction.

Grade and compact the foundation for the structure in accordance with Section 423.3.4., "Permanent MSE Walls."

Place earth reinforcement and facing system as shown on the approved working drawings. Backfill the 2-ft. zone immediately behind the facing with clean, coarse rock meeting the requirements of Coarse Aggregate Grade 1, 2, or 3 of Item 421, or with Type DS backfill as described in Section 423.2.4.2., "Select." Cement-stabilized backfill as described in Section 423.2.4.4., "Cement-Stabilized Backfill," or crushed concrete may be used in place of the coarse rock.

Place and compact backfill in accordance with Section 423.3.4., "Permanent MSE Walls."

Construct walls to a vertical and horizontal alignment tolerance of 3 in. when measured along a 10-ft. straightedge. Construct walls to an overall vertical tolerance (plumbness from top to bottom) of 2 in. per 10 ft. of wall height. Place adjacent facing elements so the maximum out-of-plane offset at any facing element joint is less than 1 in. Place facing elements and filter fabric with no gaps in the facing or fabric.

Prevent surface water or rainwater from damaging the retaining walls during and after construction. Place temporary berms or curbs, shape the backfill, or use other approved methods to prevent water from flowing against or over the wall face. Remove and replace any portion of the wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

- 3.6. **Concrete Block Retaining Walls.** The concrete block units may be sampled and tested by the Engineer before shipment or upon delivery to the construction site. Display samples of block units indicating the color, texture, and finish for approval. Store, transport, and handle all block units carefully to prevent cracking or damage.

Grade and compact the foundation for the structure, and place the leveling pad in Section 423.3.4., "Permanent MSE Walls."

Place the concrete block facing units as shown on the approved working drawings. Fill the voids within the units and fill the 1-ft. zone immediately behind the facing with drainage aggregate as described in Section 423.2.4.3., "Drainage Aggregate for Concrete Block Wall." Systems tested without unit fill may omit the fill as shown on the approved drawings. Systems with approved filter fabric details may omit the drainage aggregate in the 1-ft. zone immediately behind the facing.

Place reinforcements and backfill for walls using earth reinforcements in accordance with the requirements of Section 423.3.4., "Permanent MSE Walls." Pay particular attention to the connection details of the earth reinforcements to the concrete block units.

Construct walls to a vertical and horizontal alignment tolerance of 1-1/2 in. when measured along a 10-ft. straightedge. Construct walls to an overall vertical tolerance (deviation from the vertical or battered control line, top to bottom) of 1 in. per 10 ft. of wall height. Place adjacent facing elements so the maximum out-of-plane offset at any facing element joint is less than 1 in. Place facing elements with maximum 1/4-in. gaps between block units.

Prevent surface water or rainwater from damaging the retaining walls during construction. Shape the backfill to prevent water from ponding or flowing on the backfill or against the wall face. Remove and replace all portions of the retaining wall damaged or moved out of tolerance by erosion, sloughing, or saturation of the retaining wall or embankment backfill.

4. MEASUREMENT

This Item will be measured by the square foot of the front surface area of the wall. Unless otherwise shown on the plans, the area will be measured from 1 ft. below finished grade of the ground line on the face of the exterior wall to the top of the wall, including any coping required (not including railing).

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Retaining Walls" of the type or special surface finish specified. This price is full compensation for excavation in back of retaining walls and for footings; furnishing and placing footings, leveling pads, copings, and traffic railing foundations; furnishing, placing, and compacting backfill (except in embankment areas), including cement for stabilization; proof rolling; furnishing and placing concrete, reinforcing steel, waterproofing material, joint material, water stop, and filter fabric when required; fabricating, curing, and finishing all panels; furnishing and placing earth reinforcement, anchorage systems, and fasteners; wall erection; and equipment, labor, tools, and incidentals.

The underdrain filter material and drain pipe will be considered part of the quantities measured and paid for under Item 556.

Retaining wall backfill areas that are also in embankment areas will be considered part of the quantities measured and paid for under Item 132.

When drilled shafts are required, they will be measured and paid for in accordance with Item 416, "Drilled Shaft Foundations." When piling is required, it will be measured and paid for as shown on the plans for piling of the appropriate type.

Item 424

Precast Concrete Structural Members (Fabrication)



1. DESCRIPTION

Fabricate precast prestressed and precast nonstressed concrete members. This Item, in conjunction with [DMS-7300](#), "Precast Concrete Fabrication Plants," applies to both multi-project and project-specific fabrication plants. For this Item, the following definitions apply.

- **Box Beams.** For this specification, all box beams, X-beams, slab beams, and decked slab beams are referred to as box beams.
- **I-Beams.** For this specification, all I-girders and bulb-tee beams are referred to as I-beams.
- **Major Prestressed Members.** Includes all other prestressed members not listed as minor prestressed members, including by not limited to I-beams, U-beams, box beams, cylindrical piling, bent caps, and abutments.
- **Minor Prestressed Members.** Includes piling and bridge deck panels.
- **Multi-Project Fabrication Plant.** A facility at an offsite location that fabricates precast prestressed or precast nonstressed members. This definition also applies to single Contract offsite facilities.
- **Nonstressed Members.** Precast concrete members that have not been pre-tensioned or post-tensioned.
- **Post-Tensioning.** The application of prestressing force to the tensioning devices after concrete has hardened.
- **Prestressed Members.** Precast concrete members fabricated by the process of pre-tensioning, post-tensioning, or a combination of both methods.
- **Prestressing.** The introduction of internal stresses (pre-tensioning or post-tensioning) into a structural member by tensioning and anchoring strands or bars, to counteract the stresses resulting from the applied load.
- **Pre-Tensioning.** The application of prestressing force to the tensioning devices before casting concrete.
- **Project-Specific Fabrication Plant.** A temporary facility at or near the project location that fabricates precast prestressed or precast nonstressed members for only one Contract. This definition may be applied to temporary facilities that fabricate for multiple adjacent Contracts, if approved.
- **Self-Consolidating Concrete (SCC).** A highly workable concrete that can flow through densely reinforced or complex structural elements under its own weight and adequately fill voids without segregation, excessive bleeding, or the need for vibration.
- **Temperature Probe.** Thermocouple for measuring concrete temperature or air temperature.
- **Temperature Recording Device.** Data logger for recording temperatures from the temperature probes.
- **Tendon.** Any single unit used to apply prestressing force to the member. For post-tensioned units, a tendon is a bar or group of strands with common end anchorage.

2. EQUIPMENT

- 2.1. **Field Office and Inspection Laboratory.** Provide a field office and inspection laboratory for multi-project and project-specific fabrication plants in accordance with [DMS-7300](#).
- 2.2. **Furnishings and Laboratory Equipment.** Provide furnishings and laboratory equipment for multi-project and project-specific fabrication plants in accordance with [DMS-7300](#).

- 2.3. **Plant Facilities.** Provide plant facilities for multi-project and project-specific fabrication plants that produce prestressed members in accordance with [DMS-7300](#).
- 2.4. **Batch Plant.** Provide batch plant onsite for SCC production unless otherwise approved. Do not use volumetric mixers for SCC.

3. MATERIALS

Furnish materials in accordance with Item 425, "Precast Prestressed Concrete Structural Members," and other pertinent Items.

4. CONSTRUCTION

4.1. General Requirements.

- 4.1.1. **Shop Drawings.** Prepare and electronically submit shop drawings before fabrication in accordance with the *Guide to Shop Drawing Submittals* available on the Bridge Division website. Provide one complete approved 11 × 17 in. set in hardcopy to the Department inspector at the fabrication plant. Stamp it "For Materials and Tests Division Inspector." The Engineer may require additional complete hardcopy sets.

Provide a title block on each sheet in the lower right corner with the following information:

- sheet index data shown on lower right corner of the plans,
- sheet numbering for shop drawings,
- name of structure or stream,
- name of owner or developer,
- name of fabricator or supplier, and
- name of Contractor.

- 4.1.1.1. **Prestressed Members.** Furnish shop drawings for prestressed members unless otherwise shown on the plans or in conformance with other Items. Submit the proposed designs on forms furnished by the Department when optional designs are permitted by the plans. Obtain approval of these designs before casting. Approval of optional designs does not relieve the Contractor from the responsibility of furnishing a satisfactory completed structure. Provide submittals for precast post-tensioned members in accordance with this specification and Item 426, "Post-Tensioning."
- 4.1.1.2. **Nonstressed Members.** Furnish shop drawings for nonstressed members when required by the plans or pertinent Items.
- 4.1.2. **Plant Approval.**
- 4.1.2.1. **Plant Submittals.** Provide submittals in accordance with [DMS-7300](#) for each particular plant operation. This requirement does not apply to project-specific nonstressed member fabrication plants.
- 4.1.2.2. **Plant Audits.** Multi-project and project-specific fabrication plants must successfully complete initial and periodic Department-directed plant audits in accordance with [DMS-7300](#).
- 4.1.3. **Notice of Beginning Work.** Give adequate notice before beginning work as specified in Table 1. Include a schedule for all fabrication processes and dates when inspections are to occur.

Table 1
Notice of Beginning Work

Plant Location	Notice Required
In Texas	7 days
In the contiguous United States	21 days
Outside the contiguous United States	60 days

Perform no Department work in the plant before the Engineer authorizes fabrication. The Contractor must bear all Department travel costs when changes to their fabrication or inspection schedules are not adequately conveyed to the Department. When fabrication is performed outside the contiguous 48 states, the additional cost of inspection will be in accordance with Article 6.4., "Sampling, Testing, and Inspection."

- 4.1.4. **Personnel Qualifications.** Provide qualified personnel in accordance with [DMS-7300](#) for each particular plant operation.
- 4.1.5. **Quality Responsibilities.** The quality responsibilities for the Contractor for each particular plant operation will be in accordance with [DMS-7300](#).
- 4.2. **Fabrication.** Prepare a casting schedule on Department-approved forms in accordance with [DMS-7300](#), and submit it daily to the Department before fabrication. This requirement does not apply to project-specific minor prestressed member or project-specific nonstressed member fabrication plants. Perform fabrication during daylight hours unless the production site has an approved lighting system. Submit lighting details electronically to the Engineer for review before installing lighting system. Allow for plant and Department inspection in accordance with Item 6, "Control of Materials."
- 4.2.1. **Forms.** Design forms to prevent damage to the concrete from restraint as the concrete shrinks, from form expansion and contraction from thermal changes, from stripping operations, and from dimensional changes due to pre-tensioning. Forms, regardless of material, must conform to the profiles, dimensions, and tolerances of the finished product as shown on the plans and in accordance with this Item. Maintain forms free of dents, grease, or other foreign materials that may affect the appearance of the member, and clean forms thoroughly before each casting operation and immediately before applying a form-release agent.
- 4.2.1.1. **External Forms.** Construct side and bottom forms of steel unless otherwise approved or shown on the plans. Timber forms, when permitted, must meet the requirements of Section 420.4.4., "Forms." End headers may be of other material as approved.

Construct forms with sufficient thickness, external bracing and stiffeners, and anchorage to withstand the forces generated during concrete placement and consolidation. Do not stabilize forms with bracing and holding devices that will remain in the finished member.

Provide corners with a chamfer or radius as shown on the plans.

Maintain forms sufficiently mortar-tight to prevent damage that requires repair to the finished product. Where sections of forms will be joined, an offset of 1/16 in. for flat surfaces and 1/8 in. for corners and bends is permitted. Longitudinal form joints in prestressed concrete beams are not permitted except for the side forms of slab beams, decked slab beams, box beams, and X-beams, or as shown on the plans. Do not allow vertical or horizontal gaps or offsets to exceed 1/4 in. between adjacent sections of built-up end headers.

Check and maintain the grade and alignment of forms each time they are set and during placement of concrete.

Apply a form-release agent, in conformance with the manufacturer's recommendations, to the facing of forms before placing concrete. Use a form-release agent that facilitates form removal and does not affect any required coating, painting, or color-staining operations. Do not use materials that appreciably stain or react with the concrete. Remove excess form-release agent from the form surface before casting, and ensure it does not contaminate strands, reinforcing steel, and embedments. Use a clear form-release agent of the

same brand throughout the casting of retaining wall panels per structure, unless it can be shown that a different form-release agent does not change the appearance of the concrete.

Construct the forms to facilitate removal of members without damage to the concrete.

Construct and maintain the soffit (liner) to provide a maximum 1/4-in. variation from the theoretical plane, and do not allow the soffit to vary more than 1/4 in. between any two points in any 50-ft. length.

At the Contractor's option, construct side forms for bridge deck panels and prestressed piling with a draft for ease of product removal. Maintain product dimensional tolerances shown in Table 3. A maximum 1/4-in. draft is allowed for bridge deck panels.

4.2.1.2.

Internal Forms. Use solid expanded polystyrene conforming to ASTM C578, Type I for forming internal voids. The form material must be inert, non-biodegradable, non-absorptive, and strong enough to maintain sufficient rigidity to withstand the forces generated during concrete placement and consolidation without damage. Other materials for forming internal voids may be used when approved. Provide certification of conformance for void forms. The Engineer may require samples to be submitted when needed.

Anchor internal void forms to prevent movement or misalignment while placing concrete. Provide hold-down devices for all types of void forms at 30-in. maximum spacing unless otherwise approved. Do not use internal hold-down or lateral bracing devices that will remain in the finished member unless approved. Provide enough bearing area on the void form to prevent penetration of hold-down devices into the void form. Splice void form sections to prevent separation or misalignment during concrete placement and consolidation operations.

During casting, verify and document void form placement at 10-ft. maximum spacing using an approved method.

Drain prestressed concrete U-beams and voided box beams through the bottom flange by forming holes in each voided area as shown on the plans.

4.2.2.

Prestressing. Perform pre-tensioning in accordance with this Item and post-tensioning in accordance with Item 426.

4.2.2.1.

Prestressing Equipment. Furnish hydraulic jacks with sufficient capacity for prestressing the steel. Equip the jacks with instruments for monitoring the hydraulic pressure. Provide gauges at least 6 in. in diameter and with means to prevent the gauge pointer from fluctuating. Electronic pressure transducers with digital indicators may be used. Pressure gauges or electronic pressure indicators must indicate the load directly to 1% of the maximum gauge or sensor/indicator capacity, or 2% of the maximum load applied, whichever is smaller.

Calibrate each jack and its gauge with the cylinder extension in the approximate position at final jacking force. Jacks and gauges for post-tensioning and single-strand pre-tensioning must be calibrated as a unit. Have certified calibration charts furnished by an independent laboratory and with each jack and gauge used on the project. Provide certified calibration of each ram before starting stressing operations on the project and:

- every 6 mo. thereafter for post-tensioning operations,
- every 12 mo. thereafter for pre-tensioning operations, and
- as requested.

The calibration frequency for multiple-strand pre-tensioning equipment may be extended to every 24 mo. thereafter if an approved master gauge system monitors it. The master gauge must check this equipment when suspect results occur and at least every 6 mo. Calibrate the master gauge in conformance with the manufacturer's recommendations and at least every 12 mo.

Recalibrate jacks and gauges when a malfunction occurs; when repairs such as replacing the seals, changing the length of the hydraulic lines, or changing the pump occur; or when using gauges that have not been calibrated with the jack. Extra compensation will not be allowed for the initial or subsequent calibrations.

Post-tensioning jacks must have provisions for measuring tendon elongation directly on the strand or bar. The jacks must be capable of slow release of force to properly seat the tendon anchors.

Single-strand stressing jacks for pre-tensioning must have provisions for measuring the elongation directly on the strand.

Multi-strand detensioning jacks must have sufficient capacity and throw to permit simultaneous release of the entire load in the strands. Use an approved single-strand flame-release procedure to release the remaining load if there is not enough throw in the multi-strand jacks to release all load in the strands.

4.2.2.2.

Pre-Tensioning. Pre-tension all strands to a uniform initial load between 5% and 25% of the final load, unless otherwise approved. Apply the load within a tolerance of:

- ± 100 lb. per strand if the designated initial load is less than or equal to 10% of the final load, or
- ± 200 lb. per strand if the designated initial load is greater than 10% of the final load.

Measure the initial load with a calibrated dynamometer or other suitable instrument.

Do not allow the modulus of elasticity of individual strands to vary more than 1% from each other when multiple-strand tensioned. Use a weighted average modulus of elasticity of strands to calculate elongation for multiple-strand tensioning operations.

Establish reference marks on the strand for measuring elongation after initial tensioning. Provide means for measuring the elongation of the strand to an accuracy of 1% of the theoretical elongation or 1/8 in., whichever is smaller. Establish independent references on the strand adjacent to each anchorage, to indicate slippage that may occur between the time of initial stressing and final release of the strands.

Do not allow the stress in the strand to exceed 80% of the specified ultimate tensile strength of the strand at any time.

Do not use any portion of the strand that has been previously gripped with chucks in the length of strand to be tensioned, except where gripped with chucks during initial tensioning. Do not drive over prestressing strand.

Strand chucks designed with spring caps must be used with the spring caps. Visually inspect strand chucks that are not equipped with spring caps to ensure all wedges are evenly seated after applying initial load. Correct unevenly seated wedges by releasing the stress, repositioning wedges, and reapplying the initial load.

Failure of individual wires in a seven-wire strand is acceptable if the total area of wire failure is not more than 2% of the total cross-sectional area of all strands in the member, and if no more than one wire fails in any single strand. Any setup with one or more broken wires must be examined by a licensed professional engineer or Quality Control Supervisor (as defined in [DMS-7300](#)) to determine the cause before continuing stressing operations on the particular casting line.

4.2.2.2.1.

Strand Splicing. Do not splice draped strands. One splice per straight strand will be permitted subject to the following.

- Locate splices outside the members.
- Splice strands with the lay or twist in the same direction to avoid unraveling.
- Splice all straight strands in a multiple-strand tensioning operation so an adjustment can be made for the average seating loss.

- Cut strand ends to be spliced with shears, abrasive saws, or grinders to remove regions where chucks were previously seated. Cut in the same manner at least 12 in. from strand ends to be spliced that were previously flame cut.

4.2.2.2.2. **Single and Multiple Straight Strand Tensioning.** After initial tensioning, apply the required load to the strands as shown on the plans by means of single-strand or multiple-strand hydraulic jacks equipped with calibrated gauges. Verify the final load in the strands by observing either the gauge pressure or elongation and independently checking the other. The final load and elongation must agree within 5% of the computed theoretical values. Additionally, the final load and elongation must agree algebraically with each other within 5%. Suspend tensioning operations until the problem has been identified and corrected in the event of discrepancies exceeding these tolerances.

Verify uniform application of load to strands for multiple strand-tensioning systems by measuring the movement on opposite sides of the anchorage.

4.2.2.2.3. **Draped Strand Tensioning.** Verify the intermediate load by observing either the gauge pressure or elongation and independently checking the other when draped strands are tensioned in a straight or partially draped position before application of final load. If strands are tensioned in the final position, intermediate or final load and elongation must agree within 5% of the computed theoretical values. Additionally, the intermediate or final load and elongation must agree algebraically within 5% of each other. Suspend tensioning operations until the problem has been identified and corrected in the event of discrepancies exceeding these tolerances.

After application of final load, measurements on individual draped strands to establish differential stresses at selected points on the member will be averaged at a cross-section of the member. The averages must be within 5% of the theoretical elongation. The measured elongation of any individual draped strand must not vary from the theoretical elongation by more than 10% at any measured cross-section. Suspend tensioning operations until the problem has been identified and corrected in the event of discrepancies exceeding these tolerances.

Other methods to measure the intermediate load and final load in the draped strands may be submitted for approval.

4.2.2.2.4. **Strand Debonding.** Encase strands in plastic sheathing along the entire debonded length, when shown on the plans, and seal the ends with waterproof tape. Use split plastic sheathing only if the seam is sufficiently sealed with waterproof tape to prohibit grout infiltration. Use sheathing that will not react with the surrounding concrete.

Full-length debonding of straight strands will be approved on an individual basis. Full-length debonding, when permitted, must be symmetrical about the vertical centerline of the beam and limited to 10% of the total number of straight strands or six straight strands, whichever is less. Do not debond draped strands full length. When using a concrete anchor block to combine strand patterns, the same criteria apply.

4.2.2.3. **Combined Pre-Tensioning and Post-Tensioning.** When the plans call for a combination of pre-tensioning and post-tensioning, all the requirements for pre-tensioning in this specification and for post-tensioning in Item 426 apply.

4.2.3. **Placing Reinforcing Steel.** Place reinforcing steel in accordance with Item 440, "Reinforcement for Concrete." Reinforcing steel projection outside the member must not be more than 1/2 in. or less than 3/4 in. from plan dimension unless otherwise approved. Do not damage sheathing for strand debonding. Do not tie reinforcing steel to debonded strand regions.

Weld steel components in accordance with Item 441, "Steel Structures."

4.2.4. **Quality of Concrete.** Provide concrete in accordance with Item 421, "Hydraulic Cement Concrete." Use the class of concrete shown on the plans or in the pertinent Item for each type of structure or unit. Provide

concrete meeting the approved mix design water-cement ratio. SCC is not allowed for project-specific fabrication plants unless approved. Mix concrete for 1 min. for 1 cu. yd. and 15 sec. for each additional cubic yard of rated capacity of the mixer. Count the mixing time from the time all materials are in the drum. Increase mixing time if necessary to achieve a uniform mix. Control concrete by compressive strength tests of cylinders or other pertinent performance tests detailed on the plans or pertinent items. Concrete compressive-strength test cylinders will be made, cured, and tested in accordance with [Tex-704-I](#). Cure release-of-tension strength cylinders in accordance with [Tex-715-I](#) when match-cure technology is used.

High-strength concrete ($f'_c > 9,000$ psi) is accepted based on 56-day compressive strength testing. Concrete design-strength test cylinders for high-strength concrete will be made, cured, and tested in accordance with [Tex-704-I](#).

Product with concrete that fails to meet minimum design compressive strength requirements will be reviewed. Concrete that has been determined to be structurally adequate may be accepted at an adjusted price based on the formula in Article 421.6., "Measurement and Payment." If the Engineer requires cores be taken to determine the strength of the in-situ concrete, the coring will be at the Contractor's expense and in accordance with [Tex-424-A](#). All cores from precast members must meet 100% of the minimum design compressive strength requirements. For concrete that has been determined to be structurally adequate, coring of the in-situ concrete will not be allowed for the purpose of avoiding the price adjustment. The Department may require reimbursement for testing of cores. Testing by an approved commercial testing laboratory will be at the Contractor's expense. Test results from a commercial laboratory must be sealed by a licensed professional engineer.

SCC used for prestressed beams must have a Modulus of Elasticity of 5,000 ksi at 28 days. Test the concrete mix design before use in accordance with ASTM C469.

4.2.5.

Placing Concrete. Place concrete only when its temperature at time of placement is between 50°F and 95°F.

Take responsibility for producing quality concrete under any weather condition and ensure adequate weather protection provisions are on-site and available for immediate use.

Provide immediate protective measures without compromising the quality of the product if rainfall occurs after concrete placing operations have started. Failure to immediately provide adequate weather protection may be cause for rejection of the affected product.

Maintain concrete transporting equipment clean and free of hardened concrete.

At the time of concrete placement, reinforcing steel, strands, and embedments must be free of dirt, oil, or other bond-breaking substances.

Place and adequately consolidate concrete while all lifts are in a plastic state. Concrete must not exhibit segregation or excessive bleeding. Minimize concrete flow lines and displacement of the reinforcing steel, strands, embedments, and ducts during concrete placement. Place concrete as near as possible to its final position in the forms, except when using SCC. Do not deposit large quantities of concrete at one location and run or work it along the forms to other locations, except for SCC. Place SCC in a manner to avoid segregation.

Do not allow fresh concrete to free-fall more than 8 ft. unless approved.

Work the coarse aggregate back from the face of the concrete and force the concrete under and around the reinforcing steel, strands, embedments, and ducts. If prestressed concrete I-beams are cast in multiple lifts, the thickness of the first lift must be slightly above the juncture of the bottom flange and web.

Unless otherwise approved by the Engineer, cast prestressed concrete voided box beams monolithically in two stages, maintaining the concrete in the previously placed bottom slab in a plastic state until the web (side wall) concrete is placed and vibrated into the bottom slab.

The maximum time between the addition of mixing water or cement to the concrete batch and the placing of concrete in the forms is 30 min. for concrete delivered in non-agitated delivery equipment and 60 min. for concrete delivered in agitated delivery equipment. If conditions of wind, humidity, and temperature cause quick stiffening of the concrete, the required placement times may be reduced and an approved retarder may be required, or increased if currently in use. Submit a plan for approval, if necessary, to demonstrate the concrete can be properly placed, consolidated, and finished without reducing placement time limits.

The maximum acceptable placement slump will be in accordance with Item 421, unless otherwise specified. When the maximum acceptable placement slump or slump flow is exceeded, the affected concrete will be rejected, and retesting for slump or slump flow will not be allowed, regardless of the concrete placement times.

Additional requirements for precast mass placements will be in accordance with Item 420, "Concrete Substructures." In the case of a conflict between the two Items, the more stringent requirements apply.

4.2.5.1.

Placing Concrete in Cold Weather. Maintain concrete temperature between 50 and 95°F at time of placement in accordance with Section 424.4.2.5., "Placing Concrete," and maintain the concrete temperature of precast members at or above 50°F during the specified curing period in accordance with Section 424.4.2.7., "Curing of Concrete." Do not place concrete when the atmospheric temperature in the shade is below 40°F and falling, unless approved. Concrete may be placed when the atmospheric temperature in the shade is at least 35°F and rising or above 40°F, provided adequate cold-weather protection provisions are on-site and available for immediate use before placing concrete when weather conditions indicate a possible need for temperature protection. When required, provide necessary covering material or an approved accelerated curing system in accordance with Section 424.4.2.7.4., "Accelerated Curing," and do not allow any concrete to remain unprotected for longer than 1 hr. after placement. Do not place concrete in contact with any material coated with frost or with material at a temperature of 32°F or lower. Do not apply heat directly to concrete surfaces if accelerated curing is used. Take protective measures to ensure the difference between air temperature and concrete surface temperature does not cause thermal cracking.

Maintain aggregates free of ice, frost, and frozen lumps. Heat the aggregate and the water when needed to produce the minimum concrete placement temperature of 50°F, but:

- do not allow the water temperature to exceed 180°F or the aggregate temperature to exceed 150°F,
- heat the aggregate uniformly to eliminate overheated areas in the stockpile that might cause flash set of the cement, and
- provide an aggregate and water mixture temperature between 50 and 85°F before introduction of the cement.

4.2.5.2.

Placing Concrete in Hot Weather. Keep concrete at or below 95°F at time of placement in accordance with Section 424.4.2.5., "Placing Concrete." Use any of the following methods, as needed, to control the concrete placement temperature.

- Cool the aggregate by sprinkling or fogging (fine mist) with water, shading, or using an approved liquid nitrogen system and procedure.
- Cool the fresh concrete by using chilled mixing water, partially replacing mixing water with shaved or crushed ice, or using an approved system and procedure to discharge liquid nitrogen into concrete during batching.

Apply a fog spray (fine mist) of water to the steel just before placing concrete when the temperature of steel forms, strand, or reinforcing steel is greater than 120°F. Water droplets left on the form surfaces must not adversely affect surface finishes.

When field conditions are such that evaporation of water from the concrete makes the surface finishing operation difficult, a fog spray (fine mist) of water may be applied above the concrete surface. Do not fog directly toward the concrete or in any manner that will wash cement paste from the fresh concrete surface or cause water to puddle. Do not use fog to add finishing water and do not work moisture from the fog spray

into the fresh concrete. An approved evaporation retardant conforming to [DMS-4650](#), "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants," is also acceptable if used in conformance with the manufacturer's recommendations. Do not apply the evaporation retardant when floating and troweling concrete. Do not allow it to puddle or be worked into the concrete surface immediately after application. Misuse of fog spray or evaporation retardant will be cause for disallowing its use. Shade the concrete during casting if necessary.

Use an approved retarder, in conformance with the manufacturer's recommendations, when the air temperature is above 85°F if necessary to control concrete slump loss and lengthen the time for placing, consolidating, and finishing operations.

- 4.2.5.3. **Consolidation of Concrete.** Consolidate concrete thoroughly using high-frequency vibration immediately after placement. For prestressed concrete beams and piling, internal vibration is required and may be supplemented with external vibration.

Provide at least one on-site standby vibrator of the type being used for emergency use.

Perform concrete vibration using trained personnel and proper timing and spacing to ensure adequate consolidation. Revise the concrete placement and consolidation procedures, and review the concrete mix design and batching procedures, if necessary, when unacceptable defects such as excessive honeycombing, aggregate or mortar pockets, or surface air voids (bugholes) are present. Provide supplemental vibrators or modify the vibration system when required to accomplish thorough consolidation of the concrete and complete embedment of the strands, reinforcing steel, embedments, or ducts. Avoid segregation or excessive bleeding of the concrete during vibration.

- 4.2.5.3.1. **Internal Vibration.** Insert vibrators into the concrete immediately after concrete placement at points spaced to ensure uniform vibration of the entire concrete mass. Limit the insertion spacing to within the radius where the vibrators are visibly effective. Allow the vibrators to sink into the concrete by their own weight and penetrate previously placed lifts that are still in a plastic state to thoroughly consolidate the layers together and prevent cold joints. Withdraw the vibrators slowly to avoid forming holes after the concrete is thoroughly consolidated.

Do not allow prolonged contact of vibrators with forms so vibrator marks on concrete surfaces are minimal. Do not use vibrators to move concrete to other locations in the forms.

Use vibrators with nonmetallic vibrating heads to prevent damage to the epoxy coating when epoxy coated reinforcing steel is used. Increase the consolidation time and decrease the insertion spacing, if necessary, when using these vibrators.

- 4.2.5.3.2. **External Vibration.**

- 4.2.5.3.2.1. **Form Vibrators.** Form vibrators may be used to consolidate thin members, supplement internal vibration, or consolidate members with highly congested reinforcing steel.

Determine the size, number, and location of external vibrators to provide enough intensity of vibration to the desired area of the form. Adjust the spacing, frequency, amplitude, and duration of vibration according to the concrete mix and size of member to produce uniform consolidation of the concrete.

- 4.2.5.3.2.2. **Surface Vibrators.** Use vibratory screeds to consolidate thin sections. Move vibratory screeds at a rate that will bring enough mortar to the surface to embed and cover the coarse aggregate. Do not over-vibrate by causing an excessive amount of mortar to be brought to the surface.

- 4.2.5.3.2.3. **Vibrating Tables.** Determine the size, number, and location of external vibrators to provide enough intensity of vibration to the desired area of the form. Adjust the spacing, frequency, amplitude, and duration of vibration according to the concrete mix and size of member to produce uniform consolidation of the concrete.

4.2.5.3.3. **Vibration of Self-Consolidating Concrete (SCC).** Vibrate SCC only when approved. Provide an adequate amount of viscosity modifying admixture (VMA) in SCC mix when internal vibration is allowed.

4.2.6. **Finishing of Concrete.** Finished, unformed surfaces must not have distortions greater than 1/4 in. Screed or rough-float unformed surfaces of members, bringing enough mortar to the surface to embed and cover the coarse aggregate. Provide a uniform rough wood float finish to the surface of the member unless otherwise shown on the plans. Do not loosen aggregate when roughening the surface using a broom or when providing a tine finish.

Provide a smooth metal trowel finish for surfaces at anchor bolt locations.

4.2.7. **Curing of Concrete.** Cure concrete to promote early cement hydration by providing adequate moisture on exposed surfaces and by maintaining the concrete temperature or curing enclosure air temperature at the concrete surface within the limits specified in this Section. Provide uniform temperature and moisture on the surfaces to prevent differential shrinkage that may cause warping or cracking. Prevent temperature differentials within the concrete that cause thermal cracking.

Begin curing after the finishing operation, before the formation of plastic shrinkage cracks, and as soon as damage to the surface finish will not occur. Provide fog spray or an evaporation retardant after finishing and before curing if needed to prevent plastic shrinkage cracks. Apply fog spray or evaporation retardant in accordance with Section 424.4.2.5.2., "Placing Concrete in Hot Weather." Keep exposed concrete surfaces continuously wet for the duration of the specified curing period, unless an approved liquid membrane-forming curing compound is used. Membrane curing compound is permitted only in accordance with this Section or in conformance with the pertinent Item.

Approved equipment and materials for curing must be on-site and available for immediate use before placing concrete. Provide temperature probes to monitor the concrete temperature or curing enclosure air temperature as specified in Table 2.

Table 2
Temperature Probe Requirements

Condition	Major Prestressed Members	Minor Prestressed Members	Nonstressed Members
Forecasted atmospheric temperature $\geq 50^{\circ}\text{F}$ during specified curing period	2 concrete temperature probes per casting line to monitor high concrete temperature regions ⁵	2 concrete temperature probes per casting line to monitor high concrete temperature regions ^{1,5}	N/A
Forecasted atmospheric temperature $< 50^{\circ}\text{F}$ during specified curing period	2 concrete temperature probes per casting line to monitor high concrete temperature regions, ⁵ and 2 concrete temperature probes per casting line to monitor low concrete temperature regions ^{2,5}	2 concrete temperature probes per casting line to monitor high concrete temperature regions, ^{1,5} and 2 concrete temperature probes per casting line to monitor low concrete temperature regions ^{2,5}	1 concrete temperature probe per 100 cu. yd. of concrete or fraction thereof to monitor low concrete temperature regions ²
Forecasted atmospheric temperature $< 40^{\circ}\text{F}$ during additional 3-day curing period ³	N/A	1 concrete temperature probe per similar curing condition for prestressed piling only	N/A
When accelerated curing is used	2 temperature probes per casting line to monitor curing enclosure air temperature at concrete surfaces ^{4,5}	2 temperature probes per casting line to monitor curing enclosure air temperature at concrete surfaces ^{4,5}	1 temperature probe per 100 cu. yd. of concrete or fraction thereof to monitor curing enclosure air temperature at concrete surfaces

1. Excluding prestressed bridge deck panels and prestressed retaining wall panels.
2. When accelerated curing is used, concrete temperature probes to monitor low concrete temperature regions are not required.
3. After attaining specified release-of-tension strength.
4. These probes are in addition to the concrete temperature probes required for monitoring high concrete temperature regions.
5. Place probes at the beginning and end of casting line.

Attach each temperature probe to a separate temperature recording device unless multi-channel temperature recording devices are used, in which case one high concrete temperature probe and one low concrete temperature probe may be attached to the same recording device. When accelerated curing is used, one curing enclosure air temperature probe may also be attached to this multi-channel temperature recording device.

Inadequate curing facilities or lack of attention to the proper curing of concrete will be cause for the Engineer to stop concrete placement until approved curing is provided. Inadequate curing may be cause for rejection of the affected product.

Forms may be removed at the discretion of the Contractor at any time after the concrete has reached sufficient strength to prevent physical damage to the member. Do not interrupt curing for more than 60 min. during form removal.

The following curing requirements apply for prestressed members.

- Cure concrete continuously, except as allowed during form removal, until the compressive strength of the concrete has reached the specified release-of-tension strength and until detensioning has been performed.
- Maintain concrete temperatures between 50 and 150°F during the curing period. The maximum allowable concrete temperature may be increased to 170°F if the Contractor uses one of the concrete mix design options listed in Section 421.4.2.6., "Mix Design Options," other than Options 6, 7, and 8. The Engineer may require lowering of the total cementitious content in the concrete mix design to the limits specified in Item 421 for repeated violations of the maximum curing temperature.
- Membrane curing is permitted only for unformed surfaces of prestressed wall panels and interim curing on unformed surfaces of prestressed piling. Use Type 1-D or Type 2 curing compound in accordance with [DMS-4650](#) for this application.
- Water cure prestressed piling an additional 3 days after attaining the specified release-of-tension strength. Do not interrupt curing for more than 4 hr. when moving piling to the storage area. Maintain the concrete temperature of piling at 50°F or above during this additional curing period.

The following curing requirements apply for nonstressed members.

- Cure concrete continuously, except as allowed during form removal, for 4 days or until the compressive strength of the concrete has reached the design strength.
- Maintain concrete temperatures between 50°F and 150°F during the curing period. The maximum allowable concrete temperature may be increased to 170°F if the Contractor uses one of the concrete mix design options listed in Section 421.4.2.6., "Mix Design Options," other than Options 6, 7, and 8.
- Membrane curing is permitted on nonstressed members, except for surfaces to be painted or color stained.

Cure members for an additional 24 hr. beginning immediately after the normal curing period if they are out of cure at any time other than during the allowable 60 min. for form removal or during the allowable 4 hr. for moving piling to storage.

Members failing to meet the concrete temperature requirements or curing enclosure air temperature requirements during curing will be reviewed. Repeated failure to maintain proper concrete temperatures may be cause for rejection of the affected product.

4.2.7.1.

Water Curing. Water curing provides additional moisture to concrete and prevents moisture loss. Water used for curing must meet the requirements for concrete mixing and curing water specified in Section 421.2.5., "Water." Do not use seawater or water that stains or leaves an unsightly residue that cannot be removed. Monitor and maintain a temperature differential between curing water and concrete surface temperature that prevents thermal cracking.

- 4.2.7.1.1. **Wet Mat Method.** Use water-saturated cotton mats, burlap-polyethylene sheeting, or other approved moisture-retaining materials. Anchor the wet mats adequately to provide continuous contact with exposed concrete surfaces.
- 4.2.7.1.2. **Water Spray Method.** Use overlapping sprays, sprinklers, or soil-soaker hoses so concrete surfaces are kept continuously wet.
- 4.2.7.1.3. **Ponding Method.** Continuously cover exposed concrete surfaces with standing water.
- 4.2.7.2. **Moisture Retention Curing.** Moisture retention curing prevents moisture loss from the concrete.
- 4.2.7.2.1. **Form Curing Method.** Concrete surfaces in direct contact with forms that are left in place will not require additional curing methods unless cold-weather protection is necessary.
- 4.2.7.2.2. **Impermeable Cover Method.** Cover exposed concrete surfaces with polyethylene sheeting, burlap-polyethylene sheeting, impervious paper, or other approved impermeable materials placed in close contact with concrete surfaces to keep them continuously wet. Provide additional moisture inside the enclosure in accordance with Section 424.4.2.7.1., "Water Curing," if this is not enough to keep exposed concrete surfaces continuously wet.
- 4.2.7.3. **Membrane Curing.** Liquid membrane-forming curing compound is a moisture retention covering that is applied as a liquid. It is permitted only as specified in Section 424.4.2.7., "Curing of Concrete."
- Use Type 1-D or Type 2 membrane curing compound in accordance with [DMS-4650](#). Apply membrane curing compound using equipment and in a manner specified in Section 420.3.5., "Spraying Equipment," and Section 420.4.10.3., "Membrane Curing," respectively.
- Do not contaminate reinforcing steel, embedments, or concrete surfaces that will later be in direct contact with cast-in-place concrete unless the curing compound can be completely removed to the satisfaction of the Engineer when applying membrane curing compound.
- Use membrane curing compounds that do not appreciably stain the concrete.
- 4.2.7.4. **Accelerated Curing.** Accelerated curing is defined as curing using artificial heat provided to the curing enclosure or forms.
- Test accelerated curing facilities for at least 48 hr. to demonstrate temperature variations do not exceed 20°F between any points in the curing enclosure. Submit accelerated curing facility drawings and test results, and obtain approval before using these facilities for Department work. The test may be performed on the entire casting line with either freshly cast concrete inside the forms or with empty forms. Provide one curing enclosure air temperature probe per 100 ft. of casting line when accelerated curing facilities are being tested.
- Maintain the air temperature in the curing enclosure between 50°F and 85°F until initial set of the concrete (as determined in accordance with [Tex-440-A](#) when establishing mix designs under representative temperature conditions) and for at least 3 hr. after concrete placement. The concrete temperature may then be raised uniformly at a maximum rate of 36°F per hour. Provide an unobstructed air space of at least 6 in. between surfaces of the concrete and the curing jacket.
- Monitor and maintain the curing enclosure air temperature between 50°F and 160°F during accelerated curing for prestressed and nonstressed concrete members. Do not allow the air temperature to exceed 160°F for more than 1 cumulative hr. during the entire curing period. Do not allow the air temperature to exceed 170°F at any time during the specified curing period. Arrange the location of the heat discharge into the curing enclosure so temperature variations do not exceed 20°F between any points in the curing enclosure.

Provide curing enclosure air temperature probes to monitor the temperature at the concrete surface as specified in Table 2.

Provide enough moisture inside the curing enclosure to keep exposed concrete surfaces continuously wet for the specified curing period.

Provide other acceptable curing methods for the remaining curing period if accelerated curing is terminated before the specified curing period has elapsed.

4.2.7.4.1. **Steam Curing.** Steam cure in conformance with the requirements of accelerated curing. Position steam outlets so live steam is not applied directly on the concrete, forms, or test cylinders.

4.2.7.4.2. **Alternate Methods.** Other methods of accelerated curing, such as the use of radiant heaters or portable heater, may be permitted if they meet the requirements of accelerated curing. The use of any alternate method requires written approval.

4.2.8. **Detensioning.** Release the tension in the strands after concrete strength requirements are met using a sequence to minimize premature wire breakage or shock and damage to the concrete members. Release strands by multiple-strand detensioning or single-strand flame detensioning. Ensure strands are not released individually with single-strand jacks.

Flame-release each strand simultaneously at both ends of the casting bed, using a symmetrical sequence prepared by a licensed professional engineer, if strands are released individually. Heat the strands over an approved strand length and duration when flame detensioning so that the metal slowly elongates and gradually loses strength. Do not abruptly flame-cut strand by holding the heat source in a concentrated location on the strand. Submit the flame-release procedures and sequences for approval. Approval of flame-release sequences does not relieve the Contractor from responsibility for meeting the product workmanship requirements of Section 424.4.3., "Workmanship."

Release the tension in the strand hold-down anchor slowly to minimize shock and damage to the concrete member when draped strands are used. Heat the anchor until the metal slowly elongates and gradually loses strength if heat is used to release the hold-down anchor. Provide positive external hold-downs to offset the vertical forces in the members when the sum of the hold-down forces is greater than half the weight of the member or for any amount of vertical force that has previously caused cracking. External hold-downs are to remain on each member until detensioning has been completed.

4.3. **Workmanship.** Formed surfaces must not have excessive surface honeycombing, aggregate or mortar pockets, air voids, lift lines, stains, or vibrator marks. Remove form-joint-offset marks exceeding the tolerances specified in Section 424.4.2.1.1., "External Forms," and fins and rough edges along chamfer lines, in a manner that will not damage the member. Repair fabrication holes, except box beam and U-beam drain holes, using an approved repair material and procedure.

Recess strands in accordance with the *Concrete Repair Manual* unless otherwise shown on the plans. Submit for approval any other moisture-barrier systems for protecting strands.

Before shipment of members, remove:

- concrete, paste, dirt, oil, or other bond-breaking substances from exposed reinforcing steel, and
- laitance, dirt, oil, or other bond-breaking substances from concrete surfaces to be in contact with cast-in-place concrete.

4.3.1. **Defects and Breakage.** Members that sustain damage or surface defects during fabrication, handling, storage, hauling, or erection are subject to review. Evaluate and repair members in accordance with the *Concrete Repair Manual*. Submit proposed deficiencies in accordance with the Department's NCR guidelines and obtain approval before performing repairs. Repair work must reestablish the member's structural integrity, durability, and aesthetics to the satisfaction of the Engineer.

When deficiencies occur, determine the cause and take immediate corrective action. Failure to take corrective action, leading to similar repetitive deficiencies, could be cause for rejection of members.

Cracks that extend to the nearest reinforcement plane and fine surface cracks that do not extend to the nearest reinforcement plane, but are numerous or extensive, are subject to review.

Cracks in prestressed members that tend to close upon transfer of stress to the concrete are acceptable. Cracks that do not tend to close are subject to review.

Seal cracks in I-beam ends exceeding 0.005 in. in width as directed. The fabricator must decrease the spacing of Bars R and S in I-beam by providing additional bars to help limit crack width. No less than 1-in. clearance between bars will be permitted. The fabricator must take approved corrective actions if cracks greater than 0.005 in. form. All work, material, and engineering related to these cracks will be at the Contractor's expense.

Prestressed bridge deck panels will be rejected for any of the following conditions:

- any crack extending to the reinforcing plane and running parallel and within 1 in. of a strand for at least 1/3 of the embedded strand length; or
- any transverse or diagonal crack, including corner cracks and breaks, intersecting at least two adjacent strands and extending to the reinforcing plane.

Prestressed bridge deck panels that sustain damage, cracks not listed above, or surface defects during fabrication, handling, storage, hauling, or erection are subject to review.

4.3.2.

Tolerances.

4.3.2.1.

Prestressed Members. Allowable tolerances for the dimensions and configurations shown on the plans or approved shop drawings are shown in Table 3.

Variations greater than those specified in Table 3 are subject to review. However, these tolerances do not relieve the Contractor from the responsibility of furnishing a completed structure that is in reasonably close conformity with the lines, grades, cross-sections, dimensions, and details specified. Correct members not meeting these tolerances at no additional expense to the Department, to achieve a satisfactory completed structure. This also includes costs for correction due to variations in vertical beam camber. Correction may require replacement of the member.

Horizontal misalignment (sweep) in beams, which may increase later and exceed the tolerance shown in Table 3, may be acceptable if the members can be hauled, erected, and aligned to within the allowable tolerance without being damaged. Store these members in a manner that will minimize the sweep.

Embedments must be firmly held in proper position to avoid movement during concrete placement. Place embedments in conformance with the manufacturer's recommendations. Place weld clip inserts for permanent metal deck forming no more than 1/16 in. from the beam edge.

Table 3
Allowable Tolerances for Prestressed Members

Dimension	I-beams	U-beams	Box Beams	Double-T Beams	Bridge Deck Panels	Piling	Wall Panels ¹
Length (perpendicular to strands for bridge deck panels)	±1"	±1"	±1"	±3/4"	±1/2"	-1" ²	±3/16"
Width (parallel to strands for bridge deck panels)	+3/4" -1/4"	±1/4"	±1/4"	±1/2"	±1/2"	±1/4"	±3/16"
Nominal depth (thickness in case of panels)	+1/2" -1/4"	±1/4"	±1/4"	±1/4"	+1/4" -1/8"	±1/4"	±3/16"
Thickness: top slab or flange	+1/2" -1/4"	±1/2"	±1/2"	±1/4"	N/A	N/A	N/A
Thickness: bottom slab or flange	+1/2" -1/4"	±1/2"	±1/2"	N/A	N/A	N/A	N/A
Thickness: web or wall	+3/4" -1/4"	±1/2"	±1/2"	±1/4"	N/A	N/A	N/A
Horizontal alignment (deviation from straightness of all panel edges)	±1/8" per 10' of length	±1/8" per 10' of length, 3/4" Max	±1/4"	±1/4"	±1/8"	±1/8" per 10' of length	±1/8" per 10' of length, 1/2" Max
Deviation of ends (horizontal skew)	±1/2"	±1/2"	±1/2"	±1/2"	±1/2"	±1/8"	±1/4" per 5' of width, 1/2" Max
Deviation of ends (vertical batter)	±1/2" ⁸	±1/2" ⁸	±1/2"	±1/2"	N/A	±1/8"	±1/4"
Notched end areas (for diaphragms): depth	±1/4"	N/A	±1/4"	±1/4"	N/A	N/A	N/A
Notched end areas (for diaphragms): length	+2" -1"	N/A	+2" -1"	+2" -1"	N/A	N/A	N/A
Bearing surfaces: perpendicular to vertical axis	±1/8"	N/A	N/A	±1/16"	N/A	N/A	N/A
Bearing surfaces: deviation from plane	±1/16"	±1/8"	±1/8"	±1/16"	N/A	N/A	±1/16" ³
Anchor hole location: from end of member	+3/4" -1/4"	±1/4"	±1/4"	+3/4" -1/4"	N/A	N/A	N/A
Anchor hole location: longitudinal spacing	±3/4"	±1/2"	±1/2"	±3/4"	N/A	N/A	N/A
Anchor hole location: transverse location	±1/4"	±1/4"	±1/4"	±1/4"	N/A	N/A	N/A
Diaphragm or lateral tie location	±1/2"	N/A	±1/2"	±1/2"	N/A	N/A	N/A
Position of internal void form (longitudinal for box beams and U-beams)	N/A	±1"	±1" ^{4,5}	N/A	N/A	±1/2"	N/A
Projection of reinforcing steel outside member	+1/2" -3/4"	+1/2" -3/4"	+1/2" -3/4"	+1/2" -3/4"	+1/2" -3/4"	N/A	+1/2" -3/4"
Position of strands: vertical	±1/4" ⁶	±1/4"	±1/4"	±1/4"	±1/8" ⁷	±1/4"	±1/8"
Position of strands: horizontal	±1/4"	±1/4"	±1/4"	±1/4"	±1/2"	±1/4"	±1/2"
Debonded length of strands	±3"	±3"	±3"	±3"	N/A	N/A	N/A
Position of strand hold-down points	±6"	±6"	N/A	±6"	N/A	N/A	N/A
Position of handling devices: parallel to length	±6"	±6"	±6"	±6"	As shown on the plans	±6"	±6"
Position of handling devices: transverse to length	±1"	±1"	±1"	±1"	As shown on the plans	±1"	±1"
Local flatness of formed surfaces (excluding bearing surface)	±1/4" in 10'	±1/4" in 10'	±1/4" in 10'	±1/4" in 10'	±1/4"	±1/4" in 10'	±1/4" in 10'
Bow (length and width)	N/A	N/A	N/A	N/A	N/A	N/A	±1/4" per 10'

1. Prestressed and nonstressed wall panels (e.g., tie back, C-wall, and sound wall) except MSE wall panels.
2. Maximum length as approved.
3. Measured along the panel depth at the top and bottom panel sides.
4. Voided box beams only.
5. Length of box beam internal void form +1 in., -6 in.
6. For draped strands, the tolerance for vertical position of strands at the end of the beam may be increased to ±1/2 in. provided the tested concrete compressive strength, before release of tension into the member, is at least 5% greater than the release-of-tension strength shown on the plans.
7. Measured from bottom of panel.
8. 3/4 in. maximum for beams exceeding a height of 54 in.

- 4.3.2.2. **Nonstressed Members.** The allowable tolerances for nonstressed members are as specified in Table 4, unless otherwise shown on the plans. The allowable tolerances for nonstressed wall panels, except MSE wall panels, are as specified in Table 3.

Table 4
Allowable Tolerances for Nonstressed Members

Member	Dimension	Tolerance
MSE wall panels and wall components ¹ (e.g., coping and posts)	All dimensions (including deviation from edge straightness)	±3/16 in.
	Deviation of ends (horizontal skew)	±1/4 in. in 5 ft., ±1/2 in. Max
	Local flatness of formed surfaces	±1/8 in. in 5 ft.
	Connection hardware	±1/2 in.

1. Includes wall components for tie-back walls, C-walls, sound walls, etc.

- 4.4. **Storage and Handling.** Mark members for identification immediately after form removal as shown on approved shop drawings, in conformance with the pertinent Items, or as required. Do not change any identification markings or transfer material to other projects without approval. Inspect members immediately before shipping to the jobsite for damage that may have occurred in storage. Store and handle prestressed and nonstressed members in accordance with Item 425.

5. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to bid items of the Contract.

Item 425

Precast Prestressed Concrete Structural Members



1. DESCRIPTION

Furnish and erect precast prestressed concrete members fabricated by pre-tensioning, post-tensioning, or a combination of the two.

2. MATERIALS

Use materials that meet the requirements of the following.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 426, "Post-Tensioning"
- Item 427, "Surface Finishes for Concrete"
- Item 434, "Bridge Bearings"
- Item 440, "Reinforcement for Concrete"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 448, "Structural Field Welding"
- [DMS-4650](#), "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants"
- [DMS-7300](#), "Precast Concrete Fabrication Plants."

2.1. **Prestressing Hardware.** Furnish prestressing hardware in conformance with the manufacturer's specifications.

2.2. **Concrete.** Furnish concrete of the class shown on the plans.

2.3. **Prestressing Steel.** Furnish prestressing steel conforming to one of the following types:

- seven-wire steel strand meeting [DMS-4500](#), "Steel Strand, Uncoated Seven-Wire Low-Relaxation for Prestressed Concrete,"
- alloy bars meeting ASTM A722, or
- steel wire meeting ASTM A421.

Use seven-wire steel strand produced by a prequalified manufacturer on the Department's MPL. The Department may take samples in accordance with [Tex-710-I](#) to verify compliance with specification requirements.

Assign an individual lot number to all bars from each size and heat, all wire from each coil, and all strand from each reel, and tag the material for accurate identification at the jobsite. Identify each lot of anchorage assemblies and couplers in a similar manner. Unidentified prestressing steel, anchorage assemblies, or couplers received at the project site will be rejected. Loss of positive identification of these items at any time will be cause for rejection.

2.4. **Post-Tensioning System.** Furnish post-tensioning system as required by Item 426 and as shown on the plans.

3. CONSTRUCTION

Fabricate precast prestressed concrete members in accordance with Item 424, "Precast Concrete Structural Members (Fabrication)." Fabricate railroad structures in accordance with the AREMA *Manual for Railway Engineering* and Item 424. In the case of a conflict between the AREMA manual and Item 424, the more stringent requirements apply.

- 3.1. **Handling, Storing, Hauling, and Erection of Precast Prestressed Concrete Members.** Properly handle, store, haul, and erect all members so that they are placed in the structure in a manner to avoid excessive bending stresses and without damage. Lift members with approved lifting devices as shown on the shop drawings or as approved.

Maintain beams in an upright position at all times, and raise and support them near the ends to prevent torsion unless approved on shop or erection drawings.

Do not move members from the casting yard until all requirements of the pertinent Items have been met. Haul beams to the project site after at least 7 days have elapsed since casting, unless otherwise approved.

The storage area must be clean and well drained. Prevent excessive or differential settlement of members by storing on:

- stable ground and
- dunnage of sufficient size, shape, and strength to prevent crushing.

Place dunnage a distance no more than 3% of the beam length from the beam ends. When approved, cantilever beams may be supported at locations other than near the ends. Support concrete box beams and U-beams under the solid end block area during handling, storage, hauling, and erection.

Separate members with blocking arranged in vertical planes that will not crush under load when members are stacked. Stack members so lifting devices are accessible and undamaged. Use dunnage or blocking material that will not damage or stain the required finish.

Rearrange improperly stored members and inspect them for damage. Members that are improperly stored and become cracked, warped, or otherwise damaged in storage may be rejected.

Securely tie or brace all beams during erection in conformance with minimum erection and bracing standards. Protect traffic against falling objects during the erection of diaphragms and other structural members, during the placing of cast-in-place concrete, and during the erection and dismantling of forms when railroad or roadway traffic must be maintained beneath beams already placed. Protect traffic with nets or flooring with openings not larger than 1 in. or as approved.

Fit mating surfaces to prevent excessive grout leakage when erecting precast prestressed concrete bridge deck panels. Fill the joint with grout or seal it with an acceptable caulking compound before placing the cast-in-place portion of the slab if such fit is not provided.

Finish surfaces of beams or other members after slab placement in accordance with Section 420.4.13., "Ordinary Surface Finish," and Item 427.

Correct beam discrepancies including, but not limited to horizontal misalignment or variations in vertical camber, to achieve a satisfactory completed structure at no additional expense to the Department. Correction may require replacement of the member.

- 3.2. **Packaging, Storing, and Handling of Prestressing Steel.** Protect prestressing steel against physical damage and rust or other results of corrosion, from manufacture to grouting or encasing in concrete. Prestressing steel with physical damage will be rejected. Replace any reel containing broken wires. Provide wire that is bright and uniformly colored, without foreign matter or pitting on the surface.

Package prestressing steel in containers or shipping forms for protection from physical damage and corrosion during shipping and storage. A corrosion inhibitor must be:

- placed in the package or form,
- incorporated in a corrosion inhibitor carrier type packaging material, or
- applied directly to the steel when permitted.

The corrosion inhibitor must not have deleterious effect on the steel, concrete, or bond strength of steel to concrete. Inhibitor carrier-type packaging material must conform to the provisions of federal specification MIL-PRF-3420 G. Immediately replace damaged packaging or forms, or restore them to original condition.

Have the shipping package or form clearly marked with the corrosion inhibitor type, packaging date, and a statement that the package contains high-strength prestressing steel.

Handle prestressing steel carefully to avoid abrading, nicking, or kinking the strand, bar, or wire. Protect prestressing steel from damage and corrosion by storing it above the ground on platforms, skids, or other approved supports. Any pitting or tightly adhering rust on prestressing steel will be cause for rejection of the steel. Do not weld or torch-cut near any prestressing steel, so that it is not exposed to weld spatter, direct heat, or short-circuited current flow.

When prestressing steel for post-tensioning is installed in the ducts, any rust that forms during the first 14 days after installation will not be cause for rejection of the steel.

4. MEASUREMENT

This Item will be measured by the foot, square foot, square yard, cubic yard, or each member. This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Prestressed Concrete" of the specified structural component and type or size. This price is full compensation for fabricating, hauling, and erection of the members; furnishing and tensioning of prestressing steel; furnishing and placing reinforcing steel and duct; furnishing and placing bearing plates, elastomeric bearings, bars, anchorage plates, and appurtenances; grouting holes; repairs; special treatment of end anchorages and shoes as required; erection bracing; and equipment, labor, tools, and incidentals.

Precast prestressed concrete bridge deck panels will not be paid for directly, but will be subsidiary to pertinent Items.

Precast prestressed concrete piling will be paid for in accordance with Item 409, "Prestressed Concrete Piling."

No additional compensation will be made for alternate designs or for any increase in quantities required to accommodate alternate designs, including quantities paid for under other Items.

Item 426

Post-Tensioning



1. DESCRIPTION

Furnish, store, and handle post-tensioning materials, and perform post-tensioning of cast-in-place and precast structural units.

2. MATERIALS

Furnish materials that meet requirements of the following unless specified otherwise.

- PTI Guide Specification for Grouted Post-Tensioning (PTI/ASBI M50)
- PTI Specification for Grouting of Post-Tensioned Structures (PTI M55).

2.1. **Prestressing Steel.** Furnish prestressing steel strand conforming to one of the following types:

- seven-wire steel strand meeting [DMS-4500](#), "Steel Strand, Uncoated Seven-Wire Low-Relaxation for Prestressed Concrete," or
- Grade 150, high-strength, coarse thread bars meeting ASTM A722.

2.2. **Post-Tensioning System.** Furnish a post-tensioning system following the minimum requirements for Protection Level 2 (PL-2), or higher protection level when shown on the plans, in accordance with PTI/ASBI M50. Prequalify post-tensioning systems using tests on complete tendons for compliance with the requirements of PTI/ASBI M50.

The following exceptions apply.

- The embedded parts of the anchorage are not required to be galvanized or epoxy coated, unless otherwise shown on the plans.
- Provide pre-packaged grouts in accordance with [DMS-4670](#), "Grouts for Post-Tensioning." Do not use grouts that exceed the manufacturers' recommended shelf life or 6 mo. after date of manufacture, whichever is less.
- Provide unbonded single-strand tendons in accordance with PTI M10.2-00, *Specification for Unbonded Single Strand Tendons*.

3. EQUIPMENT

3.1. **Stressing Equipment.** Provide hydraulic jacks, pressure gauges, and other stressing equipment that meets PTI/ASBI M50.

3.2. **Grouting Equipment.** Provide grout mixing, testing, and pumping equipment that meets PTI M55.

4. CONSTRUCTION

Item 420, "Concrete Substructures," and Item 422, "Concrete Superstructures," will govern for cast-in-place construction. Item 424, "Precast Concrete Structural Members (Fabrication)," will govern for precast concrete units or members.

4.1. **Qualifications of Personnel.** Perform all work for post-tensioning, including duct and hardware installation, strand insertion, and tendon or bar stressing, under the direct supervision of an individual certified as a PTI

Level 2 Bonded PT Field Specialist. Perform all grouting operations under the direct supervision of an individual who has received a Grouting Technician Certification from ASBI.

- 4.2. **Required Submittals.** Submit information in accordance with this Section for post-tensioned elements, in addition to forming and falsework plans required by Item 420 and Item 424. Include all necessary construction information in these submittals for cast-in-place and precast construction including, but not limited to the information required in this Section.
- 4.2.1. **Design Calculations.** Provide design procedures, coefficients, allowable stresses, tendon spacing, and clearances in accordance with the AASHTO LRFD *Bridge Design Specifications* and PTI/ASBI M50 unless otherwise shown on the plans. Submit enough calculations to support the proposed system and method of post-tensioning, including friction loss diagrams. When the required jacking force for a particular type of tendon, duct, and configuration is shown on the plans, design calculations are not required except to adjust for conditions different from those shown on the plans.
- 4.2.2. **Post-Tensioning Details.** Provide drawings with details that meet the requirements of PTI/ASBI M50 and this Item.
- 4.2.3. **Grouting Plan.** Submit for approval written grouting procedures at least 4 weeks before the start of the element's construction. Include items required by PTI M55. At minimum include:
- type, quantity, and brand of material used, and their corresponding material properties;
 - type of equipment needed, including backup equipment;
 - type and location of all inlets, outlets, and intermediate vents;
 - types and sizes of grout hoses and connections;
 - grouting operations procedures, including duct cleaning, mixing, pumping, direction of grouting, and sequence of the use of inlets and outlets;
 - mitigation plan if blockages occur; and
 - the names of the persons in charge and all field personnel who will be performing the grouting operations and their pertinent experience.
- Include the names of people responsible for post-tensioning installation and grouting operations, with the foreman of each grouting crew certified as a PTI Level 2 Bonded PT Field Specialist and ASBI Certified Grouting Technician.
- 4.2.4. **Stressing Safety Plan.** Provide a plan to protect the public, workers, and Department personnel in and around the vicinity where post-tensioning operations are occurring.
- Submit for approval a detailed safety plan that identifies potential risk associated with post-tensioning operations, including but not limited to:
- tendon alignment,
 - temporary shoring,
 - ram operations, and
 - strand anchorage.
- 4.3. **Packaging, Storing, and Handling of Post-Tensioning Components.** Package, store, and handle post-tensioning steel, grout, duct, and other accessories in accordance with PTI/ASBI M50 and PTI M55 unless otherwise specified. Acceptance and rejection criteria for strand will follow PTI/ASBI M50 and PTI M55.
- The following exceptions apply.
- Grout storage onsite will be limited to 30 days unless approved by the Engineer in advance of material delivery.

- Install grout caps and ensure vents are always closed so that water and other contaminants cannot enter the duct before strand installation.
- Do not flush ducts at any time.

- 4.4. **Duct and Prestressing Steel Installation for Post-Tensioning.** Follow PTI/ASBI M50 for duct and prestressing steel installation procedures and requirements unless otherwise specified. Verify that concrete strength requirements shown on the plans are met for stressing and staged loading of post-tensioned structural elements.

Before stressing, furnish certified copies of load calibration curves on all jacks and gauge systems to be used in the work.

Stress the tendons within 7 days of installing the strand in the ducts unless otherwise approved in advance. Follow the tensioning procedure noted in the approved post-tensioning details.

The Contractor is to provide documentation of elongation measurements after tendons have been stressed but before cutting strands. After the elongations have been approved, immediately cut off the tendon strand tails.

- 4.5. **Grouting.** Grout in accordance with PTI M55.

Provide grout mock-ups as shown on the plans.

Grout within 14 days of tendon stressing unless otherwise specified or approved. Obtain approval to extend the grouting time before stressing tendons.

Do not allow the grout temperature to exceed 85°F during mixing and pumping. Do not grout when the ambient temperature is below 35°F. Field-test the grout in accordance with Table 1 during grout installation. Perform field-testing by trained personnel at the Contractor's expense while witnessed by the Engineer. Pump at the lowest pressure possible that will maintain a continuous flow of grout.

Table 1
Requirements for Field-Testing of Grout

Test	Requirement	Frequency
Schupak pressure bleed test (ASTM C1741), % Max	0 at 100 psi	1 per day
Fluidity test (Tex-437-A , Method 2)		2 every 2 hr.
(a) Immediately after mixing, sec.	Min 5, Max 20	2 Min per day
(b) 30 min. after mixing with 30-sec. remix, sec.	Max 20	
Compressive strength test (3" × 6" cylinders)	3,000 at 7 days 5,000 at 28 days	1 per day
Mud balance test (Tex-130-E , Part II) ^{1,2}	Per PTI M55	2 per day

1. Take one sample from the mixer and one sample from the farthest duct outlet.
2. Verify wet density is within the range established by the manufacturer.

5. MEASUREMENT

This Item will be measured by each post-tensioning element or member. An element or member is defined by one of the following individual components:

- post-tensioned cap,
- post-tensioned column,
- post-tensioned bent, or
- other elements shown on the plans.

The post-tensioning may extend into other elements subsidiary to the main element being post-tensioned.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "PT" for the member type shown on the plans. This price is full compensation for submittals, mock-ups, prestressing steel, post-tensioning, ducts, grout fittings, grout, end anchorages, bearing plates, equipment, labor, materials, tools, and incidentals. Materials furnished for testing will not be paid for directly.

Post-tensioning of precast members, tensioned at a fabrication plant, will not be paid for directly, but will be subsidiary to pertinent Items.

Item 427

Surface Finishes for Concrete



1. DESCRIPTION

Finish concrete surface as specified.

2. MATERIALS

Furnish materials in accordance with this Article for the type of surface finish specified.

2.1. Coatings.

2.1.1. **Adhesive Grout and Concrete Paint.** Provide coatings in accordance with [DMS-8110](#), "Coatings for Concrete." Match color of coating with Federal Standard 595C color 35630, concrete gray, unless otherwise shown on the plans.

2.1.2. **Opaque Sealer.** Provide penetrating-type sealer in accordance with [DMS-8110](#). Match color of coating with Federal Standard 595C color 35630, concrete gray, unless otherwise shown on the plans.

2.1.3. **Silicone-Based Paint.** Provide silicone resin emulsion paint (SREP) meeting the requirements of [DMS-8141](#), "Paint, Silicon Resin for Concrete." Match color of coating with Federal Standard 595C color 35630, concrete gray, unless otherwise shown on the plans.

2.1.4. **Epoxy Waterproofing.** Provide Type X epoxy in accordance with [DMS-6100](#), "Epoxyes and Adhesives," or another approved waterproofing epoxy designed to limit the moisture vapor transmission into a concrete or steel surface. Match color of coating with Federal Standard 595C color 35630, concrete gray, unless otherwise shown on the plans.

2.2. **Exposed Aggregate Finish.** Provide approved aggregates meeting the grading requirements shown on the plans. Provide gravel consisting of predominantly rounded particles unless otherwise shown on the plans. Use crushed stone when a bush-hammered finish is desired. Provide a concrete surface retardant. Provide clear Type II permanent anti-graffiti coating in accordance with [DMS-8111](#), "Anti-Graffiti Coatings."

3. EQUIPMENT

The Engineer may require demonstration of the equipment's capabilities.

3.1. **Water Blasting.** Use equipment capable of supplying a minimum pressure at the nozzle end of 3,000 psi.

3.2. **Abrasive Blasting.** Use equipment with filters to produce oil-free air and water-free air when dry air is required.

3.3. **Slurry Blasting.** Use equipment capable of combining air and abrasives with water to form wet blast media capable of cleaning and preparing surface without creating dust.

3.4. **Spraying.** Use equipment with fluid and air pressure regulators and gauges to allow for adjustment to produce a uniform spray pattern for coating applications.

3.5. **Off-the-Form Finish Forms.** Use nonstaining, nonporous, high-quality forming materials (e.g., steel or medium-density and high-density overlaid plywood forms). Use steel or high-density overlaid plywood forms when the same form will be used more than twice.

- 3.6. **Form Liners.** Provide form liners capable of producing a patterned finish as shown on the plans. Use form liners that provide a clean release from the concrete surface without pulling or breaking the textured concrete.

4. CONSTRUCTION

Provide the finish shown on the plans for the specific surface areas.

- 4.1. **Surface Areas of Finish.** "Surface area of finish" designates the areas where the specified surface is to be applied.

- 4.1.1. **Surface Area I.** Surface Area I includes the following:

- surfaces of railing;
- exterior vertical faces of fascia beams, slabs, slab spans, arches, and box girders;
- the outside bottom surface of fascia beams and girders;
- the underside of overhanging slabs to the point of juncture of the supporting beam;
- the entire underside of slab spans when shown on the plans;
- vertical and underside surfaces of bents and piers;
- all surfaces of tie beams, abutments, bridge wingwalls, culvert headwalls and wingwalls, and retaining walls exposed to view after all backfill and embankment are placed; and
- all other exposed surfaces shown on the plans to require surface treatment.

- 4.1.2. **Surface Area II.** Surface Area II includes surfaces of railing, all wingwalls, and the exterior vertical faces of slabs.

- 4.1.3. **Surface Area III.** Surface Area III includes only the top and roadway faces of all concrete railing and bridge wingwalls.

- 4.1.4. **Surface Area IV.** Surface Area IV includes areas shown on the plans.

- 4.2. **Coatings.** Apply the coating specified on the plans.

- 4.2.1. **Preparation.** Clean the surface thoroughly before applying a coating by chemical cleaning, if required, and by blast cleaning.

Provide containment that keeps public property, private property, and the environment from being adversely affected by the cleaning and painting operations. Do not discharge washwater into any body of water or conveyance without TCEQ approval. Collect and properly dispose of any paint or debris dislodged by cleaning operations.

- 4.2.1.1. **Chemical Cleaning.** Clean surfaces contaminated with oil, grease, or other contaminants by scrubbing the area with an approved detergent or other concrete cleaning material before blast cleaning. Do not use a solvent that will stain the surface or inhibit coating adhesion. Perform the following test to check for surface contamination of oil type materials.

- Spray the surface with a fine mist of potable water.
- Examine the area to see if water beads up.
- Clean the surface if beading is found.

- 4.2.1.2. **Blast Cleaning.** Blast clean the designated surface to remove all surface material (including existing coatings), curing compound, and other contaminants before applying a specified coating, leaving a lightly etched uniformly textured surface. Use an approved abrasive propelled by oil-free air with or without the addition of potable water, or blast with potable water with or without the addition of an approved abrasive at sufficient pressure to effectively clean and prepare the surface. Maintain the stand-off distance of the nozzle to at most 12 in. from the surface being cleaned when water blasting.

Do not damage concrete surface by gouging, spalling, or exposing coarse aggregate by the blasting operation.

Blow clean oil- and moisture-free air on all surfaces with sufficient pressure to remove loose particles immediately before application of any coating. Perform the following test to check for surface cleanliness as directed.

- Press a 10-in. long strip of 2-in. wide clear packing tape on the surface by rubbing with moderate pressure.
- Grasp the free end of the tape and remove the tape from the surface with a sharp jerk.
- Examine the surface of the tape for clinging particles.

Continue cleaning the concrete surface until there are no particles clinging to the tape surface for subsequent tests. An additional test that can be used to check the surface for dust is to wipe the surface with a dark cloth and then examine the cloth for discoloration.

- 4.2.2. **Coating Application.** Mix coating materials in conformance with the manufacturer's instructions and thoroughly enough with a mechanical mixer at a speed that causes the mixture to rotate entirely in the container. Ensure complete mixing by probing the container using a stirring device searching for non-dispersed or settled material.

Apply coatings once the new concrete has aged at least 28 days, except for the adhesive grout coating. Do not apply coatings when weather conditions will be detrimental to the final surface finish as determined by the Engineer. Do not apply coatings when surface temperature of the concrete exceeds 110°F.

Apply coatings on a dry surface. Do not thin material unless approved. Apply when ambient temperature is between 50°F and 100°F. Apply coatings to obtain a consistent color, texture, and appearance. Apply concrete paint in two coats for a total maximum application rate of 150 sq. ft. per gallon. Apply opaque sealer in two coats for a total maximum application rate of 200 sq. ft. per gallon. Apply silicone resin paint in two coats at a rate not exceeding 300 sq. ft. per gallon per coat. Wait at least 12 hr. between coats for silicone resin paint. Apply epoxy waterproofing at a maximum application rate of 100 sq. ft. per gallon. For epoxy waterproofing, apply a thin uniform film of mixed epoxy to the substrate using a short nap roller or brush. The epoxy may be sprayed in conformance with the thinning requirements of the manufacturer. No more than 15% reduction is permitted.

Repair coatings that exhibit peeling, flaking, or discoloration or have been damaged during construction. Remove defective or damaged coating. Clean and recoat repair area in accordance with this Item.

- 4.2.2.1. **Epoxy Waterproofing.** Mix epoxy in conformance with manufacturer's instructions. Apply the coating on a dry surface at a maximum application rate of 100 sq. ft. per gallon. Apply a thin uniform film of mixed epoxy to the substrate using a short nap roller or brush. The epoxy may be sprayed in conformance with the thinning requirements of the manufacturer. No more than 15% reduction is permitted.

Match the color of the applied coating with the color standard as shown on the plans. Apply when ambient temperature is between 50°F and 100°F.

- 4.2.2.2. **Adhesive Grout.** Apply coating on a moistened surface to a uniform minimum thickness of 1/16 in. Apply when ambient temperature is at least 50°F.

- 4.3. **Special Surface Finishes.** Submit a work plan to the Engineer for any special finish shown on the plans. Include in the work plan the type of aggregates, materials, variation of panel or pattern arrangement, dimensions, construction methods, and other features affecting the work as necessary for the "Special Surface Finish" specified.

- 4.3.1. **Blast Finish.** Provide surface profile as shown on the plans, or meet the minimum requirements of Section 427.4.2.1., "Preparation." Construct a 4 × 4-ft. sample panel using the same concrete used in construction of the member to receive the blast finish. Prepare the surface of the sample panel to meet the

specified finish, and obtain approval of the sample finish. Use the approved sample panel finish as the standard for surfaces requiring a blast finish.

- 4.3.2. **Slurry Coat Finish.** Provide cementitious slurry coat finish to concrete surfaces within 14 days of placing concrete or later as approved. Water blast surface to moisten surface before application when application of slurry coat occurs more than 14 days after placing concrete. Do not apply slurry coat finish to surfaces receiving another type of coating finish.

Submit for approval proposed slurry recipe including cement, latex concrete additive, with or without sand, and other additives before application. The Engineer will direct the level of surface texture the slurry coat will have, whether to include sand, and what fineness of sand is to be used. Tint mixture of slurry as specified on the plans and as directed. Maintain consistent slurry throughout project, only modifying recipe to account for color variations noticed as work progresses.

Rub in slurry using carborundum stone, stiff bristle brush, or other approved device. Limit thickness of applied slurry to a maximum of 1/16 in. Demonstrate application methods for slurry coat and obtain approval of proposed surface. Apply slurry coat to obtain a tightly adhering cementitious finish to concrete surface. Remove material and reapply if slurry coat is not tightly adhering or is cracked.

- 4.3.3. **Rub Finish.** Provide a finish to the surface by rubbing the surface with a carborundum stone or other approved material. Begin rubbing the surface immediately after forms have been removed. Provide blast finish or other finish as directed at no additional cost to the Department if rubbing surface is delayed to the point where the surface is dry and unable to be rubbed to produce an acceptable finish. Perform the requirements to obtain the ordinary surface finish specified in Section 420.4.13., "Ordinary Surface Finish," concurrently with rubbing the surface. Rub concrete-patching areas after the patch material has thoroughly set and blend the patch in with the surrounding area to produce a surface with uniform color and texture where concrete patching is performed.

Keep the surface continuously wet after form removal until the rubbing is complete. Rub the surface sufficiently to bring the wetted concrete surface to a paste, producing a smooth, dense surface without pits, form marks, or other irregularities. Do not use cement grout to form the paste on the surface. Stripe the surface using a brush to conceal the rubbing pattern and allow the paste to reset. Wash the concrete with potable water after the paste has sufficiently set to leave it with a neat and uniform appearance and texture. Apply membrane curing, if required, in accordance with Item 420, "Concrete Substructures," after rubbing is complete.

- 4.3.4. **Off-the-Form Finish.** Provide a finish with minimal surface defects and uniform color and texture by using non-staining, non-porous, high-quality forming materials. Use the same type of forming materials for like elements for the entire structure.

Use mortar-tight forms to prevent leakage and discoloration. Seal joints using compressible gasket material, caulk, or tape, or by other suitable means that are not detrimental to the concrete finish, if necessary. Use one brand and type of form-release agents for all surfaces unless another product produces a similar concrete surface appearance. Do not use barrier-type (e.g., wax, fuel oil, and carrier oil) release agents. Use form-release agents containing a rust inhibitor on steel forms. Clean rust off steel forms before use. Use plywood that will not cause discoloration of the concrete surface.

Direct special attention to consolidation and vibration of the concrete around the form surfaces to minimize bug holes. Modify concrete placement and vibration techniques if surface contains an excessive amount of bug holes. Remove all forms without interruption once form removal begins to prevent discoloration due to differing form curing times.

Do not use membrane curing on surfaces with off-the-form finish.

Repair honeycombed and spall areas with least dimension larger than 2 in. in accordance with the concrete surface repair procedures in Item 420 to obtain an ordinary surface finish as defined in Section 420.4.13., "Ordinary Surface Finish." Patch honeycombed and spall areas with least dimension greater than 3/4 in. but

smaller than 2 in. by filling defect with repair material omitting the chipping operation. Do not patch honeycombed and spall areas with least dimension smaller than 3/4 in. Perform required repairs as soon as forms are removed. Match repair material color and texture with surrounding concrete surfaces. Minimize the area of repair by not smearing the repair material over acceptable concrete surfaces while attempting to blend the repair with the surrounding concrete. Cut out form ties at least 1/2 in. below the surface, and patch accordingly. Perform repair work as soon as possible after removing forms so that concrete and repair materials have similar ages. Replace or refurbish the forms when the Engineer determines defective formwork is causing an excessive amount of repair work.

- 4.3.5. **Form Liner Finish.** Provide patterned finish as shown on the plans. Do not splice form liner panels in a way that causes a noticeable transition or line between pieces. Wash and clean form liners after each use when the forms can be reused. Replace form liners that have become damaged or worn.

Construct a sample panel for each form liner finish. Approval is required to verify the sample panel meets the requirements shown on the plans and in conformance with specifications before beginning work. Upon approval, the sample panel becomes the model panel to which all other work will be compared. Deviation in color, grade, or depth from the model panel is grounds for rejection of the form liner finish. Removal of defective work may be necessary as determined by the Engineer and in accordance with the surface finish requirements in Item 420 to obtain an ordinary surface finish as defined in Section 420.4.13., "Ordinary Surface Finish."

Seal all form liner joints in a manner acceptable to the Engineer to prevent leakage at the surface.

- 4.3.6. **Exposed Aggregate Finish.** Provide exposed aggregate finish as shown on the plans. Provide a depth of finish between 3/8 in. and 1/2 in. unless directed otherwise.

Apply a concrete surface retarder that penetrates approximately 1/4 in. into the forms or concrete surface to help achieve the desired finish. Apply two or three coats to wood forms to account for absorption if necessary. Tape or caulk form joints to prevent escape of the retarder during the placing operations. Protect the form surfaces from sun and rain while exposed to the atmosphere. Re-treat form surfaces with retarder if disturbed. Protect adjacent areas of concrete not requiring exposed aggregate finish from the retarder.

Remove forms 12–15 hr. after concrete placement but not before concrete has gained sufficient strength to support the self-weight of the member, unless directed otherwise. Expose the aggregate for the finish immediately after form removal. Remove the grout paste covering the aggregate to be exposed by an approved method. Do not loosen the aggregate by the grout removal operation. Maintain required curing on all surfaces except for the time while the aggregate is being exposed. Cure using wet mats or membrane after the aggregate is exposed.

Repair defective areas as determined by the Engineer.

Re-clean exposed aggregate surfaces by an approved method. Apply a coat of clear Type II permanent anti-graffiti coating to cleaned exposed aggregate surface. Apply anti-graffiti coatings by spray, roller, or brush at the application rates recommended by the manufacturer and in accordance with Item 740, "Graffiti Removal and Anti-Graffiti Coating."

5. MEASUREMENT

When surface finishes for concrete are shown on the plans to be a pay item, measurement will be by the square foot of the type of surface finish specified. This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurement or calculations will be made if adjustments of quantities are required.

6. PAYMENT

Unless otherwise shown on the plans, the work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be subsidiary to pertinent Items.

When a surface finish for concrete is specified as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Adhesive Grout Finish," "Concrete Paint Finish," "Opaque Sealer Finish," "Silicone Resin Paint Finish," "Epoxy Waterproof Finish," or "Blast Finish." This price is full compensation for materials; cleaning and preparing surfaces; application of materials; and equipment, labor, tools, and incidentals.

Slurry coat, rub, off-the-form, form liner, or exposed aggregate finishes (including anti-graffiti coating) will not be paid for under this Item, but will be subsidiary to other pertinent Items.

Item 431

Pneumatically Placed Concrete



1. DESCRIPTION

Furnish and place pneumatically applied concrete for the construction of portions of structures, repairing concrete structures, encasement of structural steel members, lining ditches and tunnels, soil-nail walls, retaining walls, and other work as shown on the plans or as directed.

2. MATERIALS

Provide pre-bagged concrete materials for concrete structure repair and class of concrete shown on the plans for other work unless otherwise shown on the plans.

Submit pre-bagged materials information for approval. Material testing may be required before approval and installation test panels will be required in accordance with Section 431.2.4., "Proportioning and Mixing."

Provide materials in accordance with the following, with the exceptions noted in accordance with Section 431.2.1., "Exceptions to Item 421, 'Hydraulic Cement Concrete,'" Section 431.2.2., "Exceptions to Item 440, 'Reinforcement for Concrete,'" and Section 431.2.3., "Exception to [DMS-6310](#), 'Joint Sealants and Fillers.'"

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- [DMS-4655](#), "Concrete Repair Materials"
- [DMS-6310](#), "Joint Sealants and Fillers"

2.1. **Exceptions to Item 421, "Hydraulic Cement Concrete."** Provide a fine aggregate that meets the requirements of Item 421, Table 6, Grade 1, and a coarse aggregate that meets the requirements of Item 421, Table 4, Grade 7, unless otherwise shown on the plans.

2.2. **Exceptions to Item 440, "Reinforcement for Concrete."** Provide mushroom-headed steel anchors or expansion anchor hook bolts with a minimum diameter of 1/8 in. and a minimum length of 2 in. to attach reinforcement for the repair of concrete structures as shown on the plans or as directed. Reinforcing steel may be either welded wire fabric or reinforcing bars unless otherwise shown on the plans.

2.3. **Exception to [DMS-6310](#), "Joint Sealants and Fillers."** Provide a preformed bituminous fiber material unless otherwise noted on the plans.

2.4. **Proportioning and Mixing.** Submit for approval a proposed mix design conforming to the basic mix design requirements shown in Table 1 unless otherwise shown on the plans.

Table 1
Classes of Concrete

Class	Ratio of Cement to Total Aggregate ¹	Minimum 7-Day Compressive Strength (psi) ²
I	1:4	3,000
II	1:5	2,500

1. More cement may be used when approved.
2. Higher minimum strengths may be specified.

Measure the cement and aggregates by volume and mix with enough water to achieve the desired consistency. Use as little water as possible to achieve sufficient adhesion. Mix concrete sufficiently dry so it will not sag or fall from vertical or inclined surfaces or separate in horizontal work.

Prepare test panels using the same air pressure, nozzle tip, and position to be used for the production work to verify the mix design before approval. Apply a 3-in. layer of concrete to a plywood sheet with minimum dimensions of 18 in. × 18 in. for each test panel. Cure the test panels in the same manner as the proposed work.

Take three cores, each 2 in. in diameter, out of each test panel and test in compression at 7 days in accordance with [Tex-424-A](#). The mix design will be approved when the average strength of the three cores conforms to the strengths shown in Table 1 or strength shown on the plans. Provide additional test panels as directed if there are any changes in materials, equipment, or nozzle operator during the work.

3. CONSTRUCTION

- 3.1. **Qualification.** Provide experienced personnel able to produce concrete satisfying plan requirements and of uniform quality as required. Provide documentation of nozzle operator's qualification for the process proposed and orientation of the application meeting the minimum requirements when shown on the plans.

Demonstrate nozzle operator's abilities by constructing test panels before commencement of work. Orient test panels to match application direction of placement. Include reinforcing steel in the test panel with similar spacing as in member. Qualification test panels may be used for mix verification in accordance with Section 431.2.4., "Proportioning and Mixing."

- 3.2. **Surface Preparation.** Grade the area of proposed work accurately to the elevation and dimensions shown on the plans when concrete is to be placed against soil. Compact with sufficient moisture to provide a firm foundation and to prevent absorption of water from the concrete but without free surface moisture.

Remove paint, rust, loose mill scale, grease or oil, and all other foreign materials that may reduce the bond of the concrete to the steel when concrete is used to encase structural steel members.

Remove all deteriorated or loose material by chipping with pneumatic, electric, or hand tools when concrete is placed against concrete or rock. Cut square or slightly undercut shoulders approximately 1 in. deep along the perimeter of repair areas. Sandblast the surface to clean all rust from exposed reinforcing steel and to produce a clean rough-textured surface on the concrete or rock. Place the concrete while the substrate is in a saturated surface-dry (SSD) condition. Achieve SSD conditions by high-pressure water blasting 15–30 min. before placing the repair material. An SSD condition is achieved when the surface remains damp until the concrete is applied. The surface must be free of standing water. Remove all free (ponded) water just before placing concrete.

Provide joints, side forms, headers, and shooting strips for backing or paneling. Use ground or gauging wires where necessary to establish thickness, surface planes, and finish lines.

- 3.3. **Reinforcement.** Place and secure reinforcement to ensure there is no displacement from impact of applying pneumatically placed concrete. Place reinforcing bars at a spacing not less than 2-1/2 in. Support reinforcing wire fabric or bars using mushroom-headed anchors, expansion hook bolts, or grouted rebar capable of resisting a pullout force of 2,500 lb. Space anchors no more than 12 in. center-to-center on overhead surfaces, 18 in. center-to-center on vertical surfaces, and 36 in. center-to-center on top horizontal surfaces. Use at least three anchors in each patch area. Do not use explosive force to shoot anchors into concrete. Check the resistance to pullout of the reinforcing anchors when directed. Notify the Engineer before installation of the anchors. Locate anchors so there is no damage to prestressing tendons or conduits embedded in the concrete.

Use reinforcement when performing repair work in all areas where the thickness of the concrete will exceed 1-1/2 in. Use a single layer of either 2 × 2—W1.2 × W1.2 or 3 × 3—W1.5 × W1.5 of welded wire fabric, or

approved equivalent, unless otherwise shown on the plans. Use a single layer of wire fabric to reinforce each 4-in. thickness of patch or fractional part in areas where the concrete thickness exceeds 4 in. Encase completely each layer of wire fabric in concrete that has taken its initial set before installing the succeeding layer of wire fabric. Place the reinforcing fabric parallel to the finished surface and support it so it will be at least 3/4 in. out from the surface to be covered. Provide at least 1 in. of clearance between the finished concrete surface and all steel items, including anchors, reinforcing bars, and wire fabric. Lap adjacent fabric sheets at least 6 in. and tie together securely at a spacing of no more than 18 in. Pre-bend fabric before installing to fit around corners and into re-entrant angles.

Pre-bend the welded wire fabric for encasement of steel members using a template to conform as nearly as possible to the outlines of the members to be encased. Drill holes between 1/2 and 1 in. in diameter in the webs of the members as close as possible to the flanges to allow for attachment of the reinforcing fabric. Space these holes at approximately 3 ft. on center. Use 3/8-in. diameter rods placed through these holes to secure the reinforcing fabric. Hold the reinforcing fabric at least 3/4 in. out from the surface of the steel member. Lap adjacent fabric sheets at least 6 in. and tie together at a spacing of no more than 12 in.

- 3.4. **Pneumatic Placement of Concrete.** Pneumatically applied concrete can be either dry-mix or wet-mix. The dry-mix process consists of dry-mixed fine aggregate and hydraulic cement to which water is added immediately before its pneumatic expulsion from a nozzle. The wet-mix process consists of mechanically premixed concrete pneumatically applied through a nozzle.

- 3.4.1. **General.** Place the concrete when the ambient temperature is above 35°F and rising and material temperature is between 50°F and 90°F for wet-mix and below 100°F for dry-mix. Do not place concrete against a surface containing frost, ice, or standing water. Protect concrete from freezing or quick drying after placement. Apply the concrete using pneumatic equipment that sprays the mix onto the prepared surface at a velocity less than 100 ft. per second for construction of portions of structures, repairing concrete structures, or encasement of structural steel members. Minimize rebound and produce a compacted dense homogenous mass. Do not apply concrete if high winds will prevent proper application or if rain could wash out the concrete.

Hold the nozzle approximately 2–4 ft. from the surface and position it so the concrete impinges nearly at right angles to the surface being covered. Use shooting strips to ensure straight lines, square corners, and a plane surface of concrete. Place to keep the trapping of rebound to a minimum. Slope the concrete off to a thin edge at the end of each day's work or at similar stopping periods requiring construction joint. Thoroughly clean and wet previously placed concrete before placing an adjacent or additional section. Apply a sufficient number of coats to obtain the required thickness. Place coats on vertical and overhead surfaces in layers of such thickness to prevent sloughing, sagging, tearing, or debonding. Provide a sufficient interval between successive layers in sloping, vertical, or overhead work to allow initial but not final set. Clean the surface to remove the thin film of laitance to provide for a bond with succeeding applications. Remove rebound and accumulated loose sand from the surface to be covered before placing the original or succeeding layers of concrete. Correct any sags or other defects to the proper section as directed.

Place concrete to completely encase reinforcing steel. Encase reinforcing steel by shooting with sufficient velocity and plasticity that material flows around and behind reinforcement.

Apply the concrete using either the wet-mix or dry-mix process unless otherwise shown on the plans. Mix the materials thoroughly and uniformly using a paddle or drum-type mixer designed for pneumatic application. Wet-mix process applications can use transit-mix concrete. Do not use the wet-mix process for repair of damaged concrete.

Clean mixing and placing equipment at regular intervals. Inspect the nozzle liner and water and air injection system daily; replace worn parts as necessary.

Do not reuse rebound or overspray concrete.

- 3.4.2. **Dry-Mix Process.** Use a compressor or blower capable of delivering a sufficient volume of oil-free air at the pressure shown in Table 2. Maintain steady pressure throughout the placing process.

Use a water pump with the size and capacity to deliver water to the nozzle with a pressure at least 15 psi more than the required air pressure.

The values shown in Table 2 are based on a hose length of 150 ft. with the nozzle less than 25 ft. above the delivery equipment. Increase operating pressure approximately 5 psi for each additional 50 ft. of hose and approximately 5 psi for each 25 ft. the nozzle is raised.

Table 2
Compressor Capacities

Compressor Capacity, cu. ft/min.	Hose Diameter, in.	Maximum Size of Nozzle Tip, in.	Operating Air Pressure Available, psi
250	1	3/4	40
315	1-1/4	1	45
365	1-1/2	1-1/4	55
500	1-5/8	1-1/2	65
600	1-3/4	1-5/8	75
750	2	1-3/4	85

- 3.4.3. **Wet-Mix Process.** Operate the pump at a line pressure between 100 psi and 300 psi. Use delivery hoses between 1-1/2 in. and 3 in. in diameter. Use mixing equipment capable of thoroughly mixing the materials in sufficient quantity to maintain continuous placement.
- 3.5. **Construction Joints.** Use a square butt joint where the joint is subject to compressive stress or is over existing construction joints, unless otherwise shown on the plans. Use tapered or square butt joints at other locations. Square the outside 1 in. of tapered joints perpendicular to the surface.
- 3.6. **Finish.** Use a sharp trowel to cut off all high spots after the concrete has been placed to the desired thickness or screed to a true plane as determined by shooting strips or by the original concrete surface. Lightly apply cutting screeds, where used, to all surfaces so as not to disturb the concrete for an appreciable depth. Work in an upward direction when concrete is applied on vertical surfaces. Give the finished concrete a final flash coat of approximately 1/8 in. unless directed otherwise. Obtain a uniform appearance on all exposed surfaces unless otherwise shown on the plans.
- 3.7. **Curing.** Cure encasements with water for 4 days. Cure repairs and structural construction using either a piece of wet burlap taped over the repaired area with a covering of 4-mil minimum plastic sheet also taped in place or membrane curing as approved. Overlap the burlap with the plastic sheet and continuously tape the edges with a tape at least 3 in. wide (air duct tape or better) to completely enclose the mat and hold in moisture. Cure in this manner for 4 days. Curing is not required for soil-nail walls unless walls are the final exposed surfaces; in this case, cure at least 4 days in accordance with Item 420. Apply membrane curing in accordance with Section 420.2.7., "Curing Materials," for tunnel and ditch linings and vertical or overhead patches as approved.
- 3.8. **Repair of Defects.** Repair or replace debonded areas as directed.

4. MEASUREMENT

Measurement of pneumatically placed concrete for encasement of structural members will be by the square foot of the actual contact area.

Measurement of pneumatically placed concrete for repair of concrete structures will be by the cubic foot in place using the surface area times the average depth of the patch. When pneumatically placed concrete for repair of concrete structures is allowed or specified for Item 429, "Concrete Structure Repair," measurement and payment are in accordance with Article 429.5., "Payment."

5. PAYMENT

When pneumatically placed concrete is specified as a bid item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pneumatically Placed Concrete (Encasement)" or for "Pneumatically Placed Concrete (Repair)." This price is full compensation for cement, aggregate, water, and reinforcement; furnishing and installing steel anchors; removal of deteriorated or unsound concrete; mixing, placing, and curing pneumatically placed concrete; and equipment, labor, tools, and incidentals. Pneumatically placed concrete used for work other than encasement or repair will not be paid for directly, but will be subsidiary to pertinent Items.

Item 432

Riprap



1. DESCRIPTION

Furnish and place concrete, stone, cement-stabilized, or special riprap.

2. MATERIALS

Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 431, "Pneumatically Placed Concrete"
- Item 440, "Reinforcement for Concrete"
- [DMS-6200](#), "Filter Fabric"

2.1. **Concrete Riprap.** Use Class B concrete unless otherwise shown on the plans.

2.2. **Pneumatically Placed Concrete Riprap.** Use Class II concrete that meets the requirements of Item 431, unless otherwise shown on the plans.

2.3. **Stone Riprap.** Use durable natural stone with a bulk specific gravity of at least 2.50 as determined in accordance with [Tex-403-A](#), unless otherwise shown on the plans. Provide stone that, when tested in accordance with [Tex-411-A](#), has weight loss of no more than 18% after five cycles of magnesium sulfate solution.

Perform a size verification test on the first 5,000 sq. yd. of finished riprap stone for all types of stone riprap at a location determined by the Engineer. Test the riprap stone in accordance with ASTM D5519, Test Method D, unless otherwise directed. Additional tests may be required. Do not place additional riprap until the initial 5,000 sq. yd. of riprap has been approved.

Provide grout or mortar in accordance with Item 421 when specified. Provide grout with a consistency that will flow into and fill all voids.

Provide filter fabric in accordance with [DMS-6200](#). Provide Type 2 filter fabric for protection stone riprap, unless otherwise shown on the plans. Provide Type 2 filter fabric for Type R, F, or Common stone riprap when shown on the plans.

2.3.1. **Type R.** Use stones between 50 and 250 lb., with at least 50% of the stones heavier than 100 lb.

2.3.2. **Type F.** Use stones between 50 and 250 lb., with at least 40% of the stones heavier than 100 lb. Use stones with at least one broad flat surface.

2.3.3. **Common.** Use stones between 50 and 250 lb. Use stones that are at least 3 in. in their least dimension. Use stones that are at least twice as wide as they are thick. When shown on the plans or approved, material may consist of broken concrete removed under the Contract or from other approved sources. Cut exposed reinforcement flush with all surfaces before placement of each piece of broken concrete.

2.3.4. **Protection.** Use boulders or quarried rock that meets the gradation requirements shown in Table 1. Both the width and the thickness of each piece of riprap must be at least 1/3 of the length. When shown on the plans or as approved, material may consist of broken concrete removed under the Contract or from other approved

sources. Cut exposed reinforcement flush with all surfaces before placement of each piece of broken concrete. Determine gradation of the finished, in-place, riprap stone under the direct supervision of the Engineer in accordance with ASTM D5519, Test Method D, unless otherwise directed.

Table 1
In-Place Protection Riprap Gradation Requirements

Nominal Size	Maximum Weight (lb.)	90% Weight ¹ (lb.)	50% Weight ² (lb.)	Minimum 8% Weight ³ (lb.)
12 in.	200	80–180	30–75	3
15 in.	320	170–300	60–165	20
18 in.	530	290–475	105–220	22
21 in.	800	460–720	175–300	25
24 in.	1,000	550–850	200–325	30
30 in.	2,600	1,150–2,250	400–900	40
36 in.	4,400	2,200–3,900	800–1,700	140

1. The 90% weight is the stone weight heavier than 90% of the individual riprap stones, and lighter than 10% of individual riprap stones.
2. The 50% weight is the stone weight heavier than 50% of individual riprap stones, and lighter than 50% of individual riprap stones.
3. The 8% weight is the stone weight heavier than 8% of individual riprap stones, and lighter than 92% of individual riprap stones.

The Engineer may require in-place verification of the stone gradation. Determine the in-place gradation of the riprap stone by taking linear transects along the riprap and measuring the intermediate axis of the stone at select intervals. Place a tape measure along the riprap and determine the intermediate axis size of the stone at 2-ft. intervals. Measure at least 100 stones, either in a single transect or in multiple transects, then follow ASTM D5519, Test Method D to determine the gradation, unless otherwise directed. Table 2 is a guide for comparing the stone size in inches to the stone weight shown in Table 1.

Table 2
Protection Riprap Stone Size¹

Nominal Size	D _{max} (in.)	D ₉₀ (in.)	D ₅₀ (in.)	D ₈ (in.)
12 in.	13.76	10.14–13.29	7.31–9.92	3.39
15 in.	16.10	13.04–15.75	9.21–12.91	6.39
18 in.	19.04	15.58–18.36	11.10–14.21	6.59
21 in.	21.85	18.17–21.09	13.16–15.75	6.88
24 in.	23.53	19.28–22.29	13.76–16.18	7.31
30 in.	32.36	24.65–30.84	17.34–22.72	8.05
36 in.	38.56	30.61–37.04	21.85–28.09	12.22

1. Based on a specific gravity of 2.5 and using the following equation for the intermediate axis diameter: $D = (12 \text{ in./ft.}) * \{(W)/(Gs * 62.4 * 0.85)\}^{1/3}$

where:

D = intermediate axis diameter (in.)

W = weight of stone (lb.)

Gs = Specific gravity of stone

Note—If the specific gravity of the stone is greater than 2.5, then the above equation can be used to determine the appropriate size using the actual specific gravity.

When bedding is required, provide bedding stone that, in place, meets the gradation requirements shown in Table 3 or as otherwise shown on the plans. If the nominal size of the protection riprap is less than or equal to 30 in., verify the gradation of the bedding material in accordance with [Tex-401-A](#) unless otherwise directed. If the nominal size of the protection riprap is equal to 36 in., verify the gradation of the bedding material in accordance with ASTM D5519, Test Method D, unless otherwise directed.

Table 3
Protection Riprap Bedding Material Gradation Requirements

Nominal Size <36 in.		Nominal Size = 36 in.	
Sieve Size (Sq. Mesh)	% by Weight Passing	Sieve Size (Sq. Mesh)	% by Weight Passing
3"	100	6"	100
1-1/2"	50–80	4"	35–75
3/4"	20–60	3"	45–60
#4	0–15	2"	0–15
#10	0–5	–	–

- 2.4. **Cement-Stabilized Riprap.** Provide aggregate that meets the requirements of Item 247, "Flexible Base," for the type and grade shown on the plans. Use cement-stabilized riprap with 7% hydraulic cement by dry weight of the aggregate unless otherwise directed.
- 2.5. **Special Riprap.** Furnish materials for special riprap as shown on the plans.

3. CONSTRUCTION

Dress slopes and protected areas to the line and grade shown on the plans before the placement of riprap. Place riprap and toe walls as shown on the plans or as directed.

- 3.1. **Concrete Riprap.** Reinforce concrete riprap with 6 × 6 – W2.9 × W2.9 welded wire fabric or with No. 3 or No. 4 reinforcing bars spaced at a maximum of 18 in. in each direction unless otherwise shown on the plans. Alternative styles of welded wire fabric that provide at least 0.058 sq. in. of steel per foot in both directions may be used if approved. A combination of welded wire fabric and reinforcing bars may be provided when both are permitted. Provide a minimum 6-in. lap at all splices. Provide horizontal cover of at least 1 in. and no more than 3 in. at the edge of the riprap. Place the first parallel bar no more than 6 in. from the edge of concrete. Use approved supports to hold the reinforcement approximately equidistant from the top and bottom surface of the slab. Adjust reinforcement during concrete placement to maintain correct position.

Sprinkle or sprinkle and consolidate the subgrade before the concrete is placed as directed. All surfaces must be moist when concrete is placed.

Compact and shape the concrete once it has been placed to conform to the dimensions shown on the plans. Finish the surface with a wood float after it has set sufficiently to avoid slumping to secure a smooth surface or broom finish as approved.

Cure the riprap immediately after the finishing operation in accordance with Item 420.

- 3.2. **Stone Riprap.** Provide the following types of stone riprap when shown on the plans.

- **Dry Riprap.** Stone riprap with voids filled with only spalls or small stones.
- **Grouted Riprap.** Type R, F, or Common stone riprap with voids grouted after all the stones are in place.
- **Mortared Riprap.** Type F stone riprap laid and mortared as each stone is placed.

Use spalls and small stones lighter than 25 lb. to fill open joints and voids in stone riprap, and place to a tight fit.

Place mortar or grout only when the air temperature is above 35°F. Protect work from rapid drying for at least 3 days after placement.

For slope or wave protection, if filter fabric is required, place filter fabric with its long axis running up and down the slope unless otherwise approved. For stream bank protection, if filter fabric is required, place the filter fabric with its long axis parallel to the centerline of the channel unless otherwise approved. Overlap the uphill or upstream sheet over the downhill or downstream sheet. For above water applications, ensure

adjacent sheets of filter fabric have a minimum overlap of 2 ft. in each direction. Secure filter fabric in place with nails or pins. Use 12-in. long, 3/16-in. diameter nails with 1.5-in. washers, or U-shaped steel pins with each leg at least 9 in. long. Space nails or pins at a maximum of 10 ft. in each direction and 5 ft. along the seams. Along the seams, place nails or pins through both strips of filter fabric at approximately the midpoint of the overlap. Place additional nails or pins as necessary to hold the filter fabric in position. Alternative anchorage and spacing may be used when approved. Keep the fabric material free of tension, stress, folds, wrinkles, or creases.

Methods for underwater filter placement must be approved before installation. For underwater placement, filter fabric should be unrolled in the direction of flow, overlapped at least 3 ft., and secured with sandbags, rocks, nails, or pins to prevent distortion. To prevent segregation and transport, underwater installation of a granular filter must be by clamshell bucket or tremie, with the granular material released on or very near the bed, unless otherwise approved. Underwater placement of a granular filter is permitted only if the water velocity is less than 5 ft. per second unless otherwise approved.

Any defects, tears, holes, flaws, or damage to filter fabric may be cause for rejection. Repair torn or punctured filter fabric by placing an additional layer of filter fabric over the damaged area, ensuring a minimum overlap of 3 ft. beyond the damaged area in all directions, and securing the filter fabric in place with pins or nails. Store filter fabric out of direct sunlight and cover the filter fabric as soon as possible after placement, but within 3 days.

- 3.2.1. **Type R.** Construct riprap as shown in Figure 1 on the *Stone Riprap Standard* and as shown on the plans. Place stones in a single layer with close joints so most of their weight is carried by the earth and not the adjacent stones. Place the upright axis of the stones at an angle of approximately 90° to the embankment slope. Place each course from the bottom of the embankment upward with the larger stones in the lower courses.

Fill open joints between stones with spalls. Place stones to create a uniform finished top surface. Do not exceed a 6-in. variation between the tops of adjacent stones. Replace, embed deeper, or chip away stones that project more than the allowable amount above the finished surface.

Prevent earth, sand, or foreign material from filling the spaces between the stones when the plans require Type R stone riprap to be grouted. Wet the stones thoroughly after they are in place, fill the spaces between the stones with grout, and pack. Sweep the surface of the riprap using a stiff broom after grouting.

- 3.2.2. **Type F.**

- 3.2.2.1. **Dry Placement.** Construct riprap as shown in Figure 2 on the *Stone Riprap Standard*. Set the flat surface on a prepared horizontal earth bed and overlap the underlying course to secure a lapped surface. Place the large stones first, roughly arranged in close contact. Fill the spaces between the large stones with suitably sized stones placed to leave the surface evenly stepped and conforming to the contour required. Place stone to drain water down the face of the slope.

- 3.2.2.2. **Grouting.** Construct riprap as shown in Figure 3 on the *Stone Riprap Standard*. Size, shape, and lay large flat-surfaced stones to produce an even surface with minimal voids. Place stones with the flat surface facing upward parallel to the slope. Place the largest stones near the base of the slope. Fill spaces between the larger stones with stones of suitable size, leaving the surface smooth, tight, and conforming to the contour required. Place the stones to create a plane surface with a variation no more than 6 in. in 10 ft. from true plane. Provide the same degree of accuracy for warped and curved surfaces. Prevent earth, sand, or foreign material from filling the spaces between the stones. Wet the stones thoroughly after they are in place, fill the spaces between them with grout, and pack. Sweep the surface using a stiff broom after grouting.

- 3.2.2.3. **Mortaring.** Construct riprap as shown in Figure 2 on the *Stone Riprap Standard*. Lap courses as described for dry placement. Wet the stones thoroughly before placing mortar. Bed the larger stones in fresh mortar as they are being placed and shove adjacent stones into contact with one another. Spread excess mortar forced out during placement of the stones uniformly over them to fill all voids completely. Point up all joints roughly either with flush joints or shallow, smooth-raked joints as directed.

- 3.2.3. **Common.** Construct riprap as shown in Figure 4 on the *Stone Riprap Standard*. Place stones on a bed excavated for the base course. Bed the base course of stone well into the ground with the edges in contact. Bed and place each succeeding course in even contact with the preceding course. Use spalls and small stones to fill any open joints and voids in the riprap. Ensure the finished surface presents an even, tight surface, true to the line and grades of the typical sections.
- Prevent earth, sand, or foreign material from filling the spaces between the stones when the plans require grouting common stone riprap. Wet the stones thoroughly after they are in place, fill the spaces between them with grout, and pack. Sweep the surface using a stiff broom after grouting.
- 3.2.4. **Protection.** Construct riprap as shown in Figure 5 on the *Stone Riprap Standard*. Place riprap stone on the slopes within the limits shown on the plans. Place stone for riprap on the filter fabric to produce a reasonably well-graded mass of riprap with the minimum practicable percentage of voids. Place riprap stone on top of the filter fabric, always starting at the bottom and working toward the top of any slope. Construct the riprap to the lines and grades shown on the plans or staked in the field. A tolerance of +6 in. and -0 in. from the slope line and grades shown on the plans is allowed in the finished surface of the riprap. Place riprap to its full thickness in a single operation. Avoid displacing the filter fabric. Ensure the entire mass of stones in its final position is free of objectionable pockets of small stones and clusters of larger stones. Do not place riprap in layers, and do not place it by dumping it into chutes, dumping it from the top of the slope, pushing it from the top of the slope, or any method likely to cause segregation of the various sizes. Obtain the desired distribution of the various sizes of stones throughout the mass by selective loading of material at the quarry or other source, or by other approved methods of placement that will produce the specified results. Rearrange individual stones using mechanical equipment or by hand if necessary to obtain a reasonably well-graded distribution of stone sizes. If required, use the bedding thickness shown on the plans and place stone for riprap on the bedding material to produce a reasonably well-graded mass of riprap with the minimum practicable percentage of voids.
- 3.3. **Pneumatically Placed Concrete Riprap, Class II.** Meet the requirements of Item 431. Provide reinforcement as shown on the plans and in accordance with Item 440. Support reinforcement with approved supports throughout placement of concrete.
- Give the surface a wood-float finish or a gun finish as directed. Cure the riprap with membrane-curing compound immediately after the finishing operation in accordance with Item 420.
- 3.4. **Cement-Stabilized Riprap.** Follow the requirements of the plans and the provisions for concrete riprap except when reinforcement is not required. The Engineer will approve the design and mixing of the cement-stabilized riprap.
- 3.5. **Special Riprap.** Construct special riprap as shown on the plans.

4. MEASUREMENT

This Item will be measured by the cubic yard of material complete in place. Volume will be computed based on the measured area in place and the thickness and toe wall width shown on the plans.

If required on the plans, the pay quantity of the bedding material for stone riprap for protection to be paid for will be measured by the cubic yard as computed from the measured area in place and the bedding thickness shown on the plans.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Riprap" of the type, nominal size, and void-filling technique (dry, grout, or mortar) specified, as applicable. This price is full compensation for furnishing, hauling, and placing riprap and for filter fabric, expansion joint material, concrete and reinforcing steel, grout and mortar, scales, test weights, equipment, labor, tools, and incidentals.

Payment for excavation of toe wall trenches, for all necessary excavation below natural ground or bottom of excavated channel, and for shaping of slopes for riprap will be included in the unit price bid per cubic yard of riprap.

When bedding is required for protection stone riprap, payment will be made at the unit price bid for "Bedding Material" of the thickness specified. This price is full compensation for furnishing, hauling, placing, and maintaining the stone bedding material until placement of the riprap cover is completed and accepted; excavation required for placement of bedding material; and equipment, scales, test weights, labor, tools, and incidentals. No payment will be made for excess thickness of bedding or for material required to replace embankment material lost by rain wash, wind erosion, or otherwise.

Item 440

Reinforcement for Concrete



1. DESCRIPTION

Furnish and place reinforcement of the type, size, and details shown on the plans.

2. MATERIALS

Use deformed steel bar reinforcement unless otherwise specified or allowed.

2.1. **Approved Mills.** Before furnishing steel, producing mills of reinforcing steel for the Department must be pre-approved in accordance with [DMS-7320](#), "Qualification Procedure for Reinforcing Steel Production Mills," by the Materials and Tests Division. The Department's MPL includes approved producing mills. Reinforcing steel obtained from unapproved sources will not be accepted.

2.2. **Deformed Steel Bar Reinforcement.** Provide deformed reinforcing steel conforming to one of the following:

- ASTM A615, Grade 60 or 80;
- ASTM A996, Type A, Grade 60;
- ASTM A996, Type R, Grade 60, permitted in concrete pavement only (Furnish ASTM A996, Type R bars as straight bars only and do not bend them. Bend tests are not required.); or
- ASTM A706, Grade 60 or 80.

Provide the grade of reinforcing steel shown on the plans. Provide Grade 60 if no grade is shown.

The nominal size, area, and weight of reinforcing steel bars this Item covers are shown in Table 1.

Table 1
Size, Area, and Weight of Reinforcing Steel Bars

Bar Size Number (in.)	Diameter (in.)	Area (sq. in.)	Weight per Foot (lb.)
3	0.375	0.11	0.376
4	0.500	0.20	0.668
5	0.625	0.31	1.043
6	0.750	0.44	1.502
7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313
14	1.693	2.25	7.650
18	2.257	4.00	13.60

2.3. **Smooth Steel Bar Reinforcement.** Provide steel conforming to ASTM A615 or meet the physical requirements of ASTM A36 for smooth bars that are larger than No. 3. Designate smooth bars by size number up to No. 4 and by diameter in inches above No. 4.

2.4. **Spiral Reinforcement.** Provide bars or wire for spiral reinforcement of the grade and minimum size or gauge shown on the plans.

Provide smooth or deformed wire conforming to ASTM A1064. Provide bars conforming to ASTM A615; ASTM A996, Type A; or ASTM A675, Grade 80, meeting dimensional requirements of ASTM A615.

- 2.5. **Weldable Reinforcing Steel.** Provide reinforcing steel conforming to ASTM A706 or with a maximum carbon equivalent (C.E.) of 0.55% if welding of reinforcing steel is required or desired. Provide a report showing the percentages of elements necessary to establish C.E. for reinforcing steel that does not meet ASTM A706, to be structurally welded. These requirements do not pertain to miscellaneous welds on reinforcing steel as defined in Section 448.4.2.1.1., "Miscellaneous Welding Applications."

Calculate C.E. using the following formula:

$$C.E. = \%C + \frac{\%Mn}{6}$$

Do not weld stainless reinforcing steel without permission from the Engineer. Provide stainless reinforcing steel suitable for welding, if required, and submit welding procedures and electrodes to the Engineer for approval.

All welding operations must be performed before any required hot-dip galvanizing.

- 2.6. **Welded Wire Reinforcement (WWR).** Provide WWR conforming to ASTM A1064. Observe the relations shown in Table 2 among size number, diameter in inches, and area when ordering wire by size numbers, unless otherwise specified. Precede the size number for deformed wire with "D" and for smooth wire with "W."

Designate WWR as shown in the following example: 6 × 12 – W16 × W8 (indicating 6-in. longitudinal wire spacing and 12-in. transverse wire spacing with smooth No. 16 wire longitudinally and smooth No. 8 wire transversely).

Table 2
Wire Size Number, Diameter, and Area

Size No. (in.)	Diameter (in.)	Area (sq. in.)
31	0.628	0.310
30	0.618	0.300
28	0.597	0.280
26	0.575	0.260
24	0.553	0.240
22	0.529	0.220
20	0.505	0.200
18	0.479	0.180
16	0.451	0.160
14	0.422	0.140
12	0.391	0.120
10	0.357	0.100
8	0.319	0.080
7	0.299	0.070
6	0.276	0.060
5.5	0.265	0.055
5	0.252	0.050
4.5	0.239	0.045
4	0.226	0.040
3.5	0.211	0.035
2.9	0.192	0.029
2.5	0.178	0.025
2	0.160	0.020
1.4	0.134	0.014
1.2	0.124	0.012
0.5	0.080	0.005

Note—Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Fractional sizes between the sizes listed above are also available and acceptable for use.

- 2.7. **Welded Deformed Bar Mat Reinforcement.** Provide welded deformed bar mats in accordance with ASTM A184 except as otherwise noted in this Specification. Fabricate welded bar mats from deformed steel bars in accordance with ASTM A706 by securely connecting every intersection with a process of electrical resistance welding that employs the principle of fusion combined with pressure. The bars must be assembled by automatic machines or by other suitable mechanical means that will assure accurate spacing and alignment of all bars of the finished product

- 2.8. **Epoxy Coating.** Provide epoxy-coated reinforcing steel as shown on the plans. Before furnishing epoxy-coated reinforcing steel, an epoxy applicator must be pre-approved in accordance with [DMS-7330](#), "Qualification Procedure for Reinforcing Steel Epoxy Coating Applicators." The Department's MPL includes approved applicators.

Furnish epoxy-coated reinforcing steel meeting the requirements in Table 3.

Table 3
Epoxy Coating Requirements for Reinforcing Steel

Material	Specification
Bar	ASTM A775 or A934
Wire or WWR	ASTM A884 Class A or B
Mechanical couplers	As shown on the plans
Hardware	As shown on the plans

Use epoxy coating material and coating repair material that complies with [DMS-8130](#), "Epoxy Powder Coating for Reinforcing Steel." Patch no more than 1/4-in. total length in any foot at the applicator's plant.

Maintain identification of all reinforcing steel throughout the coating and fabrication process and until delivery to the project site.

Furnish one copy of a written certification verifying the epoxy-coated reinforcing steel meets the requirements of this Item and one copy of the manufacturer's control tests.

- 2.9. **Mechanical Couplers.** Use couplers of the type specified in [DMS-4510](#), "Mechanical Couplers for Reinforcing Steel," Article 4510.6.1, "General Requirements," when mechanical splices in reinforcing steel bars are shown on the plans.

Furnish only couplers pre-qualified in accordance with [DMS-4510](#). Ensure sleeve-wedge type couplers are not used on coated reinforcing. Sample mechanical couplers in accordance with [Tex-743-I](#) for testing before use on individual projects. Test the mechanical couplers for every project in which mechanical couplers are used in accordance with [Tex-744-I](#). Furnish couplers only at locations shown on the plans.

Furnish couplers for stainless reinforcing steel with the same alloy designation as the reinforcing steel.

Provide hot-dip or mechanically galvanized couplers when splicing galvanized reinforcing steel or CGR.

- 2.10. **Fibers.** Supply fibers conforming to [DMS-4550](#), "Fibers for Concrete," at the minimum dosage listed in the Department's MPL, when shown on the plans. Use non-metallic fibers when shown on the plans.

- 2.11. **Stainless Reinforcing Steel.** Provide deformed steel bars of the types shown in Table 4 and conforming to ASTM A955, Grade 60 or higher when stainless reinforcing steel is required on the plans.

Table 4
Acceptable Types of Deformed Stainless Steel Bar

Universal Numbering System designation	S31653	S31803	S24100	S32304
ASTM type	316LN	2205	XM-28	2304

- 2.12. **Low-Carbon and Low-Chromium Reinforcing Steel.** Provide deformed steel bars conforming to ASTM A1035, Grade 100, Type CS when low carbon and low chromium reinforcing steel is required on the plans. Type CM will be permitted only if specifically allowed as shown on the plans.

- 2.13. **Glass-Fiber Reinforced Polymer (GFRP) Bars.** For reinforced concrete bridge decks, provide bars conforming to ASTM D7957/D7957M when GFRP bars are required on the plans. Provide GFRP bars with a minimum modulus of elasticity of 7,500 ksi when GFRP bars are required on the plans. Provide sample certification demonstrating the GFRP bar supplier has produced bar that meets the material specifications 2 mo. before fabrication. Furnish certification upon shipment that the GFRP bar supplied meets these requirements.
- 2.14. **Galvanized Reinforcement.** Provide galvanized reinforcing steel conforming to one of the following as shown on the plans:
- zinc-coated, hot-dip galvanized Class I or II steel reinforcement conforming to ASTM A767, Grade 60 or 80; or
 - continuously hot-dip galvanized reinforcement (CGR) conforming to ASTM A1094 steel reinforcement, Grade 60 or 80.

3. CONSTRUCTION

- 3.1. **Bending.** Fabricate reinforcing steel bars in accordance with the CRSI *Manual of Standard Practice* to the shapes and dimensions shown on the plans. Fabricate in the shop if possible. Field-fabricate, if permitted, using an approved method. Replace improperly fabricated, damaged, or broken bars at no additional expense to the Department. Repair damaged or broken bars embedded in a previous concrete placement using an approved method.

Unless otherwise shown on the plans, the inside diameter of bar bends, in terms of the nominal bar diameter (d), must not be less than that shown in Table 5.

Table 5
Minimum Inside Diameter of Bar Bends

Bend	Bar Size No. (in.)	Diameter
Bends of 90° and greater in stirrups, ties, and other secondary bars that enclose another bar in the bend	3, 4, 5	4d ¹
	6, 7, 8	6d
Bends in main bars and in secondary bars not covered above	3–8	6d
	9, 10, 11	8d
	14, 18	10d ²

1. For Grade 80 bars, minimum finished diameter is 5.0db.
2. Do not bend bars larger than No. 14 with grade designation of Grade 80 or higher

Bend-test representative specimens as described for smaller bars in the applicable ASTM specification where bending No. 14 or No. 18 Grade 60 bars is required. Make the required 90° bend around a pin with a diameter of 10 times the nominal diameter of the bar.

Bend stainless reinforcing steel in accordance with ASTM A955.

Do not bend hot-dip galvanized reinforcement. Only minor positioning adjustments are permitted.

Bending CGR is permitted after galvanizing.

- 3.2. **Tolerances.** Fabrication tolerances for bars are shown in Figure 1.

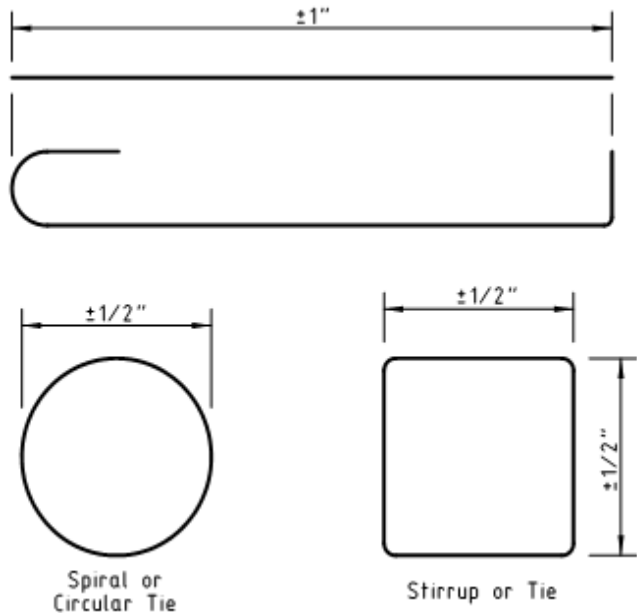


Figure 1
Fabrication Tolerances for Bars

3.3. **Storage.** Store reinforcement above the ground on platforms, skids, or other supports, and protect it from damage and deterioration. Ensure reinforcement is free of dirt, paint, grease, oil, and other foreign materials when it is placed in the work. Use reinforcement free of defects such as cracks and delaminations. Rust, surface seams, surface irregularities, or mill scale will not be cause for rejection if the minimum cross-sectional area of a hand wire-brushed specimen meets the requirements for the size of steel specified.

Do not allow stainless reinforcing steel to be in direct contact with uncoated reinforcing steel, or with galvanized reinforcing steel. This does not apply to stainless steel wires and ties. Store stainless reinforcing steel separately, off the ground on wooden supports.

3.4. **Splices.** Lap-splice, weld-splice, or mechanically splice bars as shown on the plans. Additional splices not shown on the plans will require approval. Splices not shown on the plans will be permitted in slabs no more than 15 in. in thickness, columns, walls, and parapets.

Do not splice bars less than 30 ft. in plan length unless otherwise approved. For bars exceeding 30 ft. in plan length, the distance center-to-center of splices must be at least 30 ft. minus one splice length, with no more than one individual bar length less than 10 ft. Make lap splices not shown on the plans, but otherwise permitted, in accordance with Table 6. Maintain the specified concrete cover and spacing at splices, and place the lap-spliced bars in contact, securely tied together.

Table 6
Minimum Lap Requirements for Steel Bar Sizes Through No. 11

Bar Size No. (in.)	Uncoated Lap Length	Coated Lap Length
3	1 ft. 4 in.	1 ft. 7 in.
4	1 ft. 10 in.	2 ft. 8 in.
5	2 ft. 8 in.	4 ft. 0 in.
6	3 ft. 8 in.	5 ft. 6 in.
7	4 ft. 10 in.	7 ft. 2 in.
8	6 ft. 0 in.	9 ft. 0 in.
9	7 ft. 4 in.	11 ft. 0 in.
10	8 ft. 11 in.	13 ft. 4 in.
11	10 ft. 6 in.	15 ft. 9 in.

Do not lap No. 14 or No. 18 bars.

Lap spiral steel at least one full turn.

Splice WWR using a lap length that includes the overlap of at least two cross wires plus 2 in. on each sheet or roll. Splices using bars that develop equivalent strength and are lapped in accordance with Table 6 are permitted.

Lap the existing longitudinal bars with the new bars as shown in Table 6 for box culvert extensions with less than 1 ft. of fill. Lap at least 1 ft. 0 in. for extensions with more than 1 ft. of fill.

Ensure welded splices conform to the requirements shown on the plans and Item 448, "Structural Field Welding." Field-prepare ends of reinforcing bars if they will be butt-welded. Delivered bars must be long enough to permit weld preparation.

Install mechanical coupling devices in conformance with the manufacturer's recommendations at locations shown on the plans. Protect threaded male or female connections, and ensure the threaded connections are clean when making the connection. Do not repair damaged threads.

Mechanical coupler alternate equivalent strength arrangements, to be accomplished by substituting larger bar sizes or more bars, will be considered if approved in writing before fabrication of the systems.

- 3.5. **Placing.** Place reinforcement as near as possible to the position shown on the plans. Do not vary bars from plan placement by more than 1/12 of the spacing between bars in the plane of the bar parallel to the nearest surface of concrete. Do not vary bars from plan placement by more than 1/4 in. in the plane of the bar perpendicular to the nearest surface of concrete. Provide a minimum 1-in. clear cover of concrete to the nearest surface of bar unless otherwise shown on the plans.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement is -0, +1/2 in.

Locate the reinforcement accurately in the forms and hold it firmly in place before and during concrete placement by means of bar supports that are adequate in strength and number to prevent displacement and keep the reinforcement at the proper distance from the forms. Provide bar supports in accordance with the *CRSI Manual of Standard Practice*. Use Class 1 supports, approved plastic bar supports, precast mortar, or concrete blocks when supports are in contact with removable or stay-in-place forms. Use Class 3 supports in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade must be approved.

Use Class 1A supports with epoxy-coated reinforcing steel. Use Class 1 or Class 1A supports with CGR. Provide epoxy- or plastic-coated tie wires and clips for use with epoxy-coated reinforcing steel.

Use mortar or concrete with a minimum compressive strength of 5,000 psi for precast bar supports. Provide a suitable tie wire in each block for anchoring to the bar.

Place individual bar supports in rows at 4-ft. maximum spacing in each direction. Place continuous type bar supports at 4-ft. maximum spacing. Use continuous bar supports with permanent metal deck forms.

The exposure of the ends of longitudinals, stirrups, and spacers used to position the reinforcement in concrete pipe and storm drains is not cause for rejection.

Tie reinforcement for bridge slabs and top slabs of direct traffic culverts at all intersections, except tie only alternate intersections where spacing is less than 1 ft. in each direction. Tie the bars at enough intersections to provide a rigid cage of reinforcement for reinforcement cages for other structural members. Fasten mats of WWR securely at the ends and edges.

Clean mortar, mud, dirt, debris, oil, and other foreign material from the reinforcement before concrete placement. Do not place concrete until authorized.

Stop placement until corrective measures are taken if reinforcement is not adequately supported or tied to resist settlement, reinforcement is floating upward, truss bars are overturning, or movement is detected in any direction during concrete placement.

3.6. **Handling, Placing, and Repairing Epoxy-Coated Reinforcing Steel.**

3.6.1. **Handling.** Provide systems for handling coated reinforcing steel with padded contact areas. Pad bundling bands or use suitable banding to prevent damage to the coating. Lift bundles of coated reinforcement using a strongback, a spreader bar, multiple supports, or a platform bridge. Transport the bundled reinforcement carefully and store it on protective cribbing. Do not drop or drag the coated reinforcement.

3.6.2. **Placing.** Do not flame-cut coated reinforcement. Saw- or shear-cut only when approved. Coat cut ends in accordance with Section 440.3.6.3., "Repairing Coating."

Do not weld or mechanically couple coated reinforcing steel except where specifically shown on the plans. Remove the epoxy coating at least 6 in. beyond the weld limits before welding and 2 in. beyond the limits of the coupler before assembly. Clean the steel of oil, grease, moisture, dirt, welding contamination (slag or acid residue), and rust to a near-white finish after welding or coupling. Check the existing epoxy for damage. Remove any damaged or loose epoxy back to sound epoxy coating.

Coat the splice area after cleaning with epoxy repair material to a thickness of 7–17 mils after curing. Apply a second application of repair material to the bar and coupler interface to ensure complete sealing of the joint.

3.6.3. **Repairing Coating.** Use material that complies with the requirements of this Item and ASTM D3963 for repairing of the coating. Make repairs in conformance with procedures recommended by the manufacturer of the epoxy coating powder. Apply at least the same coating thickness as required for the original coating for areas to be patched. Repair all visible damage to the coating.

Repair sawed and sheared ends, cuts, breaks, and other damage promptly before additional oxidation occurs. Clean areas to be repaired to ensure they are free of surface contaminants. Make repairs in the shop or field as required.

3.7. **Repair of Galvanized Reinforcing Steel.** Repair damaged galvanized surfaces in accordance with Section 445.3.4.2. "Repair Processes."

3.8. **Handling and Placing Stainless Reinforcing Steel.** Handle, cut, and place stainless reinforcing steel bar using tools that are not used on carbon steel. Do not use carbon steel tools, chains, or slings when handling stainless steel. Use only nylon or polypropylene slings. Cut stainless steel reinforcing using shears, saws, abrasive cutoff wheels, or torches. Remove any thermal oxidation using pickling paste. Do not field bend stainless steel reinforcing without approval.

Use 16-gauge fully annealed stainless steel tie wire conforming to the material properties listed in Section 440.2.11., "Stainless Reinforcing Steel." Support all stainless reinforcing steel on solid plastic, stainless steel, or epoxy-coated steel chairs. Do not use uncoated carbon steel chairs in contact with stainless reinforcing steel.

3.9. **Bending, Handling, Repairing, and Placing GFRP Bars.** Fabricate, handle, repair, and place GFRP bars in accordance with the AASHTO *LRFD Bridge Design Guide Specifications for GFRP-Reinforced Concrete*, Section 6, "Construction Specifications."

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

Item 441

Steel Structures



1.	DESCRIPTION Fabricate and erect structural steel and other metals used for steel structures or for steel portions of structures.
2.	MATERIALS
2.1.	Base Metal. Use metal that meets Item 442, "Metal for Structures."
2.2.	Approved Electrodes and Flux-Electrode Combinations. Use only electrodes and flux-electrode combinations conforming to AWS A5 specifications and pertinent classifications for the applicable welding processes. When requested, submit a current Certificate of Conformance (COC) containing all test results as required by the applicable AWS A5 specification and welding code. Provide proof of Buy America compliance for welding consumables when requested. For bridge main member fabrication, submit the COC annually.
2.3.	High-Strength Bolts. Use fasteners that meet Item 447, "Structural Bolting." Use galvanized fasteners on field connections of bridge members when ASTM F3125, Grade A325 bolts are specified and steel is painted.
2.4.	Paint Systems. Provide the paint system (surface preparation, primer, intermediate, and appearance coats as required) shown on the plans. Provide System IV if no system is specified.
2.4.1.	Standard Paint Systems. Standard paint systems for painting new steel include the following.
2.4.1.1.	System III-B. Provide paint in accordance with DMS-8101 , "Structural Steel Paints—Performance." Provide inorganic zinc (IOZ) prime coat, epoxy intermediate coat, and urethane appearance coat for all outer surfaces except those to be in contact with concrete. Provide epoxy zinc prime coat for touchup of IOZ.
2.4.1.2.	System IV. Provide paint in accordance with DMS-8101 . Provide IOZ prime coat and acrylic latex appearance coat for all outer surfaces except those to be in contact with concrete. Provide epoxy zinc prime coat for touchup of IOZ.
2.4.2.	Paint Inside Tub Girders and Closed Boxes. Provide IOZ primer meeting the requirements of DMS-8101 to all interior surfaces, including faying surfaces and splice plates.
2.4.3.	Special Protection System. Provide the type of paint system shown on the plans or in conformance with special provisions to this Item. Special Protection Systems must have completed AASHTO Product Evaluation & Audit Solutions Structural Steel Coatings (SSC) testing regimen as a complete system, with full data available from AASHTO, and be approved before use.
2.4.4.	Galvanizing. Provide galvanizing, as required, in accordance with Item 445, "Galvanizing."
2.4.5.	Paint over Galvanizing. Paint over galvanized surfaces, when required, in accordance with Item 445.
2.4.6.	Field Painting. Provide field paint, as required, in accordance with Item 446, "Field Cleaning and Painting Steel."

3. CONSTRUCTION

3.1. General Requirements.

- 3.1.1. **Applicable Codes.** Perform all fabrication of bridge members in accordance with AASHTO/NSBA Steel Bridge Collaboration S2.1. Follow all applicable provisions of the appropriate AWS code (D1.5 or D1.1) except as otherwise shown on the plans or in accordance with this Item. Weld sheet steel (thinner than 1/8 in.) in accordance with ANSI/AWS D1.3, *Structural Welding Code—Sheet Steel*. Unless otherwise stated, requirements of this Item are in addition to the requirements of S2.1 for bridge members. Follow the more stringent requirement in case of a conflict between this Item and S2.1. Perform all bolting in accordance with Item 447.

Fabricate railroad underpass structures in accordance with the AREMA *Manual for Railway Engineering* and this Item. In the case of a conflict between this Item and the AREMA manual, the more stringent requirements apply.

- 3.1.2. **Notice of Fabrication.** Give adequate notice before commencing fabrication as specified in Table 1. Include a schedule for all major fabrication processes and dates when inspections are to occur.

Table 1
Notice of Commencing Fabrication

Plant Location	Notice Required
In Texas	7 days
In the contiguous United States	21 days
Outside the contiguous United States	60 days

Perform no Department work in the plant before the Engineer authorizes fabrication. The Contractor must bear all costs associated with the Department's inspection when changes to their fabrication schedules occur and are not adequately conveyed to the Department in accordance with Table 1.

When any structural steel is fabricated outside the contiguous 48 states, the additional cost of inspection will be in accordance with Article 6.4., "Sampling, Testing, and Inspection."

- 3.1.3. **Bridge Members.** Primary bridge members include:

- web and flanges of plate, tub, and box girders;
- rolled beams and cover plates;
- floor beam webs and flanges;
- arch ribs and arch tie beams or girders;
- truss members;
- diaphragm members for curved plate girders or beams;
- pier diaphragm members for tub girders;
- splice plates for primary members; and
- any other member designated as "primary" or "main" on the plans.

Secondary bridge members include:

- bracing (diaphragms, cross frames, and lateral bracing); and
- all other miscellaneous bridge items not considered primary bridge members.

- 3.1.4. **Responsibility.** The Contractor is responsible for the correctness and completeness of shop drawings and for the fit of shop and field connections.

3.1.5. Qualification of Plants and Personnel.

- 3.1.5.1. **Plants.** Fabrication plants that produce bridge members must be approved in accordance with [DMS-7370](#), "Steel Bridge Member Fabrication Plant Qualification." The Department's MPL has a list of approved bridge member fabrication plants.

Fabrication plants that produce the following non-bridge steel members must be approved in accordance with [DMS-7380](#), "Steel Non-Bridge Member Fabrication Plant Qualification":

- Item 610, "Roadway Illumination Assemblies,"
- Item 613, "High Mast Illumination Poles,"
- Item 614, "High Mast Illumination Assemblies,"
- Item 650, "Overhead Sign Supports,"
- Item 654, "Sign Walkways,"
- Item 686, "Traffic Signal Pole Assemblies," and
- Special Specification, "Intelligent Transportation System (ITS) Pole with Cabinet."

The Materials and Tests Division (MTD) maintains a list of approved non-bridge fabrication plants on the Department MPL that produce these members.

Fabrication plants that produce metal bridge rail must be approved in accordance with [DMS-7395](#), "Metal Railing Fabrication Plant Qualification." The Department's MPL has a list of approved metal bridge railing fabrication plants.

- 3.1.5.2. **Personnel.** Provide a QC staff qualified in conformance with the applicable AWS code. Provide an adequate number of qualified QC personnel for each specific production operation. QC must be onsite and independent of production personnel, as the Engineer determines. QC personnel must be proficient in using the applicable plans, specifications, and test methods, and in verifying compliance with the plant QC and production procedures. Welding inspectors must be current AWS Certified Welding Inspectors for bridge member plants and for non-bridge member plants requiring Department approval in accordance with [DMS-7380](#) and [DMS-7395](#). The QC staff must provide inspection of all materials and workmanship before the Department's inspection. Provide the Department inspector with adequate personnel and equipment needed to move material for inspection access. QC is solely the Contractor's responsibility.

- 3.1.5.3. **Nondestructive Testing (NDT).** Personnel performing NDT must be qualified in conformance with the applicable AWS code and the employer's Written Practice. Level III personnel who qualify Level I and Level II technicians must be certified by ASNT within the areas in which the NDT Level III is qualified. In addition, NDT technicians must pass hands-on tests administered by MTD. This will remain current provided they continue to perform testing on Department materials as evidenced by test reports requiring their signature. A technician who fails any of the hands-on tests must wait 3 mo. or as approved before retesting. Qualification to perform NDT will be revoked when the technician's employment is terminated or when the technician does not perform a test on a Department project for 6 consecutive mo. The technician must pass a new hands-on test to be re-certified. Testing of similar weld joints for non-Department projects may be considered by the Engineer instead of re-testing, provided sufficient documentation is submitted with the signature of the project's Engineer. These requirements also apply to testing agencies and individual third-party contractors.

- 3.1.5.4. **Welding Procedure Specifications (WPSs) Qualification Testing.** For fabricators qualified in accordance with [DMS-7370](#), [DMS-7380](#), or [DMS-7395](#), laboratories performing procedure qualification testing for WPSs must be accredited by a nationally recognized agency that performs testing in accordance with ISO/International Electrotechnical Commission (IEC) 17025 in the mechanical field of testing.

3.1.6. Drawings.

- 3.1.6.1. **Erection Drawings.** Submit erection drawings prepared by a licensed professional engineer, including calculations, for approval in accordance with Item 5, "Control of the Work," at least 4 weeks before erecting any portion of field-spliced (welded or bolted) girders, railroad underpasses, trusses, arches, or other

members for which erection drawings are required on the plans. Include drawings and calculations for any temporary structures used to support partially erected members. Erection drawings are not required for rolled I-beam units unless otherwise shown on the plans.

Prepare erection drawings following the procedures outlined in Section 2.2 of AASHTO/NSBA Steel Bridge Collaboration S10.1. At minimum, include:

- plan of work area showing structure location relative to supports and all obstructions;
- equipment to be used, including allowable load information;
- erection sequence for all pieces;
- member weights and center of gravity location of pieces to be lifted;
- locations of cranes, holding cranes, and temporary supports (falsework), including when to release load from temporary supports and holding cranes;
- details of falsework, including specific bracing requirements with maximum allowable design wind speed clearly indicated;
- girder lifting points;
- diaphragm and bracing requirements; and
- minimum connection requirements when more than the standard requirements.

Perform erection engineering evaluation of the structural adequacy and stability of constructing the bridge system for each step of the steel erection.

Do not proceed if site conditions differing from those depicted on the approved erection drawings could affect temporary support stresses, erected girders, or public safety in any manner. Revise erection drawings and resubmit to the Engineer for approval before proceeding.

- 3.1.6.2. **Shop Drawings.** Prepare and electronically submit shop drawings before fabrication for each detail of the general plans requiring the use of structural steel, forgings, wrought iron, or castings in accordance with the Bridge Division *Guide to Shop Drawing Submittals* available on the Department's website, and as directed for other items the standard specifications require.

Indicate joint details on shop drawings for all welds. Provide a title block on each sheet in the lower right corner that includes:

- project identification data, including federal and state project numbers,
- sheet numbering for the shop drawings,
- name of the structure or stream for bridge structures,
- name of owner or developer,
- name of the fabricator or supplier, and
- name of the Contractor.

Provide one complete approved 11 × 17-in. set in hardcopy to the Department Inspector at the fabrication plant. Stamp it "For Materials and Tests Division Inspector." The Engineer may require additional complete hardcopy sets.

- 3.1.6.2.1. **Bridge Members.** Prepare drawings in accordance with AASHTO/NSBA Steel Bridge Collaboration G1.3, "Shop Detail Drawing Presentation," unless otherwise approved. Print a bill of material on each sheet, including the Charpy V-Notch (CVN) and fracture-critical requirements, if any, for each piece. Indicate fracture-critical areas of members.

- 3.1.6.2.2. **Non-Bridge Members.** Furnish shop drawings for non-bridge members when shown on the plans or in conformance with pertinent Items.

- 3.1.7. **Welding Procedure Specifications (WPSs).** Submit WPSs and test reports in conformance with the applicable AWS code to MTD before fabrication begins and notify the Engineer which procedures will be used for each joint or joint type. Do not begin fabrication until the Engineer approves WPSs.

Post the approved WPSs for the welding being performed on each welding machine or use another approved method of ensuring the welder always has access to the procedure information.

- 3.1.8. **Documentation.** Provide a completed Material Statement Form 1818 (D-9-USA-1) with supporting documentation [such as mill test reports (MTRs)] that the producing mill issues and qualified personnel verify. Ensure the documentation legibly reflects all information the applicable ASTM specifications require. Supply documents electronically to the Department.

Provide a copy of the shipping or storage invoice, as material is shipped or placed in approved storage, that reflects:

- member piece mark identification and calculated weight per piece from the Contract drawings,
- number of pieces shipped or in storage,
- total calculated weight for each invoice per bid item, and
- the unique identification number of the shipping or storage invoice.

The Inspector's acceptance of material or finished members will not prohibit subsequent rejection if the material or members are found to be damaged or defective. Replace rejected material promptly.

- 3.1.9. **Material Identification.** Assembly-mark individual pieces and issue cutting instructions to the shop using a system that will maintain identity of the original piece.

Identify structural steel by standard and grade of steel. Also differentiate between material toughness requirements (CVN or fracture-critical) as well as any other special physical requirements. In addition, identify structural steel for primary members by mill identification numbers (heat numbers). Use an approved identification system. Use either paint or low-stress stencils to make identification markings on the metal. Mark the material as soon as it enters the shop and carry the markings on all pieces through final fabrication. Transfer the markings before cutting steel for primary members of bridge structures into smaller pieces. Loss of identification marking on any piece, with no other positive identification, or loss of heat number identification on any primary member piece will render the piece unacceptable for use. Unidentifiable material may be approved for use after testing to establish acceptability to the satisfaction of the Engineer. Have an approved testing facility perform testing and a licensed professional engineer sign and seal the results.

Low-stress stencil marks must have a radius instead of a sharp point. Acceptable stencils include dot, vibration, and rounded-V stencils. Label these stencils so that they are easily distinguishable from other stencils that are not low-stress.

3.2. **Welding.**

3.2.1. **Details.**

- 3.2.1.1. **Rolled Edges.** Trim plates with rolled edges used for webs by thermal cutting.

- 3.2.1.2. **Weld Tabs.** Use weld tabs at least 2 in. long for manual and semi-automatic processes, at least 3 in. long for automatic processes, and in all cases at least as long as the thickness of the material being welded. Use longer weld tabs as required for satisfactory work. Duplicate the configuration of the weld tab to the joint detail being fabricated.

- 3.2.1.3. **Weld Termination.** Terminate fillet welds approximately 1/4 in. from the end of the attachment except for galvanized structures and flange-to-web welds, for which the fillet weld must run the full length of the attachment, unless otherwise shown on the plans.

- 3.2.1.4. **No-Paint Areas at Field-Welded Connections.** Keep surfaces within 4 in. of groove welds or within 2 in. of fillet welds free of shop paint.

- 3.2.1.5. **Galvanized Assemblies.** Completely seal all edges of tightly contacting surfaces by welding before galvanizing.

- 3.2.1.6. **Submerged-Arc Welding (SAW).** Do not use hand-held semiautomatic SAW for welding bridge members unless altered to provide automatic guidance or otherwise approved.
- 3.2.1.7. **Non-Bridge Member Weathering Steel Welds.** Provide weld metal with atmospheric corrosion resistance and coloring characteristics similar to that of the base metal for weathering steel structures fabricated in accordance with AWS D1.1.
- 3.2.2. **Shop Splices.**
- 3.2.2.1. **Shop Splice Locations.** Keep at least 6 in. between shop splices and stiffeners or cross-frames. Obtain approval for shop splices added after shop drawings are approved.
- 3.2.2.2. **Grinding Splice Welds.** Grind shop groove welds in flange plates smooth and flush with the base metal on all surfaces, whether the joined parts are of equal or unequal thickness. Grind so the finished grinding marks run in the direction of stress and keep the metal below the blue brittle range (below 350°F). Groove welds in web plates, except at locations of intersecting welds, need not be ground unless shown on the plans except as required to meet AWS welding code requirements.
- 3.2.3. **Joint Restraint.** Never restrain a joint on both sides when welding.
- 3.2.4. **Stiffener Installation.**
- 3.2.4.1. **Flange Tilt.** Members must meet combined tilt and warpage tolerances before the installation of stiffeners. Cut stiffeners to fit acceptable flange tilt and cupping. Minor jacking that does not deform the material will be permitted.
- 3.2.4.2. **Stiffeners Near Field Splices.** Tack weld intermediate stiffeners within 12 in. of a welded field splice point in the shop. Weld the stiffeners in the field in accordance with Item 448, "Structural Field Welding," after the splice is made.
- 3.2.5. **Nondestructive Testing (NDT).** Perform magnetic particle testing (MT), radiographic testing (RT), or ultrasonic testing (UT) at the Contractor's expense in accordance with AWS code D1.5 for bridge structures. The Engineer will periodically witness, examine, verify, and interpret NDT. Additional welds may be designated for NDT on the plans. Retest repaired groove welds in conformance with the applicable AWS code after repairs are made and have cooled to ambient temperature. Complete NDT and repairs before assembly of parts into a member, but after any heat-correction of weld distortion.
- 3.2.5.1. **Radiographic Testing (RT).** Radiographs must have a density of at least 2.5 and no more than 3.5, as confirmed by a radiographer. The density in any single radiograph showing a continuous area of constant thickness must not vary in this area by more than 0.5. Use only ASTM System Class I radiographic film in accordance with ASTM E1815. Use low-stress stencils to make radiograph location identification marks on the steel.
- 3.2.5.2. **Ultrasonic Testing (UT).** Have UT equipment calibrated yearly by an authorized representative of the equipment manufacturer or by an approved testing laboratory.
- 3.2.5.3. **Magnetic Particle Testing (MT).** Use alternating current (AC) when using the yoke method unless otherwise approved. Welds may be further evaluated using half-wave rectified direct current (DC) for subsurface indications. Centerline cracking may be detected by aluminum prod method when approved.
- 3.3. **Bolt Holes.** Detail holes on shop drawings 1/16 in. larger in diameter than the nominal bolt size shown on the plans, unless another hole size is shown on the plans.

Thoroughly clean the contact surfaces of connection parts in accordance with Item 447 before assembling them for hole fabrication. Make holes in primary members full-size (by reaming from a subsize hole, drilling full-size, or punching full-size where permissible) only in assembly unless otherwise approved.

Ream and drill with twist drills guided by mechanical means unless otherwise approved. If subpunching holes, punch them at least 3/16 in. smaller than the nominal bolt size. Submit the proposed procedures for approval to accomplish the work from initial drilling or punching through check assembly when numerically controlled (N/C) equipment is used. Use thermal cutting for holes only with permission. Permission for thermal cutting is not required for making slotted holes, when slotted holes are shown on the plans, by drilling or punching two holes and then thermally cutting the straight portion between them. Perform all thermal cutting in accordance with Section 441.3.5.1., "Thermal Cutting."

Slightly conical holes that naturally result from punching operations are acceptable provided they do not exceed the tolerances of AASHTO/NSBA Steel Bridge Collaboration S2.1. The tolerance for anchor bolt hole diameter for bridge bearing assemblies is +1/8 in., -0.

3.4. **Dimensional Tolerances.** Meet tolerances in conformance with the applicable AWS specifications except as modified in this Section.

3.4.1. **Rolled Sections.** Use ASTM A6 mill tolerances for rolled sections, except AWS D1.5 camber tolerances apply to rolled sections with a specified camber.

3.4.2. **Flange Straightness.** Ensure flanges of completed girders are free of kinks, short bends, and waviness that depart from straightness or the specified camber by more than 1/8 in. in any 10 ft. along the flange. Rolled material must meet this straightness requirement before being laid out or worked. Plates must meet this requirement before assembly into a member. Inspect the surface of the metal for evidence of fracture after straightening a bend or buckle. The Engineer may require NDT.

3.4.3. **Alignment of Deep Webs in Welded Field Connections.** For girders 48 in. deep or deeper, the webs may be slightly restrained while checking compliance for lateral alignment at field-welded connections. In the unrestrained condition, webs 48 in. deep or deeper must meet the tolerances shown in Table 2. Girders under 48 in. deep must meet the alignment tolerances in accordance with AWS D1.5.

Table 2
Web Alignment Tolerances for Deep Girders

Web Depth (in.)	Maximum Web Misalignment (in.)
48	1/16
60	1/8
72	1/4
84	5/16
96	5/16
108	3/8
120	7/16
132	7/16
144	1/2

3.4.4. **Bearings.** Correct bearing areas of shoes, beams, and girders using heat, external pressure, or both. Grind or mill only if the actual thickness of the member is not reduced by more than 1/16 in. below the required thickness.

3.4.4.1. **I-Beams, Plate Girders, and Tub Girders.** The plane of the bearing area of beams and girders must be perpendicular to the vertical axis of the member within 1/16 in. in any 24 in.

3.4.4.2. **Closed Box Girders.** Meet these tolerances.

- The plane of the bearing areas of the box girder is perpendicular to the vertical axis of the girder within 1/16 in. across any horizontal dimension of the bearing.
- The planes of the beam supports on the box girder are true to the vertical axis of the supported beams or girders to 1/16 in. in any 24 in.

In the shop, verify the plane of all bearing areas with the box placed on its bearings to field grade, using an approved process for verification.

- 3.4.4.3. **Shoes.** Meet these tolerances.
- The top bolster has the center 75% of the long dimension (transverse to the girder) true to 1/32 in., with the remainder true to 1/16 in., and is true to 1/32 in. across its entire width in the short dimension (longitudinal to the girder).
 - The bottom bolster is true to 1/16 in. across its diagonals.
 - For a pin-and-rocker type expansion shoe, the axis of rotation coincides with the central axis of the pin.
 - When the shoe is completely assembled, as the top bolster travels through its full anticipated range, no point in the top bolster plane changes elevation by more than 1/16 in. and the top bolster does not change inclination by more than 1°, for the full possible travel.
- 3.4.4.4. **Beam Supports.** Fabricate beam support planes true to the box girder bearing to 1/16 in. in the short direction and true to the vertical axis of the nesting girders to 1/16 in.
- 3.4.5. **End Connection Angles.** For floor beams and girders with end connection angles, the tolerance for the length back-to-back of connection angles is $\pm 1/32$ in. Do not reduce the finished thickness of the angles below that shown on the shop drawings if end connections are faced.
- 3.5. **Other Fabrication Processes.**
- 3.5.1. **Thermal Cutting.** Use a mechanical guide to obtain a true profile. Hand-cut only where approved. Hand-cutting of radii for beam copes, weld access holes, and width transitions is permitted if acceptable profile and finish are produced by grinding. Provide a surface finish on thermal-cut surfaces, including holes, in accordance with AWS D1.5 requirements for base metal preparation. Obtain approval before using other cutting processes.
- 3.5.2. **Oxygen-Gouging.** Do not oxygen-gouge quenched and tempered (Q&T), normalized, or thermo-mechanically controlled processed (TMCP) steel.
- 3.5.3. **Annealing and Normalizing.** Complete all annealing or normalizing (as defined in ASTM A941) before finished machining, boring, and straightening. Maintain the temperature uniformly throughout the furnace during heating and cooling so the range of temperatures at all points on the member is no more than 100°F.
- 3.5.4. **Machining.** Machine the surfaces of expansion bearings so the travel direction of the tool is in the direction of expansion.
- 3.5.5. **Camber.** Complete cambering in accordance with AASHTO/NSBA Steel Bridge Collaboration S2.1 before any heat-curving.
- 3.5.6. **Heat Curving.** Heat-curve in accordance with AASHTO/NSBA Steel Bridge Collaboration S2.1. The methods in the AASHTO bridge construction specifications are recommended. Attach cover plates to rolled beams before heat-curving only if the total thickness of one flange and cover plate is less than 2-1/2 in. and the radius of curvature is greater than 1,000 ft. Attach cover plates for other rolled beams only after heat-curving is completed. Locate and attach connection plates, diaphragm stiffeners, and bearing stiffeners after curving, unless girder shrinkage is accounted for.
- 3.5.7. **Bending of Quenched and Tempered (Q&T) Steels.** The cold-bending radius limitations for HPS 70W in AASHTO/NSBA Steel Bridge Collaboration S2.1 apply to all Q&T steels.
- 3.5.8. **Hammering.** Do not perform hammering on any portion of the member that causes the material to permanently deform. Avoid damage to the material by measures such as use of brass or aluminum hammers or by padding the area to be hammered.
- 3.6. **Nonconformance Reports (NCRs).** Submit an NCR to the Engineer for approval when the requirements of this Item are not met. Submit NCRs in conformance with MTD's NCR guidelines document. Have readily available access to the services of a licensed professional engineer experienced in steel structures design

and fabrication. This licensed professional engineer may be responsible for reviewing potentially structurally deficient members in conformance with the NCR guidelines document. Receive Department approval before beginning repairs. Perform all repair work in strict compliance with the approved NCR and repair procedure.

3.7. **Shop Assembly.**

- 3.7.1. **General Shop Assembly.** Shop-assemble field connections of primary members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, field connections of floor beams and stringers (including for railroad structures), field-bolted diaphragms for curved plate girders and railroad underpasses, and rigid frames. Field-bolted cross-frames and rolled-section diaphragms do not require shop assembly. Complete fabrication, welding (except for shear studs), and field splice preparation before members are removed from shop assembly. Obtain approval for any deviation from this procedure. The Contractor is responsible for accurate geometry.

Use a method and details of preassembly consistent with the erection procedure shown on the erection plans and camber diagrams. The sequence of assembly may start from any location in the structure and proceed in one or both directions. An approved method of sequential geometry control is required unless the full length of the structure is assembled.

Verify by shop assembly the fit of all bolted and welded field connections between bent cap girders and plate girders or between plate girders and floor beams.

Do not measure horizontal curvature and vertical camber for final acceptance until all welding and heating operations are completed and the steel has cooled to a uniform temperature. Check horizontal curvature and vertical camber in a no-load condition.

- 3.7.2. **Bolted Field Connections.** Each shop assembly, including camber, alignment, accuracy of holes, and fit of milled joints, must be approved before the assembly is dismantled.

Assemble with milled ends of compression members in full bearing. Assemble non-bearing connections to the specified gap. Ream all subsize holes to the specified size while the connections are assembled, or drill full size while the connections are assembled. Notify the Engineer before shipping if fill plates or shims are added. Adding or increasing the thickness of shims or fill plates in bearing connections requires approval. Use drift pins and snug-tight bolts during the drilling process to ensure all planes of the connection (webs and flanges) can be assembled simultaneously. Do not use tack welds to secure plates while drilling.

Secure parts not completely bolted in the shop with temporary bolts to prevent damage in shipment and handling. Never use tack welds in place of temporary bolts.

Match-mark connecting parts in field connections using low-stress stencils in conformance with the diagram on the erection drawings.

- 3.7.3. **Welded Field Connections.** Mill or grind bevels for groove welds. Do not cut into the web when cutting the flange bevel adjacent to the web. End preparation, backing, and tolerances for girder splices must be in accordance with Item 448. Details for all other field welds must conform to the applicable AWS code unless otherwise shown on the plans.

In the shop, prepare ends of beams or girders to be field-welded taking into account their relative positions in the finished structure due to grade, camber, and curvature. Completely shop-assemble and check each splice. Match-mark the splice while it is assembled with low-stress stencils in conformance with the diagram on the erection drawings.

3.8. **Finish and Painting.**

- 3.8.1. **Shop Painting.** Perform shop painting of bridge members in accordance with [DMS-8104](#), "Paint, Shop Application for Steel Bridge Members." Grind corners on new steel items to be painted that are sharp or form

essentially 90° angles to an approximately 1/16-in. flat surface before blast cleaning. (A corner is the intersection of two plane faces.) This requirement does not apply to punched or drilled holes. Do not omit shop paint to preserve original markings.

Ensure painted faying surfaces meet the required slip and creep coefficients for bolted connections in accordance with [DMS-8104](#).

Use a Class A slip (minimum slip coefficient of 0.33) if no slip coefficient or corresponding surface condition is specified. Perform all required testing at no expense to the Department.

Surface preparation and painting the interiors of tub girders and closed boxes must be in accordance with [DMS-8104](#).

Measure the anchor profile after blast cleaning at random locations along the thermal cut surfaces. If specified anchor profile is not achieved over the entire flame-cut surface, grind the edges and re-blast to achieve the required anchor pattern.

3.8.2. **Weathering Steel.** Provide an SSPC-SP 6, "Commercial Blast Cleaning," blast in the shop to all fascia surfaces of unpainted weathering steel beams. Fascia surfaces include:

- exterior sides of outermost webs and undersides of bottom flanges of plate girders and rolled beams,
- all outer surfaces of tub girders and box girders,
- all surfaces of truss members,
- webs and undersides of bottom flanges of plate diaphragms,
- bottom surfaces of floor beams, and
- any other surfaces designated as "fascia" on the plans.

Do not mark fascia surfaces. Use one of the following methods as soon as possible to remove any markings or any other foreign material that adheres to the steel during fabrication and could inhibit the formation of oxide film:

- SSPC-SP 1, "Solvent Cleaning,"
- SSPC-SP 2, "Hand Tool Cleaning,"
- SSPC-SP 3, "Power Tool Cleaning," and
- SSPC-SP 7, "Brush-Off Blast Cleaning."

Do not use acids to remove stains or scales. Feather out touched-up areas over several feet.

3.8.3. **Machined Surfaces.** Clean and coat machine-finished surfaces that are in sliding contact, particularly pins and pinholes, using a non-drying, water-repellent, grease-type material containing rust-inhibitive compounds. Ensure the coating material contains no ingredients that might damage the steel. Protect machined surfaces from abrasive blasting.

3.9. **Handling and Storage of Materials.** Prevent damage when storing or handling girders or other materials. Remove or repair material damaged by handling devices or improper storage by acceptable means in accordance with ASTM A6 and the applicable AWS code.

Place stored materials on skids or acceptable dunnage above the ground. Keep materials clean and avoid damaging the applied coating. Shore girders and beams to keep them upright and free of standing water. Place support skids close enough to prevent excessive deflection in long members such as columns. Do not stack completed girders or beams at the jobsite.

Protect structural steel from salt water or other corrosive environments during storage and transit.

3.10. **Marking and Shipping.** Mark all structural members in conformance with the erection drawings. If a surface is painted, make the marks over the paint. Do not use impact-applied stencils to mark painted surfaces.

Mark the weight directly on all members weighing more than 3 tons.

Keep material clean and free of damage during loading, transportation, unloading, and storage. Pack bolts of each length and diameter, and loose nuts or washers of each size, separately, and ship them in boxes, crates, kegs, or barrels. Plainly mark a list and description of the contents on the outside of each package.

- 3.11. **Field Erection.** Do not lift and place any steel member, including girders and diaphragms, over an open highway or other open travel way unless otherwise approved. Do not allow traffic to travel under erected members until sufficiently stable as shown on approved erection drawings.
- 3.11.1. **Pre-Erection Conference.** Schedule and attend a pre-erection conference with the Engineer at least 7 days before commencing steel erection operations. Do not install falsework or perform any erection operations before the meeting.
- 3.11.2. **Methods and Equipment.** Do not tack-weld parts instead of using erection bolts. Do not tack-weld parts to hold them in place for bolting. Provide falsework, tools, machinery, and appliances, including drift pins and erection bolts. Provide enough drift pins, 1/32 in. larger than the connection bolts, to fill at least 1/4 of the bolt holes for primary connections. Use erection bolts of the same diameter as the connection bolts.
- Securely tie, brace, or shore steel beams or girders immediately after erection as shown on the erection drawings. Maintain bracing or shoring until the diaphragms are in place and as specified on the erection drawings. Protect railroad, roadway, and marine traffic underneath previously erected girders or beams from falling objects associated with other construction activities.
- Only welders certified or working directly under the supervision of a foreman certified in accordance with Item 448 may handle torches when applying heat to permanent structural steel members.
- 3.11.3. **Falsework.** Construct falsework in conformance with the erection plan. Construct foundations for shore towers as shown on erection drawings. Do not use timber mats with deteriorated timbers or soil to construct shore tower foundations. Notify the Engineer of completed falsework to obtain approval before opening roadway to traffic or starting girder erection activities. Ensure falsework is protected from potential vehicle impact. Inspect and maintain falsework daily. Use screw jacks or other approved methods to control vertical adjustment of falsework to minimize the use of shims.
- 3.11.4. **Handling and Assembly.** Accurately assemble all parts as shown on the plans and the approved shop drawings. Verify match-marks. Handle parts carefully to prevent bending or other damage. Do not hammer if doing so damages or distorts members. Do not weld any member for transportation or erection unless shown on the plans or approved.
- 3.11.4.1. **Welded Connections.** Weld flange splices to 50% of their thickness and meet the minimum erection bracing and support requirements before releasing the erection cranes, as shown on the plans and on the approved erection plans. Field-weld in accordance with Item 448.
- 3.11.4.2. **Bolted Connections.** Before releasing the erection cranes:
- install 50% of the bolts in the top and bottom flanges and the web with all nuts finger-tight,
 - meet the minimum erection bracing and support requirements shown on the plans and on the approved erection plans, and
 - install top lateral bracing across the connection for tub girders, and fully tension the bolts connecting the bracing to the top flanges.

Install high-strength bolts, including erection bolts, in accordance with Item 447. Clean bearing and faying surfaces for bolted connections in accordance with Item 447. Clean the areas of the outside ply under washers, nuts, and bolt heads before bolt installation. Ensure the required faying surface condition is present at the time of bolting.

- 3.11.5. **Misfits.** Correct minor misfits. Ream no more than 10% of the holes in a plate connection (flange or web), and ensure no single hole is more than 1/8 in. larger than the nominal bolt diameter. Submit proposed correction methods for members with defects that exceed these limits or prevent the proper assembly of parts. Straighten structural members in accordance with AASHTO/NSBA Steel Bridge Collaboration S2.1. Make all corrections in the presence of the Engineer at no expense to the Department. Do not remove and reweld gusset plates without approval.
- 3.11.6. **Bearing and Anchorage Devices.** Place all bearing devices such as elastomeric pads, castings, bearing plates, or shoes on properly finished bearing areas with full and even bearing on the concrete. Place metallic bearing devices on 1/4-in. thick preformed fabric pads manufactured in accordance with [DMS-6160](#), "Water Stops, Nylon-Reinforced Neoprene Sheet, and Elastomeric Pads," to the dimensions shown on the plans. Provide holes in the pad that are no more than 1/4 in. larger than the bolt diameter.
- Build the concrete bearing area up to the correct elevation once it has been placed below grade using mortar that meets Item 420, "Concrete Substructures," and provide adequate curing. Use only mortar for buildups between 1/8 in. and 3/8 in. thick. Use galvanized steel shims or other approved shim materials in conjunction with mortar if the bearing area must be raised more than 3/8 in.
- Provide at least 75% contact of flange to shoe with no separation greater than 1/32 in. for beams and girders. Make corrections using heat or pressure in accordance with AASHTO/NSBA Steel Bridge Collaboration S2.1 or using galvanized shims. Correct small irregularities by grinding.
- Provide at least 85% contact between the rocker plate and the base plate. Adjust the location of slotted holes in expansion bearings for the prevailing temperature. Adjust the nuts on the anchor bolts at the expansion ends of spans to permit free movement of the span. Provide lock nuts or burr the threads.
- Remove all foreign matter from sliding or machine-finished surfaces before placing them in the structure.
- Restore distorted bearing pads or expansion bearings to an equivalent 70°F position after completion of all welded or bolted splices, using an approved method of relieving the load on the bearing devices.
- 3.11.7. **Erecting Forms.** Do not erect forms until all welding or bolting is complete and the unit is positioned and properly set on the bearings, unless otherwise shown on the plans.
- 3.11.8. **Field Finish.** Paint in accordance with Item 446. Restore weathering steel that will remain unpainted to a uniform appearance by solvent cleaning, hand cleaning, power brush, or blast cleaning after all welding and slab concrete placement have been completed. Remove from all unpainted weathering steel fascia surfaces (as listed in Section 441.3.8.2., "Weathering Steel") any foreign material, including markings, that adheres to the steel and could inhibit formation of oxide film as soon as possible. Feather out touched-up areas over several feet. Do not use acids to remove stains or scales.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

Item 442

Metal for Structures



1. DESCRIPTION

Provide structural steel, high-strength bolts, forgings, steel castings, iron castings, wrought iron, steel pipe and tubing, aluminum castings and tubing, or other metals used in structures, except reinforcing steel and metal culvert pipe.

2. MATERIALS

Furnish mill test reports (MTRs), supplemental test documentation, and certifications required by this Item and other pertinent Items.

2.1. **Structural Steel.** The Engineer may sample and test steel in accordance with ASTM A370.

2.1.1. **Bridge Structures.** Provide the grade of ASTM A709 steel shown on the plans. Grade 50W, 50S, or HPS 50W may be substituted for Grade 50 at no additional cost to the Department. Use Zone 1 if no AASHTO temperature zone is shown on the plans.

2.1.2. **Non-Bridge Structures.**

2.1.2.1. **Steel Classifications.** Provide the types and grades of steel in accordance with this Section unless otherwise shown on the plans.

2.1.2.1.1. **Carbon Steel.** Meet ASTM A36.

2.1.2.1.2. **Low-Alloy Steel.** Meet the requirements of one of the following:

- ASTM A529 Grade 50;
- ASTM A572 Grade 50 or Grade 55;
- ASTM A588;
- ASTM A709 Grade 50, 50S, 50W, or HPS 50W; or
- ASTM A992.

Specify ASTM A6 supplemental requirement S18, "Maximum Tensile Strength," for material used for sign, signal, and luminaire supports.

2.1.2.2. **Impact Testing.** The following components, if greater than 1/2 in. thick, and other members designated on the plans must meet the Charpy V-notch (CVN) requirements of Table 1:

- base plates for roadway illumination assemblies, traffic signal pole assemblies, high mast illumination poles, ITS poles, and overhead sign supports;
- pole mounting plates, arm mounting plates, and clamp-on plates for traffic signal pole assemblies;
- arm stiffeners, pole gussets, and stiffeners for traffic signal pole long mast arm assemblies (50 ft. and greater);
- pole shafts, ground sleeves, and handhole frames for high mast illumination poles;
- W-columns, tower pipes, multiple-sided shafts, tower pipe and multiple-sided shaft connection plates, chord angles, chord splice plates or angles, and truss bearing angles for truss type overhead sign supports; and

- pipe posts, pipe arms, post and arm flange plates, and handhole frames for monotube overhead sign supports.

Table 1
CVN Requirements for Non-Bridge Steel

Material	Thickness	Minimum CVN Toughness
ASTM A36, A53, A242, A500, A501, A709, Grade 36, any other steel with minimum specified yield point below 40 ksi	up to 4"	15 foot-pounds (ft.-lb.) at 70°F
ASTM A5721, A5881, A6331, any other steel with minimum specified yield point between 40 and 65 ksi, inclusive	up to 2"	15 ft.-lb. at 70°F
	over 2" to 4", mechanically fastened	15 ft.-lb. at 70°F
	over 2" to 4", welded	20 ft.-lb. at 70°F
Any steel with minimum specified yield point over 65 ksi and under 90 ksi ²	up to 2-1/2"	20 ft.-lb. at 50°F
	over 2-1/2" to 4", mechanically fastened	20 ft.-lb. at 50°F
	over 2-1/2" to 4", welded	25 ft.-lb. at 50°F

1. Reduce the testing temperature by 15°F for each 10-ksi increment or fraction thereof above 65 ksi if the yield point of the material given on the MTR exceeds 65 ksi.
2. Reduce the testing temperature by 15°F for each 10-ksi increment or fraction thereof above 85 ksi if the yield point of the material given on the MTR exceeds 85 ksi.

Use the (H) frequency of testing for material with minimum specified yield point up to 50 ksi. Use the (P) frequency of testing for material with minimum specified yield point greater than 50 ksi. Ensure steel is sampled and tested in accordance with ASTM A673.

2.1.3. Other Components.

2.1.3.1. **Miscellaneous Bridge Components.** Provide steel that meets ASTM A36, A709 Grade 36, or A500 Grade B for members such as steel bearing components not bid under other items, steel diaphragms for use with concrete bridges, and armor and finger joints, unless otherwise shown on the plans.

2.1.3.2. **Shear Connectors and Anchors.** Provide cold-drawn bars for stud shear connectors, slab anchors, and anchors on armor and finger joints that meet the requirements of ASTM A108, Grade 1010, 1015, 1018, or 1020, either semi-killed or killed, and that have the tensile properties shown in Table 2 after drawing or finishing. Determine tensile properties in accordance with ASTM A370.

Table 2
Minimum Tensile Properties for Bar Stock

Tensile strength	60 ksi
Yield strength	50 ksi
Elongation	20% (2")
Reduction of area	50%

Provide certification from the manufacturer that the studs or anchors as delivered have the required material properties.

2.1.3.3. **Fasteners.** Provide high-strength bolts that meet ASTM F3125 Grade A325, unless otherwise shown on the plans. The Department may sample high-strength bolts, nuts, and washers for structural connections in accordance with [Tex-719-I](#).

Follow the requirements of Item 447, "Structural Bolting," for tests, test reports, and supplemental requirements for high-strength bolts, nuts, and washers.

2.1.3.4. **Slip-Resistant Deck Plates.** Furnish steel for deck plates that meets ASTM A786 and one of ASTM A242, A588, or A709 Grade 50W. State the type and trade name of material to be used on the shop drawings.

- 2.1.3.5. **Rail Posts.** Provide material for rail posts that meets ASTM A36 or ASTM A709 Grade 36 unless otherwise shown on the plans.
- 2.2. **Steel Forgings.** Provide steel forgings for pins, rollers, trunnions, or other forged parts that meet ASTM A668, Class C, D, F, or G, as shown on the plans. For pins 4 in. or smaller in diameter for non-railroad structures, material that meets ASTM A108 Grade 1016–Grade 1030, with a minimum yield strength of 36 ksi, may be used instead.
- 2.3. **Steel Castings.** Provide steel castings that meet ASTM A27, Grade 70-36.
- 2.4. **Iron Castings.** Provide iron castings that are true to pattern in form and dimensions; free of pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended; and meet the standards shown in Table 3.

Table 3
Standards for Iron Castings

Casting Material	ASTM Standard	Grade or Class
Gray iron	A48	35B
Malleable iron	A47	32510
Ductile iron	A536	70-50-05

- 2.5. **Steel Tubing.** Provide steel tubing that meets ASTM A500 Grade B, unless otherwise shown on the plans. Tubing that meets API Standard 5L Grade X52 may be used if produced by a mill listed in the standard API specifications as authorized to produce pipe with the API monogram. Hydrostatic tests are not required for API 5L steel, and instead of an MTR, the manufacturer may furnish a certificate for each lot or shipment certifying the tubing meets the requirements of this Section.
- 2.6. **Aluminum.** Provide aluminum materials that meet the standards shown in Table 4 unless otherwise shown on the plans.

Table 4
Aluminum Standards

Material	ASTM Standard	Alloy-Temper
Castings	B108	A444.0-T4
Extrusions	B221	6061-T6
Sheet or plate	B209	6061-T6

When testing is required, cut test specimens from castings from the lower 14 in. of the tension flange, but not at the junction of the rib or base. Flatten the curved surfaces before machining. Provide standard test specimens in accordance with ASTM E8.

3. CONSTRUCTION

- 3.1. **Fabrication, Erection, and Painting.** Fabricate, weld, and erect metal structures in accordance with Item 441, "Steel Structures"; Item 447, "Structural Bolting"; and Item 448, "Structural Field Welding"; and in conformance with the applicable AWS welding code. Paint in accordance with Item 446, "Field Cleaning and Painting Steel." Aluminum or galvanized steel members do not require painting unless otherwise shown on the plans.
- 3.2. **Galvanizing.** Galvanize fabricated steel items, steel castings, bolts, nuts, screws, washers, and other miscellaneous hardware, when required, in accordance with Item 445, "Galvanizing."

4. MEASUREMENT

This Item will be measured by the pound of structural metal furnished and placed in a complete structure not including the weight of erection bolts, paint, or weld metal.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

The maximum percent variance from the plans quantity will be as shown in Table 5.

Table 5
Percent Variance

Quantity	Variance
Over 1,000,000 lb.	1/2%
100,000–1,000,000 lb.	1%
Under 100,000 lb.	1-1/2%

If the requests for increases in sizes or weights of members are approved, measurement will be made on the sizes or weights shown on the plans.

Castings, bearing plates, anchor bolts, drains, deck plates, armor and finger joints, and other metal for which no separate measurement is specified will be included in the total quantity of structural steel.

The weights of rolled materials (e.g., structural shapes and plate) will be computed based on nominal weights and dimensions using measurements shown on the plans. Deductions will not be made for material that is removed for copes, clips, planing, or weld preparation. The weight of castings will be computed from the dimensions shown on the plans. Shoes will be measured by the weights shown on the plans.

Weight of high-strength fasteners will be based on Table 6. Weight of other metal will be based on Table 7.

Table 6
Pay Weight for High-Strength Fasteners, Pounds per Hundred Units

Diameter	Item		
	Bolt Heads	Nuts	Washers
3/4"	15	19	4.8
7/8"	23	30	7
1"	32	43	9.4
1-1/8"	45	59	11
1-1/4"	64	79	14

Table 7
Pay Weight for Metals

Material	Weight (lb./cu. in.)
Steel	0.2836
Cast iron	0.2604
Wrought iron	0.2777

Splices will be measured as follows.

- No additional weight will be allowed for weld metal in a welded splice.
- Where a bolted splice is permitted as an alternate for a welded splice, measurement will be made based on a welded splice.
- Where a bolted splice is required, the weight of the splice material, bolt heads, washers, and nuts will be measured with no deduction for holes.

5. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Structural Steel" of the type ("Rolled Beam," "Plate Girder," "Tub Girder," "Box Girder," "Railroad Through-Girder," "Railroad Deck-Girder," "Miscellaneous Bridge," "Miscellaneous Non-Bridge," "Pedestal," "Diaphragm," and "Stiffener") specified. This price is full

compensation for materials, fabrication, transportation, erection, paint, painting, galvanizing, equipment, tools, labor, and incidentals.

Item 445

Galvanizing



1. DESCRIPTION

Galvanize or repair galvanizing on metal items.

2. MATERIALS

Provide galvanized metal items that meet the standards shown in Table 1.

Table 1
Galvanizing Standards

Item	Standard
Fabricated items; rolled, pressed, or forged steel shapes; plates; pipes; tubular items; and bars	ASTM A123
Steel or iron castings	ASTM A153, Class A
Bolts, nuts, screws, washers, and other miscellaneous hardware	ASTM F2329 or ASTM B695, Class 50
Miscellaneous fasteners	ASTM B633, Class Fe/Zn 8
Rail elements for metal beam guard fence or bridge railing	AASHTO M 180
Permanent metal deck forms, supporting angles, and incidental items	ASTM A653, Coating Designation G165

3. CONSTRUCTION

- 3.1. **General.** Provide for proper filling, venting, and draining during cleaning and galvanizing if fabricated members or assemblies are required to be hot-dip galvanized. Provide drain holes or slots as required, except where prohibited by the plans. Provide a surface finish on the thermal-cut drain holes or slots in accordance with AWS D1.1 requirements for base metal preparation. Drain to the small end of tapered sections that are assembled using slip-joint splices. Ensure cleaning and galvanizing do not produce hydrogen embrittlement.

Remove weld spatter on exposed surfaces, weld flux, weld slag, and any other weld residue or impurities before galvanizing. Before galvanizing material 1/4 in. or greater in thickness:

- remove all sharp burrs, and
- chamfer to approximately 1/16 in. all edges.

- 3.2. **Painting Galvanized Materials.** Provide a paint system if painting is specified on galvanized materials in accordance with [DMS-8102](#), "Paint Systems for Galvanized Steel," unless otherwise shown on the plans. Follow all manufacturer instructions for surface preparation and application, including the following.

- 3.2.1. **Surface Preparation.** Do not water-quench or chromate-quench galvanized surfaces to be painted. Prepare the surface in accordance with ASTM D6386 or ASTM D7803, as applicable. Apply coating within 12 hr. of cleaning. Re-clean the surface if more than 12 hr. elapse before initial painting.

- 3.2.2. **Coating Application.** Ensure the coating is smooth, even, continuous, and free of drips, runs, sags, holidays, wrinkles, or other coating defects. Ensure the coating has a uniform appearance within all portions of the painted piece and all related pieces and components of a project. Ensure all repairs are smooth, even, and visually match the remainder of the coated piece by use of feathering and other appropriate techniques to avoid sharp transitions.

3.3. Workmanship.

- 3.3.1. **Coverage.** Bare spots no more than 1/8 in. across are acceptable unless numerous. Repair larger bare spots in accordance with Section 445.3.4., "Repairs." Local runs or drips of zinc coating are acceptable unless they interfere with the intended use of the product. Carefully remove plainly visible excessive zinc accumulations.
- 3.3.2. **Adhesion.** Tap the coated area using a small hammer to test coating adhesion. The coating is acceptable if it is not brittle and does not scale or flake.
- 3.3.3. **Appearance.**
- 3.3.3.1. **White Rust.** A white powdery residue indicates moisture. Remove heavy layers of white rust that have caused the coating to pit. Light coatings may remain unless the Engineer requires chemical removal. Remove white rust from articles that will be in direct contact with soil.
- 3.3.3.2. **Red Rust.** Red rust on galvanized items indicates uncoated areas. Refer to Section 445.3.3.1., "Coverage," for acceptance criteria.
- 3.3.3.3. **Alligator Cracking or Spider Webbing.** The composition of the base metal may cause dark lines resembling alligator skin. Refer to Section 445.3.3.2., "Adhesion," to determine whether the coating is acceptable.
- 3.3.3.4. **Dull Gray Coating.** The composition of the base metal can cause a dull gray color. Refer to Section 445.3.3.2., "Adhesion," to determine whether the coating is acceptable.
- 3.3.4. **Coating Thickness.** Galvanize to the thickness specified. Use [Tex-728-I](#) to determine coating thickness.
- 3.4. **Repairs.** Use zinc-based solders, sprayed zinc, or zinc-rich paints for repairs in accordance with this Section.
- 3.4.1. **Materials.**
- 3.4.1.1. **Zinc-Based Solders.** Solders used in rod form or as powders:
- zinc-tin-lead alloys with liquidus temperatures in the range of 446–500°F, or
 - zinc-cadmium alloys with liquidus temperatures in the range of 518–527°F.
- 3.4.1.2. **Sprayed Zinc (Metallizing).** Zinc coating applied by spraying with droplets of molten metal using wire, ribbon, or powder processes.
- 3.4.1.3. **Organic Zinc-Rich Paints.** Zinc-rich paints based on organic binders that meet the requirements of [DMS-8103](#), "Galvanizing Repair Paints." The Department's MPL has a list of approved repair paints for galvanized coatings.
- 3.4.2. **Repair Processes.**
- 3.4.2.1. **Zinc-Based Solders.** Remove moisture, oil, grease, dirt, corrosion products, and welding slag or flux from surfaces to be repaired. Clean surface to white metal by wire-brushing, light grinding, or mild blasting extending into the surrounding undamaged galvanized coating. Preheat cleaned areas to at least 600°F, but not more than 750°F. Wire-brush while heating and evenly distribute a layer of zinc solder. Flush the repaired area with water or wipe with a damp cloth to remove flux residue when repair is completed.
- 3.4.2.2. **Sprayed Zinc (Metallizing).** Remove oil, grease, corrosion products, and any welding slag or flux from surfaces to be repaired, and ensure the surfaces are dry. Clean surface to white metal by wire-brushing, light grinding, or mild blasting extending into the surrounding undamaged galvanized coating. Apply coating by metal-spraying pistols fed with either zinc wire, ribbon, or powder. Provide a coating that is uniform and free of lumps, coarse areas, or loose particles.

- 3.4.2.3. **Organic Zinc-Rich Paints.** Remove oil, grease, corrosion products, and welding slag or flux from surfaces to be repaired, and ensure the surfaces are clean and dry. Clean surface to near-white metal by wire-brushing, light grinding, or mild blasting extending into the surrounding undamaged coating to provide a smooth repair. Spray or brush-apply the paint to the prepared area in conformance with the paint manufacturer's instructions to attain the required dry-film thickness. Provide multiple passes when using spray application.
- 3.5. **Repair Coating Thickness.** Measure thickness in the repaired area in accordance with [Tex-728-I](#) after completing repair and cooling or curing. The minimum thickness required is the same as that required for the specified galvanizing. However, if the repair uses zinc-rich paints, the minimum coating thickness is 50% higher than the specified galvanizing thickness but not greater than 4.0 mils.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent items.

Item 446

Field Cleaning and Painting Steel



1. DESCRIPTION

Prepare steel surfaces for painting and apply paint.

2. MATERIALS

Provide the paint system (surface preparation, primer, intermediate, and appearance coats as required) shown on the plans. Provide System II if no system specified. Provide a concrete gray appearance coat (Federal Standard 595C, color 35630), unless otherwise shown on the plans. Use differing colors for each coat with enough contrast between colors to distinguish the various steps in the painting process, including differing the color of the stripe coat relative to the primer and intermediate coat.

2.1. **Paint Systems.** Standard paint systems for painting new and existing steel include the following.

2.1.1. **System I (Overcoating, One Coat).** Provide paint in accordance with [DMS-8105](#), "Paint, One Coat Overcoat," and the manufacturer's specifications.

2.1.2. **System II.** Provide paint in accordance with [DMS-8101](#), "Structural Steel Paints—Performance." Provide organic zinc (OZ) prime coat and acrylic latex appearance coat meeting [DMS-8101](#).

2.1.3. **System III-A.** Provide paint in accordance with [DMS-8101](#). Provide organic zinc (OZ) prime coat, epoxy intermediate stripe coat, epoxy intermediate full coat, and urethane appearance coat.

2.1.4. **System III-B.** Provide paint in accordance with [DMS-8101](#). Provide inorganic zinc (IOZ) prime coat, epoxy intermediate coat, and urethane appearance coat. Provide epoxy zinc prime coat, as recommended by the IOZ manufacturer, for touchup of IOZ.

2.1.5. **System IV.** Provide paint in accordance with [DMS-8101](#). Provide IOZ prime coat and acrylic latex appearance coat. Provide epoxy zinc prime coat, as recommended by the IOZ manufacturer, for touchup of IOZ.

2.2. **Paint Inside Tub Girders and Closed Boxes.** In accordance with Item 441, "Steel Structures."

2.3. **Paint over Galvanizing.** In accordance with Item 445, "Galvanizing."

2.4. **Special Protection System (SPS).** Provide the type of paint system shown on the plans or in conformance with special provisions to this Item. SPS paints must have completed AASHTO Product Evaluation & Audit Solutions Structural Steel Coatings (SSC) testing regimen as a complete system, with full data available from AASHTO unless specified otherwise.

3. EQUIPMENT

Provide spray equipment that:

- has adequate capacity and enough gauges, filters, agitators, regulators, and moisture separators to ensure delivery of clean, dry air meeting ASTM D4285 at the proper pressure and volume;
- is adequate for the type of paint being used;
- has spray heads that provide a smooth, uniform coat of paint; and
- has no dried coatings, solvents, or other foreign matter on surfaces that paint is likely to contact.

Maintain all equipment and accessories in good working order. Keep hoses serviceable, with no cracks or deterioration. Equip paint pots (or other containers from which the paint is dispensed) with agitators that operate whenever paint is in the pot.

When placing steel grit recycler and other surface preparation equipment, comply with Section 7.16.2, "Construction Equipment Operating on Structures."

4. CONSTRUCTION

- 4.1. **Qualification.** Certification of the cleaning and painting contractor, subcontractor, or fabricator is required as follows.

Submit to the Engineer documentation verifying AMPP QP 2 Cat A certification. If the plans specify that the existing coating system does not contain hazardous materials, provide AMPP QP 1 certification. Maintain certifications throughout the project. No work may be performed without current and active certifications unless otherwise shown on the plans. The Engineer may waive certification requirements for minor, touch-up repair work and coating steel members repaired in accordance with Item 784, "Steel Member Repair."

The Engineer may waive certification requirements, when shown on the plans, for qualification in either contractor certification program if the project has been accepted as a qualification project as part of the process for obtaining AMPP QP1 certification. Submit certification applications and proof of acceptance before beginning work or provide AMPP QP 7 certification when shown on the plans.

Inform the Engineer within 1 business day of all scheduled or unannounced inspections or audits by AMPP, OSHA, EPA, TCEQ, or other agencies or organizations. Furnish the Engineer a complete copy of all inspection and audit reports and any actions within 7 days of receipt.

- 4.2. **Responsibility for Hazards.** Comply with Article 6.10., "Hazardous Materials." Handle all paints and cleaning products in conformance with the information provided by the manufacturer and all applicable federal and state regulations.

- 4.3. **Steel to be Painted.** Clean and paint all structural steel except weathering steel that is to remain unpainted, unless otherwise shown on the plans. Structural steel includes all main members, bearing apparatus, diaphragms, floor beams, rivets, bolts, and lateral bracing, where applicable. Paint the rolling faces of rockers and base plates, all surfaces of bearing plates, and all surfaces of iron or steel castings, regardless of whether the surfaces are milled, unless otherwise shown on the plans or exempted in accordance with this Item. Perform the initial cleaning and application of required prime coating on new steel before shipment of the steel to the jobsite, unless otherwise provided in the Contract or approved in writing.

Areas deemed inaccessible by the Engineer will be cleaned and painted in conformance with the Engineer's instructions.

- 4.4. **SPS.** Apply paint as shown on the plans.

- 4.5. **Cleaning and Painting New Steel.** Clean and prime new steel in accordance with Item 441 before erection or installation of repair pieces. Clean and paint unpainted areas of newly erected steel, including bolts, nuts, washers, and areas where the shop-applied paint has been damaged or fails to meet specification requirements, in accordance with the method required under the paint system specified and Section 446.4.6.3.1., "General Preparation." Water blast exposed surfaces of all newly erected steel. Provide tool cleaning surface preparation to all repair areas. Prepare all unpainted areas by abrasive-blast cleaning. Repair prime coat and apply remaining coats after erection and maintenance work is complete. Prevent abrasive debris, paint, and overspray from contacting passing traffic, private and public property, and areas of the bridge not designated to be painted.

4.6. Cleaning and Painting Existing Steel.

4.6.1. **Hold Points.** No work may proceed beyond the listed hold point until the Engineer has reviewed and given provisional approval. Provide at least the following hold points:

- at containment completion,
- following any surface preparation,
- immediately before each coating application,
- after coating application,
- after each coat has cured, and
- after preparation of areas for repair.

4.6.2. **Containment.** Submit a plan that details the procedures and type and size of equipment proposed to keep public property, private property, and the environment from being adversely affected by the cleaning and painting operations. Approval of the plan is required before cleaning and painting operations begin. Containment is not required for painting new steel erected under Item 441 that is not erected or installed onto an existing steel structure other than to comply with Section 446.4.5., "Cleaning and Painting New Steel."

When shown on the plans, include with the containment plan an engineering analysis showing that the loads added to the existing structure by the containment system and waste materials do not result in overstress of the members. Have a licensed professional engineer sign, seal, and date the submittal.

Provide containment during all cleaning and painting operations of existing steel structures. Obtain approval of the constructed containment system before beginning cleaning and painting.

Construct and maintain a structure meeting the following minimum requirements:

- AMPP Guide 6, Class 1A, Level 1 emissions;
- ability to withstand winds up to 30 mph;
- enclosure of all sides of area with air-impenetrable walls;
- illumination meeting AMPP Guide 12;
- rigid and solid, watertight floor formed from minimum 20-gauge steel;
- overlapping seams and entryways; and
- exhaust air filtration system capable of creating negative pressure inside the enclosure, causing the sides of the containment to have a concave appearance and demonstrating minimum 100-ft. per minute cross-draft airflow and minimum 50-ft. per minute downdraft airflow in all areas within the containment.

In place of a full containment structure, a modified containment system may be proposed for the following situations:

- when using abrasive blasting equipment with negative pressure able to contain all blast refuse. Demonstrate, for approval, the equipment's ability to contain all blast refuse.
- when tool cleaning and water blasting for spot cleaning only, provide a system that will contain all removed paint, rust, and other debris. Place an airtight membrane below the member being cleaned to collect all falling debris and wastewater.
- when using power hand tools for spot cleaning only that are equipped with high-efficiency particulate air (HEPA) filter vacuums that will capture all removed paint, rust, and other debris. Otherwise, provide an airtight membrane below the member being cleaned to collect all falling debris.

Provide a system meeting AMPP Guide 6, Class 1W, when using water blasting. Manage wastewater from water blasting in accordance with Section 446.4.8.2., "Wastewater."

Provide safe access to all parts of the work for proper inspection. When a temporary facility is proposed for inspection access, provide a plan for review. This facility requires a licensed professional engineer in accordance with Article 5.2, "Plans and Working Drawings," Table 1. Do not place rigging or scaffolds in

contact with previously painted surfaces until the previously applied coating has fully cured. Protect previously painted and cured surfaces using an approved padding to minimize damage when rigging or scaffolds will be placed on or hung from those surfaces. Avoid and minimize coating damage to the extent possible. Repair all coating damaged by rigging or scaffolding as directed.

Remove tree limbs, bushes, grass, and other items that will interfere with the cleaning and painting operations as directed. Remove vertical clearance signs, and erect and maintain temporary ground-mounted signs matching the content and letter size on the existing sign unless otherwise directed. Re-attach permanent clearance signs as directed.

Use a skimmer when cleaning and painting over bodies of water. Remove any blast or paint material the skimmer collects the day the release occurs. Correct the containment problem that allowed the release before continuing work.

Ensure air is clear of dust and remove all blast refuse from cleaned members before the Inspector enters the containment to inspect the cleaned surfaces. Remove all blast refuse from the containment before ending work for the day.

4.6.3. **Preparation of Surfaces.** Prepare surfaces before applying paint.

4.6.3.1. **General Preparation.** Ensure all surfaces to be painted are completely free of all visible contaminants including but not limited to oil, grease, moisture, dirt, sand, overspray, and welding contamination (slag or acid residue); loose or flaking mill scale, rust, or paint; weld spatter; and any other conditions that will prevent the paint from forming a continuous, uniform, tightly adhering film.

Before other cleaning operations, remove grease-like contaminants using clean petroleum solvents or other approved methods. Contain solvents and removed material as approved. Dispose of properly or reuse solvents as approved.

Remove all hackles, splinters, weld spatter, sharp edges, fins, slag, or other irregularities that may interfere with proper paint adhesion to the steel. Remove all steel splinters (hackles) raised or evident during cleaning. Round all corners and edges to a 1/16-in. radius. Abrasive blast areas from which hackles and irregularities are removed and edges that have been rounded to achieve a minimum 1.5-mil profile. Grind all flame-cut edges when necessary to produce a minimum 1.5-mil profile over the entire flame-cut surface to achieve adequate coating adhesion.

Remove all pack rust and expansive rust between steel plates and in crevices using either abrasive blasting, ultra-high pressure waterjetting (UHP), heated water, or other approved methods.

Ensure all surfaces to be painted meet the minimum non-visible contaminant level established by the coating manufacturer or in accordance with AMPP-SP 12, NV-2, whichever is more stringent. Perform soluble salt contamination tests in accordance with AMPP Technology Guide 15, "Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates," immediately before paint application of each coat to determine whether salt contamination has occurred. If a method other than Class A is used, then it must first be validated against the Class A method before adopting structure-wide. Test at least four random locations every 1,000 sq. ft. If soluble salt levels exceed maximum requirements, provide additional water blast cleaning to remove salt contamination (or recontamination) and retest the area. If additional water blasting does not reduce the concentration to the acceptable level, a surface treatment or water additive may be used. Use a surface treatment or water additive that is approved by the coating system supplier and the Engineer. All salt test results must be preserved and made accessible to the Engineer.

Clean coated surfaces by an approved method that does not damage applied paint to remove all dirt, grease, concrete, overspray, and any other substance that may impair adhesion before the application of the next coat.

Clean far enough into any shop-applied paint to ensure removal of all contaminants.

Feather edges of sound paint around spot-cleaned areas. Feather all sound, tightly adhered coating edges surrounding cleaned or repaired areas at least 1 in., and ensure a smooth, blended transition.

Completely remove, as directed, the protective coating on machined surfaces and pins.

Do not damage adjacent materials such as concrete during surface preparation or painting.

- 4.6.3.2. **Classes of Cleaning.** Water blast to remove contaminants before any mechanical or abrasive surface preparation. Water blast the steel and between coats when necessary to remove non-visible contamination. System I requires tool cleaning for defective areas of disbanded coating or rust. All other paint systems require abrasive blast cleaning unless otherwise shown on the plans.

Prepare all surfaces of painted steel members subsequently exposed from structural operations, such as deck removal or steel repair, in accordance with this Item. Prevent loose or damaged paint from entering the environment.

- 4.6.3.2.1. **Abrasive Blast Cleaning.** Meet the surface preparation requirements in accordance with AMPP-SP 10 unless otherwise shown on the plans. Ensure a minimum profile of 1.5 mils. Do not add depth to existing profile when the surface profile exceeds 4.0 mils. Measure surface profile in accordance with ASTM D4417, Method C. Containment mounting points and other repair areas under 1 sq. ft. may be tool-cleaned to AMPP-SP 11 with at least a minimum 1.5-mil profile when approved.

For existing steel structures, use an abrasive recycling system with an approved recyclable abrasive unless otherwise shown on the plans. New steel erected under Item 441 that is not erected or installed onto an existing steel structure is excluded from the recyclable abrasive requirement. Do not use steel shot. Abrasive will be considered recyclable if it is separated from the dust and paint debris before being reused. A non-recyclable abrasive may be used when the coating system has been identified as nonhazardous as shown on the plans. All abrasives must meet AMPP AB1, AB2, or AB3 as appropriate.

- 4.6.3.2.2. **Tool Cleaning.** Meet the requirements of AMPP-SP 11 unless otherwise shown on the plans. Probe the perimeter of peeled areas of paint using a putty knife to ensure remaining paint is tightly adhered.

- 4.6.3.2.3. **Water Blasting.** Meet the requirements of AMPP-SP WJ-4. Tight mill scale and tightly adhered rust and paint are permitted. Probe the perimeter of peeled areas of paint using a putty knife to ensure remaining paint is tightly adhered.

- 4.6.3.3. **Tape Test.** Perform the tape test, as necessary to determine cleanliness, on any surface before painting as follows:

- Press a strip of filament tape onto the surface by rubbing using moderate thumb pressure four times, leaving approximately 2 in. of one end of the tape free from the surface.
- Grasp the free end and remove the tape from the surface using a sharp pull.

The surface will be considered contaminated and not adequately cleaned if visible particles cling to the tape.

- 4.6.4. **Painting.**

- 4.6.4.1. **Paint Condition.** Thoroughly mix and strain paints to be applied in conformance with the manufacturer's recommendations. Mix by mechanical methods. Provide continuous mechanical agitation during painting operations to prevent settling. Ensure the paint is a completely homogeneous mixture free of lumps, skins, and agglomerates and contains all pigments, vehicle solids, and thinners required in the original formulation. Keep paint containers tightly covered and protected from weather when not in use.

- 4.6.4.2. **Thinning.** Adjust paint to the correct application consistency in conformance with the manufacturer's recommendations.

- 4.6.4.3. **Paint System Requirements.** Ensure all coatings in the paint system, including shop-applied coats, are from the same manufacturer.
- 4.6.4.4. **Stripe Coat.** All stripe coat will be unthinned and worked in by brush to achieve a contiguous film over all edges, corners, bolts, nuts, threads, rivets, and weld seams, extending at least 1 in. onto adjacent steel and must be of a contrasting color to the coating over which it is being applied. Ensure the paint is mixed in the appropriate proportions by weight and is agitated continuously during the striping operation.
- 4.6.4.5. **Paint Systems.** Apply the paint system specified in accordance with this Item and in conformance with the equipment and coating materials manufacturer's recommendations. Conflicts between this Item and the manufacturer's recommendations will be resolved by the Engineer.
- 4.6.4.5.1. **System I (Overcoating, One Coat).** Apply at least 4.0 mils dry film thickness (DFT) overcoat to all surfaces to be painted.
- 4.6.4.5.2. **System II.**
- **Prime Coat.** Apply at least 3.5 mils DFT of epoxy zinc primer.
 - **Stripe Coat.** Apply stripe coat of epoxy zinc primer to all edges, corners, bolts, nuts, threads, rivets, and weld seams, extending at least 1 in. onto adjacent steel.
 - **Appearance Coat.** Apply at least 2.0 mils DFT of appearance coat.
- 4.6.4.5.3. **System III-A.**
- **Prime Coat.** Apply at least 3.5 mils DFT of epoxy zinc primer.
 - **Stripe Coat.** Apply stripe coat of epoxy zinc primer to all edges, corners, bolts, nuts, threads, rivets, and weld seams, extending at least 1 in. onto adjacent steel.
 - **Intermediate Coat.** Apply at least 2.0 mils DFT of epoxy intermediate coating.
 - **Appearance Coat.** Apply at least 2.0 mils DFT of appearance coating.
- 4.6.4.5.4. **System III-B.**
- **Prime Coat.** Apply at least 3.5 mils DFT of IOZ primer to new steel in accordance with Item 441. Spot-clean all damaged and unpainted areas in accordance with Section 446.4.5., "Cleaning and Painting New Steel." Apply at least 3.5 mils DFT of epoxy zinc primer to the spot-cleaned areas.
 - **Stripe Coat.** Apply stripe coat of epoxy zinc primer to all edges, corners, bolts, nuts, threads, rivets, and weld seams, extending at least 1 in. onto adjacent steel.
 - **Intermediate Coat.** Apply at least 2.0 mils DFT of epoxy intermediate coating.
 - **Appearance Coat.** Apply at least 2.0 mils DFT of appearance coat.
- Apply stripe, intermediate, and appearance coat to new steel after erection and repair of all damaged areas. Extend stripe coat at least 1 in. onto flat steel in all directions.
- 4.6.4.5.5. **System IV.**
- **Prime Coat.** Apply at least 3.5 mils DFT of IOZ primer to new steel in accordance with Item 441. Spot-clean all damaged and unpainted areas in accordance with Section 446.4.5., "Cleaning and Painting New Steel." Apply at least 3.5 mils DFT of epoxy zinc primer to the spot-cleaned areas.
 - **Appearance Coat.** Apply at least 2.0 mils DFT of appearance coat.
- Apply stripe, intermediate, and appearance coat to new steel after erection and repair of all damaged areas. Extend stripe coat at least 1 in. onto flat steel in all directions.
- 4.6.4.6. **SPS.** Apply paint as shown on the plans.
- 4.6.4.7. **Application.** Do not apply paint when the steel or air temperature is below 50°F or when the steel or air temperature is expected to drop below 50°F within 2 hr. after application, unless otherwise approved. Do not

apply paint to any surface with discernible moisture. Do not apply paint to any surface when steel is within 5°F of the dewpoint. Do not apply paint when impending weather conditions might result in damage to fresh paint.

Provide environmental controls such as dehumidification, heaters, or additional containment measures as needed to control and maintain favorable atmospheric conditions in all areas of the containment. Provide environmental controls at no additional cost to the Department.

Apply each coat in two passes using a crosshatch pattern. Apply each coat of paint to clean, dry, firm surfaces in accordance with all specification requirements. Ensure each coat fully cures to form a smooth, continuous, tightly adhering film of uniform thickness and appearance and free of defects before applying the next coat. Apply all coats by spray, except brush-applied stripe coats. Obtain approval for alternative methods of application to paint inaccessible areas.

Repair all runs, sags, and other defects in each coat of paint before application of subsequent coats.

Measure the dry film thickness of coatings in accordance with AMPP PA 2, Level 3, "Procedure for Determining Conformance to Dry Coating Thickness Requirements."

If, in the opinion of the Engineer, there is an objectionable amount of dust in the atmosphere, discontinue painting or take necessary precautions to prevent dust and dirt from contacting freshly painted surfaces or surfaces before the paint is applied.

Provide full coverage of the steel with the concrete surface when painting steel that is in contact with concrete. Do not extend paint more than 4 in. onto the concrete surfaces or as directed. Ensure when painting is completed the only visible paint on concrete surfaces is the finish coat. Remove excessive or objectionable paint on concrete surfaces in an approved manner. Intermediate and appearance coats do not have to be applied to surfaces that will be in full contact with concrete. Before applying the appearance coat onto existing steel structures, caulk gaps or crevices greater than 1/16 inch. New steel erected under Item 441 that is not erected or installed onto an existing steel structure is excluded from the caulking requirement. Use a paintable caulk meeting the requirements of [DMS-8142](#), "Paintable Caulk for Concrete and Steel." Use caulk that is compatible with the coatings to be applied, as determined by coating manufacturer. Apply caulking in a manner that does not trap moisture.

- 4.6.4.8. **Workmanship.** Perform all painting using skilled painters who can adjust equipment and application techniques as dictated by the type of paint, weather conditions, environment, and size and shape of the surface being painted. Painters who, in the opinion of the Engineer, do not adjust equipment to apply coatings in a uniform, full wet coat free of runs, sags, holidays, and overspray will not be considered skilled painters and may be removed from the project.

Brush application for touchup is acceptable if the paint is mixed in the appropriate proportions by weight and is agitated continuously during the painting operation.

- 4.6.5. **Handling and Shipping.** Pad the blocks, chains, slings, braces, and clamps used for handling, moving, storing, and shipping painted members so the paint will not be damaged.

- 4.7. **Paint Improperly Applied.** To uncover evidence of improperly applied paint, the Engineer may at any time during construction explore underneath the surface of any paint coats already applied. Repair these areas of investigation at no additional expense to the Department. Whenever unsatisfactory conditions are found, the Engineer may require remedial measures.

Repair or completely remove and replace all paint that has been applied improperly, has been applied to improperly cleaned surfaces, fails to dry and harden properly, fails to adhere tightly to underlying metal or other paint film, or does not have a normal, workmanlike appearance in accordance with this Item. When the final field coat does not have a uniform color and appearance throughout the structure, correct it using whatever additional coats or other corrective measures are required. Remove freshly applied paint that has

not yet set using suitable solvents. Remove dried paint films by blast cleaning, scraping, or flame torches, as approved.

- 4.8. **Waste and Wastewater.** Manage all waste and wastewater generated by cleaning and painting operations as necessary to prevent unauthorized release into the environment.

- 4.8.1. **Waste.** At minimum, collect all waste before leaving the jobsite each day. Handle and store the waste as if it were hazardous or Universal Waste until classification is made. Follow the requirements of 30 TAC § 335 for onsite handling of the waste. Store waste collected in containers that comply with 49 CFR Part 178. Seal containers containing waste each day before leaving the jobsite.

Test a representative sample of waste in accordance with EPA Test Method 1311, "Toxicity Characteristic Leaching Procedure" (TCLP), to determine existing metal and organic content. Handle and dispose of nonhazardous waste as a "Special Waste" as defined in 30 TAC § 330.2 or as directed. Provide documentation showing disposal of the waste was in a suitable landfill holding permits to handle this type of material. Dispose of hazardous waste in conformance with applicable waste rules and regulations. Transport hazardous waste using a permitted transporter and dispose of it in an authorized hazardous waste facility.

When the plans show the existing coating to be removed contains hazardous materials and steel grit is used as the abrasive, the waste generated is classified as hazardous or Universal Waste regardless of the results of the TCLP. For manifesting purposes, the Department is considered the waste generator for paint removal wastes generated from structures owned or controlled by the State. Dispose of this waste in conformance with applicable waste rules and regulations as specified above and in accordance with the Contract.

Provide copies of all test reports and transportation manifests to the Engineer before shipping waste. Provide signed original manifests to the Engineer verifying all steps of the handling and disposal process were correctly handled.

- 4.8.2. **Wastewater.** Avoid unauthorized discharge of wastewater to streams or other surface waters. Contain and dispose of all wastewater to a publicly owned treatment works (POTW), with written approval from the POTW, or at a permitted commercial disposal facility, unless authorization for reuse or discharge is obtained from TCEQ and approved. Wastewater from cleaning operations of new steel erected under Item 441 that meets the TCEQ Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit (CGP) TXR150000 guidelines for non-stormwater discharge may be discharged in accordance with best management practices described in the site Stormwater Pollution Prevention Plan (SW3P).

- 4.9. **Miscellaneous.** Notify the Engineer of any condition that may require the repair or replacement of any portion of the bridge.

5. MEASUREMENT

When this Item is shown on the plans to be a pay item, this Item will be measured by the lump sum or by each structure, structure unit, or group of structures as shown on the plans.

6. PAYMENT

When this Item is specified as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Cleaning and Painting Existing Structures," "Cleaning and Painting Existing Railing," or "Cleaning and Painting Existing Piling" for the system specified and, when paid by each, for the structure description by reference number. "Cleaning and Painting Existing Structures" includes painting of railing and piling unless otherwise shown on the plans. This price is full compensation for paint; cleaning, spot painting, and painting; removal of vegetative obstructions; containment systems; traffic protection and scaffolding; disposal of waste; and materials, equipment, labor, tools, and incidentals.

When the Item is not specified as a pay item, the work performed and materials furnished in accordance with this Item will not be measured or paid for directly, but will be subsidiary to pertinent Items.

Item 447

Structural Bolting



1. DESCRIPTION

Furnish and install high-strength bolts for structural connections.

2. MATERIALS

- 2.1. **General.** Use the same supplier for bolts and nuts to ensure proper fit. Have the manufacturer or distributor perform rotational-capacity (R-C) tests in accordance with [Tex-452-A](#) on all bolt, nut, and washer assemblies. Test each combination of bolt production lot, nut lot, and washer lot as an assembly and assign an R-C lot number to each lot tested. Test two samples from each assigned R-C lot.

Furnish a manufacturer's certified test report (MCTR) or a distributor's certified test report (DCTR) for each R-C lot supplied. Include in the MCTR or DCTR:

- results of the R-C tests,
- R-C lot number,
- manufacturing location for assembly components,
- date and location of tests, and
- a statement that the materials represented by the test report are in accordance with the specifications.

- 2.2. **Bolt Assemblies.** Provide ASTM F3125 bolts, nuts, and washers meeting the type, grade, and finish requirements shown in Table 1, unless otherwise shown on the plans.

Use Grade A325 or Grade A490 Type 3 plain (uncoated) bolts for weathering steel as specified and Grade A325 Type 1 galvanized bolts for coated steel, unless otherwise shown on the plans.

Provide bolts long enough for the installed bolt end to be flush with or outside the face of the nut.

Ensure galvanized nuts are lubricated with a lubricant containing a dye of a color that contrasts with the color of the galvanizing. Order ASTM A563 nuts with supplemental requirement S2 if they will be galvanized.

Table 1
ASTM Type, Finish, and Grade for Structural Bolts, Nuts, and Washers

	ASTM Designation	Bolt Type	Bolt Finish	ASTM A563 Nut Grade and Finish	ASTM F436 Washer Type and Finish
Heavy-hex bolts ¹	A325	1	Galvanized	DH ² , galvanized and lubricated	1; galvanized
	A325	3	Plain	C3 and DH3; plain and lubricated	3; plain
	A490	3	Plain	DH3; plain and lubricated	3; plain
Tension-control bolts ¹	F1852	1	Galvanized	DH ² , galvanized and lubricated	1; galvanized
	F1852	3	Plain	C3 and DH3; plain and lubricated	3; plain
	F2280	3	Plain	DH3; plain and lubricated	3; plain

1. ASTM F3125 high strength structural bolts
2. ASTM A194 heavy hex Grade 2H nuts may be substituted.

- 2.3. **Washer-Type Indicating Devices.** Use compressible-washer type direct-tension indicators that meet ASTM F959 if allowed. Alternative washer-type indicating devices must be approved. Provide detailed testing, installation, and inspection requirements prepared by the manufacturer.
- 2.4. **Storage.** Protect all bolts and nuts from dirt and moisture at the jobsite. Remove from protected storage only those bolts and nuts anticipated to be installed during a workday. Return unused fasteners to protected storage at the end of the day. Do not clean fasteners of lubricant present in the as-delivered condition. Perform a field R-C test at the Contractor's expense in accordance with [Tex-452-A](#) on any lot of fasteners that shows signs of rust, dirt, or loss of lubrication as directed. Apply additional lubrication and rerun the R-C test before installing bolts if the fasteners fail the R-C test. Replace any fasteners that cannot be re-lubricated to pass the field R-C test. Tension control bolts may be re-lubricated only by the manufacturer.
- 2.5. **Sampling and Testing.** Sample high-strength bolts, nuts, and washers in accordance with [Tex-719-I](#), when directed. Perform field R-C tests as directed in accordance with [Tex-452-A](#). Perform installation verification tests in accordance with Section 447.4.1., "Verification Testing."
- 2.6. **Fitup Bolts and Erection Pins.** Provide heavy-hex fitup bolts of the same diameter as the connection bolts. Do not use washer-type indicating devices for fitups. Do not reuse galvanized bolts or Grade A490 bolts that have been used as fitup bolts. Provide enough erection or drift pins, 1/32 in. larger than the bolt diameter.
- 2.7. **Paint Markers.** Provide white or yellow paint markers for marking bolts or nuts for wrench calibration, R-C tests, and bolt installation.

3. EQUIPMENT

- 3.1. **Testing Equipment.** Provide a calibrated tension-measuring device (Skidmore-Wilhelm or equivalent), calibrated torque wrench, and other accessories necessary to perform the installation verification test and the R-C test, and to calibrate hydraulic or electric torque wrenches.
- 3.2. **Wrenches.** Furnish either of the following types of wrenches.
- 3.2.1. **Air-Driven Impact Wrenches.** Furnish air-driven impact wrenches, air compressors, and related accessories of enough capacity to properly tension high-strength bolts. Impact wrenches should be of enough size and capacity to be able to tension fully a bolt in less than 15 sec. Repair or replace any wrenches that are unable to apply full tension to a bolt within this time.
- 3.2.2. **Calibrated Torque Wrenches.** Furnish calibrated hydraulic or electric torque wrench and related accessories capable of properly tensioning high-strength bolts. Calibrate the wrench to stall out or cut out completely when the bolt tension reaches 1.05 times the tension shown in Table 2. Calibrate the wrench by tensioning three bolts of each size in a calibrated tension-measuring device (Skidmore-Wilhelm or equivalent). Mark each bolt and verify the rotation from snug-tight when calibrating the wrench in accordance with Section 447.4.5.3.1., "Turn-of-the-Nut Method." Calibrate the wrench at least once each working day or as directed. Recalibrate the wrench for changes in bolt diameter; changes in bolt length greater than two bolt diameters; significant differences in the surface condition of the bolts, threads, nuts, or washers; or changes in the equipment or hose length.

4. CONSTRUCTION

- 4.1. **Verification Testing.** Have each member of the bolting crew that will perform the actual work complete an acceptable pre-installation verification test in the presence of the Engineer. Only crewmembers that have demonstrated proper workmanship by verification testing may perform production bolting work.
- 4.1.1. **Air-Driven Impact Wrench.** Perform an installation verification test on three complete fastener assemblies of each combination of diameter, length, grade, and lot to be installed before beginning bolting. Follow the bolt-tensioning procedures in accordance with Section 447.4.5.3., "Tension Bolts." Use a calibrated tension-measuring device (Skidmore-Wilhelm or equivalent) to verify and demonstrate that the method for

estimating the snug-tight condition and controlling the turns from snug-tight develops a tension greater than 1.05 times the tension shown in Table 2. The snug-tight condition is defined as the tightness that exists when the plies of the joint are in firm contact.

- 4.1.2. **Calibrated Torque Wrench.** Calibrate the wrench before beginning bolting in accordance with Section 447.3.2.2., "Calibrated Torque Wrenches." Use the bolting crew that will perform the actual work for the calibration and calibrate the wrench in the presence of the Engineer. Follow the bolt-tensioning procedures in accordance with Section 447.4.5.3., "Tension Bolts."

- 4.1.3. **Direct-Tension Indicator.** Use a calibrated tension-measuring device for compression-type indicators to verify the gap is not less than 0.015 in. or the job inspection gap specified by the manufacturer when tension in the bolt reaches 1.05 times the tension shown in Table 2.

Follow the manufacturer's instructions for pre-installation verification testing methods and frequency for alternative washer type indicating devices deemed acceptable.

- 4.2. **Workmanship.** The Engineer will disqualify any crewmembers not adhering to proper installation methods during production work. Disqualified crew may not perform further bolting work until they complete an additional pre-installation verification test suitable to the Engineer.

- 4.3. **General.** Ensure all material within the grip of the bolt is steel. Do not allow any compressible material such as gaskets or insulation within the grip. Ensure the slope of parts in contact with the bolt head or nut does not exceed 1:20 with respect to a plane normal to the bolt axis. Prepare all joint surfaces, including those in contact with the bolt heads, nuts, or washers, so that the surfaces are free of dirt, loose rust, loose mill scale, burrs, and other matter that would prevent solid seating of the parts.

Replace any bolts and nuts installed for shipping purposes unless the shop drawings specify the shop-installed bolts are to be fully tensioned in the shop. Do not tension bolts that have been installed snug-tight in the shop. Remove any bolts installed snug-tight in the shop and replace them with new bolts. Inspect and prepare the joint surfaces after removing shop-installed bolts that are not fully tensioned in the shop.

Provide a hardened washer for heavy-hex and tension-control bolts under either the nut or the bolt head, whichever is turned during tensioning. Install hardened washers under both the nut and bolt head of Grade A490 bolts when the outer plies being fastened have a yield strength less than 40 ksi.

Install an ASTM F436 washer for direct-tension indicators as follows:

- under the nut when the nut is turned and the direct-tension indicator is located under the bolt head,
- between the nut and the direct-tension indicator when the nut is turned and the direct-tension indicator is located under the nut,
- under the bolt head when the bolt head is turned and the direct-tension indicator is located under the nut, and
- between the bolt head and the direct-tension indicator when the bolt head is turned and the direct-tension indicator is located under the bolt head.

Tension all bolts to provide the minimum bolt tension values shown in Table 2.

Erect steel in accordance with Item 441, "Steel Structures." Do not tack-weld any parts to eliminate fitup bolts or to hold parts together while bolting.

Remove lubricant from bolt assemblies on painted structures after tensioning and before coating the connections.

Re-tighten the nuts or tack weld the nuts to the bolts when bolts are used to temporarily support welded diaphragms after completing the welding operations if the diaphragms are over vehicular or pedestrian traffic.

Table 2
Bolt Tension

Nominal Bolt Size, in.	Minimum Tension (kips)	
	Grade A325 Bolts	Grade A490 Bolts
1/2	12	15
5/8	19	24
3/4	28	35
7/8	39	49
1	51	64
1-1/8	64	80
1-1/4	81	102
1-3/8	97	121
1-1/2	118	148

- 4.4. **Preparation of Faying Surfaces.** Perform blast cleaning or painting of faying surfaces in accordance with Item 441. Provide an AMPP-SP 10 blast cleaning before shipment for weathering steel. Do not wire-brush weathering steel faying surfaces.
- 4.5. **Bolt Installation.** Use the following procedure for bolt installation of a complete connection.
- 4.5.1. **Fair-Up Holes.** Use a minimum number of erection or drift pins, as directed, in the holes to “fair-up” all holes.
- 4.5.2. **Install Bolts.** Install bolts in all remaining holes of the connection. Do not use excessive force, which could result in damage to the threads, to install the bolts. Increase the number of erection or drift pins as necessary to align the holes if force is required to install the bolts. Do not ream the holes unless approved. Ream the holes in accordance with Section 441.3.11.5., “Misfits,” if approved. Remove the erection or drift pins and install bolts in these holes. Bring the connection to a full snug-tight condition by snugging systematically from the most rigid part of the connection to the free edges. The snug-tight condition is defined as the tightness that exists when the plies of the joint are in firm, full contact and all of the bolts in the joint have been tightened enough to prevent the removal of the nuts without the use of a wrench. A snug-tight condition can usually be attained by a few impacts of an impact wrench or the full effort of a worker using an ordinary spud wrench, as demonstrated in the installation verification test. As necessary, re-snug previously snugged bolts that may have relaxed due to the subsequent snugging of adjacent bolts to ensure all bolts are simultaneously snug-tight and the connection plates are in full contact.
- Fully tighten a minimum number of bolts as directed until the plies are in full contact if snugging does not bring the plies of the joint into full contact. Mark these bolts as fitup bolts. Use a non-galvanized Grade A325 bolt of the same diameter as a fitup bolt in connections requiring the use of galvanized Grade A325 bolts. Re-snug all remaining bolts.
- Do not use washer-type indicating devices to bring the connection to a snug-tight condition. Rather, install heavy-hex bolt assemblies in enough holes (approximately 20%) to attain firm, full contact between plies. Remove the heavy-hex bolts and install the washer-type indicating device assemblies after firm contact is established by connections in surrounding bolt holes.
- 4.5.3. **Tension Bolts.** Loosen all fitup bolts after tensioning all the other bolts in the connection. Ungalvanized Grade A325 bolts used as fitup bolts may be reused in a connection using this type of bolt. Replace all galvanized bolts and Grade A490 bolts used as fitup bolts. Tension these remaining untensioned bolts in accordance with this Section. Ensure the element not turned by the wrench (bolt head or nut) does not rotate.
- 4.5.3.1. **Turn-of-the-Nut Method.** Match-mark the nuts and the protruding bolt ends after the bolts have been brought up to snug-tight condition and before final tensioning so that actual rotation can be determined. Tension all bolts in the connection to their final tension by the amount of rotation shown in Table 3. Start final tensioning at the center or most rigid part of the connection and progress toward the free edges.

- 4.5.3.2. **Calibrated Wrench Method.** Use a calibrated hydraulic torque wrench to tension all bolts to 1.05 times the tension shown in Table 2 after they have been brought to the snug-tight condition. Calibrate the wrench in accordance with Section 447.3.2.2., "Calibrated Torque Wrenches." Start tensioning at the most rigid part of the connection and proceed to the free edges. Return the wrench to re-tension previously tensioned bolts that may have relaxed due to the subsequent tensioning of adjacent bolts. Place marks on the socket at one-third points so the amount of rotation can be visually determined.
- 4.5.3.3. **Washer-Type Indicating Devices.**
- 4.5.3.3.1. **Compressible-Washer Type, Direct-Tension Indicators.** Ensure the direct-tension indicator arches are oriented away from the work and that they bear against the hardened bearing surface. Confirm the appropriate feeler gauge is accepted in at least half the spaces between protrusions before tensioning and refused entry in at least half the spaces between protrusions after tensioning.
- 4.5.3.3.2. **Alternative Washer Type Indicating Devices.** Follow the procedures prepared by the manufacturer and approved. Verify proper installation after tensioning.
- 4.5.4. **Bolt Reuse.** Do not reuse Grade A490 or galvanized Grade A325 bolts. Ungalvanized Grade A325 bolts may be reused once if the threads have not been damaged. Re-tensioning previously tensioned bolts loosened by the tensioning of adjacent bolts is not considered to be reuse.

Tension all bolts in a connection within 10 days of installation. Bolts not tensioned within 10 days of installation are subject to field R-C testing. Re-lubricate or replace any installed bolts that do not have enough lubrication as determined by the field R-C test.

Table 3
Nut Rotation from Snug-Tight Condition¹

Bolt Length (underside of head to end of bolt)	Disposition of Outer Face of Bolted Parts		
	Both Faces Normal to Bolt Axis	One Face Normal to Bolt Axis and Other Face Sloped Less than 1:20 (beveled washer not used)	Both Faces Sloped Less than 1:20 from Bolt Axis (beveled washer not used)
Up to and including 4 bolt diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 bolt diameters up to and including 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 bolt diameters up to and including 12 diameters ²	2/3 turn	5/6 turn	1 turn

1. Nut rotation is relative regardless of the element (nut or bolt) being turned. The tolerance is -0° , $+30^{\circ}$ for bolts installed by 1/2 turn or less and -0° , $+45^{\circ}$ for bolts installed by 2/3 turn or more.
2. Determine the required rotation for bolt lengths greater than 12 diameters using the installation verification test in a simulated connection of solidly fitted steel.

5. MEASUREMENT AND PAYMENT

Installation and testing of bolts will not be paid for directly, but will be subsidiary to pertinent Items requiring the use of high-strength bolts.

When payment for the structure associated with the bolts is made under Item 442, "Metal for Structures," bolts, nuts, and washers will be paid for in accordance with Item 442.

Item 448

Structural Field Welding



1. DESCRIPTION

Field-weld metal members using the shielded metal arc or flux cored arc welding processes.

2. MATERIALS

Provide electrodes for shielded metal arc welding (SMAW) conforming to the requirements of ANSI/AWS A5.1 or ANSI/AWS A5.5.

Provide electrodes for flux cored arc welding (FCAW) conforming to the requirements of ANSI/AWS A5.20 or ANSI/AWS A5.29.

Use only electrodes and flux-electrode combinations conforming to AWS A5 specifications and pertinent classifications for the applicable welding processes. When requested, submit a current Certificate of Conformance (COC) containing acceptable wording indicating Buy America compliance and all tests required by the applicable AWS specifications and welding codes. Tests must be conducted on electrodes of the same class, size, and brand and manufactured by the same process and with the same materials as the electrodes to be furnished. Resubmit electrodes or flux-electrode combinations every 12 mo.

Table 1 shows the classes of electrodes required. Use electrodes with the type of current, with the polarity, and in the positions permitted by AWS A5.1 and A5.5 for SMAW. AWS A5.20 and A5.29 specifications govern for FCAW. Obtain approval for electrode use on steel not listed in Table 1.

Table 1
Classification of Electrodes Permitted

Type of Steel (ASTM Standards)	Electrode Specification	Process	Filler Metal Requirements
Steel piling	AWS A5.1 or A5.5	SMAW	E60XX E70XX or E70XX-X
Armor joints A 500 A 501	AWS A5.20 or A5.29	FCAW	E6XTX-X E7XTX-X (except -2, -3, -10, -GS)
A 36 A 572 Gr. 50 A 588 A 242 A 709 Gr. 36, 50, or 50S	AWS A5.1 or A5.5	SMAW	E7016 E7018 E7028
	AWS A5.20 or A5.29	FCAW	E7XT-1 E7XT-5 E7XT-6 E7XT-8
Weathering steel A 588 A 242 A 709 Gr. 50W	AWS A5.5	SMAW	E8018-W E8016-C3 E8018-C3 E8016-C1 E8018-C1 E8016-C2 E8018-C2
	AWS 5.29	FCAW	E8XT1-W E8XTX-Ni1 E8XTX-Ni2 E8XTX-Ni3
A 709 Gr. HPS 70W	AWS A5.5	SMAW	E9018-M-H8R
Reinforcing steel Grade 40	AWS A5.1 or A5.5	SMAW	E70XX
Reinforcing steel Grade 60	AWS A5.5	SMAW	E90XX
Permanent metal deck forms	AWS A5.1 or A5.5	SMAW	E6010 E6011 E6013 E7018

Note—Low-hydrogen electrodes applicable to the lower strength base metal may be used in joints involving base metals of different yield points or strengths.

E7010 and E8010 electrodes may be used when welding the root passes of beam and girder splices if the requirements of Section 448.4.3.5.1., “High-Cellulose Electrodes for Root Passes,” are met.

Use electrodes meeting the diffusible hydrogen requirements for fracture-critical welding in AASHTO/AWS D1.5 when welding fracture-critical applications.

Use gas or gas mixtures that are welding grade and have a dew point of -40°F or lower for gas-shielded FCAW. Furnish certification to the Engineer that the gas or gas mixture is suitable for the intended application and will meet the dew point requirements.

3. EQUIPMENT

Provide electrode drying and storing ovens that can maintain the required temperatures specified in Section 448.4.3.1., “Electrode Condition.” Each oven must have a door that is sealed and can be latched. Each oven must have a small port that may be opened briefly to insert a thermometer, or the oven must be equipped with a thermometer that allows for direct reading of temperature inside the oven without opening the oven. Provide equipment able to preheat and maintain the temperature of the base metal as required and as shown on the plans. Provide approved equipment (e.g., temperature indicator sticks or infrared thermometer) for checking preheat and interpass temperatures at all times while welding is in progress.

Provide welding equipment meeting the requirements of the approved welding procedure specifications (WPSs), if required, and capable of making consistent high-quality welds.

4. CONSTRUCTION

- 4.1. **Procedure Qualification.** Use the proper classification and size of electrode, arc length, voltage, and amperage for the thickness of the material, type of groove, welding positions, and other circumstances of the work.
- Submit WPSs for FCAW, qualified in accordance with AASHTO/AWS D1.5 for approval before any field welding on a project.
- 4.2. **Welder Qualification.** Provide Department certification papers for each welder and for each welding process to be used before welding, except for miscellaneous welds described in Section 448.4.2.1.1., "Miscellaneous Welding Applications." The Department issues certification as described in Section 448.4.2.2., "Certified Steel Structures Welder."
- 4.2.1. **Miscellaneous Welding.** A qualified welder is an experienced welder who is capable of making welds of sound quality but does not have Department certification papers. The Engineer will check the welder's ability by conducting a jobsite test in accordance with Section 448.4.2.1.2., "Miscellaneous Weld Qualification Test," before welding begins. Furnish all materials and equipment necessary for this test.
- 4.2.1.1. **Miscellaneous Welding Applications.** A welder certified for structural or reinforcing steel or a qualified welder may make miscellaneous welds of the following types:
- splicing reinforcing steel to extend bars in the bottom of a drilled shaft;
 - attaching chairs to the reinforcing steel cage of a drilled shaft;
 - armor joints and their supports;
 - screed rail and form hanger supports where permitted on steel units;
 - reinforcing steel to R-bars for lateral stability between prestressed beams, spirals, or bands to reinforcing bars in drilled shaft cages;
 - permanent metal deck forms;
 - additional steel added in railing when slip-form construction is used; and
 - other similar miscellaneous members that have no load-carrying capacity in the completed structure.
- 4.2.1.2. **Miscellaneous Weld Qualification Test.** A qualified welder must pass a jobsite Miscellaneous Weld Qualification Test before welding.
- Make a single-pass fillet weld of 1/4-in. maximum size in the vertical position approximately 2 in. long on 1/2-in. plate in the location shown in Figure 1. Use the same electrode proposed for the work.
 - The Engineer will visually inspect the fillet weld for a reasonably uniform appearance and then rupture the weld as shown in Figure 2 using force or by striking it with a hammer.
 - The fractured surface of the weld will be inspected to ensure complete penetration into the root of the joint, complete fusion to the base metal, and no inclusion or porosity larger than 3/32 in. in its greatest dimension.

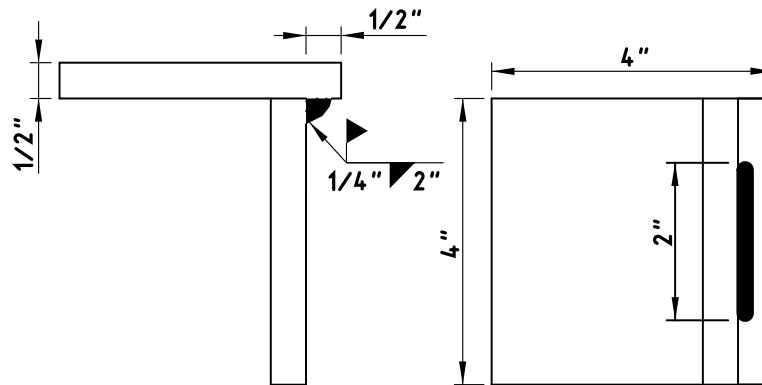


Figure 1
Miscellaneous Qualification—Fillet Weld Break Specimen

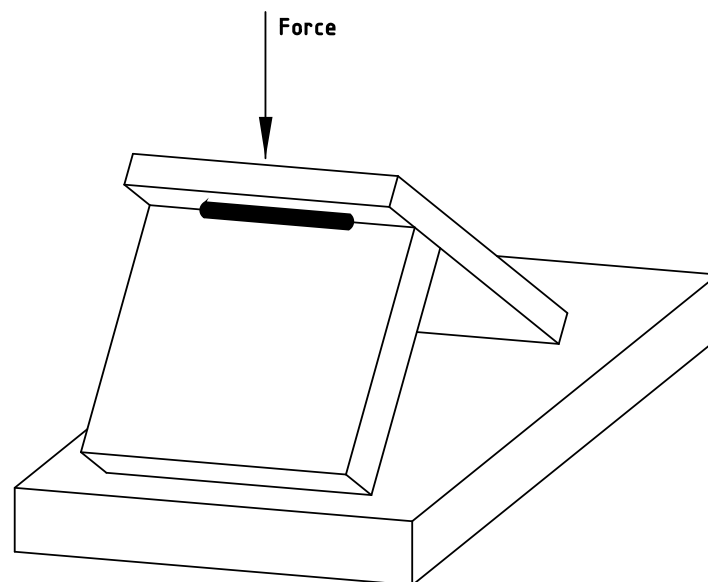


Figure 2
Miscellaneous Qualification—Method of Rupturing Specimen

A welder who fails the Miscellaneous Weld Qualification Test may retest under the following conditions.

- The retest occurs immediately and consists of two test welds as described above, with both test specimens meeting all the requirements.
- The retest occurs after 30 days if the welder provides evidence of further training or practice. In this case, the test consists of a single test weld.

Qualification by the Miscellaneous Weld Qualification Test is effective immediately upon satisfactory completion of the test and remains in effect for the duration of a project.

4.2.2.

Certified Steel Structures Welder. Before making non-miscellaneous welds on structural steel, a welder must pass the AASHTO/AWS D1.5 qualification test for groove welds for plates of unlimited thickness in the vertical (3G) and overhead (4G) positions with the following additional requirements.

- Use metal for test plates that meets Item 442, "Metal for Structures," with a minimum yield point of 36 ksi. The minimum width of test plate must be sufficient to accommodate the radiograph inspection of 5-1/4 continuous inches of the weld, not counting the ends of the weld.
- Use approved electrodes meeting the required class in accordance with Table 1 and, in the case of FCAW, in conformance with the approved WPS.
- Have a radiographic inspection performed on the weld on each test plate. Any porosity or fusion-type discontinuity with greatest dimension larger than 1/16 in. found in the weld will result in failure of the test. Discontinuities with greatest dimension less than 1/16 in. are acceptable provided the sum of their greatest dimensions does not exceed 3/8 in. in any inch of weld.
- Have two side-bend specimens prepared, tested, and inspected for each test plate.

The test must be administered by an approved laboratory and welding observed by laboratory personnel. Submit two copies of the certification issued by the laboratory, all accompanying test papers, and the radiographic films to the Bridge Division for review. The Bridge Division issues Department certification papers if the laboratory's certification is approved. A welder must also demonstrate to the Engineer a thorough knowledge of the required welding procedures together with the ability and desire to follow them and make welds of sound quality and good appearance. The certification issued by an approved laboratory is accepted for 1 mo. from the time of certification, during which time the welder may work on Department projects if the work is satisfactory. Certification papers issued by the Department remain in effect as long as the welder performs acceptable work as determined by the Bridge Division. The certification may be cancelled at any time if the welder's work is not acceptable.

For SMAW, a welder certified using EXX18 electrodes is qualified to weld with all approved SMAW electrodes up to E90XX to join metals with a maximum specified yield strength of 65 ksi.

4.3. **Welding Steel Structures.**

4.3.1. **Electrode Condition.**

- 4.3.1.1. **SMAW.** For electrodes with low-hydrogen coverings in conformance with AWS A5.1, dry to the manufacturer's written drying instructions or dry for at least 2 hr. between 450°F and 500°F. For electrodes with low-hydrogen coverings conforming to AWS A5.5, dry for at least 1 hr. between 700°F and 800°F or as specified by the electrode manufacturer. If using electrodes from a newly opened, undamaged, hermetically sealed container, drying is not required. Store electrodes in ovens held at a temperature of at least 250°F immediately after drying or removal from hermetically sealed container. Elapsed time permitted between removal of an electrode from the storage oven or hermetically sealed container and use of the electrode is shown in Table 2. If the electrodes have the moisture resistance designator "R" and are being used on steel with minimum specified yield strength of 50 ksi or less, exposure time may be increased up to 9 hr.

Table 2
SMAW Electrode Exposure Limits

Electrode Type	Exposure Time (hr.)
E70	4
E80	2
E90	1

Leave electrodes in the holding oven for at least 4 hr. at 250°F before reusing if they are placed back in it before the times shown in Table 2 have lapsed. The Engineer may reduce times allowed for use without re-drying in humid atmospheres. Do not redry electrodes more than once. Do not use electrodes with flux that has been wet, cracked, or otherwise damaged.

- 4.3.1.2. **FCAW.** Protect or store welding wire coils removed from the original package to keep their characteristics or welding properties intact. Do not use coils or portions of coils that are rusty.

- 4.3.1.3. **Special Applications.** Dry electrodes for fracture-critical applications or when welding steel not shown in Table 1 in conformance with the manufacturer's specifications and in accordance with AASHTO/AWS D1.5.
- 4.3.2. **Environmental Conditions.** Do not weld when the air temperature is lower than 20°F; when surfaces are wet or exposed to rain, snow, or wind; or when operators are exposed to inclement conditions. Provide wind breaks to protect welding operations from winds greater than 5 mph.
- 4.3.3. **Assembly and Fitup.** Verify that ends of members to be welded are prepared in conformance with the welded joint detail specified. Refer to Figures 3, 4, and 5 for proper end preparation and weld details of girder splices.

Bring the parts to be joined by fillet welds into as close contact as possible, not separated more than 3/16 in. Increase the leg of the fillet weld by the amount of the separation if the separation is 1/16 in. or more. Keep the separation between faying surfaces of lap joints and of butt joints landing on backing strips to no more than 1/16 in.

Make suitable allowance for shrinkage, and never restrain the joint on both sides in any welding process.

Use the following fitup procedure for groove welds for butt joints.

- Align splices of beams and girders joined by groove welds with the center of gravity of both cross-sections coinciding or each flange vertically offset equally. Fit beams and girders with offset webs with the webs aligned and the flanges offset laterally. Make the joint with a smooth transition between offset surfaces and with a slope of no more than 1:4 when flanges are offset or abutting parts differ in thickness or width by more than 1/8 in.
- Space members to provide a 3/16-in. root opening at the nearest point. At other points of the joint when the spacing provides up to a 7/16-in. opening, correction may be made by buildup up to 1/8 in. on each bevel nose. Rebevel openings exceeding 7/16 in. and move the parts to be joined closer together to bring the joint within the maximum buildup limits. Allow buildups to cool to the maximum preheat and interpass temperatures before welding the joint.
- Bring all members into correct alignment and hold them in position using acceptable clamps while welding.

Complete all butt splices before welding diaphragms or sway bracing in a particular section of a unit. Diaphragms and sway bracing may be welded in a unit behind the splice welding to provide stability, except where such welding interferes with butt splice adjustments, such as at a drop-in segment of a continuous unit. Complete all splices before welding beams or girders to shoes.

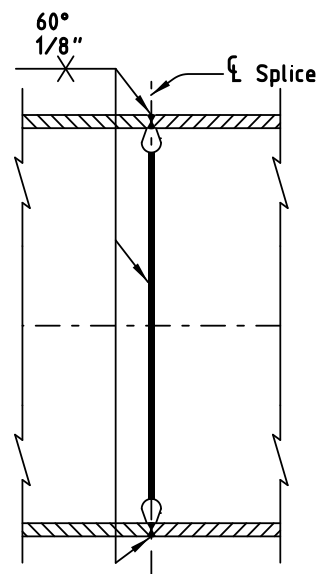


Figure 3
Girder Splice Details

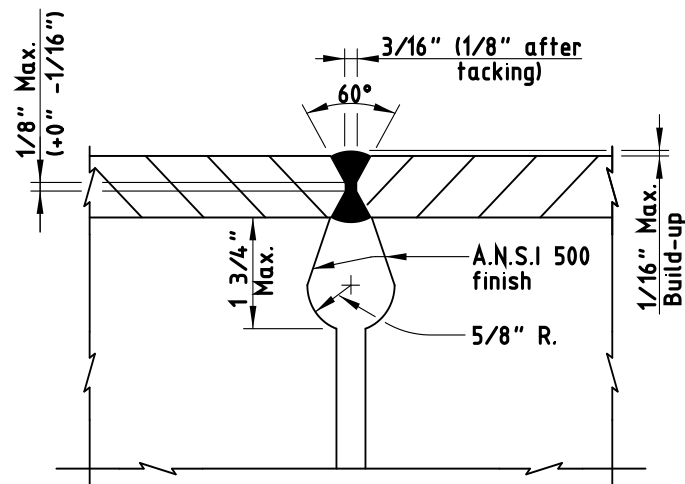


Figure 4
Girder Splice Details (Flange)

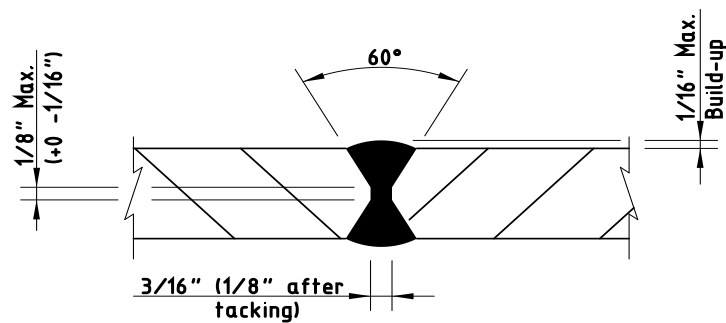


Figure 5
Girder Splice Details (Web)

- 4.3.4. **Preheat.** Preheat ahead of welding both groove and fillet welds (including tack welding) to the temperatures shown in Table 3. Keep preheat and interpass temperatures high enough to prevent cracks. The preheat temperatures shown in Table 3 are minimums, and higher preheats may be necessary in highly restrained welds. Preheat the base metal when it is below the required temperature so that parts being welded are not cooler than the specified temperature within 3 in. of the point of welding.

Measure preheat temperature on the side opposite to which the heat is applied at points approximately 3 in. away from the joint.

Completely weld a joint before allowing it to cool below the specified temperature. Always deposit enough weld to prevent cracking before allowing a joint to cool. Do not allow preheat and interpass temperatures to exceed 400°F for thickness up to 1-1/2 in. and 450°F for greater thicknesses.

Table 3
Minimum Preheat and Interpass Temperature for Welding with Low-Hydrogen Electrodes

Thickest Part at Point of Welding	Temperature
Up to 3/4 in., inclusive	50°F
More than 3/4 in. up to 1-1/2 in., inclusive	70°F
More than 1-1/2 in. up to 2-1/2 in., inclusive	150°F
More than 2-1/2 in.	225°F

Preheat the material in accordance with Table 4 when E7010 or E8010 electrodes are used for tacking or temporary root pass.

Table 4
Minimum Preheat Temperature for Welding with E7010 or E8010 Electrodes

Thickest Part at Point of Welding	Temperature
1/2 in. and less	150°F
9/16 in. through 3/4 in.	200°F
13/16 in. through 1-1/2 in.	300°F
More than 1-1/2 in.	400°F

Use preheat and interpass temperatures for the thicker plate thickness when joining steels of different thickness.

Preheat base metal to at least 70°F when the base metal temperature is below 32°F and maintain this minimum temperature during welding. Preheat base metal to 200°F before starting to weld if it is moist.

Preheat fracture-critical applications in accordance with AASHTO/AWS D1.5.

- 4.3.5. **Welding Practice.** Use an approved procedure to control shrinkage and distortion. Weld FCAW in conformance with an approved WPS. Weld as required by the Contract or erection drawings. Do not change the location or size of welds without approval. Do not make temporary welds for transportation, erection, or other purposes on main members, except as shown on the plans or approved. Use a crayon, paint, or other approved method to mark each groove weld to identify the welder who performed the work.

Use the stringer-bead technique where possible for groove welds. Progress upward in vertical welding passes using a back-step sequence, keeping the end of the low-hydrogen electrode contained within the molten metal and shield of flux unless the electrode manufacturer's specifications indicate otherwise.

Begin and terminate groove welds at the ends of a joint on extension bars. Make edge preparation and thickness of extension bars the same as that of the member being welded but extending at least 2 in. beyond the joint. Remove extension bars using a cutting torch or arc-air gouging and grind the flange edges smooth after the weld is completed and cooled. Clean any defects exposed by the grinding, fill them with weld metal, and regrind them to a uniform finish. Grind so that grind marks are parallel to the flange and avoid excess grinding of the parent metal. Clean and fuse tack welds thoroughly with the final weld. Remove defective, cracked, or broken tack welds.

Gouge, chip, or otherwise remove the root of the initial weld to sound metal for all groove welds, except those produced with the aid of backing or those on steel piling or armor joints, before welding is started on the second side. Clean the back side thoroughly before placing the backup pass. Fuse the weld metal thoroughly with the backing, and use backing that is continuous for the full length of the weld. Make a continuous length of backing by welding shorter sections together only under the following conditions.

- All splices in the backing are complete joint penetration (CJP) groove welds made with the same controls as similar CJP groove welds in the structure.
- The welds are radiographed and examined as described in Section 448.4.3.7., "Radiographic Inspection," to ensure weld soundness.
- All welding and testing of the backing are complete before the backing is used to make the structural weld.

4.3.5.1. **High-Cellulose Electrodes for Root Passes.** E7010 and E8010 electrodes may be used when welding the root passes of beam and girder splices if the work is preheated in accordance with Table 4. Remove the E7010 or E8010 electrode pass completely by arc-air gouging and replace it using a low-hydrogen electrode after the root passes are backed up.

4.3.5.2. **Welding Sequence.** Make beam and girder splices using the sequences shown in Figure 6. (Some members will require fewer or more passes than Figure 6 shows.) Alternate welds from flat to overhead to prevent heat buildup along bevel edge. Arrange the passes between the top and bottom flange to maintain balance and symmetry.

Place passes 1, 2, and 3 in the top flange, followed by passes 4, 5, and 6 in the bottom flange (Figure 6) for rolled I-beams and built-up girders. Gouge out and replace passes 1 and 4, which always are placed in the overhead position. Next, place passes 7, 8, and 9 in the top flange, followed by passes 10, 11, and 12 in the bottom flange. Continue with placing passes 13–17 in the top flange, followed by passes 18–22 in the bottom flange. Continue to alternate welding between top and bottom flange with at most five passes per flange until the flange splices are complete. Tack weld web after aligning girder webs with short tacks as required to obtain proper alignment. Place pass 23 and pass 24 on the web. Gouge out and replace pass 23. Finish web splice with pass 25.

Remove all slag for each layer, bead, and the crater area, and clean the weld and adjacent base metal before welding over previously deposited metal. Avoid arc strikes, and if they occur, grind resulting cracks and blemishes out to a smooth contour, checking them visually to ensure soundness.

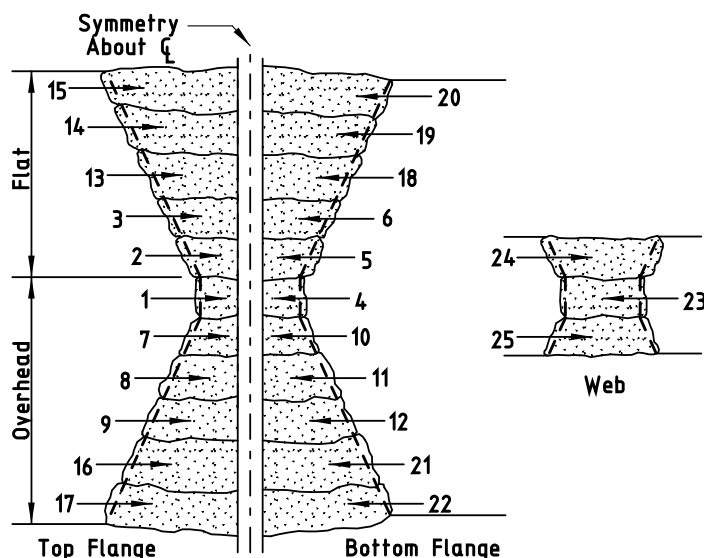


Figure 6
Welding Sequence for Splices for Material up to 50,000-psi Yield Strength

Deviation from the above sequence of weld passes requires approval. Obtain approval from the Bridge Division for welding procedures and sequences for special connections.

4.3.5.3. **Electrode Size and Weld Layer Thickness.**

4.3.5.3.1. **SMAW.**

4.3.5.3.1.1. **Electrode Size.** Use electrodes with the following maximum size:

- 1/4 in. for all welds made in the flat position except root passes,
- 1/4 in. for horizontal fillet welds,
- 1/4 in. for root passes of fillet welds made in the flat position and of groove welds made in the flat position with backing and with a root opening of 1/4 in. or more,
- 5/32 in. for welds made with low-hydrogen electrodes in the vertical and overhead positions, and
- 3/16 in. for all other welds.

4.3.5.3.1.2. **Weld Size and Layer Thickness.** Make the root pass large enough to prevent cracking. Make layers subsequent to the root pass in fillet welds and all layers in groove welds of the following maximum thickness:

- 1/4 in. for root passes of groove welds,
- 1/8 in. for subsequent layers of welds made in the flat position, and
- 3/16 in. for subsequent layers of welds made in the vertical, overhead, and horizontal positions.

Make fillet weld passes using no larger than:

- 3/8 in. in the flat position,
- 5/16 in. in the horizontal or overhead positions, and
- 1/2 in. in the vertical position.

4.3.5.3.2. **FCAW.**

4.3.5.3.2.1. **Electrode Size.** Use electrodes with the following maximum size:

- 5/32 in. for the flat and horizontal positions,
- 3/32 in. for the vertical position, and
- 5/64 in. for the overhead position.

4.3.5.3.2.2. **Weld Size and Layer Thickness.** Make weld layers, except root and surface layers, no thicker than 1/4 in. Use a multiple-pass split-layer technique when the root opening of a groove weld is 1/2 in. or wider. Use the split-layer technique to make all multiple-pass welds when the width of the layer exceeds 5/8 in.

Ensure each pass has complete fusion with adjacent base metal and weld metal and that there is no overlap, excessive porosity, or undercutting.

Do not use FCAW with external gas shielding in a draft or wind. Furnish an approved shelter of material and shape to reduce wind velocity near the welding to a maximum of 5 mph.

Make fillet weld passes using no larger than:

- 1/2 in. in the flat position,
- 3/8 in. in the horizontal or overhead positions, and
- 5/16 in. in the vertical position.

4.3.6. **Weld Quality.** Provide welds that are sound throughout, with no cracks in the weld metal or weld pass. Completely fuse the weld metal and the base metal and each subsequent pass. Keep welds free of overlap and keep the base metal free of undercut more than 1/100 in. deep when the direction of undercut is transverse to the primary stress in the part that is undercut. Fill all craters to the full cross-section of the welds.

- 4.3.7. **Radiographic Inspection.** Conduct radiographic testing (RT) as required in the field, at the expense of the Contractor, by an agency or individual registered and licensed to perform industrial radiography. Follow all applicable rules and regulations for radiographic operations. Testing includes furnishing all materials, equipment, tools, labor, and incidentals necessary to perform the required testing. The Department may require further tests in accordance with Article 5.10., "Inspection," and may perform additional testing, including other methods of inspection.

Perform RT in accordance with AASHTO/AWS D1.5. The Engineer will examine and interpret the resulting radiographs in accordance with AASHTO/AWS D1.5. All radiographs become the property of the Department and remain with the Engineer.

Radiographically inspect the full flange width of all flange splices and the top and bottom 1/6 of the web at each splice for field welds of splices in beams or girders. Radiographically retest repaired welds. Make necessary repairs before any further work is done. Additional RT required because of unacceptable welding or poor radiograph quality is at the Contractor's expense. RT of particular welds shown on the plans is in addition to the RT required by this Item.

Meet the requirements specified in Section 441.3.2.5.1., "Radiographic Testing (RT)," for radiograph film quality.

- 4.3.8. **Corrections.** When welding is unsatisfactory or indicates inferior workmanship, the Engineer will require corrective measures and approve the subsequent corrections.

Use oxygen gouging or arc-air gouging when required to remove part of the weld or base metal. Back-gouge splices in beams and girders or cut out defective welds using arc-air gouging by a welder qualified to make beam and girder splices.

Slope the sides of the area to be welded enough to permit depositing new metal where corrections require depositing additional weld metal.

Use a smaller electrode than that used for the original weld where corrections require depositing additional weld metal. Clean surfaces thoroughly before re-welding.

Remove cracked welds completely and repair. Remove the weld metal for the length of the crack if crack length is less than half the length of the weld plus 2 in. beyond each end of the crack, and repair.

Restore the original conditions where work performed after making a deficient weld has made the weld inaccessible or has caused new conditions making the correction of the deficiency dangerous or ineffectual by removing welds, members, or both before making the necessary corrections; otherwise, compensate for the deficiency by performing additional work in conformance with a revised and approved design.

Cut apart and re-weld improperly fitted or misaligned parts.

Straighten members distorted by the heat of welding using mechanical means or the carefully supervised application of a limited amount of localized heat. Do not let heated areas exceed 1,200°F as measured by temperature-indicating crayons or other approved methods for steel up to 65,000-psi yield strength. Do not let heated areas exceed 1,100°F for higher-strength steels. Keep parts to be heat-straightened substantially free of stress from external forces except when mechanical means are used with the application of heat. Before straightening, submit a straightening procedure to the Engineer for approval.

Correct defective or unsound welds either by removing and replacing the entire weld or as follows.

- 4.3.8.1. **Excessive Convexity.** Reduce to size by grinding off the excess weld metal, leaving a smooth profile.

- 4.3.8.2. **Shrinkage Cracks, Cracks in Base Metal, Craters, and Excessive Porosity.** Remove defective portions of base and weld metal down to sound metal, and replace with additional sound weld metal.

- 4.3.8.3. **Undercut, Undersize, and Excessive Concavity.** Clean and deposit additional weld metal.
- 4.3.8.4. **Overlap and Incomplete Fusion.** Remove and replace the defective portion of weld.
- 4.3.8.5. **Slag Inclusions.** Remove the parts of the weld containing slag, and replace them with sound weld metal.
- 4.3.8.6. **Removal of Base Metal During Welding.** Clean and form full size by depositing additional weld metal using stringer beads.
- 4.4. **Shear Stud Welding.** Weld shear studs to steel surfaces and perform preproduction and production tests as required in AASHTO/AWS D1.5.
- 4.5. **Welding Reinforcing Steel.** Splice reinforcing steel by welding only at locations shown on the plans. Before welding galvanized rebar, remove the zinc coating at least 1 in. from either side of the intended weld zone by grinding or equivalent means. After welding, repair the galvanized zinc coating damage in the welded area in accordance with Item 445, "Galvanizing."
- 4.5.1. **Base Metal.** Provide weldable reinforcing steel in accordance with Item 440, "Reinforcement for Concrete."
- 4.5.2. **Preheat and Interpass Temperature.** Minimum preheat and interpass temperatures are shown in Table 5. Preheat reinforcing steel when it is below the listed temperature for the size and carbon equivalency range of the bar being welded so that the cross-section of the bar is above the minimum temperature for at least 6 in. on each side of the joint. Allow bars to cool naturally to ambient temperature after welding is complete. Do not accelerate cooling.

Table 5
Minimum Preheat and Interpass Temperature for Reinforcing Steel

Carbon Equivalent Range (%)	Size of Reinforcing Bar (No.)	Temperature (°F)
Up to and including 0.40	Up to 11 inclusive	None
	14 and 18	50
0.41 through 0.45 inclusive	Up to 11 inclusive	None
	14 and 18	100
0.46 through 0.55 inclusive	Up to 6 inclusive	None
	7 to 11 inclusive	50
	14 and 18	200
Unknown	Up to 18 inclusive	500

Base the preheat and interpass temperatures for widening projects on the existing reinforcing steel and the requirements shown in Table 5.

- 4.5.3. **Joint Types.** Use butt splices for all No. 7 and larger bars. Use lap splices for No. 6 and smaller bars.

Make groove welds in lap splices at least 4 in. long and weld them on each side of the lap joint as shown in Figure 7. For No. 5 and smaller bars, weld from one side of the lap when it is impractical to weld from both sides of the joint if approved, but in this case make the weld at least 6 in. long.

Make all butt splices in the flat position. Make all welds for butt splices, except horizontal welds on vertical bars, as shown in Figures 8 and 9. The backup strip is required when access to the splice is from the top only. When bars can be rotated or access to the splice is available from two sides, the double V-groove splice may be used, and this type of weld requires gouging out the root pass similar to a flange splice on structural steel. The root pass may be made using E7010 or E8010 electrodes for all double V-groove splices. Preheat the steel to 400°F, if using E7010 or E8010 electrodes, and then completely remove the root pass before welding the opposite side. Make horizontal splices on vertical bars as shown in Figure 10. Provide alignment strips as shown in Figures 9 and 10 to hold bars during welding operation. Trim alignment strips after welding is complete.

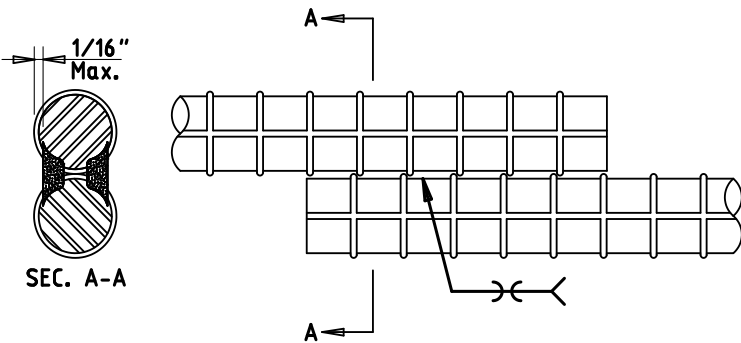


Figure 7
Direct Lap Joint with Bars in Contact

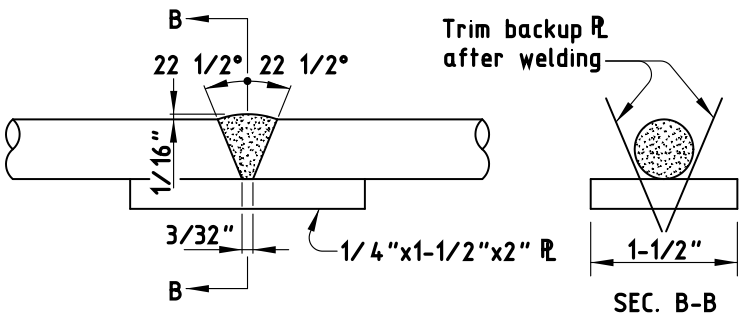


Figure 8
Single V-Groove Weld in Horizontal Position

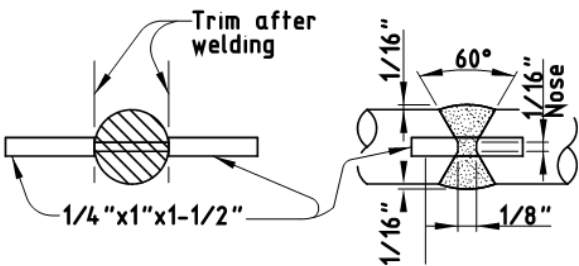


Figure 9
Double V-Groove Weld in Horizontal Position

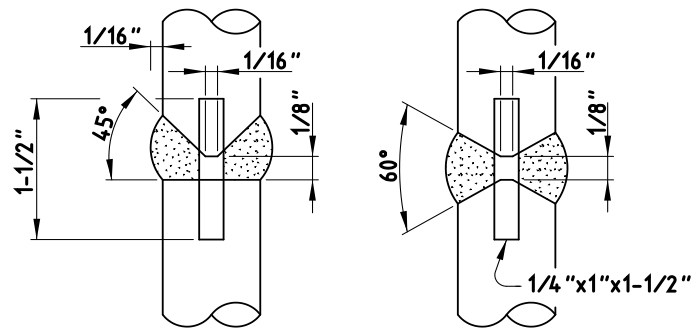


Figure 10
Double Bevel and Double V-Groove Welds in Vertical Position

- 4.5.4. **Radiographic Inspection.** Radiograph welded butt splices at the expense of the Contractor when designated on the plans. Follow all applicable rules and regulations for radiographic operations. Ensure welds have no cracks and that the sum of the greatest dimensions of porosity and fusion-type defects do not exceed 1/10 of the nominal bar diameter.

The Engineer will examine and interpret the resulting radiographs, which become the property of the Department and remain with the Engineer.

5. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

Item 449

Anchor Bolts



1. DESCRIPTION

Fabricate and install anchor bolts to be embedded in or attached to concrete. Anchor bolts are also referred to as anchor rods.

2. MATERIALS

- 2.1. **Bolts and Nuts.** Provide bolts and nuts that meet the standards shown in Table 1.

Table 1
Bolt and Nut Standards

Specified Anchor Bolt Category	Bolt Standards	Nut Standards
Mild steel	ASTM A307 Grade A, F1554 Grade 36, or A36	ASTM A563
Medium-strength, mild steel	ASTM F1554 Grade 55 with supplementary requirement S1	ASTM A194 Grade 2 or A563 Grade D or better
High-strength steel	ASTM F3125 Grade A325 or ASTM A449 ¹	ASTM A194 or ASTM A563, heavy hex
Alloy steel	ASTM A193 Grade B7 or ASTM F1554 Grade 105	ASTM A194 Grade 2H or ASTM A563 Grade DH, heavy hex

1. If headed bolts are specified, ASTM A449 bolts must be heavy hex head.

Provide a mill test report or manufacturer's certification indicating the material conforms to these requirements. For alloy steel anchor bolts, provide a test report or certification attesting to the heat-treating process if applicable. If no specific bolt category is shown on the plans, provide mild steel anchor bolts and nuts that meet the standards shown in Table 1.

- 2.2. **Washers.** Use washers that meet ASTM F436.

- 2.3. **Threads.** Provide anchor bolts with rolled or cut threads of UNC or 8UN series in accordance with ASME B1.1. Anchor bolts 1 in. in diameter and smaller and 1-3/4 in. in diameter and larger must have UNC series threads. If bolts have rolled threads, ensure the diameter of the unthreaded portion of bolts with rolled threads is at least the minimum pitch diameter and no greater than the maximum major diameter of the threads. If bolts have cut threads, ensure the diameter of the unthreaded portion is at least the minimum major diameter of the threads. Ensure all threads for bolts and nuts have Class 2 fit tolerances in accordance with ASME B1.1.

3. CONSTRUCTION

- 3.1. **Fabrication.** Welded splicing of anchor bolts is not permitted.

Provide an anchorage device with each anchor bolt consisting of a standard bolt head, a threaded bolt with nuts, or, if shown on the plans, a 90° bend. Make the inside-bend diameter approximately two times the anchor bolt diameter, but at no point along the bend greater than three times the bolt diameter. Hot bending is permissible provided the temperature does not exceed 1,100°F.

When embedded templates are not specified and nuts are welded to the end of anchor bolts for anchorage, weld only on the nut face at the unstressed end of the bolt. Ensure no welding, arc, or other potential notch-producing effects occur in the stressed portion of the bolt.

Shipping of the anchor bolt cage in its assembled condition is not required.

3.2. **Finish.** Hot dip galvanize in accordance with Item 445, "Galvanizing."

3.2.1. **Anchor Bolts Embedded in Concrete.** Galvanize the exposed end of the thread length plus a minimum of 6 in. unless otherwise shown on the plans.

3.2.2. **Anchor Bolts Extending Through Concrete.** Galvanize the complete length of the bolt.

3.2.3. **Nuts.** Galvanize exposed nuts. Galvanize the untapped blanks before cutting the threads.

3.2.4. **Washers.** Galvanize exposed washers.

3.3. **Installation.** Hold the anchor bolt and template assembly rigidly in position during concrete placement. Use wood templates or other positive means to ensure correct positioning of anchor bolts not requiring steel templates. Positioning devices may be tack welded to the steel templates but not to any portion of the anchor bolts.

3.3.1. **Anchor Bolt Thread Lubricant Coating.** Coat anchor bolt threads before installing nuts using an electrically conducting lubricant compound described in Section 449.3.3.2.1., "Definitions," for traffic signal poles, roadway illumination poles, high mast illumination poles, intelligent transportation system (ITS) poles, steel electrical service supports, and overhead sign support structures. Coat anchor bolt threads for other structures with pipe joint compound or beeswax. After installing nuts, repair galvanizing damage on bolts, nuts, and washers in accordance with Section 445.3.4., "Repairs."

3.3.2. **Anchor Bolt Tightening Procedure.** Tighten anchor bolts for traffic signal poles, shoe base and concrete traffic barrier base roadway illumination poles, high mast illumination poles, ITS poles, steel electrical service supports, and overhead sign support structures in accordance with this Section. This procedure covers the tightening of nuts on a double-nut anchor bolt system using anchor bolts with 55-ksi or 105-ksi minimum yield strength and UNC or 8UN thread series to secure structures to drilled shaft foundations.

3.3.2.1. **Definitions.** The following definitions apply to the anchor bolt tightening procedure.

- **Double-Nut Anchor Bolt System.** An anchor bolt with two nuts that sandwich the structure's base plate. The bottom nut is positioned under the base plate to level, support, and provide the reaction for the force applied by tightening the top nut positioned above the base plate.
- **Electrically Conducting Lubricant.** A compound commonly used in the electrical industry to coat threads of field-cut rigid metal conduit and suitable for exposure to weather.
- **Impact Tightening.** The tightening of nuts using a box-end "slug" or "knocker" wrench and a sledgehammer. The wrench, matching the size of the nut to be tightened, is driven with the sledgehammer to rotate the nut.
- **Static Tightening.** The tightening of nuts using a "spud" wrench and a pipe or extension handle. The wrench, matching the size of the nut to be tightened, may be turned using more than one worker to rotate the nut.
- **Snug-Tight.** The condition when the nut is in full contact with the base plate. It may be assumed the full effort of a worker on a 12-in. wrench results in a snug-tight condition.
- **Turn-of-the-Nut Method.** The tightening of top nuts to snug-tight condition, then establishing reference positions by marking one flat on each nut with a corresponding reference mark on the base plate at each bolt. Each nut is then turned to the prescribed rotation from the referenced snug-tight position.

3.3.2.2. **Anchor Bolt Tightening.** Perform the following procedure.

- Coat the threads of the anchor bolts with electrically conducting lubricant.
- Install the bottom nuts on the bolts, one on each bolt.

- Level the top template (using it as a guide) by adjusting the bottom nuts so the template rests on each nut and the distance between the top of the concrete shaft and the bottom surface of the bottom nut is approximately 1/2 in.
- Remove the template.
- Coat the bearing surfaces of the bottom nuts and washers with electrically conducting lubricant.
- Install bottom washers on bolts, one on each bolt.
- Erect and plumb the structure as specified. Adjust the bottom nuts so each is bearing equally on the washer or base plate. The truss for cantilever overhead sign support structures and the mast arm for traffic signal poles must be removed during anchor bolt tightening.
- With the plumbed structure supported by a crane, coat the bearing surfaces of the top nuts and washers with electrically conducting lubricant. Install one washer and one top nut on each bolt. Turn the top nuts onto the bolts so each is hand-tight against the washer or base plate.
- Turn each bottom nut to a snug-tight condition using a wrench.
- Verify the structure is still plumb and still supported by the crane. Begin turn-of-the-nut method by turning each top nut down to the same snug-tight condition. Prevent rotation of the bottom leveling nut during all top nut tightening. Establish reference marks for turn-of-the-nut method once snug-tight condition is achieved, and then tighten the top nuts by turning each nut 1/12 turn (1/2 of a nut flat) past snug-tight using either static or impact tightening. Turn each top nut an additional 1/12 turn until each nut has been tightened 1/6 total turn past snug-tight.

4.**MEASUREMENT AND PAYMENT**

Top or bottom templates, washers, lock washers, nuts, lock nuts, and other devices used for installing anchor bolts are considered part of the anchor bolt assembly. All work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent items.

Item 450

Railing



1. DESCRIPTION

Construct railing of concrete, steel, aluminum, or a combination of these materials, including necessary anchorage for the railing on bridges, culverts, walls, or other structures as shown on the plans.

2. MATERIALS

Use materials that conform to requirements of the following Items.

- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 540, "Metal Beam Guard Fence"

Provide an approved Type III, Class C epoxy or an epoxy of the type and class shown on the plans where epoxy anchors are allowed or required for installing drilled and epoxied rail anchorage reinforcement or rail anchor bolts in accordance with [DMS-6100](#), "Epoxies and Adhesives." Use other materials if shown on the plans. Provide only dual-cartridge epoxy systems mixed with a static mixing nozzle supplied by the epoxy adhesive manufacturer and dispensed using a tool supplied by the epoxy adhesive manufacturer. Do not use bulk epoxies. Drill and install anchorage reinforcement or anchor bolts to the embedment depth shown on the plans or the depth the manufacturer recommends, whichever is deeper. No additional payment will be made for providing embedment deeper than shown on the plans. Select an embedment depth capable of developing the yield strength of the steel anchor based on the product literature for the epoxy and steel anchor being used if no resistance or embedment depth is shown on the plans. Use 60 ksi as the yield strength for reinforcing steel.

3. CONSTRUCTION

Construct railing in compliance with details, alignment, and grade shown on the plans. Do not place railing until falsework or formwork, if any, for the span has been released unless otherwise directed. Adhere to the schedule restrictions for placing bridge rails and opening to construction traffic in accordance with Item 422, "Concrete Superstructures." Notify the Engineer after completion of the following steps and obtain approval of work before proceeding to the next step: placing rail reinforcement and pre-pour clear cover checks.

Ensure expansion joints in the railing will function properly before placing concrete.

Furnish either steel or aluminum, but not both, for the entire Contract if the plans allow either steel or aluminum options for a particular railing type.

Install epoxy adhesive anchorages in conformance with the manufacturer's instructions, including hole size, drilling equipment and method, hole cleaning equipment and method, mixing and dispensing epoxy, and anchor insertion. Do not alter the manufacturer's mixing nozzle or dispenser. Anchorage bars or bolts must be clean and free of grease, oil, or any other foreign material. Demonstrate hole cleaning method to the Engineer for approval and continue the approved process for all anchorage locations. Do not weld to an anchor bar or anchor bolt that is anchored with epoxy adhesive. Do not expose rail to traffic until epoxy adhesive has obtained full cure in conformance with manufacturer's specifications.

3.1. Metal Railing.**3.1.1. General.** Furnish metal beam rail elements in accordance with Item 540.

Fabricate and erect metal railing in accordance with the pertinent provisions of Item 441 and this Item.

Prepare and submit for approval the required shop or erection drawings in accordance with Item 441 when shown on the plans. Show all splice locations and details on the shop or erection drawings. Splice members only as shown on the plans.

Field-weld when required in accordance with Item 448, "Structural Field Welding."

3.1.2. Fabrication. Fabrication plants that produce metal railing (steel and aluminum) must be approved in accordance with [DMS-7395](#), "Metal Railing Fabrication Plant Qualification." This required approval does not include fabricators of chain link fence. The Department maintains an MPL of approved fabrication plants of metal railing.

Permanently mark each metal railing post base plate, at a visible location when erected, with the fabrication plant's insignia or trademark. For fabricated rail panels, provide this permanent mark on one post base plate per panel.

Fabricate metal railing and post panels in sections conforming to the details shown on the plans and field-verified lines and grades. Fabricate adjacent sections so they will accurately engage each other in the field. Match-mark each pair of sections so they can be erected in the same position in which they were fabricated.

Fabricate metal rail elements included as part of the railing system to the dimensions and cross-sections shown on the plans and within a tolerance of 1/4 in. per 10 ft. in the straightness of either edge. Connect metal rail elements to the rail posts as shown on the plans, lapping metal rail elements in the direction of traffic in the adjacent lane. Bolts and nuts for metal railing should meet requirements of ASTM A307 and be galvanized in accordance with Item 445, unless otherwise shown on the plans.

Fabricate stainless steel railing in accordance with AWS D1.3. Fabricate aluminum railing in accordance with AWS D1.2.

When required, heat aluminum materials to a temperature up to 400°F for no more than 30 min. to facilitate bending or straightening.

3.1.3. Corrosion Protection. Galvanize all portions of steel railing after fabrication in accordance with Item 445, unless otherwise shown on the plans. Apply appearance coat to galvanized surface in accordance with Item 445 when shown on the plans. Repair any damage to galvanized or painted surfaces after erection in accordance with Item 445 and Item 446, "Field Cleaning and Painting Steel," respectively.

Before final acceptance, clean surfaces of aluminum and galvanized steel railing not shown to be painted to remove extrusion marks, grease, dirt, and all other surface contaminants.

3.1.4. Storage and Shipping. Store railing materials above the ground on platforms, skids, or other supports, and keep them free of grease, dirt, and contact with dissimilar metals. Avoid scratching, marring, denting, discoloring, or otherwise damaging the railing. Properly ship railing materials in a manner to avoid damage.**3.2. Concrete Railing.** Provide concrete portions of railing in accordance with the requirements of Item 420, "Concrete Substructures," and Item 422, "Concrete Superstructures." Construct forms so the railing line and grade can be checked after the concrete has been placed but before initial set. Do not disturb the form alignment during finish floating of the railing tops. Exercise particular care in other construction to avoid disturbing or vibrating the span with the newly placed railing.

Provide precast members conforming to Item 424, "Precast Concrete Structural Members (Fabrication)."

Slipform construction of railing is permitted unless otherwise shown on the plans. Demonstrate slipforming method showing line and grade of concrete surfaces can be consistently obtained and clear cover outside reinforcing steel be maintained at all times. Stop slipforming railing if specified concrete clear cover is not obtained or appearance of rail is off line and grade.

Do not slipform railing with cast-in-place anchor bolts unless noted otherwise.

Provide additional reinforcing as needed to prevent movement of the reinforcement cage. Clear cover and epoxy coating requirements for additional reinforcement are the same as those shown for the rail reinforcement. The rail reinforcing cage may be tack welded to the rail anchorage reinforcement provided the rail and anchorage reinforcement are not epoxy-coated and weld locations measured along the rail are no closer than 3 ft. Tie all bar intersections if epoxy-coated reinforcement is required for the railing proposed to be slipformed. Provide a wire line to maintain vertical and horizontal alignment of the slipform machine. Attach a grade line gauge or pointer to the machine so a continuous comparison can be made between the rail being placed and the established grade line. Rails or supports at the required grade are allowed instead of sensor controls. Make one or more passes with the slipform over the rail segment to ensure proper operation and maintenance of grades and clearances before placing concrete. Provide slipformed rail within a vertical and horizontal alignment tolerance of $\pm 1/4$ in. per 10 ft. Construct rail with a smooth and uniform appearance. Consolidate concrete so it is free of honeycomb. Provide concrete with a consistency that will maintain the shape of the rail without support. Minimize starting and stopping of the slipform operation by ensuring a continuous supply of concrete.

Do not exceed the manufacturer's recommended speed for the slipform machine. Stop slipforming and take remedial action if slipforming causes movement of the reinforcement such that plan clearances are not achieved. Remove and replace unsatisfactory slipformed rail at the Contractor's expense.

- 3.3. **Tests.** Metal beam rail elements may be sampled in accordance with [Tex-713-I](#). The Engineer may sample bolts and nuts in accordance with [Tex-708-I](#) for galvanized coating testing.

The Engineer will select five anchor bars or bolts from the first day's production to be tested after the epoxy has cured. Test the bars or bolts in the presence of the Engineer in accordance with ASTM E1512, using a restrained test, to evaluate the epoxy adhesive's bond strength. Verify the anchor bars or bolts develop the required pullout resistance on the plans or 75% of the yield strength of the bars or bolts, whichever is less, without a bond failure of the epoxy. The Engineer may require additional tests during production. Perform corrective measures to provide adequate capacity if any of the tests do not meet the required test load. Repair damage from testing.

4. MEASUREMENT

This Item will be measured by the foot.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Railing" of the type specified. This price is full compensation for furnishing, preparing, and placing concrete, expansion joint material, reinforcing steel, structural steel, aluminum, cast steel, pipe, anchor bolts or bars, testing of epoxy anchors, and all other materials required in the finished railing; removal and disposal of salvageable materials; and hardware, paint and painting of metal railing, galvanizing, equipment, labor, tools, and incidentals.

Item 454

Bridge Expansion Joints



1. DESCRIPTION

Furnish and install bridge expansion joints.

2. MATERIALS

Provide materials in accordance with the requirements of the following Items.

- Item 442, "Metal for Structures"
- [DMS-6140](#), "Polymer Concrete for Bridge Joint Systems"
- [DMS-6310](#), "Joint Sealants and Fillers"
- ASTM D5973

Use primers recommended by the manufacturer of the sealant when required. Provide backer rods that are circular and are 25% larger than the joint opening. Use backer rods compatible with the sealant that do not react with or bond to the sealant.

3. CONSTRUCTION

Place expansion joints to conform to the finished grade of the roadway surface. Set the joint opening at the dimension shown on the plans for 70°F, adjusted for the temperature at the time of installation. Place the seal for the full length of the joint for sealed joint openings and, when required, extend it into the parapet wall on the low side or sides of the bridge.

- 3.1. **Sealed Expansion Joint (SEJ).** Choose an approved joint system that conforms to the joint type and the design requirements shown on the plans. Secure each side of the joint by welding it to the adjacent reinforcing steel or other attachments as approved. Remove any connection holding the joint halves together immediately after each joint half is secured in place. Install the neoprene seal as a continuous piece to form a watertight seal.

- 3.2. **Armor Joint.** Place steel armor plates as shown on the plans. Secure each side of the joint by welding it to adjacent reinforcing steel or other attachments as approved. Remove any connection holding joint halves together immediately after each joint half is secured in place.

Seal the joint when specified. Abrasive blast clean the vertical faces of the steel plates where the sealant will be in contact to remove all visible rust, paint, mill scale, and other forms of contamination, leaving a white metal appearance. Clean the concrete in contact with the sealant by an approved method in conformance with the manufacturer's specifications before placing sealant. After cleaning, air blast the joint to remove all dust. Place sealant in conformance with the manufacturer's specifications and as shown on the plans. Repair damage to paint protection system above the seal when shown on the plans for steel armor plates to be painted.

- 3.3. **Header-Type Expansion Joint.** Meet with the manufacturer's representative and the Engineer to discuss the required installation procedures of the materials before beginning the work. Perform the work in conformance with the manufacturer's printed instructions and as discussed in the meeting. Additionally, the Engineer may request the presence of the manufacturer's representative for additional training if work personnel are not adequately following manufacturer's installation directions.

- 3.3.1. **Header.** Provide an approved polymer concrete in accordance with [DMS-6140](#). Create the required void in the concrete surface or asphalt overlay to accept the header material as shown on the plans. Extend the depth of the void in the asphalt overlay to sound concrete. Remove any unsound steel or concrete and repair concrete in accordance with Item 429, "Concrete Structure Repair," and Item 785, "Bridge Joint Repair or Replacement." Use header material as repair material only when approved. Clean the voided region of all materials that could inhibit the bond between the header material and concrete or steel. Form the joint opening to the required width shown on the plans.

Place materials once approved. Place material on a clean, sound, and dry base when the ambient temperature is at least 45°F and rising or as required by the manufacturer. Do not place material on wet substrate or when raining.

Cure for the duration required by the manufacturer's data sheets before opening to traffic.

Tool or grind the upper corner of the header adjacent to the opening to a 1/4-in. radius.

- 3.3.2. **Sealant.** Provide an approved Class 1 or Class 7 joint sealant in accordance with [DMS-6310](#), unless otherwise shown on the plans. Clean the joint opening of forming material, existing seal, and other material that will inhibit the bond between the header material and the sealant. Abrasive blast clean surfaces in contact with the sealant. Place an approved backer rod and the sealant as shown on the plans and in conformance with the manufacturer's specifications. Apply the primer, when required, at the specified rate and time interval before placing the sealant. Apply the sealant to dry joint surfaces unless otherwise recommended by the sealant manufacturer. Place primer and sealant when ambient temperature is rising and is between 55°F and 85°F to provide for adequate joint opening and compression of the sealant during curing. Tool any sealant material that is not self-leveling to force the sealant against the joint surfaces.

- 3.4. **Foam-Type Joint Seal.** Meet with the manufacturer's representative and the Engineer to discuss the required installation procedures for the materials before beginning the work. Perform the work in conformance with the manufacturer's printed instructions and as discussed in the meeting. Additionally, the Engineer may request the presence of the manufacturer's representative for additional training if work personnel are not adequately following the manufacturer's installation directions. Measure all joint openings and size the width of the seal in conformance with the manufacturer's specifications.

Provide one of the systems shown on the plans with materials meeting the following:

- ultraviolet stable polymer-impregnated foam body,
- rated for $\pm 50\%$ contraction or expansion of joint opening,
- adhered to expansion joint surfaces with epoxy adhesive,
- factory-attached traffic-grade silicone with minimum thickness of 0.07 in. on upper surface,
- compatible field-installed silicone caulk to attach silicone top to joint edges and for splicing,
- pre-compressed system for field installation, and
- a range of widths of joint seals to ensure the joint seal is in compression after installation is complete.

- 3.5. **Type "A" Joint.** Provide an approved Class 7 silicone joint sealant in accordance with [DMS-6310](#), unless otherwise shown on the plans. Clean the joint opening of forming material, existing seal, and other material that will inhibit bond between the header material and the sealant. Abrasive blast clean surfaces in contact with the sealant. Place an approved backer rod, pre-formed bituminous fiber material, and sealant as shown on the plans and in conformance with the manufacturer's specifications. Apply the primer, when required, at the specified rate and time interval before applying the sealant. Apply the sealant to dry joint surfaces unless otherwise recommended by the sealant manufacturer. Place primer and sealant when ambient temperature is rising and is between 55°F and 85°F to provide for adequate joint opening and compression of the sealant during curing. Tool any sealant material that is not self-leveling to force the sealant against the joint surfaces.

4. MEASUREMENT

SEJs, armor joints, foam-type joint seals, and Type "A" joints will be measured by the foot. Header-type expansion joints will be measured by the cubic foot of header material and foot of sealant. Length measurement will be along the centerline of the joint at the surface of the roadway and up into the parapet. Calculate volume for header-type expansion joints using the length and width shown on the plans and the header depth measured in place.

SEJs, armor joints, foam-type joint seals, and Type "A" joints are a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Sealed Expansion Joint" of the size (minimum total movement capacity) and designation specified, "Armor Joint," "Armor Joint (With Seal)," "Foam Seal," "Type A," and "Header-Type Expansion Joint." Sealing the joint will be subsidiary to these items with the exception of the header-type expansion joint. This price is full compensation for furnishing and installing the joint systems, including steel, and for materials, tools, equipment, labor, and incidentals.

For "Header-Type Expansion Joint," header material will be paid for at the unit price bid for "Header-Type Expansion Joint," and the sealant will be paid for at the unit price bid for "Joint Sealant." This price is full compensation for furnishing and installing the joint systems and for materials, tools, equipment, labor, and incidentals.

Item 458

Waterproofing Membranes for Structures



1. DESCRIPTION

Furnish and place waterproofing membranes on concrete and steel bridge decks of railroad and other types of structures.

2. MATERIALS

2.1. **Materials to be Furnished.** Furnish waterproofing materials listed below in accordance with [DMS-6300](#), "Waterproofing":

- asphalt for mopping above ground,
- asphalt for mopping below ground,
- asphaltic primer,
- treated cotton fabric,
- self-adhering polyethylene,
- coal-tar modified urethane,
- rubberized asphalt with pre-formed board membrane,
- asphalt plank,
- asphalt mat,
- rubberized asphalt with plastic film,
- asphaltic panels,
- plastic cement, and
- cold asphalt base emulsion.

Furnish butyl rubber membrane and ethylene-propylene-diene terpolymer (EPDM) sheeting in accordance with ASTM D6134.

Deliver materials requiring sampling and testing to the worksite at least 3 weeks before use. Test and obtain approval for waterproofing materials before delivery to the worksite when authorized.

2.2. **Types.** Provide the following types of waterproofing as shown on the plans or as directed.

2.2.1. **Type 1.** Butyl rubber membrane applied to a surface with a proper adhesive without protective planking and as shown on the plans. Provide a minimum thickness of 1/16 in. unless otherwise shown on the plans.

2.2.2. **Type 2.** A single asphaltic primer coat and one mopping of asphalt.

2.2.3. **Type 3.** A single asphaltic primer coat and two moppings of asphalt. Supplement with two layers of treated cotton fabric with a third mopping of asphalt placed over the outer layer of fabric at construction joints of foundation structures as shown on the plans.

2.2.4. **Type 4.** Self-adhering polyethylene with a rubberized asphalt mastic material.

2.2.5. **Type 5.** Single-component, coal-tar modified urethane coating.

2.2.6. **Type 6.** Self-adhering built-up membrane of rubberized asphalt formed on a pre-formed board with cold-applied asphaltic primer.

- 2.2.7. **Type 10.** Any of Type 1, 4, 5, or 6 waterproofing.
- 2.2.8. **Type RR-1.** Butyl rubber or EPDM membrane with a protective course of asphalt plank or asphalt mat of the specified thickness, as shown on the plans.

3. CONSTRUCTION

- 3.1. **General.** Store waterproofing material in a manner that will prevent damage. Keep material dry, and store in a warm area before using in cold weather and out of direct sunlight in hot weather. Store asphalt planks, asphalt mats, and asphaltic panels in a manner that will prevent warping and breaking.
- Provide a wood float finish to concrete decks and other unformed concrete surfaces to be waterproofed. Cure concrete surfaces to be waterproofed for at least 7 days before applying waterproofing, or as directed by the waterproofing materials manufacturers.
- Ensure steel or concrete deck surfaces to be waterproofed are clean; dry; smooth; and free of fins, sharp edges, and loose material. Use grinders, if necessary, to remove protrusions that would puncture waterproofing membrane. Ensure surfaces are free of contaminants such as form-release agents, wax-base curing compounds, oil, and grease. Remove any contaminants by abrasive blast cleaning. Ensure there are no depressions or pockets in horizontal surfaces of finished waterproofing.
- Fill expansion joints and other grooves with plastic cement in accordance with [DMS-6300](#), unless otherwise shown on the plans. Ensure joints are dry and clean when filled. Overfill slightly to allow for shrinkage in drying.
- Sweep, vacuum, or air-blow the area to be waterproofed thoroughly to remove dust, dirt, and loose foreign material. Maintain the deck in a clean condition until completion of waterproofing.
- Do not allow vehicular or equipment traffic on the bridge after the deck waterproofing work has started or until after the work is complete, cover sheets are in place, and an adequate ballast cushion has been placed on the deck. Protect the waterproofing against damage from any source.
- Use asphalt for mopping below ground in accordance with [DMS-6300](#) when asphalt waterproofing is shown as a protection for back of abutments, retaining walls, or footings. Use asphalt for mopping above ground in accordance with [DMS-6300](#) for waterproofing on bridge decks.
- 3.2. **Type 1.** Do not apply waterproofing in wet weather or when the ambient temperature is below 50°F. Ensure the rubber membrane is free of punctures, pockets, or folds.
- Turn the membrane into drainage holes and castings without break. Take special care to make the waterproofing effective along the sides and ends of members to be waterproofed.
- Install the butyl rubber membrane by first applying the adhesive as recommended by the membrane manufacturer. Apply the adhesive to the surface to be waterproofed and at necessary splices, in a solid area extending approximately 36 in. back from the edges. Apply the membrane by pressing it firmly and uniformly in place against the previously applied adhesive, avoiding wrinkles and buckles. Make splices, laps, and flashing in conformance with the membrane manufacturer's recommended procedures.
- 3.3. **Type 2.** Place the asphalt primer at least 24 hr. before the asphalt mopping. Ensure the primer is dry before the mopping. Work in the primer to give a uniform coating. Heat the asphalt for mopping in kettles equipped with armored thermometers, but do not heat above 350°F. Stir the asphalt frequently while heating. Apply the mop coating at a rate of at least 4 gal. per 100 sq. ft. of surface. Apply additional coatings, if imperfections appear, until corrected.
- 3.4. **Type 3.** Place the asphalt primer at least 24 hr. before the asphalt mopping. Ensure the primer is dry before the mopping. Work in the primer to give a uniform coating. Heat the asphalt for mopping in kettles equipped

with armored thermometers, but do not heat above 350°F. Stir the asphalt frequently while heating. Use a minimum coverage rate for each mop coating of 4 gal. per 100 sq. ft. of surface. Apply additional coatings, if imperfections appear, until corrected.

Mop the surfaces to be waterproofed in sections at construction joints. Lay a 15-in. wide strip of cotton fabric on the first mopping while the asphalt is still hot and press into place. Apply subsequent moppings to completely cover and seal the cotton fabric. Make the end laps of the cotton fabric at least 12 in. unless otherwise shown on the plans.

- 3.5. **Type 4.** Unwrap the roll of waterproofing and press the adhesive surface into contact with the concrete horizontally. Secure the free end and then unroll slowly, using hand pressure to smooth the membrane into place and help make a tight bond with the concrete. Overlap adjacent strips at least 1 in. over the previously laid strip. Backfilling may be started as soon as the initial horizontal strip has been applied.

- 3.6. **Type 5.** Apply waterproofing in two coats to produce a minimum cured film thickness of 1/16 in. Apply using a roller, a squeegee, a brush, or spray equipment unless otherwise shown on the plans. Apply the second coat within 16 hr. after the initial coat. Follow the manufacturer's instructions pertinent to the maximum time allowed between coats and any treatment of the initial coat required if this maximum time is exceeded. The minimum ambient temperature at the time of waterproofing application is 40°F. Do not begin backfilling until the second coat of waterproofing has cured enough to prevent damage by the backfilling operation.

- 3.7. **Type 6.** Apply the primer at a rate of 1 gal. per 100 sq. ft. of surface or at the rate recommended by the manufacturer if different. Allow to dry to a tacky surface before placing the waterproofing membrane. Apply the primer and waterproofing membrane board panels only when the substrate temperature is above 50°F.

Seal joints by centering 6-in. gusset tape over the joint and pressing firmly into position. Roll in the panels and jointing tape with enough pressure to assure maximum adhesion, conformance to substrate, and elimination of air bubbles. Follow the manufacturer's recommendations for installation.

Begin backfilling as soon as the application of the waterproofing is complete. Complete backfilling within 48 hr. after the waterproofing material is applied to a non-horizontal surface.

- 3.8. **Type RR-1.** Apply waterproofing to dry surfaces and only when the ambient temperature is above 50°F. Ensure the butyl rubber or EPDM membrane is free of punctures, pockets, or folds. Turn the membrane into drainage castings without break. Take special care to make the waterproofing effective along the sides and ends of girders and at stiffeners and gussets. Fill grooves with plastic cement.

Install the butyl rubber or EPDM membrane by first applying the adhesive as recommended by the membrane manufacturer to ballast retainers, to ends of deck, and at necessary splices in a solid area extending from the edges back approximately 36 in. or as shown on the plans. Apply the membrane and press it firmly and uniformly in place against the previously applied adhesive, avoiding wrinkles and buckles. Make splices, laps, and flashing in conformance with the membrane manufacturer's recommended procedures.

Place the protective cover as soon as practicable after placement of the membrane. Clean the membrane surface of dirt and other foreign material before placing the cover material. Apply a coating of cold asphalt emulsion over the membrane at a minimum rate of 4 gal. per 100 sq. ft. of surface. Place the asphalt plank or mat on the coating of cold asphalt emulsion.

Provide a minimum thickness of protection of 1 in., consisting of asphalt plank or asphalt mat, unless otherwise shown on the plans. Coat the edges and ends of adjacent planks already laid with cold asphalt emulsion as successive planks are laid. Lay the planks tightly against those previously laid so the emulsion will completely fill the joints and be squeezed out the top. Fill any joints not completely full after planks have been laid with emulsion. Offset the vertical joints of the second layer at least 4 in. transversely and 1 ft. longitudinally from the joints in the lower layer when two layers of planks are used to obtain the required 1-in. cover thickness.

Apply asphalt mat protection in the same manner, except stagger the longitudinal butt joints in a single layer by approximately 2 ft. Follow the same procedure with all vertical joints offset by at least 1 ft. when more than one thickness of asphalt mat is required. Place a follow-up coating of asphalt emulsion approximately 6 in. wide over all joints of the top layer.

Use asphalt for mopping above ground as defined in [DMS-6300](#) where deck waterproofing is carried over the back wall and down the back of the abutment for only several feet to provide a proper flashing for the deck waterproofing.

4. MEASUREMENT

When waterproofing is shown on the plans to be a pay item, measurement will be by the square yard.

5. PAYMENT

Unless otherwise shown on the plans, the work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be subsidiary to pertinent Items.

When waterproofing is specified as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Waterproofing," of the type specified. This price is full compensation for materials furnished, equipment, labor, tools, and incidentals.

Item 462

Concrete Box Culverts and Drains



1. DESCRIPTION

Furnish, construct, and install concrete box culverts and drains.

2. MATERIALS

2.1. **General.** Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 464, "Reinforced Concrete Pipe"

Provide cast-in-place or precast, formed or machine-made, box culverts and drains. Use Class S concrete for top slabs of cast-in-place concrete culverts for culverts with overlay, and a one- to two-course surface treatment or a top slab that is the final riding surface, unless otherwise shown on the plans. Use Class C concrete for the rest of the culvert and for all other cast-in-place boxes. Culverts with fill do not require Class S concrete.

Furnish material for precast formed and machine-made box culverts in accordance with [DMS-7305](#), "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures."

2.2. **Fabrication.**

2.2.1. **Cast-in-Place.** Meet Item 420 and Item 422, "Concrete Superstructures."

2.2.2. **Precast.** Multi-project fabrication plants, as defined in [DMS-7305](#), for precast formed and machine-made box culverts must be approved in accordance with [DMS-7305](#). The Materials and Tests Division maintains a list of approved multi-project precast box culvert fabrication plants on the Department's MPL. Fabricate precast boxes in accordance with [DMS-7305](#).

2.3. **Testing.**

2.3.1. **Cast-in-Place.** Provide test specimens that meet Item 421.

2.3.2. **Precast.** Make, cure, and test compressive test specimens for precast formed and machine-made box culverts in accordance with [DMS-7305](#).

2.3.3. **Testing Equipment.** The producer must furnish all equipment required for testing concrete for boxes produced in a precast plant.

2.4. **Lifting Holes.** Provide no more than four lifting holes in each section for precast boxes. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the box section. Use lifting holes no larger than 3 in. in diameter. Cut no more than 5 in. in any direction of reinforcement per layer for lifting holes.

2.5. **Marking.** Clearly mark each precast unit with the following:

- name or trademark of fabricator and plant location,

- ASTM designation and product designation (when applicable),
- date of manufacture,
- box size,
- minimum and maximum fill heights,
- designation "TX" for precast units fabricated in accordance with [DMS-7305](#),
- fabricator's designated approval stamp for each approved unit,
- designation "SR" for boxes meeting sulfate-resistant concrete plan requirements (when applicable), and
- precast drainage structures used for jacking and boring (when applicable).

Mark one end of each box section, for boxes without lifting holes, on the inside and outside walls to indicate the top or bottom as it will be installed.

Indent markings into the box section or paint them on each box with waterproof paint.

- 2.6. **Tolerances.** Ensure precast sections meet the permissible variations listed in ASTM C1577.

Ensure that the sides of a section at each end do not vary from being perpendicular to the top and bottom by more than 1/2 in. when measured diagonally between opposite interior corners. Deviations from this tolerance will be acceptable if the sections can be fitted at the plant and the joint opening at any point does not exceed 1 in. Use match-marks for proper installation on sections that have been accepted in this manner.

Ensure wall and slab thicknesses are not less than shown on the plans except for occasional deficiencies not greater than 3/16 in. or 5%, whichever is greater. If proper jointing is not affected, thicknesses in excess of plan requirements are acceptable.

- 2.6.1. **Boxes for Jacking Operations.** Use boxes for jacking operations as defined in Item 476, "Jacking, Boring, or Tunneling Pipe or Box," meeting the following additional requirements:

- the box ends must be square such that no point deviates more than 3/8 in. from a plane placed on the end of the box that is perpendicular to the box sides,
- the slab and wall thicknesses must not be less than specified on the plans and must not exceed the specified thickness by more than 1/2 in., and
- variations in laying lengths of two opposite surfaces of the box must not exceed 1/4 in.

- 2.7. **Defects and Repair.** Repair precast boxes in accordance with the [DMS-7305](#) Annex. Precast boxes may be rejected for any of the conditions stated in this Annex.

- 2.8. **Storage and Shipment.** Store precast sections on a level surface. Do not place any load on the sections until design strength is reached and curing is complete. Store and ship precast boxes in accordance with [DMS-7305](#).

3. CONSTRUCTION

- 3.1. **Excavation, Shaping, Bedding, and Backfill.** Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures," except where jacking, boring, or tunneling methods are shown on the plans or permitted. Jack, bore, or tunnel in accordance with Item 476. Immediate backfilling is permitted for all box structures where joints consist of materials other than mortar. Take precautions in placing and compacting the backfill to avoid any movement of the boxes or damage to the joints. Remove and replace boxes damaged by the Contractor at no expense to the Department.

- 3.2. **Placement of Boxes.** Place the box sections as shown on the plans or as directed when precast boxes are used to form multiple barrel structures. Place material to be used between barrels as shown on the plans or as directed. Start the laying of boxes on the bedding at the outlet end and proceed toward the inlet end with the abutting sections properly matched, unless otherwise authorized. Fit, match, and lay the boxes to form a smooth, uniform conduit true to the established lines and grades. Lower the box sections into the trench, for

trench installations, without damaging the box or disturbing the bedding and the sides of the trench. Carefully clean the ends of the box before it is placed. Prevent earthen or bedding material from entering the box as it is laid. Remove and re-lay, without extra compensation, boxes that are not in alignment or show excessive settlement after laying. Form and place cast-in-place boxes in accordance with Item 420.

- 3.3. **Jointing.** Use any of the jointing materials in accordance with the joint requirements specified in Item 464, unless otherwise shown on the plans. Box joints for rubber gasketed material may be substituted for tongue and groove joints, provided they meet the requirements of ASTM C1677 for design of the joints and permissible variations in dimensions.
- 3.4. **Connections and Stub Ends.** Make connections of boxes to existing boxes, pipes, drains, or drain appurtenances as shown on the plans. Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Connect boxes to any required headwalls, wingwalls, safety end treatments or riprap, or other structures as shown on the plans or as directed. Repair any damage to the existing structure resulting from making the connections. Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the box.
- Fill lifting holes with mortar or concrete and cure for precast boxes. Precast concrete or mortar plugs may be used.
- 3.5. **Extending.** Break back and extend existing culverts in accordance with Section 420.4.8., "Extending Existing Substructures," and Section 422.4.5., "Extending Existing Slabs," as applicable.

4. MEASUREMENT

This Item will be measured by the foot. Measurement will be made between the ends of the culvert or drain along the flow line, not including safety end treatments. Safety end treatments will be measured in accordance with Item 467, "Safety End Treatment." Measurement of spurs, branches, or new connection box section will be made from the intersection of the flow line with the outside surface of the structure into which it connects. Where inlets, headwalls, wingwalls, catch basins, manholes, junction chambers, or other structures are included in lines of culverts or drains, the length of box section tying into the structure wall will be included for measurement, but no other portion of the structure length or width will be included.

The measured length of multiple barrel structures will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Box Culvert" of the size specified. This price is full compensation for constructing, furnishing, and transporting sections; preparation and shaping of the bed; backfill material between box sections; jointing of sections; jointing material; cutting of sections on skew or slope; connections to new or existing structures; breaking back, removing, and disposing of portions of the existing structure and replacing portions of the existing structure as required to make connections; concrete and reinforcing steel; and equipment, labor, materials, tools, and incidentals.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required under Item 402, "Trench Excavation Protection," or Item 403, "Temporary Special Shoring." Excavation, shaping, bedding, and backfill will be paid for in accordance with Item 400. When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring, or tunneling is required, payment will be made under Item 476.

Item 464

Reinforced Concrete Pipe



1. DESCRIPTION

Furnish and install reinforced concrete pipe, materials for precast concrete pipe culverts, or precast concrete storm drain mains, laterals, stubs, and inlet leads.

2. MATERIALS

- 2.1. **Fabrication.** Multi-project fabrication plants, as defined in [DMS-7305](#), "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures," must be approved by the Materials and Tests Division in accordance with [DMS-7305](#) before furnishing precast reinforced concrete pipe for Department projects. The Department's MPL includes approved multi-project reinforced concrete pipe fabrication plants.

Furnish material and fabricate reinforced concrete pipe in accordance with [DMS-7305](#).

- 2.2. **Design.**

- 2.2.1. **General.** The class and D-load equivalents are shown in Table 1. Furnish arch pipe in accordance with ASTM C506 and the dimensions shown in Table 2. Furnish horizontal elliptical pipe in accordance with ASTM C507 and the dimensions shown in Table 3. For arch pipe and horizontal elliptical pipe, the minimum height of cover required is 1 ft.

Table 1
Circular Pipe
ASTM C76 and ASTM C655

Class	D-Load
I	800
II	1,000
III	1,350
IV	2,000
V	3,000

Table 2
Arch Pipe

Design Size	Equivalent Diameter (in.)	Rise (in.)	Span (in.)
1	18	13-1/2	22
2	21	15-1/2	26
3	24	18	28-1/2
4	30	22-1/2	36-1/4
5	36	26-5/8	43-3/4
6	42	31-5/16	51-1/8
7	48	36	58-1/2
8	54	40	65
9	60	45	73
10	72	54	88

Table 3
Horizontal Elliptical Pipe

Design Size	Equivalent Diameter (in.)	Rise (in.)	Span (in.)
0	15	12	19
1	18	14	23
2	24	19	30
3	27	22	34
4	30	24	38
5	33	27	42
6	36	29	45
7	39	32	49
8	42	34	53
9	48	38	60
10	54	43	68

2.2.2. **Jacking, Boring, or Tunneling.** Design pipe for jacking, boring, or tunneling considering the specific installation conditions such as the soil conditions, installation methods, anticipated deflection angles, and jacking stresses. Provide design notes and drawings signed and sealed by a Texas licensed professional engineer when requested. Provide steel reinforcement in bell and spigot.

2.3. **Marking.** Furnish each section of reinforced concrete pipe marked with the following information in accordance with [DMS-7305](#):

- class or D-load of pipe,
- ASTM designation,
- date of manufacture,
- pipe size,
- name or trademark of fabricator and plant location,
- designation "TX" for precast units fabricated in accordance with [DMS-7305](#),
- designated fabricator's approval stamp for each approved unit,
- pipe to be used for jacking and boring (when applicable), and
- designation "SR" for pipe meeting sulfate-resistant concrete plan requirements (when applicable).

Clearly mark one end of each section during the process of manufacture or immediately thereafter for pipe with elliptical reinforcement. Mark the pipe on the inside and outside of opposite walls to show the location of the top or bottom of the pipe as it should be installed unless the external shape of the pipe is such that the correct position of the top and bottom is obvious. Mark the pipe section by indenting or painting with waterproof paint.

2.4. **Inspection.** Provide access for inspection of the finished pipe at the project site before and during installation.

2.5. **Causes for Rejection.** Individual sections of pipe may be rejected for any of the conditions stated in the [DMS-7305](#) Annex.

2.6. **Repairs.** Make repairs, if necessary, in accordance with the [DMS-7305](#) Annex.

2.7. **Jointing Materials.** Use any of the following materials for the making of joints unless otherwise shown on the plans. Furnish a manufacturer's certificate of compliance for all jointing materials except mortar.

2.7.1. **Mortar.** Provide mortar for joints that meets the requirements of Section 464.3.3., "Jointing."

2.7.2. **Cold-Applied, Plastic Asphalt Sewer Joint Compound.** Provide a material that consists of natural or processed asphalt base, suitable volatile solvents, and inert filler. Ensure the consistency is such that the ends of the pipe can be coated with a layer of the compound up to 1/2 in. thick by trowel. Provide a joint

compound that cures to a firm, stiff plastic condition after application. Provide a material of a uniform mixture. Stir any small separation found in the container into a uniform mix before using.

Provide a material that meets the requirements shown in Table 4 when tested in accordance with [Tex-526-C](#).

Table 4
Cold-Applied, Plastic Asphalt Sewer Joint Compound Material Requirements

Composition	Analysis
Asphalt base, 100%–% volatiles–% ash, % by weight	28–45
Volatiles, 212°F evaporation, 24 hr., % by weight	10–26
Mineral matter, determined as ash, % by weight	30–55
Consistency, cone penetration, 150 g, 5 sec., 77°F	150–275

2.7.3. **Rubber Gaskets.** Provide gaskets that conform to ASTM C1619 Class A or Class C. Meet the requirements of ASTM C443 for design of the pipe joints and permissible variations in dimensions.

2.7.4. **Pre-Formed Flexible Joint Sealants.** Pre-formed flexible joint sealants may be used for sealing joints of tongue-and-groove concrete pipe. Provide flexible joint sealants that meet the requirements of ASTM C990. Use flexible joint sealants that do not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. Supply in extruded rope form of suitable cross-section. Provide a size of the pre-formed flexible joint sealant in conformance with the manufacturer's recommendations and large enough to properly seal the joint. Protect flexible joint sealants with a suitable wrapper able to maintain the integrity of the jointing material when the wrapper is removed.

3. CONSTRUCTION

3.1. **Excavation, Shaping, Bedding, and Backfill.** Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures," except where jacking, boring, or tunneling methods are permitted. Jack, bore, or tunnel the pipe in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box." Immediate backfilling is permitted if joints consist of materials other than mortar. Take special precautions in placing and compacting the backfill to avoid any movement of the pipe or damage to the joints. Do not use heavy earth-moving equipment to haul over the structure until at least 4 ft. of permanent or temporary compacted fill has been placed over the structure, unless otherwise shown on the plans or permitted in writing. Remove and replace pipe damaged by the Contractor at no expense to the Department.

3.2. **Laying Pipe.** Start the laying of pipe on the bedding at the outlet end with the spigot or tongue end pointing downstream and proceed toward the inlet end with the abutting sections properly matched, true to the established lines and grades unless otherwise authorized. Fit, match, and lay the pipe to form a smooth, uniform conduit. Cut cross trenches in the foundation to allow the barrel of the pipe to rest firmly on the bedding where bell-and-spigot pipe is used. Cut cross trenches no more than 2 in. larger than the bell ends of the pipe. Lower sections of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Carefully clean the ends of the pipe before the pipe is placed. Prevent earthen or bedding material from entering the pipe as it is laid. Lay the pipe in the trench, when elliptical pipe with circular reinforcing or circular pipe with elliptical reinforcing is used, so the markings for the top or bottom are not more than 5° from the vertical plane through the longitudinal axis of the pipe. Remove and re-lay, without extra compensation, pipe that is not in alignment or shows excessive settlement after laying.

Lay multiple lines of reinforced concrete pipe with the centerlines of the individual barrels parallel. Use the clear distances between outer surfaces of adjacent pipes shown in Table 5 unless otherwise shown on the plans. Use the equivalent diameter from Table 2 or Table 3 for arch pipe or horizontal elliptical pipe to determine the clear distance requirement shown in Table 5.

Table 5
Minimum Clear Distance Between Pipes

Equivalent Diameter	Min Clear Distance
18 in.	9 in.
24 in.	11 in.
30 in.	1 ft. 1 in.
36 in.	1 ft. 3 in.
42 in.	1 ft. 5 in.
48 in.	1 ft. 7 in.
54 in.	1 ft. 11 in.
60–84 in.	2 ft.

- 3.3. **Jointing.** Make available an appropriate rolling device similar to an automobile mechanic's "creeper" for conveyance through small-size pipe structures.
- 3.3.1. **Joints Sealed with Hydraulic Cement Mortar.** Use Type S mortar meeting the requirements of ASTM C270. Clean and wet the pipe ends before making the joint. Plaster the lower half of the bell or groove and the upper half of the tongue or spigot with mortar. Pack mortar into the joint from both inside and outside the pipe after the pipes are tightly jointed. Finish the inside smooth and flush with adjacent joints of pipe. Form a bead of semicircular cross-section over tongue-and-groove joints outside the pipe, extending at least 1 in. on each side of the joint. Form the mortar for bell-and-spigot joints to a 45° fillet between the outer edge of the bell and the spigot. Cure mortar joints by keeping the joints wet for at least 48 hr. or until the backfill has been completed, whichever is first. Place fill or backfill once the mortar jointing material has cured for at least 6 hr. Conduct jointing only when the atmospheric temperature is above 40°F. Protect mortared joints against freezing by backfilling or other approved methods for at least 24 hr.
- Driveway culverts do not require mortar banding on the outside of the pipe.
- Furnish pipes, with approval, that are large enough for a person to enter with the groove between 1/2 in. and 3/4 in. longer than the tongue. Such pipe may be laid and backfilled without mortar joints. Clean the space on the interior of the pipe between the end of the tongue and the groove of all foreign material, thoroughly wet and fill with mortar around the entire circumference of the pipe, and finish flush after the backfilling has been completed.
- 3.3.2. **Joints Using Cold-Applied, Plastic Asphalt Sewer Joint Compound.** Ensure both ends of the pipes are clean and dry. Trowel or otherwise place a 1/2-in. thick layer of the compound in the groove end of the pipe covering at least 2/3 of the joint face around the entire circumference. Shove home the tongue end of the next pipe with enough pressure to make a tight joint. Remove any excess mastic projecting into the pipe after the joint is made. Backfill after the joint has been inspected and approved.
- 3.3.3. **Joints Using Rubber Gaskets.** Make the joint assembly in conformance with the recommendations of the gasket manufacturer. Make joints watertight when using rubber gaskets. Backfill after the joint has been inspected and approved.
- 3.3.4. **Joints Using Pre-Formed Flexible Joint Sealants.** Install pre-formed flexible joint sealants in conformance with the manufacturer's recommendations. Place the joint sealer so no dirt or other deleterious materials contact the joint sealing material. Pull or push home the pipe with enough force to properly seal the joint. Remove any joint material pushed out into the interior of the pipe that would tend to obstruct the flow. Store pre-formed flexible joint sealants in an area warmed naturally or artificially to above 70°F in an approved manner when the atmospheric temperature is below 60°F. Apply flexible joint sealants to pipe joints immediately before placing pipe in trench, and connect pipe to previously laid pipe. Backfill after the joint has been inspected and approved.
- 3.4. **Connections and Stub Ends.** Make connections of concrete pipe to existing pipes, pipe storm drains, or storm drain appurtenances as shown on the plans.

Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Repair any damage to the existing structure resulting from making the connections.

Make connections between concrete pipe and corrugated metal pipe with a suitable concrete collar and a minimum thickness of 4 in. unless otherwise shown on the plans.

Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the pipe.

Fill lift holes with concrete, mortar, or precast concrete plugs after the pipe is in place.

4. MEASUREMENT

This Item will be measured by the foot. Measurement will be made between the ends of the pipe barrel along the flow line, not including safety end treatments. Safety end treatments will be measured in accordance with Item 467, "Safety End Treatment." Pipe that will be jacked, bored, or tunneled will be measured in accordance with Item 476. Measurement of spurs, branches, or new connecting pipe will be made from the intersection of the flow line with the outside surface of the pipe into which it connects. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of pipe, the length of pipe tying into the structure wall will be included for measurement, but no other portion of the structure length or width will be included.

For multiple pipes, the measured length will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reinforced Concrete Pipe," "Reinforced Concrete Pipe (Arch)," or "Reinforced Concrete Pipe (Elliptical)" of the size and D-load specified or of the size and class specified. This price is full compensation for constructing, furnishing, transporting, placing, and joining pipes; shaping the bed; cutting pipes on skew or slope; connecting to new or existing structures; breaking back, removing, and disposing of portions of the existing structure; replacing portions of the existing structure; cutting pipe ends on skew or slope; and equipment, labor, tools, and incidentals.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required under Item 402, "Trench Excavation Protection," or Item 403, "Temporary Special Shoring." Excavation, shaping, bedding, and backfill will be paid for in accordance with Item 400. When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring, or tunneling is required, payment will be made under Item 476.

Item 465

Junction Boxes, Manholes, and Inlets



1. DESCRIPTION

Construct junction boxes, manholes, and inlets, complete in place or to the stage detailed, including furnishing and installing frames, grates, rings, and covers.

2. MATERIALS

Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"
- Item 471, "Frames, Grates, Rings, and Covers"

Cast-in-place junction boxes, manholes, inlets, risers, and appurtenances are acceptable unless otherwise shown on the plans. Alternate designs for cast-in-place items must be acceptable to the Engineer and must conform to functional dimensions and design loading. Alternate designs must be designed and sealed by a licensed professional engineer.

- 2.1. **Concrete.** Furnish concrete in accordance with [DMS-7305](#), "Fabrication and Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Drainage Structures," for formed and machine-made precast junction boxes, manholes, and inlets. Furnish Class C concrete for cast-in-place junction boxes, manholes, and inlets unless otherwise shown on the plans.
- 2.2. **Mortar.** Furnish mortar conforming to [DMS-4675](#), "Cementitious Grouts and Mortars for Miscellaneous Applications."
- 2.3. **Timber.** Provide sound timber that is at least 3-in. nominal thickness and reasonably free of knots and warps for temporary covers when used with Stage I construction. (Refer to Article 465.3., "Construction.")
- 2.4. **Other Materials.** Use commercial-type hardware as approved.

3. CONSTRUCTION

Construct all types of junction boxes, manholes, and inlets either complete or in two stages, described as Stage I and Stage II.

Construct the Stage I portion of junction boxes, manholes, and inlets as shown on the plans or as specified in this Item. Furnish and install a temporary cover as approved.

Furnish and install the storm drain pipe and a temporary plug for the exposed end of the storm drain pipe from the storm drain to a point below the top of curb indicated on the plans for Stage I construction of cast iron or steel inlet units.

Construct Stage II after the pavement structure is substantially complete, unless otherwise approved.

Construct the remaining wall height and top of junction box, manhole, or inlet for Stage II, and furnish and install any frames, grates, rings and covers, curb beams, or collecting basins required.

Construct cast-in-place junction boxes, manholes, and inlets in accordance with Item 420. Forms are required for all concrete walls. Outside wall forms for cast-in-place concrete may be omitted with approval if the surrounding material can be trimmed to a smooth vertical face.

- 3.1. **Precast Junction Boxes, Manholes, and Inlets.** Construct formed and machine-made precast junction boxes, manholes, and inlets in accordance with [DMS-7305](#) and as shown on the plans, except as otherwise specified in this Item.

Multi-project fabrication plants as defined in [DMS-7305](#) that produce junction boxes, manholes, and inlets will be approved by the Materials and Tests Division in accordance with [DMS-7305](#). The Department's MPL has a list of approved multi-project junction box, manhole, and inlet fabrication plants.

- 3.1.1. **Marking.** Clearly mark each precast junction box, manhole, and inlet unit with the following information:
- name or trademark of fabricator and plant location,
 - product designation,
 - ASTM designation (if applicable),
 - date of manufacture,
 - designation "TX" for precast units fabricated in accordance with [DMS-7305](#),
 - designated fabricator's approval stamp for each approved unit, and
 - designation "SR" for product meeting sulfate-resistant concrete plan requirements (when applicable).

- 3.1.2. **Defects and Repair.** Repair precast junction boxes, inlets, and manholes, if necessary, in accordance with the Annex of [DMS-7305](#). Precast junction boxes, inlets, and manholes may be rejected for any of the conditions stated in this Annex.

- 3.1.3. **Storage and Shipment.** Store precast units on a level surface. Do not ship units until design strength requirements have been met.

- 3.2. **Excavation, Shaping, Bedding, and Backfill.** Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Immediate backfilling is permitted for all junction box, manhole, and inlet structures where joints consist of rubber boots, rubber gaskets, or bulk or preformed joint sealant. Take precautions in placing and compacting the backfill to avoid any movement of junction boxes, manholes, and inlets. Remove and replace junction boxes, manholes, and inlets damaged by the Contractor at no expense to the Department.

- 3.3. **Junction Boxes, Manholes, and Inlets for Precast Concrete Pipe Storm Drains.** Construct junction boxes, manholes, and inlets for precast concrete pipe storm drains before completion of storm drain lines into or through the junction box, manhole, or inlet. Neatly cut all storm drains at the inside face of the walls of the junction box, manhole, or inlet.

- 3.4. **Junction Boxes, Manholes, and Inlets for Box Storm Drains.** Place bases or risers of junction boxes, manholes, and inlets for box storm drains before or in conjunction with placement of the storm drain. Backfill the junction box, manhole, or inlet and storm drain as a whole.

- 3.5. **Inverts.** Shape and route floor inverts passing out or through the junction box, manhole, or inlet as shown on the plans. Shape by adding and shaping mortar or concrete after the base is placed or by placing the required additional material with the base.

- 3.6. **Finishing Complete Junction Boxes, Manholes, and Inlets.** Complete junction boxes, manholes, and inlets as shown on the plans. Backfill to original ground elevation in accordance with Item 400.

- 3.7. **Finishing Stage I Construction.** Complete Stage I construction by constructing the walls to the elevations shown on the plans and backfilling to required elevations in accordance with Item 400.

- 3.8. **Stage II Construction.** Construct subgrade and base course or concrete pavement over Stage I junction box, manhole, or inlet unless otherwise approved. Excavate to expose the top of Stage I construction and complete the junction box, manhole, or inlet as shown on the plans and in accordance with these specifications, including backfill and cleaning of all debris from the bottom of the junction box, manhole, or inlet.
- 3.9. **Inlet Units.** Install cast iron or steel inlet units in conjunction with the construction of concrete curb and gutter. Set the inlet units securely in position before placing concrete for curb and gutter. Form openings for the inlets and recesses in curb and gutter as shown on the plans. Place and thoroughly consolidate concrete for curb and gutter adjacent to inlets and around the inlet castings and formed openings and recesses without displacing the inlet units.

4. MEASUREMENT

All junction boxes, manholes, and inlets satisfactorily completed as shown on the plans and in conformance with specifications will be measured by each junction box, manhole, or inlet complete, or by each junction box, manhole, or inlet completed to the stage of construction required by the plans.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows.

- 5.1. **Complete Manholes.** Payment for complete manholes will be made at the unit price bid for "Manhole (Complete)" of the type specified.
- 5.2. **Complete Inlets.** Payment for inlets will be made at the unit price bid for "Inlet (Complete)" of the type specified.
- 5.3. **Complete Junction Boxes.** Payment for junction boxes will be made at the unit price bid for "Junction Box (Complete)" of the type specified.
- 5.4. **Manholes Stage I.** Payment for manholes, Stage I, will be made at the unit price bid for each "Manhole (Stage I)" of the type specified.
- 5.5. **Manholes Stage II.** Payment for manholes, Stage II, will be made at the unit price bid for each "Manhole (Stage II)" of the type specified.
- 5.6. **Inlets Stage I.** Payment for inlets, Stage I, will be made at the unit price bid for each "Inlet (Stage I)" of the type specified.
- 5.7. **Inlets Stage II.** Payment for inlets, Stage II, will be made at the unit price bid for each "Inlet (Stage II)" of the type specified.
- 5.8. **Junction Boxes Stage I.** Payment for junction boxes, Stage I, will be made at the unit price bid for each "Junction Box (Stage I)" of the type specified.
- 5.9. **Junction Boxes Stage II.** Payment for junction boxes, Stage II, will be made at the unit price bid for each "Junction Box (Stage II)" of the type specified.

These prices are full compensation for concrete, reinforcing steel, mortar, frames, grates, rings and covers, excavation, and backfill, and for all other materials, tools, equipment, labor, and incidentals.

Item 466

Headwalls and Wingwalls



1. DESCRIPTION

Furnish, construct, and install concrete headwalls and wingwalls for drainage structures and underpasses.

2. MATERIALS

2.1. **General.** Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

Use Class C concrete for cast-in-place and precast concrete units unless otherwise shown on the plans. Furnish cast-in-place or precast headwalls and wingwalls unless otherwise shown on the plans.

2.2. **Fabrication.**

2.2.1. **General.** Fabricate cast-in-place concrete units and precast units in accordance with Item 420. Use the following definitions for headwalls and wingwalls.

- **Headwalls.** Refers to all walls, including wings, at the ends of single-barrel and multiple-barrel pipe culvert structures.
- **Wingwalls.** Refers to all walls at the ends of single-barrel or multiple-barrel box culvert structures.

2.2.2. **Lifting Holes.** Provide no more than four lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 in. at the inside surface of the wall and 4 in. at the outside surface. Cut no more than one longitudinal wire or two circumferential wires per layer of reinforcing steel when locating lift holes. Repair spalled areas around lifting holes.

2.2.3. **Marking.** Clearly mark each precast unit before shipment from the casting or fabrication yard with the following:

- Date of manufacture,
- Name or trademark of the manufacturer, and
- Type and size designation.

2.2.4. **Storage and Shipment.** Store precast units on a level surface. Do not place any loads on precast concrete units until design strength is reached. Do not ship units until design strength requirements have been met.

2.2.5. **Causes for Rejection.** Precast units may be rejected for not meeting any one of the specification requirements. Individual units may also be rejected for fractures or cracks passing through the wall or surface defects indicating honeycombed or open texture surfaces. Remove rejected units from the project and replace them with acceptable units meeting the requirements of this Item.

2.2.6. **Defects and Repairs.** Occasional imperfections in manufacture or accidental damage sustained during handling may be repaired in accordance with the Department's *Concrete Repair Manual*. The repaired units will be acceptable if they conform to the requirements of this Item and the repairs are sound, properly finished, and cured in conformance with pertinent specifications.

3. CONSTRUCTION

- 3.1. **General.** Remove portions of existing structures and drill, dowel, and grout in accordance with Item 420.
- 3.2. **Excavation, Shaping, Bedding, and Backfill.** Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Take special precautions in placing and compacting the backfill to avoid any movement or damage to the units. Bed precast units on foundations of firm and stable material accurately shaped to conform to the bases of the units.
- 3.3. **Placement of Precast Units.** Provide adequate means to lift and place the precast units. Fill lifting holes with mortar or concrete and cure. Precast concrete or mortar plugs may be used.
- 3.4. **Connections.** Make connections to new or existing structures as shown on the plans. Furnish jointing material in accordance with Item 464, "Reinforced Concrete Pipe," or as shown on the plans.

Remove a length of the existing pipe from the headwall to the joint when removing existing headwalls as shown on the plans or as approved. Re-lay the removed pipe if approved or furnish and lay a length of new pipe.

4. MEASUREMENT

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

- 4.1. **Headwalls.** Headwalls will be measured by each end of a structure.
- 4.2. **Wingwalls.** Wingwalls will be measured by one of the following methods.
- 4.2.1. **Square Foot.** Wingwalls will be measured by the square foot of the front surface area of the wall of each type. The area will be measured from the top of the footing or apron to the top of the wall unless otherwise shown on the plans. If there is no footing or apron, then measurement is from the bottom of the wall.
- 4.2.2. **Each.** Wingwalls will be measured by each end of a structure.

5. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the price bid for "Headwalls" of the type and pipe size (diameter or design) specified, "Wingwalls" of the type specified when measurement is by the square foot, or "Wingwalls" of the type and wall height specified when measurement is by each. For payment purposes, the wingwall height will be rounded to the nearest foot. All wingwalls and headwalls of the same type will be paid for equally when skew does not affect the type. This price is full compensation for constructing, furnishing, transporting, and installing the headwalls or wingwalls; connecting to existing structure; breaking back, removing and disposing of portions of the existing structure, and replacing portions of the existing structure as required to make connections; excavation and backfill; and concrete, reinforcing steel, corrugated metal pipe or reinforced concrete pipe, equipment, labor, tools, and incidentals.

Apron concrete or riprap between or around the wingwalls of single- or multiple-barrel box culvert structures will be measured and paid for in accordance with Item 432, "Riprap."

The removal and re-laying of existing pipe or the furnishing of new pipe to replace existing pipe will not be paid for directly, but will be subsidiary to this item.

Item 467

Safety End Treatment



1. DESCRIPTION

Furnish, construct, and install safety end treatments for drainage structures, or install or replace pipe runners or pipe runner assemblies on existing drainage structures.

2. MATERIALS

2.1. **General.** Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 432, "Riprap"
- Item 440, "Reinforcement for Concrete"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 460, "Corrugated Metal Pipe"
- Item 464, "Reinforced Concrete Pipe"

Use Class C concrete for cast-in-place and precast concrete units unless otherwise shown on the plans. Furnish cast-in-place or precast safety end treatments unless otherwise shown on the plans. Furnish Class B concrete for concrete riprap unless otherwise shown on the plans. Provide galvanized steel for prefabricated metal end sections in accordance with Item 460.

Furnish pipe runners in accordance with the following:

- ASTM A1085;
- ASTM A53, Type E or S, Grade B;
- ASTM A500, Grade B; or
- API 5L, Grade X42.

Furnish plates and angles in accordance with ASTM A36. Furnish nuts and bolts in accordance with ASTM A307. Galvanize pipes, plates, angles, nuts, and bolts in accordance with Item 445.

2.2. **Fabrication.** Fabricate cast-in-place concrete units and precast units in accordance with Item 420. Provide either prefabricated metal end sections or mitered corrugated metal pipe (CMP) when specified for the pipe structure unless otherwise shown on the plans.

Provide one of the following when reinforced concrete pipe (RCP) is specified for the pipe structure, unless otherwise shown on the plans:

- mitered RCP, or
- precast safety end treatment (SET) units. Provide riprap only if the plans specifically require it for this alternative.

2.2.1. **SET Types.**

2.2.1.1. **Type I.** Provide Type I SET consisting of reinforced concrete headwalls or wingwalls and pipe runners as shown on the plans when required.

- 2.2.1.2. **Type II.** Provide Type II SET as shown on the plans consisting of the following:
- CMP or RCP mitered to the proper slope, concrete riprap, and pipe runners, when required;
 - prefabricated metal end sections, concrete riprap, and pipe runners, when required; or
 - precast SET units, concrete riprap, when required, and pipe runners, when required.
- 2.2.2. **Lifting Holes.** Provide no more than four lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 in. at the inside surface of the wall and 4 in. at the outside surface. Cut no more than one longitudinal wire or two circumferential wires per layer of reinforcing steel when locating lift holes. Repair spalled areas around lifting holes.
- 2.2.3. **Marking.** Clearly mark the following on each precast unit, mitered CMP, mitered RCP, or metal end section before shipment from the casting or fabrication yard:
- the date of manufacture,
 - the name or trademark of the manufacturer, and
 - the type and size designation.
- 2.2.4. **Storage and Shipment.** Store precast units on a level surface. Do not place any loads on precast units until the design strength is reached. Do not ship units until design strength requirements have been met.
- 2.2.5. **Causes for Rejection.** Precast units may be rejected for not meeting any one of the specification requirements. Individual units may also be rejected for fractures or cracks passing through the wall or surface defects indicating honeycombed or open texture surfaces. Remove rejected units from the project and replace with acceptable units meeting the requirements of this Item.
- 2.2.6. **Defects and Repairs.** Occasional imperfections in manufacture or accidental damage sustained during handling may be repaired in accordance with the Department's *Concrete Repair Manual*. The repaired units will be acceptable if they conform to the requirements of this Item and the repairs are sound and properly finished and cured in conformance with pertinent specifications. Repair damaged galvanizing in accordance with Section 445.3.4., "Repairs."

3. CONSTRUCTION

- 3.1. **General.** Remove portions of existing structures in accordance with Section 420.4.8., "Extending Existing Substructures." Drill, dowel, and grout in accordance with Item 420. Furnish concrete riprap in accordance with Item 432.
- Provide riprap on all prefabricated metal end sections.
- 3.2. **Excavation, Shaping, Bedding, and Backfill.** Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Take special precautions in placing and compacting the backfill to avoid any movement or damage to the units. Bed precast units on foundations of firm and stable material accurately shaped to conform to the bases of the units.
- 3.3. **Placement of Precast Units.** Provide adequate means to lift and place the precast units. Fill lifting holes with mortar or concrete and cure. Precast concrete or mortar plugs may be used.
- 3.4. **Connections.** Make connections to new or existing structures as shown on the plans. Furnish jointing material in accordance with Item 464.
- Also remove a length of the existing pipe from the headwall to the joint when removing existing headwalls as shown on the plans or as approved. Re-lay the removed pipe if approved, or furnish and lay a length of new pipe.

- 3.5. **Install or Replace Pipe Runners or Assemblies.** Install or replace individual pipe runners or pipe runner assemblies on existing drainage structures as shown on the plans.

4. MEASUREMENT

SETs of all types will be measured by each barrel of each structure end.

Pipe runners or pipe runner assemblies installed or replaced on existing structure will be measured by each installed or replaced on each structure end.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the various designations of "Safety End Treatment" specified as follows:

- "SET (Type I) (Barrel Span) (Wall Height) (Slope, Horizontal:Vertical) (Orientation, Cross or Parallel)";
- "SET (Type I) (Pipe Diameter or Design) (Slope, Horizontal:Vertical) (Orientation, Cross or Parallel)";
- "SET (Type II) (Pipe Diameter or Design) (Pipe Material) (Slope, Horizontal:Vertical) (Orientation, Cross or Parallel)";
- "SET (Pipe Runner)"; and
- "SET (Pipe Runner Assembly)."

For payment purposes, the wingwall heights of Type I SETs for box culverts will be rounded to the nearest foot.

This price is full compensation for constructing, furnishing, transporting, and installing the end treatments; pipe runners, or pipe runner assemblies, connecting to existing structure; breaking back, removing and disposing of portions of the existing structure, removing and disposing of existing pipe runner or pipe runner assemblies, and replacing portions of the existing structure as required to make connections; excavation and backfill; furnishing concrete, reinforcing steel, CMP or RCP, and pipe runners; and concrete riprap, nuts, bolts, plates, angles, equipment, labor, tools, and incidentals.

The removal and re-laying of existing pipe or the furnishing of new pipe to replace existing pipe will not be paid for directly, but will be subsidiary to this Item.

The mitered length of CMP or RCP that is a part of the SET (Type II) will not be paid for directly, but will be subsidiary to this Item. The limits for payment for pipe will be as shown on the plans and paid for in accordance with the pertinent bid item.

The limits of riprap to be included in the unit price bid for each SET will be shown on the plans. Any riprap placed beyond the limits shown will be paid for in accordance with Item 432. Riprap between multiple precast SET units will be required as shown on the plans and is included in the unit price bid for SET.

When precast SETs are provided as an option to mitered RCP, riprap aprons will not be required unless shown on the plans. The plans will show the limits of the riprap to be included with the precast SET for payment.

Item 471

Frames, Grates, Rings, and Covers



1. DESCRIPTION

Furnish and install frames, grates, rings, and covers for inlets, manholes, and other structures.

2. MATERIALS

- 2.1. **Frame, Grate, Ring, and Cover Castings.** Provide clean castings as shown on the plans. Ensure all gray and ductile iron castings conform to the AASHTO Designation M 306. Cast or machine the bearing surfaces for traffic service castings between manhole rings and covers and between grates and frames with such precision as to prevent rocking.

Provide gray iron castings in accordance with ASTM A48 Class 35B and AASHTO M 306 for traffic service applications unless otherwise specified. Provide gray iron castings in accordance with ASTM A48 Class 35B for sidewalk or pedestrian applications unless otherwise specified. Provide ductile iron castings in accordance with ASTM A536, Grade 70-50-05, unless otherwise specified. Provide steel castings in accordance with ASTM A27, Grade 70-36, unless otherwise specified. Ensure all traffic service castings and gratings meet or exceed the H20 proof-load requirements of AASHTO M 306. Load test results and material certifications must be made available upon request.

Ensure all traffic service (heavy-duty) rated castings and grating meet the proof-load testing requirements of AASHTO M 306. Ensure all load tests are conducted using a calibrated NIST-certified load cell. Ensure materials are loaded with a 9 × 9-in. load block to an applied load of 40,000 lb. for 1 min. without deformation or failure. Load test results and material certifications must be made available upon request.

Provide castings within $\pm 1/16$ in. per foot of plan dimensions, and within $\pm 5\%$ of plan weight.

- 2.2. **Welded Steel Grates and Frames.** Provide welded steel grates and frames as an assembly as shown on the plans. Fabricate these assemblies in accordance with Item 441, "Steel Structures." Use steel that meets ASTM A36 or equivalent.

- 2.3. **Documentation.** Furnish a manufacturer's certification stating the casting meets the proof-load testing requirements of AASHTO M 306 for traffic service castings.

3. CONSTRUCTION

Construct and install frames, grates, rings, and covers as shown on the plans. Weld in accordance with Item 448, "Structural Field Welding." Tack weld grates and covers to the frame or ring when directed.

Galvanize steel castings, welded steel grates, and frames in accordance with Item 445, "Galvanizing." Galvanizing is not required for iron castings unless used in conjunction with structural steel shapes or shown on the plans.

Provide galvanized bolts and nuts in accordance with Item 445.

4. MEASUREMENT

Frames, grates, rings, and covers, when a part of the complete manhole or inlet, will not be measured for payment directly, but will be subsidiary to Item 465, "Junction Boxes, Manholes, and Inlets." Frames, grates,

rings, and covers, when not a part of a "Manhole (Complete)" or "Inlet (Complete)," will be measured by the each.

5. PAYMENT

When payment is required, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Grate," "Frame," "Grate and Frame," "Frame and Cover," or "Ring and Cover" with the type and number of grates specified, if necessary. This price is full compensation for equipment, materials, labor, tools, and incidentals.

Item 476

Jacking, Boring, or Tunneling Pipe or Box



1. DESCRIPTION

Furnish and install pipe or box by jacking, boring, or tunneling.

2. MATERIALS

Use the following types of pipe or box:

- reinforced concrete pipe (except circular bell-and-spigot, arch, or horizontal elliptical pipe) meeting the special requirements for jacking, boring, or tunneling in accordance with Item 464, "Reinforced Concrete Pipe," of the size, strength, and dimension shown on the plans;
- reinforced concrete box meeting Item 462, "Concrete Box Culverts and Drains," of the size and type shown on the plans; or
- other types shown on the plans.

3. CONSTRUCTION

Excavate suitable shafts or trenches for conducting the jacking, boring, or tunneling operations and for placing end joints of the pipe or box if the grade at the jacking, boring, or tunneling end is below the ground surface. Maintain a 3:1 slope from edge of pavement on the shaft side of the road unless otherwise shown or directed. Provide a positive barrier when the shaft location is within the clear zone of the roadway. Protect excavations deeper than 5 ft. in accordance with Item 402, "Trench Excavation Protection," or Item 403, "Temporary Special Shoring."

Install pipe or box so there is no interference with the operation of street, highway, railroad, or other facility and no embankment or structure is weakened or damaged.

Repair any pipe or box damaged in jacking, boring, or tunneling. Remove and replace any pipe or box damaged beyond repair at the Contractor's expense.

Backfill shafts or trenches excavated to facilitate jacking, boring, or tunneling immediately after installation of pipe or box.

- 3.1. **Jacking.** Provide jacks suitable for forcing the pipe or box through the embankment. Use even pressure to all jacks during operation. Provide a suitable jacking head and suitable bracing between the jacks and the jacking head to apply uniform pressure around the ring of the pipe or circumference of the box. Use joint cushioning of plywood or other approved material. For plywood cushioning material, use 1/2-in. minimum thickness for pipe diameter 30 in. or less, and use 3/4-in. minimum thickness for pipe diameter greater than 30 in. Use 3/4-in. minimum thickness for all boxes. Use cushioning rings of single or multiple pieces. Provide a suitable jacking frame or backstop. Set the pipe or box to be jacked on guides that support the section of the pipe or box, and direct it on the proper line and grade. Place the entire jacking assembly in line with the direction and grade of the pipe or box. In general, excavate the embankment material just ahead of the pipe or box, remove the material through the pipe or box, and force the pipe or box through the embankment with jacks into the space bored or tunneled.

Furnish a plan showing the proposed method of jacking for approval. Include the design for the jacking head, jacking support or backstop (thrust block), arrangement and position of jacks, and guides in the plan.

Ensure excavation for the underside of the pipe so at least 1/3 of the circumference of the pipe conforms to the contour and grade of the pipe. Ensure the excavation for the bottom slab of the box conforms to the grade of the box. Over-excavate, if desired, to provide no more than 2 in. of clearance for the upper portion and sides of the pipe or box. Taper this clearance to zero at the point where the excavation conforms to the contour of the pipe or box. Carry out jacking without interruption to prevent the pipe from becoming firmly set in the embankment. Monitor volume of soil excavated to avoid any appreciable over-excavation. Pressure-grout any over-excavation of more than 1 in. Pressure-grout between the carrier pipe and casing when shown on the plans.

The distance the excavation extends beyond the end of the pipe or box must not exceed 2 ft. Decrease this distance as necessary to maintain stability of the material being excavated.

Jack the pipe or box from the low or downstream end. The final position of the pipe or box must not vary from the line and grade shown on the plans by more than 1 in. in 10 ft. Variation must be regular and in one direction, and the final flow line must be in the direction shown on the plans.

Use a shield or cutting edge of steel plate around the head end of the pipe or box extending a short distance beyond the end if desired. The minimum clear distance for parallel pipe or box jacking or tunneling is 3 ft., unless otherwise shown on the plans.

- 3.2. **Boring or Tunneling.** Bore from a shaft in an approved location provided for the boring equipment and workers.

Dispose of excavated material using an approved method. Use water or other appropriate drilling fluids in connection with the boring operation only as necessary to lubricate cuttings and pipe or box; do not use jetting.

Use a gel-forming colloidal drilling fluid consisting of high-grade, carefully processed bentonite to consolidate cuttings of the bit in unconsolidated soil formations. Seal the walls of the borehole and furnish lubrication for subsequent removal of cuttings and immediate installation of the pipe.

Allowable variations from line and grade are specified in Section 476.3.1., "Jacking." Pressure-grout any over-excavation of more than 1 in.

- 3.2.1. **Larger Diameter Boring Methods.** Use the pilot hole or auger method for drainage and large utility borings. Pressure-grout any over-excavation of more than 1 in. Pressure-grout between the carrier pipe and casing when shown on the plans.

- 3.2.1.1. **Pilot Hole Method.** Bore a 2-in. pilot hole the entire length of the crossing and check it for line and grade during the boring or tunneling operation on the opposite end of the bore from the work shaft. This pilot hole will serve as centerline for the larger diameter hole to be bored.

- 3.2.1.2. **Auger Method.** Use a steel encasement pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation. Use augers of large enough diameter to convey the excavated material to the work shaft.

- 3.2.2. **Electrical and Communication Conduit Boring.** Limit over-excavation to the dimensions shown in Table 1 for electrical and communication conduit borings. Increased boring diameters will be allowed for outer diameters of casing and couplings. Pressure-grouting will not be required for electrical and communication conduit borings.

Table 1
Allowable Bore Diameter for Electrical or Communication Conduit or Casing

Single Conduit Bores		Multiple Conduit Bores	
Conduit Size (in.)	Maximum Allowable Bore (in.)	Conduit Size (in.) ¹	Maximum Allowable Bore (in.)
2	4	4	6
3	6	5	8
4	6	6	10
6	10	7	12
—	—	8	12

1. The diameter of multiple conduits is the sum of the outside diameter of the two largest conduits for placement of up to four conduits in one bore. Submit boring diameters for the Engineer's approval when more than four conduits are to be placed in a bore.

- 3.3. **Tunneling.** Use an approved tunneling method where the characteristics of the soil, the size of the proposed pipe, or the use of monolithic pipe would make the use of tunneling more satisfactory than jacking or boring, or when shown on the plans.

Ensure the lining of the tunnel is strong enough to support the overburden when tunneling is permitted. Submit the proposed liner method for approval. Approval does not relieve the Contractor of the responsibility for the adequacy of the liner method.

Pressure-grout the space between the liner plate and the limits of excavation.

Pressure-grout between the carrier pipe and liner plate when shown on the plans.

- 3.4. **Joints.** Make the joints in accordance with Item 464 if reinforced concrete pipe is used. Make the joints in accordance with Item 462 if reinforced concrete box is used.

4. MEASUREMENT

This Item will be measured by the foot between the ends of the pipe or box along the flow line.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Jacking, Boring, or Tunneling Pipe" of the type, size, and class or design specified, or "Jacking or Tunneling Box Culvert" of the size specified.

This price is full compensation for excavation, grouting, backfilling, and disposal of surplus material; furnishing pipe, box, and pipe liner materials required for tunnel operations; preparation, hauling, and installing of pipe, box, and pipe liner materials; and materials, tools, equipment, labor, and incidentals.

Protection methods for open excavations deeper than 5 ft. will be measured and paid for as required under Item 402 or Item 403.

Item 496

Removing Structures



1. DESCRIPTION

Remove and either dispose of or salvage structures.

2. CONSTRUCTION

- 2.1. **Demolition Plans.** Follow the demolition sequence shown on the plans for bridge structures to be removed or submit a demolition plan if shown on the plans. Include in the required demolition plan the type and location of equipment to be used, the method and sequence of removal of the structural elements, and a narrative indicating the stability of the partially demolished structure is maintained throughout the demolition process. Have these plans signed and sealed by a licensed professional engineer when demolished structure intersects active roadways and as otherwise shown on the plans. Submit required demolition plans at least 14 days before starting work unless otherwise directed. Department approval of these plans is not required, but the Department reserves the right to request modifications to the plans when work could affect the safety of the traveling public and when around other transportation facilities to remain in place. Notify the Department 30 days before starting any bridge demolition work to allow for required notifications to other agencies.
- 2.2. **Removal.**
- 2.2.1. **Pipes.** Avoid damaging appurtenances determined by the Engineer to be salvageable.
- 2.2.2. **Concrete, Brick, or Stone Structures.** Portions of structures that will not interfere with the proposed construction may remain in place 2 ft. or more below the permanent ground line. Square off remaining structures and cut reinforcement flush with the surface of the concrete.
- 2.2.3. **Steel Structures.** Dismantle steel to be retained by the Department or re-erected by cold-cutting fastener heads and punching or drilling the remaining portion of the fastener, air-arc gouging welded connections, and flame-cutting beams along a straight line. The Engineer may approve other methods of cutting. Cut beams at the locations shown on the plans. Match-mark steel to be re-erected with paint in conformance with the erection drawings. Remove steel piles or cut off 2 ft. or more below the permanent ground line.
- 2.2.4. **Timber Structures.** Remove all fasteners from timber determined by the Engineer to be salvageable. Remove timber piles or cut off 2 ft. or more below the permanent ground line.
- 2.3. **Salvage.** Avoid damage to materials shown on the plans to be salvaged. Deliver materials to be retained by the Department to the location shown on the plans. Block up salvaged steel materials off the ground.
- 2.4. **Disposal.** Material removed that is not deemed to be salvageable is the property of the Contractor. Dispose of removed material off the right of way in conformance with federal, state, and local regulations.
- 2.5. **Backfill.** Backfill excavation and voids to the original ground line if resulting from the removal of structures. Place backfill that will support any portion of the roadbed or embankment to the same requirements for placing embankment. Backfill other areas in 10-in. layers, loose measurement, and compact to the density of adjacent undisturbed material.

3. MEASUREMENT

This Item will be measured by each structure or by the foot.

4. PAYMENT

The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Structures" of the type of structure specified. This price is full compensation for demolition plan preparation, loading, hauling, disposal, stockpiling, removal of appurtenances, excavation and backfill, equipment, labor, tools, and incidentals.

Item 503

Portable Changeable Message Sign



1. DESCRIPTION

Furnish, operate, and maintain trailer-mounted portable changeable message sign (PCMS) units.

2. MATERIALS

Furnish new or used material in accordance with this Item and as shown on the plans. Provide a self-contained PCMS unit with the following:

- sign controller,
- changeable message sign,
- trailer, and
- power source.

Paint the exterior surfaces of the power supply housing, supports, trailer, and sign with Federal Orange No. 22246 or Federal Yellow No. 13538 of Federal Standard 595C, except paint the sign face assembly flat black.

2.1. Sign Controller. Provide the following.

- A controller with permanent storage of at least 75 pre-programmed messages
- An external input device for random programming and storage of at least 75 additional messages
- A controller capable of displaying up to three messages sequentially
- A controller with adjustable display rates

Enclose sign controller equipment in a lockable enclosure.

2.2. Changeable Message Sign. Provide the following.

- A sign capable of being elevated to at least 7 ft. above the roadway surface from the bottom of the sign
- A sign capable of being rotated 360° and secured against movement in any position
- A sign with three separate lines of text and eight characters per line minimum
- A minimum 18-in. character height
- A 5 × 7-character pixel matrix
- A message legibility distance of 600 ft. for nighttime conditions and 800 ft. for normal daylight conditions
- Capability for manual and automatic dimming light sources

The following are descriptions for three screen types of PCMS.

- **Character Modular Matrix.** This screen type comprises of character blocks.
- **Continuous Line Matrix.** This screen type uses proportionally spaced fonts for each line of text.
- **Full Matrix.** This screen type uses proportionally spaced fonts, varies the height of characters, and displays simple graphics on the entire sign.

2.3. Trailer. Provide a two-wheel trailer with square top fenders, four leveling jacks, and trailer lights. Do not exceed an overall trailer width of 96 in. Shock mount the electronics and sign assembly.

2.4. Power Source. Provide a diesel generator, solar powered power source, or both. Provide a backup power source as necessary.

- 2.5. **Cellular Modem.** When shown on the plans, provide a cellular modem connection to communicate with the PCMS unit remotely.

3. CONSTRUCTION

Place or relocate PCMS units as shown on the plans or as directed. The plans will show the number of PCMS units needed, for how many days, and for which construction phases.

Maintain the PCMS units in good working condition. Repair damaged or malfunctioning PCMS units as soon as possible. PCMS units will remain the property of the Contractor.

4. MEASUREMENT

This Item will be measured by each PCMS or by the day used. All PCMS units must be set up on a work area and operational before a calendar day can be considered measurable. When measurement by the day is specified, a day will be measured for each PCMS set up and operational on the worksite.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Portable Changeable Message Sign." This price is full compensation for PCMS units; setup; relocating; removing; replacement parts; batteries (when required); fuel, oil, and oil filters (when required); cellular telephone charge (when required); software; and equipment, materials, tools, labor, and incidentals. Reimbursement for the repair of damaged devices will be in accordance with Section 7.17.1., "Reimbursable Repair."

Item 504

Field Office and Laboratory



1. DESCRIPTION

Provide field offices and laboratories for exclusive use of the Engineer and inspection staff of the type shown on the plans.

2. EQUIPMENT

- 2.1. **General.** Furnish facilities after receipt of the work order and before beginning physical work on the project. Provide field offices of the type and number specified near the worksite at an acceptable location. Use of permanent buildings or rental space meeting the requirements for field offices and laboratories instead of portable buildings is allowed. Maintain the field office until the Department accepts the project.

Provide inspection laboratories of the type specified before beginning the fabrication of products required by the Contract. Locate the building so that plant operations are visible from the building. Maintain the laboratories until the production of the associated product is complete.

Immediately repair or replace facilities if damaged in any manner. Payment for repair will not be made unless it is the result of negligence by the Department. Reimburse the Department for equipment damaged by the Contractor's operations. Remove buildings and other facilities and restore the right of way before project acceptance when facilities are allowed in the right of way.

Provide a partitioned restroom furnished with restroom supplies, a lavatory, and a flush toilet. A portable toilet is allowed unless otherwise shown on the plans. The restroom facility or portable toilet may be a shared facility but must be accessible and in proximity to the Engineer's field office and laboratory.

Dispose of trash collected by the Department associated with the facility provided. Provide for janitorial services for floors and toilets.

Provide reliable internet access when shown on the plans.

When detailed on the plans, provide for storage of the nuclear gauge that meets the exposure and security requirements of the Department and Texas Department of State Health Services (DSHS).

- 2.2. **Parking and Fencing.** Provide an all-weather parking area for the sole use of at least two State-owned vehicles unless otherwise shown on the plans. Situate the area near the field office or laboratory at an acceptable location. Maintain the parking area until the project is completed and restore the area in the right of way to a condition acceptable to the Engineer upon project completion.

Enclose the parking area and buildings with a 6-ft. chain-link fence, top-mounted three-strand barbed wire, and a 12-ft. gate when shown on the plans.

- 2.3. **Buildings.** Buildings that were considered adequate by the Department before the implementation of these Standard Specifications, except for Type E structures, may remain in service for their useful life. Buildings may either be under shared roofs with the Contractor and supplier facilities or separate facilities. Provide secured Department-only access to secure the Department's furnished equipment and files by partitioning the rooms, separate laboratories, or other approved methods.

Provide buildings with roof, floor, secured doors, and screened windows with blinds. All rooms will have a minimum 8-ft. ceiling and aisles at least 5 ft. in width. Provide floors that are strong and stable with an

impervious floor covering for interior rooms. For portable facilities, install tie downs. Ensure that the building is weatherproof, piped for water, piped for fuel (when needed for heating), and electrically wired by personnel meeting the requirements of Article 7.18., "Electrical Requirements." Provide electricity in sufficient amperage to meet the needs of the type of facility.

Furnish and install adequate outlets, lighting, air conditioning, heating, and ventilation.

Furnish strong and stable landings, ramps, and steps to all exterior doors of the building if needed for access.

Provide potable water or water from a potable source for testing and cleaning.

Provide secured and controlled access to the field office or laboratory. Provide bars on the windows. When shown on the plans, provide security fencing with a 6-ft. chain link fence, top-mounted three-strand barbed wire, and a 12-ft. gate.

For new buildings, coordinate with the Engineer on the layout to meet the requirements of this Item.

- 2.3.1. **Field Office.** Provide at least two workbenches or tables at least 30 in. wide and 5 ft. long, at least four chairs, at least three drawers of filing cabinets, and at least one desk at least 30 in. wide and 5 ft. long, or as approved.
- 2.3.2. **Laboratory.** Provide the following items unless otherwise shown on the plans:
- a minimum 4 × 4-ft. landing on all exterior doors when steps are necessary;
 - stable platforms for testing equipment;
 - a floor strong and stable enough to support testing equipment;
 - a 10-lb. ABC fire extinguisher with up-to-date inspection tag and a working smoke detector;
 - exhaust fans for removing volatiles and aggregate fines from room air. Position exhaust fans to pull volatiles and fines away from the technician. Vent all equipment exhaust to the outside of the structure in conformance with manufacturer requirements;
 - an area for a desk that is a minimum 30 in. × 5 ft., at least three drawers of filing cabinets, and at least one chair; and
 - a laboratory sink measuring at least approximately 24 × 30 in. and 12 in. deep.
- 2.3.3. **Structure Types.**
- 2.3.3.1. **Type A Structure (Concrete Laboratory).** Provide at least 100 sq. ft. of gross floor area with at least two windows and one exterior door. Provide a minimum 30-in. × 6-ft. stable work counter. Meet requirements in accordance with Section 504.2.3.2., "Laboratory," except filing cabinets, a sink, and exhaust fans are not required unless otherwise shown on the plans.
- 2.3.3.2. **Type B Structure (Field Office and Concrete Laboratory).** Provide at least 320 sq. ft. of gross floor area. Partition the floor area into at least three interconnected rooms with doors, two windows in each room, and two exterior doors. Provide enough 30-in. width counter space for performing testing, to place test equipment, for a preparation area, and for a sink.
- 2.3.3.3. **Type C Structure (Field Office).** Provide at least 200 sq. ft. of gross floor area with at least one exterior door and two windows.
- 2.3.3.4. **Type D Structure (Hot-Mix Asphalt Laboratory).** Provide enough floor area that will accommodate 30-in. width counter space for performing testing, to place test equipment, for a preparation area, and for a sink. Partition the floor area into at least two interconnected rooms with interior doors, at least two windows in each room, and two exterior doors. Provide an electrical outlet with sufficient power within 3 ft. of the ignition oven location and vent the ignition oven separately to the outside in conformance with the manufacturer's

requirements. Provide a surface for the ignition oven that is level, sturdy, and fireproof with at least 6 in. of clearance between the furnace and other vertical surfaces.

For gyratory presses that are shared, the equipment is not required to be locked behind the Department's secured access but must be under the same roof or in proximity to the Department's laboratory and must meet the Department's requirements including the requirements in test procedures, comparable and consistent test results, safety, efficiency, and accessibility.

2.3.3.5. **Type E Structure.** Provide building as shown on the plans.

3. MEASUREMENT AND PAYMENT

The work performed, equipment, utilities, testing equipment as specified for Department use, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

Item 505

Truck-Mounted Attenuator (TMA) and Trailer Attenuator (TA)



1. DESCRIPTION

Furnish, operate, maintain, and remove upon completion of work, a truck-mounted attenuator (TMA) or trailer attenuator (TA).

2. MATERIALS

Furnish, operate, and maintain new or used TMAs or TAs. Assure used attenuators are in good working condition and are approved for use. A list of approved TMA and TA units can be found on the Department's Compliant Work Zone Traffic Control Devices List. The host vehicle for the TMA and TA must weigh at least 19,000 lb. Host vehicles may be ballasted to achieve the required weight. Any weight added to the host vehicle must be properly attached to or contained within the vehicle so that the weight does not present a hazard and that proper energy dissipation occurs if the attenuator is impacted from behind. The weight of a TA will not be considered in the weight of the host vehicle, but the weight of a TMA may be included in the weight of the host vehicle. Upon request, provide either a manufacturer's curb weight or a certified scale weight ticket to the Engineer.

3. CONSTRUCTION

Place or relocate TMAs or TAs as shown on the plans or as directed. The plans show the number of TMAs or TAs required, the number of days or hours, and for which construction phases.

4. MEASUREMENT

4.1. **Truck-Mounted Attenuator or Trailer Attenuator (Stationary).** This Item will be measured by the day. TMAs or TAs must be set up in a work area and operational before a calendar day can be considered measurable. A day will be measured for each TMA or TA set up and operational on the worksite.

4.2. **Truck-Mounted Attenuator or Trailer Attenuator (Mobile Operation).** This Item will be measured by the hour or by the day. The time begins once the TMA or TA is ready for operation at the predetermined site and stops when notified by the Engineer. When measurement by the hour is specified, at least 4 hr. will be paid each day for each operating TMA or TA used in a mobile operation. When measurement by the day is specified, a day will be measured for each TMA or TA set up and operational on the worksite.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Truck-Mounted Attenuators/Trailer Attenuators (Stationary)" or "Truck-Mounted Attenuators/Trailer Attenuators (Mobile Operation)." This price is full compensation for furnishing TMA or TA; setup; relocating; removing; operating; fuel; and equipment, materials, tools, labor, and incidentals. Reimbursement for the repair of damaged devices will be in accordance with Section 7.17.1., "Reimbursable Repair."

Item 506

Temporary Erosion, Sedimentation, and Environmental Controls



1. DESCRIPTION

Install, maintain, and remove erosion, sedimentation, and environmental control measures to prevent or reduce the discharge of pollutants and protect environmental resources in accordance with the Stormwater Pollution Prevention Plan (SWP3) and environmental layout shown on the plans. Comply with Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit (CGP) TXR150000 requirements. Control measures are defined as Best Management Practices (BMPs) used to prevent or reduce the discharge of pollutants and measures to protect environmental resources. Control measures include, but are not limited to, rock filter dams, temporary pipe slope drains, temporary paved flumes, construction exits, earthwork for erosion control, pipe, construction perimeter fence, sandbags, temporary sediment control fence, biodegradable erosion control logs, vertical tracking, temporary or permanent seeding, and other measures. Erosion and sediment control devices must be selected from the Erosion Control Approved Products List. Perform work in a manner to prevent degradation of receiving waters, protect environmental resources, facilitate project construction, and comply with applicable federal, state, and local regulations. Ensure the installation and maintenance of control measures are performed in conformance with the manufacturer's or designer's specifications.

2. MATERIALS

Furnish materials in accordance with the following.

- Item 161, "Compost"
- Item 432, "Riprap"
- Item 556, "Pipe Underdrains"

2.1. Rock Filter Dams.

2.1.1. **Aggregate.** Furnish aggregate with approved hardness, durability, cleanliness, and resistance to crumbling, flaking, and eroding. Provide the following.

- **Types 1, 2, and 4 Rock Filter Dams.** Use 3–6-in. aggregate.
- **Type 3 Rock Filter Dams.** Use 4–8-in. aggregate.

2.1.2. **Wire.** Provide minimum 20-gauge galvanized wire for the steel wire mesh and tie wires for Types 2 and 3 rock filter dams. Type 4 dams require:

- a double-twisted, hexagonal weave with a nominal mesh opening of 2-1/2 × 3-1/4 in.,
- minimum 0.0866-in. steel wire for netting,
- minimum 0.1063-in. steel wire for selvages and corners, and
- minimum 0.0866 in. for binding or tie wire.

2.1.3. **Sandbag Material.** Furnish sandbags meeting Section 506.2.8., "Sandbags," except that any gradation of aggregate may be used to fill the sandbags.

2.2. **Temporary Pipe Slope Drains.** Provide corrugated metal pipe, polyvinyl chloride (PVC) pipe, flexible tubing, watertight connection bands, grommet materials, prefabricated fittings, and flared entrance sections as shown on the plans. Recycled and other materials meeting these requirements are allowed if approved.

Furnish concrete in accordance with Item 432.

- 2.3. **Temporary Paved Flumes.** Furnish asphalt concrete, hydraulic cement concrete, or other comparable non-erodible material as shown on the plans. Provide rock or rubble with a minimum diameter of 6 in. and a maximum volume of 1/2 cu. ft. for the construction of energy dissipaters.
- 2.4. **Construction Exits.** Provide materials as shown on the plans and in accordance with this Section.
 - 2.4.1. **Rock Construction Exit.** Provide crushed aggregate for long- and short-term construction exits. Furnish aggregates that are clean, hard, durable, and free of adherent coatings such as salt, alkali, dirt, clay, loam, shale, soft or flaky materials, and organic and injurious matter. Use 4–8-in. aggregate for Type 1. Use 2–4-in. aggregate for Type 3.
 - 2.4.2. **Timber Construction Exit.** Furnish No. 2 quality or better railroad ties and timbers for long-term construction exits, free of large and loose knots and treated to control rot. Fasten timbers using nuts and bolts or lag bolts, of at least 1/2 in. diameter, unless otherwise shown on the plans or allowed. Provide plywood or pressed wafer board at least 1/2 in. thick for short-term exits.
 - 2.4.3. **Foundation Course.** Provide a foundation course consisting of flexible base, bituminous concrete, hydraulic cement concrete, or other materials as shown on the plans or directed.
- 2.5. **Embankment for Erosion Control.** Provide rock, loam, clay, topsoil, or other earth materials that will form a stable embankment to meet the intended use.
- 2.6. **Pipe.** Provide pipe outlet material in accordance with Item 556 and as shown on the plans.
- 2.7. **Construction Perimeter Fence.**
 - 2.7.1. **Posts.** Provide essentially straight wood or steel posts that are at least 60 in. long. Furnish soft wood posts with a minimum diameter of 3 in. or use nominal 2 × 4-in. boards. Furnish hardwood posts with a minimum cross-section of 1-1/2 × 1-1/5 in. Furnish T- or L-shaped steel posts with a minimum weight of 1.25 lb. per foot.
 - 2.7.2. **Fence.** Provide orange construction fencing as approved.
 - 2.7.3. **Fence Wire.** Provide 14-gauge or larger galvanized smooth or twisted wire. Provide 16-gauge or larger tie wire.
 - 2.7.4. **Flagging.** Provide brightly colored flagging that is fade-resistant and at least 3/4 in. wide to provide maximum visibility both day and night.
 - 2.7.5. **Staples.** Provide staples with a crown at least 1/2 in. wide and legs at least 1/2 in. long.
 - 2.7.6. **Used Materials.** Previously used materials meeting the applicable requirements may be used if approved.
- 2.8. **Sandbags.** Provide sandbag material of polypropylene, polyethylene, or polyamide woven fabric with a minimum unit weight of 4 oz. per square yard, a Mullen burst-strength exceeding 300 psi, and an ultraviolet (UV) stability exceeding 70%.

Use natural coarse sand or manufactured sand meeting the gradation shown in Table 1 to fill sandbags. Filled sandbags must be 24–30 in. long, 16–18 in. wide, and 6–8 in. thick.

Table 1
Sand Gradation

Sieve Size	Retained (% by Weight)
#4	Maximum 3%
#100	Minimum 80%
#200	Minimum 95%

Aggregate may be used instead of sand for situations where sandbags are not adjacent to traffic. The aggregate size must not exceed 3/8 in.

- 2.9. **Temporary Sediment Control Fence.** Provide a net-reinforced fence using woven geotextile fabric. Logos visible to the traveling public will not be allowed.
- 2.9.1. **Fabric.** Provide fabric materials in accordance with [DMS-6230](#), "Temporary Sediment Control Fence Fabric."
- 2.9.2. **Posts.** Provide essentially straight wood or steel posts with a minimum length of 48 in., unless otherwise shown on the plans. Furnish soft wood posts at least 3 in. in diameter or use nominal 2 × 4-in. boards. Furnish hardwood posts with a minimum cross-section of 1-1/2 × 1-1/2 in. Furnish T- or L-shaped steel posts with a minimum weight of 1.25 lb. per foot.
- 2.9.3. **Net Reinforcement.** Provide net reinforcement of at least 12.5-gauge (Standard Wire Gauge) galvanized welded wire mesh, with a maximum opening size of 2 × 4 in., at least 24 in. wide, unless otherwise shown on the plans.
- 2.9.4. **Staples.** Provide staples with a crown at least 3/4 in. wide and legs 1/2 in. long.
- 2.9.5. **Used Materials.** Use recycled material meeting the applicable requirements if approved.
- 2.10. **Biodegradable Erosion Control Logs.**
- 2.10.1. **Core Material.** Furnish core material that is biodegradable or recyclable. Use compost, mulch, aspen excelsior wood fibers, chipped site vegetation, agricultural rice or wheat straw, coconut fiber, 100% recyclable fibers, or any other acceptable material unless specifically shown on the plans. Permit no more than 5% of the material to escape from the containment mesh. Furnish compost in accordance with Item 161.
- 2.10.2. **Containment Mesh.** Furnish containment mesh that is 100% biodegradable, photodegradable, or recyclable, such as burlap, twine, UV photodegradable plastic, polyester, or any other acceptable material.
- Furnish biodegradable or photodegradable containment mesh when log will remain in place as part of a vegetative system.
- Furnish recyclable containment mesh for temporary installations.
- 2.10.3. **Size.** Furnish biodegradable erosion control logs with diameters as shown on the plans or as directed. Stuff containment mesh densely so logs do not deform.

3. QUALIFICATIONS, TRAINING, AND EMPLOYEE REQUIREMENTS

- 3.1. **Contractor Responsible Person Environmental (CRPE) Qualifications and Responsibilities.** Provide and designate in writing at the preconstruction conference a CRPE and alternate CRPE who have overall responsibility for managing environmental compliance. The CRPE will implement stormwater and erosion control practices, oversee and observe stormwater control measure monitoring and management, oversee environmental compliance requirements, and monitor the project site daily and produce daily monitoring reports as long as there are BMPs in place or soil disturbing activities are evident to ensure compliance with the SWP3 and TPDES CGP TXR150000. Take required training in accordance with Section 7.7.4.4, "Training."

Maintain daily monitor reports and make them available within 24 hr. upon request. During time suspensions when work is not occurring or on Contract non-work days, daily inspections are not required unless a rain event has occurred. The CRPE will provide recommendations on how to improve the effectiveness of control measures. Attend the Department's preconstruction conference for the project.

Ensure training is completed in accordance with Section 7.7.4.4., "Training," by all applicable personnel before employees work on the project. Document, maintain, and make available within 24 hr. of a request, a list, signed by the CRPE, of all applicable Contractor and subcontractor employees who have completed the training. Include the employee's name, the training course name, and the date the employee completed the training.

- 3.2. **Contractor Superintendent Qualifications and Responsibilities.** Provide a superintendent who is competent, has experience with and knowledge of stormwater management, and is knowledgeable of the requirements and the conditions of the TPDES CGP TXR150000. The superintendent will manage and oversee the day-to-day operations and activities at the project site, work with the CRPE to provide effective stormwater management at the project site, represent and act on behalf of the Contractor, and attend the Department's preconstruction conference for the project. Take training as required in Section 7.7.4.4., "Training."

4. CONSTRUCTION

- 4.1. **Contractor Responsibilities.** Implement the SWP3 for the project site in accordance with the plans and specifications, TPDES CGP TXR150000, and as directed. Coordinate stormwater management with all other work on the project. Develop and implement an SWP3 for project-specific material supply plants within and outside the Department's right of way in conformance with the specific or general stormwater permit requirements. Prevent water pollution from stormwater associated with construction activity from entering any surface water or private property on or adjacent to the project site.
- 4.2. **Implementation.** The CRPE, or alternate CRPE, must be accessible by telephone and able to respond to project-related stormwater management or other environmental emergencies 24 hr. per day.
- 4.2.1. **Commencement.** Implement the SWP3 as shown on the plans and as directed. Contractor-proposed recommendations for changes will be allowed as approved. Conform to the established guidelines in the TPDES CGP TXR150000 to make changes. Do not implement changes until approval has been received and changes have been incorporated into the plans. Minor adjustments to meet field conditions are allowed and will be recorded in the SWP3.
- 4.2.2. **Phasing.** Implement control measures before the commencement of activities that result in soil disturbance. Phase and minimize the soil disturbance to the areas shown on the plans. Coordinate temporary control measures with permanent control measures and all other work activities on the project to assure economical, effective, safe, and continuous water pollution prevention. Provide control measures that are appropriate to the construction means, methods, and sequencing allowed by the Contract. Exercise precaution throughout the life of the project to prevent pollution of ground waters and surface waters. Schedule and perform clearing and grubbing operations so that stabilization measures will follow immediately thereafter if project conditions permit. Bring all grading sections to final grade as soon as possible and implement temporary and permanent control measures at the earliest time possible. Implement temporary control measures when required by TPDES CGP TXR150000 or otherwise necessitated by project conditions.
- Do not prolong final grading and shaping. Preserve vegetation where possible throughout the project, and minimize clearing, grubbing, and excavation within stream banks, bed, and approach sections.
- 4.3. **General.**
- 4.3.1. **Temporary Alterations or Control Measure Removal.** Altering or removal of control measures is allowed when control measures are restored within the same working day.

- 4.3.2. **Stabilization.** Initiate stabilization for disturbed areas no more than 14 days after the construction activities in that portion of the site have temporarily or permanently ceased. Establish a uniform vegetative cover or use another stabilization practice in accordance with TPDES CGP TXR150000.
- 4.3.3. **Finished Work.** Remove and dispose of all temporary control measures upon acceptance of vegetative cover or other stabilization practice unless otherwise directed. Complete soil disturbing activities and establish a uniform perennial vegetative cover. A project will not be considered for acceptance until a vegetative cover of 70% density of existing adjacent undisturbed areas is obtained or equivalent permanent stabilization is obtained in accordance with TPDES CGP TXR150000. The Engineer may accept the work before vegetative cover of 70% density of existing adjacent undisturbed areas. An exception will be allowed in arid areas as defined in TPDES CGP TXR150000.
- 4.3.4. **Restricted Activities and Required Precautions.** Do not discharge onto the ground or into surface waters any pollutants such as chemicals, raw sewage, fuels, lubricants, coolants, hydraulic fluids, bitumens, or any other petroleum product. Operate and maintain equipment onsite to prevent actual or potential water pollution. Manage, control, and dispose of litter onsite such that no adverse impacts to water quality occur. Prevent dust from creating a potential or actual unsafe condition, public nuisance, or condition endangering the value, utility, or appearance of any property. Wash out concrete trucks only as described in TPDES CGP TXR150000. Use appropriate controls to minimize the offsite transport of suspended sediments and other pollutants if it is necessary to pump or channel standing water (i.e., dewatering). Immediately address chemical and hydrocarbon spills caused by the Contractor. Keep a spill kit onsite. Prevent discharges that would contribute to a violation of Edwards Aquifer Rules, water quality standards, the impairment of a listed water body, or other state or federal law.
- 4.4. **Installation, Maintenance, and Removal Work.** Perform work in accordance with the SWP3, in conformance with manufacturers' guidelines, and in accordance with TPDES CGP TXR150000. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until soil disturbing activities are completed and permanent erosion control features are in place, or the disturbed area has been adequately stabilized as approved.

The Department will inspect and document the condition of the control measures at the frequency shown on the plans and will provide the Construction SWP3 Field Inspection and Maintenance Reports to the Contractor. Make corrections as soon as possible before the next anticipated rain event or within 7 calendar days after being able to enter the worksite for each control measure. The only acceptable reason for not accomplishing the corrections within the timeframe specified is when site conditions are considered "too wet to work." Take immediate action if a correction is deemed critical as directed. When corrections are not made within the established timeframe, all work will cease on the project and time charges will continue while the control measures are brought into compliance. Commence work once the Engineer reviews and documents the project is in compliance. Commencing work does not release the Contractor of the liability for noncompliance with the SWP3, the plans, or TPDES CGP TXR150000.

The Engineer may limit the disturbed area if the Contractor cannot control soil erosion and sedimentation resulting from the Contractor's operations. Implement additional controls as directed.

Remove devices upon approval or as directed. Finish-grade and dress the area upon removal. Stabilize disturbed areas in accordance with TPDES CGP TXR150000, and as shown on the plans or directed. Materials removed are considered consumed by the project. Retain ownership of stockpiled material and remove it from the project when new installations or replacements are no longer required.

- 4.4.1. **Rock Filter Dams for Erosion Control.** Remove trees, brush, stumps, and other objectionable material that may interfere with the construction of rock filter dams. Place sandbags as a foundation when required or at the Contractor's option.

Place the aggregate to the lines, height, and slopes specified, without undue voids for Types 1, 2, 3, and 5. Place the aggregate on the mesh and then fold the mesh at the upstream side over the aggregate and secure it to itself on the downstream side using wire ties, or hog rings for Type 2 and Type 3, or as directed.

Place rock filter dams perpendicular to the flow of the stream or channel unless otherwise directed. Construct filter dams in accordance with the following criteria unless otherwise shown on the plans.

4.4.1.1.

Type 1 (Non-Reinforced).

- **Height.** At least 18 in. measured vertically from existing ground to top of filter dam.
- **Top Width.** At least 2 ft.
- **Slopes.** No steeper than 2:1.

4.4.1.2.

Type 2 (Reinforced).

- **Height.** At least 18 in. measured vertically from existing ground to top of filter dam.
- **Top Width.** At least 2 ft.
- **Slopes.** No steeper than 2:1.

4.4.1.3.

Type 3 (Reinforced).

- **Height.** At least 36 in. measured vertically from existing ground to top of filter dam.
- **Top Width.** At least 2 ft.
- **Slopes.** No steeper than 2:1.

4.4.1.4.

Type 4 (Sack Gabions). Unfold sack gabions and smooth out kinks and bends. Connect the sides by lacing in a single-loop-double-loop pattern on 4–5-in. spacing for vertical filling. Pull the end lacing rod at one end until tight, wrap around the end, and twist four times. Fill with stone at the filling end, pull the rod tight, cut the wire with approximately 6 in. remaining, and twist wires four times.

Place the sack flat in a filling trough, fill with stone, connect sides, and secure ends as described above for horizontal filling.

Lift and place without damaging the gabion. Shape sack gabions to existing contours.

4.4.1.5.

Type 5. Provide rock filter dams as shown on the plans.

4.4.2.

Temporary Pipe Slope Drains. Install pipe with a slope as shown on the plans or as directed. Construct embankment for the drainage system in 8-in. lifts to the required elevations. Hand-tamp the soil around and under the entrance section to the top of the embankment as shown on the plans or as directed. Form the top of the embankment or earth dike over the pipe slope drain at least 1 ft. higher than the top of the inlet pipe at all points. Secure the pipe with hold-downs or hold-down grommets spaced at most 10 ft. on center. Construct the energy dissipaters or sediment traps as shown on the plans or as directed. Construct the sediment trap using concrete or rubble riprap in accordance with Item 432, when shown on the plans.

4.4.3.

Temporary Paved Flumes. Construct paved flumes as shown on the plans or as directed. Provide excavation and embankment (including compaction of the subgrade) of material to the dimensions shown on the plans unless otherwise indicated. Install a rock or rubble riprap energy dissipater, constructed from the materials specified above, to a minimum depth of 9 in. at the flume outlet to the limits shown on the plans or as directed.

4.4.4.

Construction Exits. Prevent traffic from crossing or exiting the construction site or moving directly onto a public roadway, alley, sidewalk, parking area, or other right of way areas other than at the location of construction exits when tracking conditions exist. Construct exits for either long- or short-term use.

4.4.4.1.

Long-Term. Place the exit over a foundation course as required. Grade the foundation course or compacted subgrade to direct runoff from the construction exits to a sediment trap as shown on the plans or as directed. Construct exits with a width of at least 14 ft. for one-way and 20 ft. for two-way traffic for the full width of the exit, or as directed.

4.4.4.1.1.

Type 1. Construct to a depth of at least 8 in. using crushed aggregate as shown on the plans or as directed.

- 4.4.4.1.2. **Type 2.** Construct using railroad ties and timbers as shown on the plans or as directed.
- 4.4.4.2. **Short-Term.**
- 4.4.4.2.1. **Type 3.** Construct using crushed aggregate, plywood, or wafer board. This type of exit may be used for daily operations where long-term exits are not practical.
- 4.4.4.2.2. **Type 4.** Construct as shown on the plans or as directed.
- 4.4.5. **Earthwork for Erosion Control.** Perform excavation and embankment operations to minimize erosion and to remove collected sediments from other erosion control devices.
- 4.4.5.1. **Excavation and Embankment for Erosion Control Features.** Place earth dikes, swales, or combinations of both along the low crown of daily lift placement, or as directed, to prevent runoff spillover. Place swales and dikes at other locations as shown on the plans or as directed to prevent runoff spillover or to divert runoff. Construct cuts with the low end blocked with undisturbed earth to prevent erosion of hillsides. Construct sediment traps at drainage structures in conjunction with other erosion control measures as shown on the plans or as directed.
- Create a sediment basin, where required, providing 3,600 cu. ft. of storage per acre drained, or equivalent control measures for drainage locations that serve an area with 10 or more disturbed acres at one time, not including offsite areas.
- 4.4.5.2. **Excavation of Sediment and Debris.** Remove sediment and debris when accumulation affects the performance of the devices, after a rain, and when directed.
- 4.4.6. **Construction Perimeter Fence.** Construct, align, and locate fencing as shown on the plans or as directed.
- 4.4.6.1. **Installation of Posts.** Embed posts 18 in. deep or adequately anchor in rock, with a spacing of 8–10 ft.
- 4.4.6.2. **Wire Attachment.** Attach the top wire to the posts at least 3 ft. from the ground. Attach the lower wire midway between the ground and the top wire.
- 4.4.6.3. **Flag Attachment.** Attach flagging to both wire strands midway between each post. Use flagging at least 18 in. long. Tie flagging to the wire using a square knot.
- 4.4.7. **Sandbags for Erosion Control.** Construct a berm or dam of sandbags that will intercept sediment-laden stormwater runoff from disturbed areas, create a retention pond, detain sediment, and release water in sheet flow. Fill each bag with sand so that at least the top 6 in. of the bag is unfilled to allow for proper tying of the open end. Place the sandbags with their tied ends in the same direction. Offset subsequent rows of sandbags 1/2 the length of the preceding row. Place a single layer of sandbags downstream as a secondary debris trap. Place additional sandbags as necessary or as directed for supplementary support to berms or dams of sandbags or earth.
- 4.4.8. **Temporary Sediment Control Fence.** Provide temporary sediment control fence near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. Incorporate the fence into erosion control measures used to control sediment in areas of higher flow. Install the fence as shown on the plans, in accordance with this Section, or as directed.
- 4.4.8.1. **Installation of Posts.** Embed posts at least 18 in. deep or adequately anchor, if in rock, with a spacing of 6–8 ft., and install on a slight angle toward the runoff source.
- 4.4.8.2. **Fabric Anchoring.** Dig trenches along the uphill side of the fence to anchor 6–8 in. of fabric. Provide a minimum trench cross-section of 6 × 6 in. Place the fabric against the side of the trench and align approximately 2 in. of fabric along the bottom in the upstream direction. Backfill the trench, then hand-tamp.

4.4.8.3. **Fabric and Net Reinforcement Attachment.** Attach the reinforcement to wooden posts using staples, or to steel posts using T-clips, in at least four places equally spaced unless otherwise shown on the plans. Sewn vertical pockets may be used to attach reinforcement to end posts. Fasten the fabric to the top strand of reinforcement using hog rings or cord every 15 in. or less.

4.4.8.4. **Fabric and Net Splices.** Locate splices at a fence post with a minimum lap of 6 in. attached in at least six places equally spaced unless otherwise shown on the plans. Do not locate splices in concentrated flow areas.

Requirements for installation of used temporary sediment control fence include the following:

- fabric with minimal or no visible signs of biodegradation (weak fibers),
- fabric without excessive patching (more than one patch every 15–20 ft.),
- posts without bends, and
- backing without holes.

4.4.9. **Biodegradable Erosion Control Logs.** Install biodegradable erosion control logs near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. Incorporate the biodegradable erosion control logs into the erosion measures used to control sediment in areas of higher flow. Install, align, and locate the biodegradable erosion control logs as specified below, as shown on the plans, or as directed.

Secure biodegradable erosion control logs in a method adequate to prevent displacement resulting from normal rain events, to prevent damage to the logs, and as approved, such that flow is not allowed under the logs. Temporarily removing and replacing biodegradable erosion logs to facilitate daily work is allowed at the Contractor's expense.

4.4.10. **Vertical Tracking.** Perform vertical tracking on slopes to temporarily stabilize soil. Provide equipment with a track undercarriage capable of producing a linear soil impression measuring at least 12 in. long × 2–4 in. wide × 1/2–2 in. deep. Do not exceed 12 in. between track impressions. Install continuous linear track impressions where the 12-in. length impressions are perpendicular to the slope. Vertical tracking is required on projects where soil disturbing activities have occurred, unless otherwise approved.

4.5. **Monitoring and Documentation.** Monitor the control measures daily as long as there are BMPs in place or soil disturbing activities are evident to ensure compliance with the SWP3 and TPDES CGP TXR150000. During time suspensions when work is not occurring or contract non-work days, daily inspections are not required unless a rain event has occurred. Monitoring will consist of, but is not limited to, observing, inspecting, and documenting site locations with control measures and discharge points to provide maintenance and inspection of controls in accordance with the SWP3. Keep written records of daily monitoring. Document in the daily monitoring report the control measure condition, the date of inspection, required corrective actions, the responsible person for making the corrections, and the date corrective actions were completed. Maintain records of all monitoring reports at the project site or at an approved place. Provide copies within 7 days. Together, the CRPE and an Engineer's representative will complete the Construction Stage Gate Checklist periodically as directed.

5. MEASUREMENT

5.1. **Rock Filter Dams.** Installation or removal of rock filter dams will be measured by the foot or by the cubic yard. The measured volume will include sandbags, when used.

5.1.1. **Linear Measurement.** When rock filter dams are measured by the foot, measurement will be along the centerline of the top of the dam.

5.1.2. **Volume Measurement.** When rock filter dams are measured by the cubic yard, measurement will be based on the volume of rock computed by the method of average end areas.

5.1.2.1. **Installation.** Measurement will be made in final position.

- 5.1.2.2. **Removal.** Measurement will be made at the point of removal.
- 5.2. **Temporary Pipe Slope Drains.** Temporary pipe slope drains will be measured by the foot.
- 5.3. **Temporary Paved Flumes.** Temporary paved flumes will be measured by the square yard of surface area. The measured area will include the energy dissipater at the flume outlet.
- 5.4. **Construction Exits.** Construction exits will be measured by the square yard of surface area.
- 5.5. **Earthwork for Erosion and Sediment Control.**
- 5.5.1. **Equipment and Labor Measurement.** Equipment and labor used will be measured by the actual number of hours the equipment is operated and the labor is engaged in the work.
- 5.5.2. **Volume Measurement.**
- 5.5.2.1. **In Place.**
- 5.5.2.1.1. **Excavation.** Excavation will be measured by the cubic yard in its original position and the volume computed by the method of average end areas.
- 5.5.2.1.2. **Embankment.** Embankment will be measured by the cubic yard in its final position by the method of average end areas. The volume of embankment will be determined between:
- the original ground surfaces or the surface upon which the embankment is to be constructed for the feature and
 - the lines, grades, and slopes of the accepted embankment for the feature.
- 5.5.2.2. **In Vehicles.** Excavation and embankment quantities will be combined and paid for under "Earthwork (Erosion and Sediment Control, In Vehicle)." Excavation will be measured by the cubic yard in vehicles at the point of removal. Embankment will be measured by the cubic yard in vehicles measured at the point of delivery. Shrinkage or swelling factors will not be considered in determining the calculated quantities.
- 5.6. **Construction Perimeter Fence.** Construction perimeter fence will be measured by the foot.
- 5.7. **Sandbags for Erosion Control.** Sandbags will be measured as each sandbag or by the foot along the top of sandbag berms or dams.
- 5.8. **Temporary Sediment Control Fence.** Installation or removal of temporary sediment control fence will be measured by the foot.
- 5.9. **Biodegradable Erosion Control Logs.** Installation or removal of biodegradable erosion control logs will be measured by the foot along the centerline of the top of the control logs.
- 5.10. **Vertical Tracking.** Vertical tracking will not be measured or paid for directly, but will be subsidiary to this Item.

6. PAYMENT

The following will not be paid for directly, but will be subsidiary to pertinent Items:

- erosion control measures for Contractor project-specific locations (PSLs) inside and outside the right of way (e.g., construction and haul roads, field offices, equipment and supply areas, plants, and material sources);
- removal of litter, unless a separate pay item is shown on the plans;
- repair to devices and features damaged by Contractor operations;

- added measures and maintenance needed due to negligence, carelessness, lack of maintenance, and failure to install permanent controls;
- removal and reinstallation of devices and features needed for the convenience of the Contractor;
- finish grading and dressing upon removal of the device; and
- minor adjustments including but not limited to plumbing posts, reattaching fabric, minor grading to maintain slopes on an erosion embankment feature, or moving small numbers of sandbags.

Stabilization of disturbed areas will be paid for under pertinent Items except vertical tacking, which will be subsidiary.

Furnishing and installing pipe for outfalls associated with sediment traps and ponds will not be paid for directly, but will be subsidiary to the excavation and embankment under this Item.

- 6.1. **Rock Filter Dams.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid as follows.

- 6.1.1. **Installation.** Installation will be paid for as "Rock Filter Dams (Install)" of the type and slope as specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.

- 6.1.2. **Removal.** Removal will be paid for as "Rock Filter Dams (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.

When the Engineer directs that the rock filter dam installation or portions thereof be replaced, payment will be made at the unit price bid for "Rock Filter Dams (Remove)" and for "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.

- 6.2. **Temporary Pipe Slope Drains.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Pipe Slope Drains" of the size specified. This price is full compensation for furnishing materials, removal and disposal, furnishing and operating equipment, labor, tools, and incidentals.

Removal of temporary pipe slope drains will not be paid for directly, but will be subsidiary to the installation Item. When the Engineer directs that the pipe slope drain installation or portions thereof be replaced, payment will be made at the unit price bid for "Temporary Pipe Slope Drains" of the size specified, which is full compensation for the removal and reinstallation of the pipe drain.

Earthwork required for the pipe slope drain installation, including construction of the sediment trap, will be measured and paid for under "Earthwork for Erosion and Sediment Control."

Riprap concrete or stone, when used as an energy dissipater or as a stabilized sediment trap, will be measured and paid for in accordance with Item 432.

- 6.3. **Temporary Paved Flumes.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Paved Flume (Install)" or "Temporary Paved Flume (Remove)." This price is full compensation for furnishing and placing materials, removal and disposal, equipment, labor, tools, and incidentals.

When the Engineer directs that the paved flume installation or portions thereof be replaced, payment will be made at the unit prices bid for "Temporary Paved Flume (Remove)" and "Temporary Paved Flume (Install)." These prices are full compensation for the removal and replacement of the paved flume and for equipment, labor, tools, and incidentals.

Earthwork required for the paved flume installation, including construction of a sediment trap, will be measured and paid for under "Earthwork for Erosion and Sediment Control."

- 6.4. **Construction Exits.** Contractor-required construction exits from off right of way locations or on right of way PSLs will not be paid for directly, but will be subsidiary to pertinent Items.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" for construction exits needed on right of way access to work areas required by the Department will be paid for at the unit price bid for "Construction Exits (Install)" of the type specified or "Construction Exits (Remove)." This price is full compensation for furnishing and placing materials, excavating, removal and disposal, cleaning vehicles, labor, tools, and incidentals.

When the Engineer directs that a construction exit or portion thereof be removed and replaced, payment will be made at the unit prices bid for "Construction Exit (Remove)" and "Construction Exit (Install)" of the type specified. These prices are full compensation for the removal and replacement of the construction exit and for equipment, labor, tools, and incidentals.

Construction of sediment traps used in conjunction with the construction exit will be measured and paid for under "Earthwork for Erosion and Sediment Control."

- 6.5. **Earthwork for Erosion and Sediment Control.**

- 6.5.1. **Initial Earthwork for Erosion and Sediment Control.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Excavation (Erosion and Sediment Control, In Place)," "Embankment (Erosion and Sediment Control, In Place)," "Excavation (Erosion and Sediment Control, In Vehicle)," "Embankment (Erosion and Sediment Control, In Vehicle)," or "Earthwork (Erosion and Sediment Control, In Vehicle)."

This price is full compensation for excavation and embankment, including hauling; disposal of material not used elsewhere on the project; embankments including furnishing material from approved sources and construction of erosion control features; and equipment, labor, tools, and incidentals.

Sprinkling and rolling required by this Item will not be paid for directly, but will be subsidiary to this Item.

- 6.5.2. **Maintenance Earthwork for Erosion and Sediment Control for Cleaning and Restoring Control Measures.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid under a Contractor Force Account Item from invoice provided to the Engineer.

This price is full compensation for excavation, embankment, and re-grading, including dewatering for removal of accumulated sediment, and the removal of accumulated sediment in various erosion control installations as directed, hauling, and disposal of material not used elsewhere on the project; excavation for construction of erosion control features; embankments, including furnishing material from approved sources and construction of erosion control features; and equipment, labor, tools, and incidentals.

Earthwork needed to remove and obliterate erosion control features will not be paid for directly, but will be subsidiary to pertinent Items unless otherwise shown on the plans.

Sprinkling and rolling required by this Item will not be paid for directly, but will be subsidiary to this Item.

- 6.6. **Construction Perimeter Fence.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Construction Perimeter Fence." This price is full compensation for furnishing and placing the fence; digging, fence posts, wire, and flagging; removal and disposal; and materials, equipment, labor, tools, and incidentals.

Removal of construction perimeter fence will not be paid for directly, but will be subsidiary to the installation Item. When the Engineer directs that the perimeter fence installation or portions thereof be removed and replaced, payment will be made at the unit price bid for "Construction Perimeter Fence," which is full compensation for the removal and reinstallation of the construction perimeter fence.

- 6.7. **Sandbags for Erosion Control.** Sandbags will be paid for at the unit price bid for "Sandbags for Erosion Control" (of the height specified when measurement is by the foot). This price is full compensation for materials, placing sandbags, removal and disposal, equipment, labor, tools, and incidentals.
- Removal of sandbags will not be paid for directly, but will be subsidiary to the installation Item. When the Engineer directs that the sandbag installation or portions thereof be replaced, payment will be made at the unit price bid for "Sandbags for Erosion Control," which is full compensation for the reinstallation of the sandbags.
- 6.8. **Temporary Sediment Control Fence.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid as follows.
- 6.8.1. **Installation.** Installation will be paid for as "Temporary Sediment-Control Fence (Install)." This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.
- 6.8.2. **Removal.** Removal will be paid for as "Temporary Sediment-Control Fence (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.
- 6.9. **Biodegradable Erosion Control Logs.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid as follows.
- 6.9.1. **Installation.** Installation will be paid for as "Biodegradable Erosion Control Logs (Install)" of the size specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, staking, proper disposal, labor, materials, tools, and incidentals.
- 6.9.2. **Removal.** Removal will be paid for as "Biodegradable Erosion Control Logs (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.
- 6.10. **Vertical Tracking.** Vertical tracking will not be measured or paid for directly, but will be subsidiary to this Item.

Item 508

Constructing Detours



1. DESCRIPTION

Construct and maintain detours. Remove detours unless otherwise directed or shown on the plans.

2. MATERIALS

2.1. **Embankment.** Use roadway excavation for embankment material or use material from other approved sources.

2.2. **Temporary Drainage Pipe.** Furnish pipe required for temporary drainage as shown on the plans or as directed. Pipe will become the property of the Contractor upon removal.

Temporary use of permanent pipe is allowable if the sequence of work permits. If pipe used temporarily is damaged such that it is not acceptable in conformance with applicable Items, it will not be acceptable for incorporation in the final project. The damaged pipe remains the property of the Contractor.

2.3. **Base and Surfacing.** Furnish base and surfacing materials in conformance with Items as shown on the plans.

3. CONSTRUCTION

Construct the detour at the locations and to the lines, grades, and typical sections shown on the plans or as directed, in conformance with pertinent Items.

Maintain detours for public travel in a safe and passable condition. Public traffic safety and convenience are essential. Maintain detours in accordance with Section 7.2.4., "Public Safety and Convenience"; Article 7.17., "Contractor's Responsibility for Work"; Section 7.17.4., "Detours"; and this Item.

Remove detours after they are no longer needed for traffic. Removed materials will become the property of the Contractor unless otherwise shown on the plans or directed. Dispose of the materials off the right of way, unless otherwise directed, in conformance with federal, state, and local requirements. If desired, dispose of materials by spreading along the adjacent roadway slopes if allowed. Salvage or stockpile in conformance with pertinent Items if embankment, base, or surfacing is to be reused within the roadway construction or stockpiled for future use.

4. MEASUREMENT

This Item will be measured by the square yard of pavement area, or surface area if not paved.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Constructing Detours," for "Constructing Detours by Type" as shown on the plans, or for "Constructing Detours (EBSS)." "Embankment Base Surface Separate (EBSS)" will be used when embankment, base, and surface are paid for separately.

The bid price for "Constructing Detours" or for "Constructing Detours by Type" as shown on the plans is full compensation for furnishing all materials required, including embankment, base, and surfacing; excavation

and hauling of excavated material; sprinkling and compacting; furnishing, installing, and removing drainage structures; removal of detour; disposal of materials; and equipment, labor, tools, and incidentals.

The price bid for "Construction Detours (EBSS)" is full compensation for furnishing, installing, and removing drainage structures; removal of detour; disposal of materials; and equipment, labor, tools, and incidentals, except that embankment, flexible base, and surfacing will be measured and paid for in conformance with other pertinent Items.

Maintenance of detours will be paid for in accordance with Section 7.17.4., "Detours."

When the plans require the base and surfacing to be removed and incorporated in the final roadway or stockpiled after use on the detour, the work will be performed, measured, and paid for in conformance with the pertinent Items shown for salvaging, replacing, or stockpiling materials.

All other Items not specifically addressed in this Article will be paid for under pertinent Items unless otherwise shown on the plans.

Item 512

Portable Traffic Barrier



1. DESCRIPTION

Furnish, install, move, and remove portable traffic barrier.

2. MATERIALS

2.1. Furnished by the Contractor.

2.1.1. Concrete. Furnish barrier of the class of concrete shown on the plans and using materials that meet the pertinent requirements of the following Items.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 424, "Precast Concrete Structural Members (Fabrication)"
- Item 440, "Reinforcement for Concrete"
- Item 442, "Metal for Structures"

2.1.2. Steel. Barrier sections will be furnished when shown on the plans.

2.1.3. Concrete and Steel. When barrier is to be furnished and retained by the Contractor, products from non-approved sources or previously used products may be provided if the Contractor submits written certification that the barrier sections and materials substantially conform to the requirements of this Item. The Engineer may approve the use of the product if:

- the barrier sections substantially meet typical cross-section dimension requirements,
- there is no evidence of structural damage such as major spalls or cracks,
- the general condition of both the barrier sections and their connectors is acceptable,
- the barrier is new,
- the barrier is being reused, and
- the applicable crash test criteria in accordance with Item 502, "Barricades, Signs, and Traffic Handling," are met.

2.1.4. Connection Hardware. When shown on the plans, provide connection hardware for Department-furnished barrier sections. Provide the type of connection hardware shown on the plans that meets the requirements of Item 442. Connection hardware is defined as being sufficient hardware for one complete connection between two traffic barrier sections, including the required bolts, nuts, washers, structural steel shapes, and dowels. Connection hardware will be retained by the Department unless otherwise shown on the plans.

2.1.5. Furnished by the Department. Department-furnished barrier sections will be at a stockpile location or an existing traffic barrier installation shown on the plans. The Department will furnish connection hardware for Department-furnished barrier sections unless otherwise shown on the plans. Connection hardware is defined as being sufficient hardware for one complete connection between two traffic barrier sections, including the required bolts, nuts, washers, structural steel shapes, and dowels.

3. CONSTRUCTION

Notify the Engineer of the location of the casting site and the date on which the work will begin. Multi-project fabrication plants as defined in Item 424 that produce concrete traffic barrier, except temporary barrier furnished and retained by the Contractor, must be qualified in accordance with [DMS-7350](#), "Qualification

Procedure for Multi-Project Fabrication Plants of Precast Concrete Traffic Barrier.” See the Department’s MPL for approved fabricators. Construct barrier in accordance with Item 420 to the dimensions and cross-sections shown on the plans. Provide forms and cure concrete in accordance with Item 424.

Provide a rough texture to the bottom surface of single-slope or F-shape barriers and to the top of low-profile barriers similar to a wood float finish.

Once concrete has attained sufficient strength to resist stresses due to handling, remove formwork and place barrier sections on blocking in a designated storage area.

Produce precast barrier to the tolerances shown in Table 1 unless otherwise shown on the plans.

Table 1
Precast Barrier Tolerances

Dimension	Tolerance
Length	±1 in.
Insert placement	±1/2 in.
Horizontal alignment	±1/8 in. per 10 ft. of length
Deviation of Ends	
Horizontal skew	±1/4 in.
Vertical batter	±1/8 in. per foot of depth

Install the barrier sections as shown on the plans or as directed. For concrete barrier, the areas that require pinning will be shown on the plans. For steel barrier, the acceptable deflection distance will be shown on the plans.

After use, stockpile barrier sections and connection hardware that will be retained by the Department at the location shown on the plans or as otherwise directed. Obtain assembly and installation information for the portable steel traffic barrier from the manufacturer and provide the Engineer with an installation and repair manual specific to the portable steel traffic barrier.

Repair or replace all traffic barrier or connecting hardware damaged by the Contractor’s operations at the Contractor’s expense.

Repair or replace any pavement damaged in the process of installing, moving, or removing barrier sections at the Contractor’s expense.

4. MEASUREMENT

This Item will be measured by the foot based on the nominal lengths of the barrier sections.

When shown on the plans, connection hardware will be measured by each complete connection between two traffic barrier sections for Department-furnished barrier.

When pinning of concrete barrier is shown on the plans, pinning of the barrier will be measured by each pin.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid as follows.

- For concrete barrier only, bid for “Portable Traffic Barrier” of the work category (Furnish and Install, Designated Source, Move, Stockpile, Remove, or Connection Hardware), shape (e.g., Single Slope, F-Shape, or Low Profile) and Type (e.g., 1, 2, or 3) of barrier sections specified. This price includes equipment, labor, tools, and incidentals.

- For concrete and steel barrier, bid for “Portable Traffic Barrier” of the work category (Furnish and Install, Designated Source, Move, Stockpile, or Remove), shape (e.g., Single Slope, F-Shape, or Low Profile) and Type (e.g., 1, 2, or 3) of barrier sections specified, or “Steel.” This price includes equipment, labor, tools, and incidentals.

- 5.1. **Furnish and Install.** This price is full compensation for furnishing and installing barrier sections and connection hardware.
- 5.2. **Designated Source.** This price is full compensation for delivering and installing Department-furnished barrier sections and connection hardware from a designated location.
- 5.3. **Move.** This price is full compensation for moving barrier section installations on the project from one location to another (including disassembly and reassembly costs), moving barrier sections from an installation on the project to a temporary storage area (including disassembly costs), or moving barrier sections from a temporary storage area to an installation site on the project (including assembly costs).
- 5.4. **Stockpile.** This price is full compensation for removing barrier sections and connection hardware from the project and delivering to the Department stockpile area shown on the plans or as directed.
- 5.5. **Remove.** This price is full compensation for removing barrier and connection hardware from the project that are retained by the Contractor.
- 5.6. **Connection Hardware.** This price is full compensation for furnishing and installing connection hardware on Department-furnished barrier sections.
- 5.7. **Pinning.** This price is full compensation for furnishing, installing, and removal of pins for pinned placement of concrete barrier. Pinning of steel barrier will not be paid for directly, but will be subsidiary to pertinent Items.

Item 520

Weighing and Measuring Equipment



1. DESCRIPTION

Provide weighing and measuring equipment for materials measured or proportioned by weight or volume.

2. EQUIPMENT

Provide certified scales, scale installations, and measuring equipment meeting the requirements of *NIST Handbook 44*, except that the required accuracy must be 0.4% of the material being weighed or measured.

Provide personnel, facilities, and equipment for checking the scales as approved. Check all weighing and measuring equipment after each move and at least once every 6 mo. or when requested.

Calibrate truck scales using weights certified by the Texas Department of Agriculture or an equivalent agency as approved. Provide a written calibration report from a scale mechanic for truck scale calibrations. Cease plant operations during the checking operation. Do not use inaccurate or inadequate scales. Bring performance errors as close to zero as practicable when adjusting equipment.

Furnish enough certified weights to check the accuracy and sensitivity of the scales. Insulate scales against shock, vibrations, or movement of other operating equipment. Provide an automated ticket printout for each truckload of material daily where payment is determined by weight. Each loading ticket must show the ticket number, truck number, gross weight, tare weight, and net weight. At the Contractor's option, an electronic ticket delivery system (e-ticketing) may be used instead of printed tickets. The use of e-ticketing will require written approval of the Engineer. At minimum, the approved system must:

- provide real-time e-tickets in conformance with the applicable bid items,
- automatically generate e-tickets using software and hardware fully integrated with the automated scale system used to weigh the material and designed such that data input cannot be altered by the Contractor or the Engineer,
- provide the Engineer access to the e-ticketing data in real time using a web-based or app-based system compatible with iOS,
- provide offline capabilities to prevent data loss if power or connectivity is lost; and
- require the Contractor and the Engineer to accept or reject the e-ticket and provide the ability to record the information required by the applicable bid items, as well as any comments. Record the time of the approval or rejection and include it in the summary spreadsheet described below. Provide each party the capability to edit their respective actions and any entered information.

The Contractor may discontinue use of the e-ticket system and provide printed tickets as needed to meet the requirements of the applicable bid items.

Provide a summary spreadsheet that lists separately the ticket number, truck number, gross weight, tare weight, net weight, overload weight, and payment weight amounts as shown in Table 1 if required on the plans for materials paid by the ton. Provide this spreadsheet:

- for each lot when materials are paid for in increments of sublots or lots, and
- daily for other materials.

Provide the totals for net weight and overload amounts to be deducted for all summary sheets within 2 days of delivery of materials. Include the overload deduction in the total amount reported for payment. Submissions are subject to verification.

Table 1
Example Spreadsheet

Ticket No.	Truck No.	Gross Wt.	Tare Wt.	Net Wt.	Overload Wt.	Payment Wt.
				Totals	Totals	Totals

Furnish leak-free weighing containers large enough to hold a complete batch of the material being measured.

- 2.1. **Truck Scales.** Furnish platform truck scales capable of weighing the entire truck or truck-trailer combination in a single draft.
- 2.2. **Aggregate Batching Scales.** Equip scales used for weighing aggregate with a quick adjustment at zero that provides for any change in tare. Provide a visual means that indicates the required weight for each aggregate.
- 2.3. **Suspended Hopper.** Provide a means for the addition or the removal of small amounts of material to adjust the quantity to the exact weight per batch. Ensure the scale equipment is level.
- 2.4. **Belt Scales.** Use belt scales for proportioning aggregate that are accurate to within 1.0% based on the average of three test runs, where no individual test run exceeds 2.0% when checked, in accordance with [Tex-920-K](#).
- 2.5. **Asphalt Material Meter.** Provide an asphalt material meter with an automatic digital display of the volume or weight of asphalt material. Verify the accuracy of the meter in accordance with [Tex-921-K](#). Ensure the accuracy of the meter is within 0.4% when using the asphalt meter for payment purposes. Ensure the accuracy of the meter is within 1.0% when used to measure component materials only and not for payment.
- 2.6. **Liquid Asphalt Additive Meters.** Provide a means to check the accuracy of meter output for asphalt primer, fluxing material, and liquid additives. Furnish a meter that reads in increments of 0.1 gal. or less. Verify accuracy of the meter in accordance with [Tex-923-K](#). Ensure the accuracy of the meter within 5.0%.
- 2.7. **Particulate Solid and Slurry Additive Meters.** Provide a means to check the accuracy of meter output for particulate solids (e.g., hydrated lime or mineral filler) and slurries (e.g., hydrated lime slurry). Ensure the accuracy of the meter within 5.0%.

3. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent items.

Item 531

Sidewalks



1. DESCRIPTION

Construct hydraulic cement concrete sidewalks, Americans with Disabilities Act ramps, and steps.

2. MATERIALS

Furnish materials in accordance with the following.

- Item 360, "Concrete Pavement"
- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 440, "Reinforcement for Concrete"

Use Class A concrete unless otherwise shown on the plans. Use Grade 8 coarse aggregate for extruded Class A concrete. Use other grades if approved.

Use of fibers meeting the requirements of [DMS-4550](#), "Fibers for Concrete," to replace reinforcing steel in Class A concrete is allowed unless otherwise shown on the plans. Dose fibers in accordance with the Department's MPL of prequalified fibers for concrete.

Furnish detectable warning material in accordance with [DMS-4350](#), "Detectable Warning Material."

3. CONSTRUCTION

Shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross-section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement. Hand-tamp and sprinkle foundation when placement is directly on subgrade or foundation materials. Remove and dispose of existing concrete in accordance with Item 104, "Removing Concrete." Provide a clean surface for concrete placement directly on the surface material or pavement.

Furnish and place reinforcing steel in accordance with Item 440 unless fiber reinforced concrete is used.

Mix and place concrete in conformance with the pertinent Items. Hand-finishing is allowed for any method of construction. Finish exposed surfaces to a uniform transverse broom finish surface. Curb ramps must include a detectable warning surface and conform to details shown on the plans. Install joints as shown on the plans. Ensure that abrupt changes in sidewalk elevation do not exceed 1/4 in., sidewalk cross slope does not exceed 2%, curb ramp grade does not exceed 8.3%, and flares adjacent to the ramp do not exceed 10% slope measured parallel to the curb line. Ensure that the sidewalk depth and reinforcement are not less than the driveway cross-sectional details shown on the plans where a sidewalk crosses and is part of the concrete driveway.

Use construction methods in conformance with manufacturers' recommendations when installing detectable warning surface. Install detectable warning surface as shown on the plans.

Provide finished work with a well-compacted mass, a surface free of voids and honeycomb, and the required true-to-line shape and grade. Cure for at least 72 hr. in accordance with Item 420.

- 3.1. **Conventionally Formed Concrete.** Provide pre-molded or board expansion joints of the thickness shown on the plans for sidewalk section lengths greater than 8 ft. but less than 40 ft., unless otherwise directed. Terminate workday production at an expansion joint.
- 3.2. **Extruded or Slipformed Concrete.** Provide any additional surface finishing immediately after extrusion or slipforming as shown on the plans. Construct joints at locations as shown on the plans or as directed.

4. MEASUREMENT

Sidewalks will be measured by the square yard of surface area. Curb ramps will be measured by the square yard of surface area or by each. A curb ramp consists of the ramp, landing or turning space, adjacent flares or side curb, and detectable warning surface as shown on the plans. Steps will be measured by the square yard of horizontal surface area.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Sidewalks" of the depth specified, "Concrete Sidewalk (Steps)," and "Curb Ramps" of the type specified. This price is full compensation for surface preparation of sidewalk foundation; materials; removal and disposal of existing concrete; excavation, hauling, and disposal of excavated material; drilling and doweling into existing concrete curb, sidewalk, and pavement; repair of adjacent street or pavement structure damaged by these operations; and equipment, labor, materials, tools, and incidentals.

Sidewalks that cross and are part of the concrete driveways or turnouts will be measured and paid for in accordance with Item 530, "Intersections, Driveways, and Turnouts."

Item 542

Removing Metal Beam Guard Fence



1. DESCRIPTION

Remove existing metal beam guard fence and store at locations shown on the plans or as directed.

2. CONSTRUCTION

Remove rail elements in original lengths. Remove fittings from the posts and the metal rail and then pull the posts. Do not mar or damage salvageable materials during removal.

Completely remove posts and any concrete or grout backfill surrounding the posts. Furnish backfill material and backfill the hole with material equal in composition and density to the surrounding soil unless otherwise directed.

Cut off or bend down deadman eyebolts to an elevation at least 1 ft. below the new subgrade elevation and leave in place along with the deadman.

Neatly stack salvaged materials to be retained by the Department at designated sites shown on the plans. Properly dispose of unsalvageable materials in conformance with federal, state, and local regulations. Repair or replace Contractor-damaged salvageable material at the Contractor's expense.

3. MEASUREMENT

This Item will be measured by the foot for "Remove Metal Beam Guard Fence" in its original position. Measurement will be made along the face of the rail, in place, including metal beam guard fence transitions, from center-to-center of end posts and from terminal points shown on the plans.

When "Remove Terminal Anchor Section" is specified as a separate bid item, measurement will be made for each removed section. A terminal anchor section consists of one post, one 25-ft. rail element, and associated hardware.

When "Remove Downstream Anchor Terminal" is specified as a separate bid item, measurement will be made for each removed section. Downstream anchor terminal consists of two posts, one section, and associated hardware.

4. PAYMENT

The work performed and measured as provided under "Measurement" will be paid for at the unit price bid for "Remove Metal Beam Guard Fence," "Remove Terminal Anchor Section," and "Remove Downstream Anchor Terminal." This price is full compensation for removing materials; loading, hauling, unloading, and storing or disposal; furnishing backfill material; backfilling postholes; and equipment, labor, tools, and incidentals.

Removal of mow strips or riprap will be paid for separately under the pertinent Items.

Removal of curb associated with the metal beam guard fence transitions will not be paid for directly, but will be subsidiary to this Item.

Item 550

Chain Link Fence



1. DESCRIPTION

Furnish, install, remove, repair, or replace chain link fence and gates.

2. MATERIALS

Furnish certification from the chain link fence materials manufacturer stating that all fencing materials comply with the requirements of this Item before installation of the fence. Use only new materials.

2.1. General. Furnish materials in accordance with the following.

- Item 421, "Hydraulic Cement Concrete," Class B
- Item 445, "Galvanizing"

2.2. Wire Fabric. Provide wire fabric with:

- 9-gauge (0.148-in. diameter) steel wire with a minimum breaking strength of 1,290 lb. meeting ASTM A392 Class I or ASTM A491;
- mesh size of 2 in. $\pm$ 1/8 in. between parallel wires with at least seven meshes in a vertical dimension of 23 in. along the diagonals of the openings; and
- knuckled selvages at the top and bottom edge of the fabric, unless otherwise shown on the plans.

2.3. Posts. Provide posts of the size and weight shown on the plans. Do not provide rerolled or open-seam posts. Use material for all posts meeting ASTM F1043 Group 1A Regular Grade or Group 1C High Strength.

2.4. Post Caps. Provide malleable iron post caps designed to exclude all moisture. Furnish barbed wire support arms integral with the post caps if barbed wire is shown on the plans. Furnish post caps with an opening for the top rail if top rail is shown on the plans. Post caps must have a 2-in. skirt.

2.5. Gates. Provide gates fabricated from round sections of pipe of the size and weight shown on the plans. Use material for all gate pipes meeting ASTM F1043 Group 1A Regular Grade or Group 1C High Strength. For each gate, include:

- corner and tee fittings of malleable iron or pressed steel with means for attaching diagonal bracing members;
- hinges of malleable iron allowing a full 180° swing, easily operated by one person;
- ball-and-socket type bottom hinges that do not twist or turn from the action of the gate and prevent the closed gate from being lifted off the hinges;
- a positive stop that prevents any portion of the gate from swinging over an adjacent traffic lane;
- malleable iron pulley systems for roll-type gate (only when required);
- diagonal braces consisting of 3/8-in. diameter cable with turnbuckles, two to each gate frame, and, for vehicle gates, a vertical pipe brace of the size and weight shown on the plans at the center of each gate leaf;
- latches of malleable iron or steel for single gates with a single-fork latch and padlock eye that will keep the gate closed;
- two fork latches mounted on a center plunger rod with a padlock eye for double-leaf gates;
- holdbacks for each leaf of vehicular gates, with a semi-automatic holdback catch anchored at least 12 in. into a 12-in. diameter $\times$ 24-in. deep concrete footing; and

- a malleable iron center rest, designed to receive the plunger rod anchored as shown on the plans for all double-leaf gates.
- 2.6. **Top Rail.** Use material meeting ASTM F1043 Group 1A or Group 1C for all top rail pipes. Provide 1.660-in. outside diameter (OD) top rail manufactured from Group 1A standard weight (Schedule 40) steel pipe weighing 2.27 lb. per foot, or from Group 1C high-strength pipe weighing 1.84 lb. per foot when shown on the plans. Provide pipe in sections at least 18 ft. long joined with outside steel sleeve couplings at least 6 in. long with a minimum wall thickness of 0.70 in. Use couplings designed to allow for expansion of the top rail.
- 2.7. **Tension Wire.** Use 7-gauge (0.177-in.) carbon steel wire with a minimum breaking strength of 1,950 lb. for the bottom edge of all fence fabric, and for the top edge of fence fabric when a top rail is not specified.
- 2.8. **Truss Bracing.** Provide truss bracing as shown on the plans.
- 2.9. **Cables.** Provide seven-wire strand cables manufactured of galvanized annealed steel at least 3/8 in. in diameter.
- 2.10. **Barbed Wire.** Provide three strands of twisted 12.5-gauge barbed wire with two-point, 14-gauge barbs spaced approximately 5 in. apart conforming to ASTM A121 or ASTM A585 when shown on the plans.
- 2.11. **Barbed Wire Support Arms.** Provide support arms at an angle of 45° from vertical, with clips for attaching three strands of barbed wire to each support arm and sufficient strength to support a 200-lb. weight applied at the outer strand when barbed wire is shown on the plans.
- 2.12. **Stretcher Bars.** Provide stretcher bars made of flat steel at least 3/16 × 3/4 in. and not more than 2 in. shorter than the fabric height. Provide one stretcher bar for each gate and end post and two stretcher bars for each corner and pull post.
- 2.13. **Grounds.** Provide copper-clad steel rods 8 ft. long with a minimum diameter of 5/8 in., or other UL-listed ground rods.
- 2.14. **Miscellaneous Fittings and Fasteners.** Furnish enough fittings and fasteners to erect all fencing materials in a proper manner. Furnish fittings for posts from pressed or rolled steel, forged steel, malleable iron, or wrought iron of good commercial quality spaced as shown on the plans.
- 2.15. **Coatings.** Hot-dip galvanize all materials unless specified otherwise in this Item or as shown on the plans. Fabric, tension wire, and barbed wire may be aluminum-coated or alloy-coated if approved. Additionally, coat all material except bolts, nuts, washers, and pipe material with thermally fused polyvinyl chloride (PVC) in accordance with ASTM F668, Class 2b, meeting the specified color when shown on the plans.
 - 2.15.1. **Fabric.**
 - 2.15.1.1. **Galvanizing.** Hot-dip galvanize in accordance with ASTM A392, Class I.
 - 2.15.1.2. **Aluminum Coating.** Aluminum-coat in accordance with ASTM A491.
 - 2.15.1.3. **Alloy Coating.** Coat with zinc-5% aluminum-mischmetal alloy (Zn-5Al-MM) in accordance with ASTM F1345, Class I.
 - 2.15.2. **Posts, Braces, and Gates.**
 - 2.15.2.1. **Standard Weight (Schedule 40) Pipe.** Hot-dip galvanize inside and outside in accordance with ASTM F1043 (1.8 oz. per square foot galvanized zinc weight).

- 2.15.2.2. **High Strength Pipe.** Hot-dip galvanize before or after forming pipe in accordance with ASTM F1043 Group 1C and as follows.
 - **Outside.** Minimum 0.9 oz. per square foot galvanized zinc weight with a verifiable polymer overcoat.
 - **Inside.** Minimum 0.9 oz. per square foot galvanized zinc weight before forming, or minimum 0.3 mils zinc-based coating after forming containing a minimum 90% zinc dust, by weight.
- 2.15.2.3. **Optional Additional Coating.** Additionally, coat all pipe material with 10 mils minimum thermally fused PVC in accordance with ASTM F1043, meeting the specified color when shown on the plans.
- 2.15.3. **Fittings, Bolts, and Other Miscellaneous Hardware.** Galvanize all fittings, bolts, and miscellaneous hardware in accordance with Item 445.
- 2.15.4. **Tension Wire.** Zinc-coat tension wire with a minimum coating of 0.80 oz. per square foot, or aluminum-coat with a minimum coating of 0.30 oz. per square foot.
- 2.15.5. **Barbed Wire.** Zinc-coat barbed wire in accordance with ASTM A121 (0.80 oz. per square foot), or aluminum-coat in accordance with ASTM A585 (0.30 oz. per square foot).
- 2.15.6. **Pull Cable.** Zinc-coat pull cable with a minimum coating of 0.80 oz. per square foot of individual-wire surface when tested in accordance with ASTM A116.

3. **CONSTRUCTION**

Erect the chain link fence to the lines and grades established on the plans. Overall height of the fence when erected is the height above the grade shown.

Repair or replace damaged fence or gates. Remove and replace the post and foundation if posts cannot be repaired by straightening. Return all salvageable material to the location shown on the plans when a fence installation is to be removed in its entirety and not replaced. Backfill all postholes with suitable material. Return the salvaged fence fabric in secured rolls not more than 50 ft. long. Dispose of unsalvageable material.

- 3.1. **Clearing and Grading.** Clear all brush, rocks, and debris necessary for the installation of this fencing.

Stake the locations for corner posts and terminal posts unless otherwise shown on the plans. Follow the finished ground elevations for fencing panels between corner and terminal posts. Level off minor irregularities in the path of the fencing.
- 3.2. **Erection of Posts.** Install posts as shown on the plans. Plumb and permanently position posts with anchorages firmly set before fabric is placed. Brace corner and pull posts as shown on the plans.
- 3.2.1. **Post Spacing.** Space posts as shown in Table 1.

Table 1 Post Spacing and Placement	
Post Type	Required Spacing or Placement
Line posts	No more than 10 ft. apart
Pull posts	No more than 500 ft. apart and at each change in direction exceeding 20° vertically
Corner posts	At each horizontal angle point

Install cables on all terminal posts and extend to adjacent posts. Install cables on each side of corner and pull posts using a 3/8-in. drop-forged eye-and-eye or eye-and-clevis turnbuckle unless otherwise shown on the plans.

- 3.2.2. **Postholes.** Drill holes for concrete footings for all posts to provide footings of the dimensions shown on the plans.
- Penetrate solid rock by at least 12 in. (18 in. for end, corner, gate, and pull posts) or to plan depth where the rock is encountered before reaching plan depth. Drill holes in the solid rock with a diameter at least 1 in. greater than the OD of the post.
- Fill the hole in the solid rock with grout consisting of one part hydraulic cement and three parts clean, well-graded sand after the posts are set and plumbed. If desired, other grouting materials may be used only if approved. Thoroughly work the grout into the hole, leaving no voids. Construct concrete footings from the solid rock to the top of the ground.
- 3.2.3. **Gate Posts.** Align the tops of all gate frames with the fencing top tension wire or top rail. Provide vehicular gates that are greater in overall height than the adjacent fencing by the height necessary to extend to within 2 in. of the pavement between the curbs if curbs are shown on the plans.
- 3.2.4. **Concrete Footings.** Center posts in their footings. Place concrete and compact by tamping or other approved methods. Machine mix all batches of concrete more than 1/2 cu. yd. Hand mixing concrete is allowed on batches less than 1/2 cu. yd.
- Use forms for footings where the ground cannot be satisfactorily excavated to neat lines. Crown the concrete or grout (for solid rock) to carry water from the post. Keep the forms in place for at least 24 hr. Backfill the footing with moistened material as soon as each form is removed, and thoroughly tamp. Cover concrete with at least 4 in. of loose moist material, free of clods and gravel, immediately after placing concrete. No other curing is required.
- Spread all excess excavated and loose material used for curing neatly and uniformly. Remove excess concrete and other construction debris from the site.
- 3.3. **Erection of Fabric.** Place the fabric with the cables drawn taut with the turnbuckles after all posts have been permanently positioned and anchorages firmly set. Secure one end and apply enough tension to the other end to remove all slack before making attachments. Cut the fabric, independently attach each span at all corner posts, and pull posts unless otherwise shown on the plans.
- Follow the finished contour of the site with the bottom edge of fabric located approximately 2 in. above the grade. Grade uneven areas so the maximum distance between the bottom of fabric and ground is 6 in. or less.
- Fasten fabric at 12-in. intervals to the top and bottom tension wires between posts. Fasten the fabric in the same manner when top rail is shown on the plans. Fasten the fabric on gate frames to the top and bottom of the frame at 12-in. intervals. Use steel wire fabric ties of 9-gauge steel or larger. Fasten fabric to terminal posts using steel stretcher bars and stretcher bar bands fitted with carriage bolts and nuts of the size and spacing shown on the plans. Use stretcher bars to fasten end posts, pull posts, corner posts, and gateposts with stretcher bar bands at intervals of no more than 15 in. Attach stretcher bars to terminal posts using 1 × 1/8-in. flat steel bands with 3/8-in. carriage bolts at intervals up to 15 in.
- 3.4. **Electrical Grounds.** Provide at least one electrical ground for each 1,000 ft. of fence, located near the center of the run. Provide additional grounds directly under the point where power lines pass over the fence. For fence placed on bridge structures, install grounds as shown on the plans.
- Vertically drive or drill in the grounding rod until the top of the rod is approximately 6 in. below the top of the ground. Connect a No. 6 solid copper conductor to the rod and to the fence by a UL-listed method so that each element of the fence is grounded.
- 3.5. **Repair of Coatings.** Repair damaged zinc coating in accordance with Section 445.3.4., "Repairs."

4. MEASUREMENT

Chain link fence will be measured by the foot of fence installed, repaired, replaced, or removed, measured at the bottom of the fabric along the centerline of the fence from center to center of posts, excluding gates.

Gates will be measured as each gate installed, repaired, replaced, or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Chain Link Fence (Install)" or "Chain Link Fence (Repair)" of the height specified, or "Chain Link Fence (Remove)" and "Gate (Install)" or "Gate (Repair)" of the type, height, and width of opening specified, or "Gate (Remove)." Clearing and grading for fencing and gates will not be paid for directly, but will be subsidiary to this Item.

- 5.1. **Chain Link Fence (Install).** This price is full compensation for furnishing and installing fencing, except gates; cleaning, grading, and backfilling; removing and disposing of surplus material; and equipment, labor, tools, and incidentals.
- 5.2. **Chain Link Fence (Repair).** This price is full compensation for furnishing materials; repairing or replacing fencing, except gates; cleaning, grading, and backfilling; removing and disposing of surplus or damaged material; and equipment, labor, tools, and incidentals.
- 5.3. **Chain Link Fence (Remove).** This price is full compensation for removing all fencing, except gates; cleaning, grading, and backfilling; removing and disposing of surplus material; and equipment, labor, tools, and incidentals.
- 5.4. **Gate (Install).** This price is full compensation for installing gate and for providing materials, center anchorages, equipment, labor, tools, and incidentals.
- 5.5. **Gate (Repair).** This price is full compensation for repairing or replacing gate and for furnishing materials; removing and disposing of damaged materials; and equipment, labor, tools, and incidentals.
- 5.6. **Gate (Remove).** This price is full compensation for removing gate and for materials, equipment, labor, tools, and incidentals.

Item 556

Pipe Underdrains



1. DESCRIPTION

Install pipe underdrains.

2. MATERIALS

2.1. Pipe. Furnish the types and sizes of pipe shown on the plans. Use only one type of pipe for any underdrain system on the project. Use perforated pipe in areas to be drained and use non-perforated pipe between the perforated pipe and the outfall.

2.1.1. Type 1. Corrugated steel pipe (CSP) conforming to any type specified in AASHTO M 36, fabricated from corrugated galvanized sheet.

2.1.2. Type 2. Corrugated aluminum pipe conforming to AASHTO M 196, Type I or Type IA, fabricated from corrugated sheet.

2.1.3. Type 3. Bituminous-coated CSP conforming to the requirements of Type 1 and uniformly coated inside and out with a minimum thickness of 0.05 in. of bituminous material meeting the requirements shown in Table 1 when tested in accordance with ASTM A849 Material Class A or Material Class PA.

Table 1
Requirements of Bituminous Material

Test	Requirements
Solubility, % by wt., in trichloroethylene	99.5 Min
Brittleness	Pass
Flow, in.	0.25 Max

2.1.4. Type 4. Bituminous-coated corrugated aluminum pipe conforming to the requirements of Type 2 and uniformly coated inside and out with a minimum thickness of 0.05 in. of bituminous material meeting the requirements shown in Table 1 when tested in accordance with ASTM A849 Material Class A or Material Class PA.

2.1.5. Type 6. Corrugated polyethylene plastic tubing conforming to AASHTO M 252.

2.1.6. Type 7. Corrugated polyvinyl chloride (PVC) pipe conforming to ASTM F949.

2.1.7. Type 8. Smooth-wall PVC pipe conforming to AASHTO M 278 Class PS 46.

2.1.8. Type 9. As shown on the plans.

2.2. Filter Material. Furnish hard, durable, and clean sand, gravel, crushed stone, or crushed shell meeting the gradation by percent weight shown in Table 2 unless otherwise shown on the plans. Filter material must be free of clay balls or other organic or deleterious matter as determined by in accordance with [Tex-413-A](#). Use of crushed limestone is allowed unless otherwise shown on the plans. Use only one type of filter material for any underdrain system on a project.

Table 2
Acceptable Gradations for Filter Material

Sieve Size	Type B	Type C	Type E	Type F	Type G
	% Retained on Sieve (Tex-401-A)				
1-1/2"	—	0–10	Grade 2 Coarse Aggregate ²	Grade 3 Coarse Aggregate ²	Grade 4 (57) Coarse Aggregate ²
3/4"	0–10	20–40			
3/8"	15–35	—			
#4	35–55	40–60			
#20	35–65 ¹	35–65 ¹			
#50	75–100 ¹	75–100 ¹			

1. Of the portion finer than No. 4 sieve.
2. Refer to Table 4 in Item 421, "Hydraulic Cement Concrete."

Loss by decantation as determined by in accordance with [Tex-406-A](#) must not exceed 1% of the material retained on a No. 4 sieve or 4% of the material passing a No. 4 sieve. Use Type G filter material around the underdrains unless otherwise shown on the plans.

2.3. **Filter Fabric.** Meet [DMS-6200](#), "Filter Fabric," Type 1.

2.4. **Riprap.** Provide concrete riprap in accordance with Item 432, "Riprap," when required.

3. CONSTRUCTION

Begin excavation of the trench at the outfall and proceed toward its upper end, following the lines and grades shown on the plans or as directed. Hold the minimum horizontal limits of excavation for filter material to the dimensions shown in Table 3 or as shown on the plans.

Table 3
Minimum Horizontal Limits of Excavation for Filler Material

Depth of Trench (ft.)	Distance Outside Neat Lines of Pipe Underdrains (ft.)
0–6	1.00
>6–10	1.50
>10–15	2.00
>15	2.50

Place filter fabric in the bottom and sides of the trench in areas to be drained before placing pipe or filter material, as shown in Figure 1. Provide enough width of fabric to overlap on top of the filter material. Center perforated pipe in the excavated ditch with the perforations below the horizontal axis. Join the pipe with appropriate couplers if required. Join plastic pipe in conformance with the manufacturer's recommendations. Do not use tarpaper strips. Obtain approval for pipe placement before placing filter material.

Place filter material at least 12 in. above the bottom of the pipe or as shown on the plans. Do not allow filter material to displace the pipe.

Lap filter fabric over the top of the filter material after placing pipe and filter material in conformance with the manufacturer's recommendation or as shown on the plans.

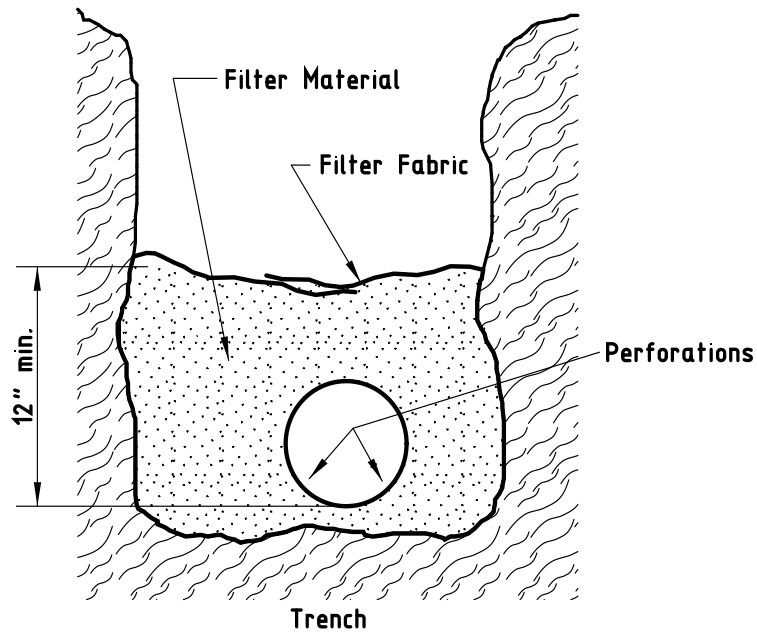


Figure 1
Installation Process

Install non-perforated pipe sections between the perforated pipe and the outfall. The sections of non-perforated pipe do not require filter fabric or filter material.

Place approved plugs in the upper ends of all pipe. Cover exposed outfall ends with 1/2-in. galvanized hardware cloth as directed. Provide Class B concrete riprap, when required, in accordance with Item 432 and as shown on the plans. Place the riprap to the contour and grade of the embankment slope. Cut the pipe to the slope of the riprap.

Backfill the remainder of the trench with suitable material in layers not to exceed 6 in.

4. MEASUREMENT

This Item will be measured by the foot along the top of the pipe and will include the length of elbows, wyes, tees, and other branches.

5. PAYMENT

The work performed and material furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pipe Underdrains" of the pipe type and size specified. This price is full compensation for pipe, couplers, plugs, screens, filter material, filter fabric, riprap, excavation, backfill, equipment, labor, materials, tools, and incidentals.

Protection methods for excavations deeper than 5 ft. will be measured and paid for in accordance with Item 402, "Trench Excavation Protection."

Item 585

Ride Quality for Pavement Surfaces



1. DESCRIPTION

Measure and evaluate the ride quality of pavement surfaces.

2. EQUIPMENT

2.1. **Surface Test Type A.** Provide a 10-ft. straightedge.

2.2. **Surface Test Type B.** Provide a high-speed or lightweight inertial profiler, certified at the Texas A&M Transportation Institute. Provide equipment certification documentation. Display a current decal on the equipment indicating the certification expiration date.

Use a certified profiler operator from the MPL. When requested, furnish documentation for the person certified to operate the profiler.

2.3. **Diamond Grinding and Grooving Equipment.** Provide self-propelled powered grinding and grooving equipment specifically designed to smooth and texture pavements using circular diamond blades when grinding or grooving is required. Provide equipment with automatic grade control capable of grinding at least 3 ft. of width longitudinally in each pass without damaging the pavement. When grooving, configure blades to produce grooves 0.10–0.16 in. wide and 0.19 in. deep with a land area 0.70–0.80 in. between the grooves unless otherwise shown on the plans. Meet the groove tolerances ± 0.02 in. for width and ± 0.06 in. for depth unless otherwise directed.

3. WORK METHODS

Measure and evaluate profiles using Surface Test Type A and Type B on surfaces as described below unless otherwise shown on the plans.

3.1. **Longitudinal Profile.** Measure the longitudinal profile of the surface, including horizontal curves.

3.1.1. **Travel Lanes.** Unless otherwise shown on the plans, use Surface Test Type B on the final riding surface of all travel lanes except as follows.

3.1.1.1. **Service Roads and Ramps.** Use Surface Test Type A on service roads and ramps unless Surface Test Type B is shown on the plans.

3.1.1.2. **Short Projects.** Use Surface Test Type A when project pavement length is less than 2,500 ft. unless otherwise shown on the plans.

3.1.1.3. **Bridge Structures.** Measure the profile in conformance with the pertinent Item or use Surface Test Type A for span type bridge structures, approach slabs, and the 100 ft. leading into and away from such structures.

3.1.1.4. **Leave-Out Sections.** Use Surface Test Type A for leave-out sections and areas between leave-out sections that are less than 400 ft., and 100 ft. leading into and away from leave-out sections.

3.1.1.5. **Ends.** Use Surface Test Type A on the first and last 100 ft. of the project pavement length.

3.1.2. **Shoulders and Other Areas.** Use Surface Test Type A for shoulders and all other areas, including intermediate pavement layers.

- 3.2. **Profile Measurements.** Measure the finished surface using Surface Test Type A or Type B in accordance with Section 585.3.1., "Longitudinal Profile," and the plans.
- 3.2.1. **Surface Test Type A.** Test the surface using a 10-ft. straightedge as directed.
- 3.2.2. **Surface Test Type B.**
- 3.2.2.1. **Quality Control (QC) Testing.** Perform QC tests throughout the duration of the project. Use a 10-ft. straightedge, inertial profiler, profilograph, or any other means to perform QC tests.
- 3.2.2.2. **Quality Assurance (QA) Testing.** Perform QA tests using either a high-speed or lightweight inertial profiler. Coordinate with and obtain authorization from the Engineer before starting QA testing. Perform QA tests on the finished surface of the completed project or at the completion of a major stage of construction, as approved. Perform QA tests within 7 days after receiving authorization.
- The Engineer may require QA testing to be performed at times of off-peak traffic flow. Operate the inertial profiler in a manner that does not unduly disrupt traffic flow as directed. When using a lightweight inertial profiler to measure a surface that is open to traffic, use a moving traffic control plan in accordance with the TMUTCD, Part 6, and the plans.
- In accordance with [Tex-1001-S](#), operate the inertial profiler and deliver test results within 24 hr. of testing. Provide all profile measurements in electronic data files using the format specified in [Tex-1001-S](#).
- 3.2.2.2.1. **Verification Testing.** The Engineer may perform ride quality verification testing within 10 working days after the Contractor's QA testing is complete for the project or major stage of construction. When the Department's profiler produces an overall average international roughness index (IRI) value of more than 3.0 in. per mile higher than the value calculated using Contractor data, the Engineer will decide whether to accept the Contractor's data, use the Department's data, use an average of both parties' data, or request a referee test. Referee testing is mandatory if the difference is greater than 6.0 in. per mile.
- 3.2.2.2.2. **Referee Testing.** The Maintenance Division will conduct referee testing, and the results are final. The Maintenance Division may require recertification for the Contractor's or Department's inertial profiler when the results between the verification, Contractor, and referee testing are greater than 6.0 in. per mile.
- 3.3. **Acceptance Plan and Payment Adjustments.** The Engineer will evaluate profiles for determining acceptance, payment adjustment, and corrective action.
- 3.3.1. **Surface Test Type A.** Use diamond grinding or other approved work methods to correct surface areas that have more than 1/8-in. variation between any two contacts on a 10-ft. straightedge. For asphalt concrete pavements, when directed, fog seal the aggregate exposed from diamond grinding. The Engineer will waive surface variation requirements for deficiencies resulting from manholes, permanent traffic markings, or other similar appurtenances near the wheel paths. Before performing work, the Engineer will determine whether repair areas or crack sealing may result in reflective defects, and may waive surface variation requirements. Following corrective action, retest the area to verify compliance with this Item.
- 3.3.2. **Surface Test Type B.** The Engineer will use the QA test results to determine payment adjustments for ride quality using Department software. IRI values will be calculated using the average of both wheel paths. When taking corrective actions to improve a deficient 0.1-mi. section, payment adjustments will be based on the data obtained from reprofiling the corrected area.
- 3.3.2.1. **International Roughness Index (IRI) Payment Adjustment for 0.1-mi. Sections.** For asphalt concrete pavements, unless payment adjustment Schedule 1 or Schedule 2 is shown on the plans, Schedule 3 will be used to determine the level of payment adjustment for each 0.1-mi. section on the project. Before performing work, the Engineer will determine whether Surface Test Type A will be used instead of the specified payment adjustment schedule when the following conditions exist in existing travel lanes:
- travel lane is directly adjacent to existing curb and gutter, or

- travel lane has repair areas or crack sealing that may result in reflective defects.

For concrete pavements, payment adjustment Schedule 5 will be used unless payment adjustment Schedule 4 is shown on the plans.

No positive payment adjustment will be paid for any 0.1-mi. section that contains localized roughness after corrective action is performed.

- 3.3.2.2. **International Roughness Index (IRI) Deficient 0.1-mi. Sections.** Correct any 0.1-mi. section with an average IRI of more than 95.0 in. per mile. The Engineer may apply a \$3,000 penalty if the IRI is greater than 95 instead of requiring corrective action. No corrective action is required for Schedule 3 or Schedule 5. After making corrections, reprofile the pavement section to verify that corrections have produced the required improvements.

The associated payment adjustment shown in Table 1 and Table 2 applies when successful corrective action improves the IRI of a deficient 0.1-mi. section.

If corrective action does not produce the required improvement, the Engineer may require:

- continued corrective action, or
- application of the pertinent payment adjustment in accordance with Table 1 or Table 2.

- 3.3.2.3. **Localized Roughness.** Measure localized roughness using an inertial profiler in accordance with [Tex-1001-S](#). The Engineer will determine areas of localized roughness using the individual profile from each wheel path.

Before performing corrective action, the Engineer and Contractor, together, will use a 10-ft. straightedge to confirm localized roughness identified from inertial profiler results. Correct confirmed areas that have more than 1/8-in. variation between any two contacts on the straightedge.

The Engineer will waive localized roughness requirements for deficiencies resulting from manholes, permanent traffic markings, or other similar appurtenances near the wheel paths.

- 3.3.2.3.1. **Localized Roughness Payment Adjustment.** Instead of corrective action, the Engineer may assess a payment adjustment for each occurrence of confirmed localized roughness. No more than one payment adjustment will be applied for any 5 ft. of longitudinal distance. No payment adjustment will be applied where the Engineer waived localized roughness requirements. For Schedule 1, a localized roughness payment adjustment of \$500 per occurrence will be applied. For Schedule 2 and Schedule 4, a localized roughness payment adjustment of \$250 per occurrence will be applied. For Schedule 3 and Schedule 5, a localized roughness payment adjustment will not be applied; however, corrective action will be required in areas not waived by the Engineer.

Localized roughness payment adjustments will be evaluated within 0.1-mi. sections and applied unless the IRI deficient 0.1-mi. section payment adjustment is greater. When the IRI deficient payment adjustment is greater, the payment adjustment in Table 1 or Table 2 will be applied.

- 3.3.2.4. **Corrective Action.** Use diamond grinding or other approved work methods to correct IRI deficient sections and localized roughness. After corrective action is complete, perform the following.
- For asphalt concrete pavements, when directed, fog seal the aggregate exposed from diamond grinding or other approved work methods allowed.
 - For concrete pavements, when directed, groove the pavement longitudinally after diamond grinding.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, certification and recertification, traffic control for all testing, materials and work needed for corrective action, equipment, labor, tools, and incidentals will not be

measured or paid for directly but will be subsidiary to pertinent Items. Sections shorter than 0.1 mi. and longer than 50 ft. will be prorated in accordance with [Tex-1001-S](#).

Table 1
Payment Adjustments for Ride Quality of Asphalt Concrete Pavements

Average IRI for Each 0.10 mi. of Traffic Lane	Payment Adjustment for \$/0.10 mi. of Traffic Lane		
(in./mi.)	Schedule 1	Schedule 2	Schedule 3
≤30	600	600	300
31	580	580	290
32	560	560	280
33	540	540	270
34	520	520	260
35	500	500	250
36	480	480	240
37	460	460	230
38	440	440	220
39	420	420	210
40	400	400	200
41	380	380	190
42	360	360	180
43	340	340	170
44	320	320	160
45	300	300	150
46	280	280	140
47	260	260	130
48	240	240	120
49	220	220	110
50	200	200	100
51	180	180	90
52	160	160	80
53	140	140	70
54	120	120	60
55	100	100	50
56	80	80	40
57	60	60	30
58	40	40	20
59	20	20	10
60–65	0	0	0
66	-20	0	0
67	-40	0	0
68	-60	0	0
69	-80	0	0
70	-100	0	0
71	-120	0	0
72	-140	0	0
73	-160	0	0
74	-180	0	0
75	-200	0	0
76	-220	-20	0
77	-240	-40	0
78	-260	-60	0
79	-280	-80	0
80	-300	-100	0
81	-320	-120	0
82	-340	-140	0
83	-360	-160	0
84	-380	-180	0
85	-400	-200	0
86	-420	-220	0
87	-440	-240	0
88	-460	-260	0

Average IRI for Each 0.10 mi. of Traffic Lane	Payment Adjustment for \$/0.10 mi. of Traffic Lane		
(in./mi.)	Schedule 1	Schedule 2	Schedule 3
89	-480	-280	0
90	-500	-300	0
91	-520	-320	0
92	-540	-340	0
93	-560	-360	0
94	-580	-380	0
95	-600	-400	0
>95	See Section 585.3.3.2.2.		0

Table 2
Payment Adjustments for Ride Quality of Concrete Pavements

Average IRI for Each 0.10 mi. of Traffic Lane	Payment Adjustment for \$/0.10 mi. of Traffic Lane	
(in./mi.)	Schedule 4	Schedule 5
≤30	600	300
31	580	290
32	560	280
33	540	270
34	520	260
35	500	250
36	480	240
37	460	230
38	440	220
39	420	210
40	400	200
41	380	190
42	360	180
43	340	170
44	320	160
45	300	150
46	280	140
47	260	130
48	240	120
49	220	110
50	200	100
51	180	90
52	160	80
53	140	70
54	120	60
55	100	50
56	80	40
57	60	30
58	40	20
59	20	10
60–85	0	0
86	-40	0
87	-80	0
88	-120	0
89	-160	0
90	-200	0
91	-240	0
92	-280	0
93	-320	0
94	-360	0
95	-400	0
>95	See Section 585.3.3.2.2.	

Item 610

Roadway Illumination Assemblies



1. DESCRIPTION

- 1.1. **Installation.** Furnish, fabricate, and install roadway illumination assemblies.
- 1.2. **Relocation.** Remove and relocate existing roadway illumination assemblies.
- 1.3. **Removal.** Remove existing roadway illumination assemblies.
- 1.4. **Replace Luminaires (Light Fixtures).** Remove and replace existing luminaires.

2. MATERIALS

Provide new materials as shown on the plans and in accordance with this Item and the following Items.

- Item 416, "Drilled Shaft Foundations"
- Item 421, "Hydraulic Cement Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 616, "Performance Testing of Lighting Systems"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"

Fabrication plants that produce roadway illumination poles, including luminaire arms, must be approved in accordance with [DMS-7380](#), "Steel Non-Bridge Member Fabrication Plant Qualification." This includes fabricators of aluminum roadway illumination poles and luminaire arms. The Materials and Tests Division maintains a list of approved fabrication plants of roadway illumination poles.

Furnish light fixtures from new materials that are in accordance with [DMS-11010](#), "Roadway Illumination Light Fixtures."

Provide prequalified light fixtures from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

Do not provide shop drawings for complete assemblies that are fabricated in accordance with this Item and the details shown on the plans. Electronically submit shop drawings in accordance with Item 441 for optional multi-sided steel pole designs; optional aluminum pole designs; and non-standard designs, required when basic wind speeds or pole base mounting heights at the installation locations exceed those shown in the Roadway Illumination Pole (RIP) standard. Manufacturers may request that the Department add their submitted shop drawings and design calculations to a pre-approved list of optional and non-standard pole designs, maintained by the Traffic Safety Division.

Hot-dip galvanize fabricated pole sections and associated parts in accordance with Item 445. Provide punched, drilled, or mechanically guided thermal-cut holes in steel parts or members, when allowed, before galvanizing. Mechanically guided thermal-cut hole quality will be in accordance with Item 445.

When shown on the plans, paint galvanized poles in accordance with Item 445.

3. CONSTRUCTION

Perform work as shown on the plans and in accordance with this Item. Permanently mark roadway illumination pole base plates, at a visible location when erected, with the fabrication plant's insignia or trademark.

Use established industry and utility safety practices when installing, relocating, or removing poles or luminaires located near overhead or underground utilities. Consult with the appropriate utility company before beginning work.

Prevent scarring or marring of the poles, luminaire arms, and luminaires. Replace damaged components. Repair damaged galvanizing in accordance with Section 445.3.4., "Repairs." Repair damaged painted areas of a roadway illumination assembly in accordance with Item 441 or Item 445.

Stake, install, and align each roadway illumination assembly as shown on the plans.

The Engineer may shift an assembly's location, if necessary, to secure a more desirable location or avoid conflict with utilities.

Construct foundations for roadway illumination assemblies in accordance with Item 416 and as shown on the plans.

- 3.1. **Installation.** Furnish and install roadway illumination assembly components as shown on the plans. Do not use screw-in type foundations. Install anchor bolts and coat anchor bolt threads in accordance with Item 449. Erect structures after foundation concrete has attained its design strength as shown on the plans and in accordance with Item 421. Tighten anchor bolts for poles with shoe bases and concrete traffic barrier base poles in accordance with Item 449. Do not place grout between base plate and foundation. Test installed roadway illumination assemblies in accordance with Item 616.

- 3.2. **Relocation.** Relocate roadway illumination assembly components as shown on the plans. Do not use screw-in type foundations. Install existing structures on new foundations in accordance with Section 610.3.1., "Installation." Do not place grout between base plate and foundation. Test installed roadway illumination assemblies in accordance with Item 616.

Disconnect and remove conductors from abandoned circuits. Remove abandoned conduit or ducts to a point 6 in. below final grade. Reconnect conduit and ducts to be reused. Replace damaged conduit and ducts. Replace conductors.

Unless otherwise shown on the plans, remove abandoned concrete foundations and replace surfacing in accordance with Section 610.3.3., "Removal." Do not remove existing concrete bridge lighting brackets.

Furnish and install new internal conductors, fused and unfused connectors, and lamps if present. Clean optical assembly. Furnish and install new transformer bases that meet AASHTO and plan requirements when relocating transformer base poles. Destroy existing transformer bases to prevent reuse.

Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

- 3.3. **Removal.** Remove roadway illumination assembly components in conformance with established industry and utility safety practices.

Remove transformer bases from transformer base poles. Destroy removed transformer bases to prevent reuse. Remove luminaires and luminaire arms from the pole shaft. Stockpile pole shafts, luminaire arms, and assembly hardware at a location designated by the Department. Pole shafts, luminaire arms, and assembly hardware will remain Department property unless otherwise shown on the plans or directed.

Disconnect and remove conductors from abandoned circuits. Remove abandoned conduit and ducts to a point 6 in. below final grade.

Unless otherwise shown on the plans, remove abandoned concrete foundations, including steel, to a point 2 ft. below final grade. Backfill the hole with material that is equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition. Do not remove existing concrete bridge lighting brackets.

Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

- 3.4. **Replace Luminaires.** Remove existing luminaires. Furnish and install luminaires as shown on the plans. Replace conductors and breakaway fuse holders when necessary. Test installed luminaires in accordance with Item 616.

4. MEASUREMENT

This Item will be measured as each roadway illumination assembly installed, relocated, or removed, or by each luminaire replaced.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Roadway Illumination Assemblies" of the types specified, "Relocate Roadway Illumination Assemblies" of the types specified, "Remove Roadway Illumination Assemblies" of the types specified, or "Replace Luminaires" of the types specified. The Department will pay for electrical energy consumed by the lighting system.

New drilled shaft foundations will be paid for under Item 416. New concrete riprap placed around foundations will be paid for under Item 432, "Riprap." New conduit will be paid for under Item 618. New conductors, except the conductors internal to the pole, will be paid for under Item 620. New duct cable will be paid for under Special Specification, "Duct Cable." New ground boxes will be paid for under Item 624, "Ground Boxes." New electrical services will be paid for under Item 628, "Electrical Services."

- 5.1. **Installation.** This price is full compensation for furnishing, installing, and testing luminaires; furnishing and installing lamps, luminaire arms, brackets, poles, anchor bolt assemblies, templates, internal conductors, and connections; conducting system performance testing; and materials, equipment, labor, tools, and incidentals.
- 5.2. **Relocation.** This price is full compensation for salvaging and relocating the existing conduit and duct; removing existing foundations, backfilling, and surface placement; removing, erecting, connecting, and testing illumination assemblies; removing existing conductors; furnishing and installing new anchor bolt assemblies, templates, transformer bases, lamps, connections, and conductors; replacing damaged components; disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.
- 5.3. **Removal.** This price is full compensation for removing, salvaging, disassembling, and stockpiling illumination assemblies; salvaging and relocating existing conduit; removing existing foundations; backfilling and surface placement; splicing existing conductors; disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.
- 5.4. **Replace Luminaires.** This price is full compensation for removing, salvaging, disassembling, and stockpiling existing luminaires; furnishing and installing new luminaires, connections, and conductors internal to the pole; replacing damaged components; disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

Item 616**Performance Testing of Lighting Systems**

1. DESCRIPTION

Test the performance of roadway and high mast lighting systems.

2. CONSTRUCTION

Perform tests on the lighting system and tests required by Item 618, "Conduit"; Item 620, "Electrical Conductors"; and Special Specification, "Duct Cable." Ensure all components are properly installed.

Place the lighting system in operation for a 14-day test period. Burn the lighting system steadily for 48 hr., then cycle the photocell or other control device for 12 days.

Pass a 14-day performance test of the lighting system.

Replace materials that are damaged or have failed before acceptance. Damaged illumination assemblies, except those damaged by the Contractor, and minor failures of lamps, ballasts, and photocells are not cause for modifying or restarting the performance test.

Replace failed or damaged existing lighting system components when caused by the Contractor.

The Department will relieve the Contractor of maintenance responsibilities upon passing a 14-day performance test of the lighting system.

3. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items. The Department will pay for electrical energy consumed by the lighting system.

Item 618

Conduit



1. DESCRIPTION

Furnish and install conduit; prepare existing conduit.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items.

- Item 400, "Excavation and Backfill for Structures"
- Item 476, "Jacking, Boring, or Tunneling Pipe or Box"

When specified on the plans, provide:

- rigid metal conduit (RMC),
- polyvinyl chloride (PVC) conduit,
- high density polyethylene (HDPE) conduit,
- liquid-tight flexible metal conduit (LFMC), or
- liquid-tight flexible nonmetallic conduit (LFNC).

Furnish conduit from new materials in accordance with [DMS-11030](#), "Conduit."

Provide prequalified conduit from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

Provide other types of conduit not on the MPL that comply with the details shown on the plans and the NEC. Fabricate fittings such as junction boxes and expansion joints from a material like the connecting conduit, unless otherwise shown on the plans. Use watertight fittings. Do not use set screw fittings. Steel compression fittings are permissible. When using HDPE conduit, provide fittings that are UL-listed as electrical conduit connectors, or connect conduit by thermal fusing with an electrically heated welding method.

Use red 3-in. 4-mil polyethylene underground warning tape that continuously states, "Caution Buried Electrical Line Below."

3. CONSTRUCTION

Perform work as shown on the plans and in accordance with this Item.

Use established industry and utility safety practices when installing conduit located near underground utilities. Consult with the appropriate utility company before beginning work.

- 3.1. **Installation of Conduit.** Install conduit at least 18 in. deep below finished grade to top of conduit unless otherwise shown on the plans. Meet the requirements of the NEC when installing conduit. Secure and support conduit placed for concrete encasement such that the alignment will not be disturbed during placement of the concrete. Cap ends of conduit and close box openings before concrete is placed.

Ream conduit to remove burrs and sharp edges. Use a standard conduit cutting die with a 3/4-in. taper per foot when conduit is threaded in the field. Galvanize or paint threads in accordance with Item 445, "Galvanizing." Fasten conduit placed on structures with conduit straps or hangers as shown on the plans or

as directed. Fasten conduit within 3 ft. of each box or fitting and at other locations shown on the plans or as directed. Use two-hole type clamps for 2-in. diameter or larger conduit.

Fit PVC and HDPE conduit terminations with bushings or bell ends. Fit metal conduit terminations with a grounding type bushing, except conduit used for duct cable casing that does not terminate in a ground box and is not exposed at any point. Conduit terminating in threaded bossed fittings does not need a bushing. Before installation of conductors or final acceptance, pull a properly sized mandrel or piston through the conduit to ensure that it is free of obstruction. Cap or plug empty conduit placed for future use.

Perform trench excavation and backfilling as shown on the plans or as directed, and in accordance with Item 400. Excavation and backfilling will be subsidiary to the installation of the conduit.

Jack and bore as shown on the plans or as directed, and in accordance with Item 476.

Place warning tape approximately 10 in. above trenched conduit. Where existing surfacing is removed for placing conduit, repair by backfilling with material equal in composition and density to the surrounding areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition. Mark conduit locations as directed.

- 3.2. **Preparation of Conduit.** Pull a mandrel through empty conduits. Use a mandrel with a diameter greater than 70% of the inside diameter of the conduit and 2-in. length. Repair or replace conduit runs that will not allow passage of the mandrel. Replace conduit deemed impractical to repair or that remains unsuitable in accordance with Item 618, "Conduit." Clean the conduit by pulling a rubber swab slightly larger in diameter than the conduit.

Blow compressed air through conduits that contain wires. Remove debris from the conduit by pushing a fish tape through the conduit. Do not use water to clear debris. Retest the conduit by blowing compressed air.

Install one pull cord in each conduit for use in installing the conductors, cables, or innerduct.

4. MEASUREMENT

This Item will be measured by the foot of conduit installed, or by the foot of conduit cleared, tested, replaced, and repaired.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

- 5.1. **Installation of Conduit.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Conduit" of the type and size specified and the installation method specified as applicable, or for "Conduit (Prepare)." This price is full compensation for furnishing and installing conduit; cleaning and testing conduit; hanging, strapping, jacking, boring, tunneling, trenching, and furnishing and placing backfill; encasing in steel or concrete; replacing pavement structure, sod, riprap, curbs, or other surface; marking location of conduit (when required); furnishing and installing fittings, junction boxes, and expansion joints; and materials, equipment, labor, tools, and incidentals.

Flexible conduit will not be paid for directly, but will be subsidiary to pertinent Items. Unless otherwise shown on the plans, no payment will be allowed under this Item for conduit used on electrical services or in foundations.

Repair of existing conduit will be paid for by the Department in accordance with Article 9.7., "Payment for Extra Work and Force Account Method."

Item 620

Electrical Conductors



1. DESCRIPTION

Furnish and install electrical conductors, except conductors specifically covered by other Items.

2. MATERIALS

Provide new materials that comply with the details shown on the plans and the requirements of this Item. Use stranded insulated conductors that are rated for 600V, approved for wet locations, and marked in conformance with UL, NEC, and Canadian Standards Association (CSA) requirements. Furnish electrical conductors in accordance with [DMS-11040](#), "Electrical Conductors."

Provide pre-qualified electrical conductors from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

Ensure all grounding conductors Size 8 AWG and larger are stranded, except for the grounding electrode conductor at the electrical service, which will be a 6-AWG solid conductor.

Use white insulation for grounded (neutral) conductors, except grounded conductors Size 4 AWG and larger may be black with white tape marking at every accessible location. Do not use white insulation or marking for any other conductor except control wiring specifically shown on the plans.

Ensure insulated grounding conductors are green, except insulated grounding conductors Size 4 AWG and larger may be black with green tape marking at every accessible location. Do not use green insulation or marking for any other conductor except control wiring specifically shown on the plans.

3. CONSTRUCTION

Perform work as shown on the plans and in accordance with this Item.

Splice conductors only in junction boxes, ground boxes, and transformer bases, and in poles and structures at the handholes. Splice as shown on the plans. Do not exceed the manufacturer's recommended pulling tension. Use lubricant as recommended by the manufacturer. Install conductors in accordance with the NEC.

Test insulation resistance on the conductors before making final connections and ensure each continuous run of insulated conductor has a minimum direct-current (DC) resistance of 5 megohms (MΩ) when tested at 1,000V DC. The Engineer may require verification testing of all or part of the conductor system. The Engineer will witness these verification tests. Replace conductors exhibiting an insulation resistance of less than 5 MΩ at no additional cost to the Department.

4. MEASUREMENT

This Item will be measured by the foot of each single conductor.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Electrical Conductors" of the types and sizes specified. This price is full compensation for furnishing, installing, and testing electrical conductors; furnishing and installing breakaway connectors; and materials, equipment, labor, tools, and incidentals, with the following exceptions:

- conductors used in connecting the components of electrical services will be paid for under Item 628, "Electrical Services";
- conductors inside roadway illumination assemblies will be paid for under Item 610, "Roadway Illumination Assemblies";
- conductors inside traffic signal pole assemblies will be paid for under this Item; and
- conductors used for internal wiring of equipment will not be paid for directly, but will be subsidiary to pertinent Items.

Item 621

Tray Cable



1. DESCRIPTION

Furnish and install tray cable.

2. MATERIALS

Provide new materials that comply with the details shown on the plans and meet the requirements of Item 620, "Electrical Conductors."

Furnish tray cable from new materials in accordance with [DMS-11050](#), "Tray Cable."

Provide pre-qualified tray cable from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

3. CONSTRUCTION

Perform work as shown on the plans and in accordance with this Item.

Provide an additional 5 ft. of cable coiled in each ground box when installing cable in underground conduit. Splice tray cable conductors only at locations shown on the plans. Obtain the Engineer's written approval for each splice. Ensure splices are watertight. Test the cable's conductors after installation and before any connection. Remove and replace tray cable exhibiting a direct-current (DC) insulation resistance of less than 5 megohms at 1,000V DC at no additional cost to the Department.

4. MEASUREMENT

This Item will be measured by the foot of tray cable.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Tray Cable" of the types and sizes specified. This price is full compensation for furnishing and installing materials and for equipment, labor, tools, and incidentals.

Item 624

Ground Boxes



1. DESCRIPTION

- 1.1. **Installation.** Construct, furnish, and install ground boxes complete with lids.
- 1.2. **Removal.** Remove existing ground boxes.

2. MATERIALS

Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 432, "Riprap"
- Item 440, "Reinforcement for Concrete"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"

Provide fabricated precast polymer concrete ground boxes in accordance with [DMS-11070](#), "Ground Boxes." Provide pre-qualified ground boxes from the Department's MPL. When required by the Engineer, notify the Department in writing of selected materials from the MPL intended for use on each project.

Provide other precast or cast-in-place ground boxes that comply with the details shown on the plans.

3. CONSTRUCTION

Perform work as shown on the plans and in accordance with this Item.

Use established industry and utility safety practices when installing or removing ground boxes located near underground utilities. Consult with the appropriate utility company before beginning work.

- 3.1. **Installation.** Fabricate and install ground boxes as shown on the plans. Install ground box to approved line and grade.

Construct precast and cast-in-place concrete ground boxes in accordance with Item 420 and Item 440.

Construct concrete aprons as shown on the plans and in accordance with Item 432 and Item 440.

- 3.2. **Removal.** Remove existing ground boxes and concrete aprons to at least 6 in. below the conduit level. Uncover conduit to a sufficient distance so that 90° bends can be removed and conduit reconnected. Clean the conduit in accordance with Item 618. Replace conduit within 5 ft. of the ground box. Remove old conductors and install new conductors as shown on the plans. Backfill area with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

4. MEASUREMENT

This Item will be measured by each ground box installed complete in place or each ground box removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Ground Box" of the types and sizes specified and for "Remove Ground Box."

- 5.1. **Installation.** This price is full compensation for excavating, backfilling, and aggregate; constructing, furnishing, and installing ground boxes and concrete aprons; and material, equipment, labor, tools, and incidentals. All wiring connections required inside the ground box will be subsidiary to this Item. Conduit will be paid for under Item 618. Electrical conductors will be paid for under Item 620.
- 5.2. **Removal.** This price is full compensation for removing and disassembling ground boxes and concrete aprons; excavating, backfilling, and surface placement; removing old conductors; disposal of unsalvageable materials; and materials, equipment, labor, tools, and incidentals. Cleaning of conduit will be subsidiary to this Item. Conduit replaced within 5 ft. of the ground box will be subsidiary to this Item. Additional conduit will be paid for under Item 618. Installation of conductors will be paid for under Item 620.

Item 627

Treated Timber Poles



1. DESCRIPTION

Furnish and install treated timber poles.

2. MATERIALS

Use new treated southern pine timber poles in accordance with ANSI O 5.1 and this Item. Use ANSI Class 5 treated timber poles for electrical services and ANSI Class 2 for all other applications, unless otherwise shown on the plans.

Ensure poles are free of pith holes at the tops and butts. Do not use poles that have a trimmed scar with a depth greater than 2 in. if the diameter is 10 in. or less, or 1/5 the pole diameter at the scar location if the diameter is more than 10 in. Provide poles that do not deviate from straightness by more than 1 in. for each 10 ft. of length. A pole may have sweep in one plane and one direction (single sweep), provided a straight line joining the midpoint of the pole at the butt and the midpoint of the pole at the top does not at any intermediate point pass through the external surface of the pole. Timber poles with more than one complete twist of spiral grain are not acceptable.

Furnish treated poles in accordance with AWPAs to the minimum net retention and penetration of preservative treatment in accordance with Table 1.

Table 1
AWPA Commodity Specification and Use Category for Poles

Product	AWPA Commodity Specification ¹	AWPA Use Category ²
Poles (southern pine)	D	UC4C

- For minimum preservative retention requirements, refer to AWPAs Use Category System Standard U1, Commodity Specification D, for the preservative provided for the southern pine poles. For preservative penetration and assay zone requirements, refer to AWPAs Use Category System Standard T1, Commodity Specification D.
- Refer to this designated Use Category when locating the minimum required retention for the provided preservative in AWPAs Use Category System Standard U1, Commodity Specification D.

Mark all poles by branding in accordance with Table 2.

Table 2
Timber Pole Markings

Marking	Description of Marking
PTC	Supplier's code or trademark (e.g., Pole Treating Company)
F-20	Plant location and year of treatment (e.g., Forestville, 2020)
SPC	Species and preservative code (e.g., southern pine, creosote)
5-35	Class length (e.g., Class 5, 35-ft. pole)

Place the bottom of the brand squarely on the face of the pole 10 ft. (± 2 in.) from the butt.

Furnish a treatment certification with every shipment of treated timber poles that includes:

- name of treating company,
- location of treating plant,
- applicable product standard (AWPA U1),
- charge number,

- date of treatment,
- contents of charge (poles),
- preservative treatment, and
- actual preservative retention values.

3. CONSTRUCTION

Perform work as shown on the plans and in accordance with this Item.

Use established industry and utility safety practices while installing poles located near overhead or underground utilities. Consult with the appropriate utility company before beginning work.

Set the pole a minimum depth in accordance with Table 3, unless otherwise shown on the plans.

Table 3
Pole Setting Depth

Pole Length (ft.)	Min Setting Depth (ft.)
25 or less	4.5
26–30	5.0
31–35	5.5
36–40	6.0
41–45	6.5
46–50	7.0

Locate timber poles as shown on the plans or as directed. Drill holes for setting poles a minimum of 1.5 diameters of the pole butt. Set the poles plumb, unless otherwise shown on the plans. Backfill the holes thoroughly by tamping in 6-in. lifts. After tamping to grade, place additional backfill material in a 6-in. high cone around the pole to allow for settling. Use material equal in composition and density to the surrounding area. Repair surface where existing surfacing material is removed, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

4. MEASUREMENT

This Item will be measured by each timber pole installed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Treated Timber Pole" of the various lengths and classes specified. This price is full compensation for furnishing and installing timber poles; all hardware; and materials, equipment, labor, tools, and incidentals.

This payment clause excludes payment for treated timber poles when subsidiary to another Item.

Item 628

Electrical Services



1. DESCRIPTION

- **Installation.** Furnish and install electrical services.
- **Relocation.** Relocate existing electrical services.
- **Removal.** Remove existing electrical services.

2. MATERIALS

Provide materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items.

- Item 441, "Steel Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"
- Item 627, "Treated Timber Poles"
- Item 656, "Foundations for Traffic Control Devices"

For the installation of electrical services, use new materials that meet the requirements of the NEC, UL, the Canadian Standards Association (CSA), and NEMA, and are in accordance with [DMS-11080](#), "Electrical Services."

Provide pre-qualified electrical services from the Department's MPL. When required, notify the Department in writing of selected materials from the MPL intended for use on each project.

3. CONSTRUCTION

Perform work as shown on the plans and in accordance with this Item. Use established industry and utility safety practices when installing, relocating, or removing electrical services located near overhead or underground utilities. Consult with the appropriate utility company before beginning work.

- 3.1. **Installation.** Furnish and install electrical service equipment. Ensure components of the electrical service meet the requirements of the Electrical Detail Standards. Install the electrical equipment in accordance with the NEC and in conformance with local utility company requirements. Coordinate the utility companies' work for providing service.
- 3.2. **Relocation.** Coordinate relocation with the appropriate utility company before beginning work. Remove existing electrical service in accordance with Section 628.3.3., "Removal." Reinstall existing electrical service in accordance with Section 628.3.1., "Installation." Replace or add circuit breakers as shown on the plans.
- 3.3. **Removal.** Coordinate removal with the appropriate utility company before beginning work. Before the removal of the electrical service, disconnect and isolate any existing electrical service equipment in conformance with the utility company's requirements.

Remove existing electrical service support at least 2 ft. below finished grade unless otherwise shown on the plans. Repair the remaining hole by backfilling with material equal in composition and density to the surrounding area. Replace any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

Disconnect and remove conductors from the conduit. Cut off and cap all protruding conduit 6 in. below finished grade. Abandoned conduit need not be removed unless otherwise shown on the plans.

Reconnect conductors and conduit to be reused when shown on the plans. Make all splices in ground boxes unless otherwise shown on the plans.

Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

4. MEASUREMENT

This Item will be measured by each electrical service installed, relocated, or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Electrical Services" of the types specified, "Relocate Electrical Services," or "Remove Electrical Services."

Costs for utility-owned power line extensions, connection charges, meter charges, consumption charges, and other charges will be paid for by the Department. The Department will reimburse the Contractor the amount billed by the utility, plus an additional 5% of the invoice cost will be paid for labor, equipment, administrative costs, superintendence, and profit.

Applications for a permanent utility service will designate the Department as the service owner unless otherwise shown in the plans.

- 5.1. **Installation.** This price is full compensation for paying all fees, testing, permits, utility company inspections, connection or meter charges, and other costs; making arrangements with the utility company for all work and materials provided by the utility company; furnishing, installing, and connecting all components, including poles, service supports, foundations, anchor bolts, riprap, enclosures, switches, breakers, service conduit (from the service equipment, including the elbow below ground), fittings, service conductors (from the service equipment, including the elbow below ground), brackets, bolts, hangers, and hardware; and materials, equipment, labor, tools, and incidentals.
- 5.2. **Relocation.** This price is full compensation for disconnecting and isolating the existing electrical service; relocating the service supports; new service support foundation; backfilling holes; paying all fees, testing, permits, utility company inspections, connection or meter charges, and other costs; making arrangements with the utility company for all work and materials provided by the utility company; removing, disconnecting, installing, and connecting all components, including poles, service supports, foundations, anchor bolts, riprap, enclosures, switches, breakers, service conduit (from the service equipment, including the elbow below ground), fittings, service conductors (from the service equipment, including the elbow below ground), brackets, bolts, hangers, and hardware; and materials, equipment, labor, tools, and incidentals.
- 5.3. **Removal.** This price is full compensation for coordinating with the utility company to disconnect and isolate the electrical service; removing the service supports; backfilling holes; and materials, equipment, labor, tools, and incidentals.

Item 636

Signs



1.	DESCRIPTION ■ Installation. Furnish, fabricate, and erect aluminum signs. Sign supports are provided for under other Items. ■ Replacement. Replace existing signs on existing or replaced sign supports.
2.	MATERIALS 2.1. Signs. Furnish completed signs in accordance with DMS-8301, "Highway Sign Fabrication." 2.2. Hardware. Use galvanized steel, stainless steel, or dichromate-sealed aluminum for bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. Use plastic or nylon washers when in direct contact with the reflective sheeting. Furnish steel or aluminum products in accordance with DMS-7120, "Sign Hardware." When dissimilar metals are used, select or insulate metals to prevent corrosion. 2.3. Sign Identification Decals. Furnish materials that meet the requirements of DMS-8315, "Sign Identification Decals."
3.	CONSTRUCTION 3.1. Decals. The sign fabricator must code the sign identification decals by punching out the appropriate letter or digits for Rows 1–7 as shown in Figure 1 and Table 1. Rows 8–12 (Installation Date) are only for coding by the Engineer at their discretion. Affix the decal to lower left corner of the sign back in an upright position. Figure 1 shows the sign identification decal. The numbers to the far right as shown in Figure 1 are reference row numbers for Table 1 and are not part of the decal. Table 1 describes the information required in each row of the decal.

Texas Department of Transportation													
C	Fabrication Date											T	1
J	F	M	A	M	J	J	A	S	O	N	D		2
	202		203		204		205		206				3
	0	1	2	3	4	5	6	7	8	9			4
Sheeting MFR—Substrate													
A	B	C	D	E	F	G	H	J	K	L	M		5
Film MFR													
A	B	C	D	E	F	G	H	J	K	L	M		6
Sheeting MFR—Legend													
A	B	C	D	E	F	G	H	J	K	L	M		7
Installation Date													
				0	1	2	3						8
	0	1	2	3	4	5	6	7	8	9			9
J	F	M	A	M	J	J	A	S	O	N	D		10
	202		203		204		205		206				11
	0	1	2	3	4	5	6	7	8	9			12
Name of Sign Fabricator Physical Address City, State, Zip Code													13

Figure 1
Decal Design (Row Numbers Explained in Table 1)

Table 1
Decal Description
Row Explanation

1—Sign fabricator
2—Month fabricated
3—First 3 digits of year fabricated
4—Last digit of year fabricated
5—Manufacturer of the sheeting applied to the substrate
6—Film (colored transparent or non-reflective black) manufacturer
7—Manufacturer of the sheeting for the legend
8—Tens digit of date installed¹
9—Ones digit of date installed¹
10—Month installed¹
11—First 3 digits of year installed¹
12—Last digit of year installed¹
13—Name of sign fabricator and physical location of sign shop

1. Only for coding by the Engineer at their discretion.

Code the decal by punching out the following:

- "C" if fabricated by a commercial sign fabricator or "T" if fabricated by the Department or the Texas Department of Criminal Justice,
- month fabricated,
- first three digits of the year fabricated,
- fourth digit of the year fabricated, and
- sheeting and film manufacturers. (Codes for these manufacturers are located on the Department's MPL.)

- 3.2. **Storage and Handling.** Ship, handle, and store completed sign blanks and completed signs so that corners, edges, and faces are not damaged. Damage to the sign face that is not visible when viewed at a distance of 50 ft., night or day, will be acceptable. Replace unacceptable signs.

Store all finished signs off the ground and in a vertical position until erected. Store finished sheet aluminum substrate signs in a weatherproof building. Extruded aluminum substrate signs may be stored outside.

Stockpile salvageable materials at the location shown on the plans or as directed. Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

- 3.3. **Cleaning.** Wash completed signs in the fabrication shop using a biodegradable cleaning solution acceptable to the manufacturers of the sheeting, colored transparent film, and screen ink to remove grease, oil, dirt, smears, streaks, finger marks, and other foreign material. Wash again before final inspection after erection.

- 3.4. **Installation.** Install signs as shown on the plans or as directed.

- 3.5. **Replacement.** Remove the existing signs from the existing or replaced supports and replace with new signs, including mounting hardware, as shown on the plans. At the Engineer's discretion, existing galvanized mounting hardware can be reused if it was not damaged during removal of existing sign.

- 3.6. **Documentation.** Provide a notarized original of the project-specific Signing Material Statement (Form 2273), from the sign fabricator, along with attached copies of pertinent material certifications for verification of compliance.

4. MEASUREMENT

Signs installed or replaced will be measured by the square foot of the sign face.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Aluminum Signs," or "Replacing Existing Aluminum Signs," of the type specified.

- 5.1. **Installation.** This price is full compensation for furnishing and installing new signs and hardware; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams, and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; and materials, equipment, labor, tools, and incidentals.

- 5.2. **Replacement.** This price is full compensation for furnishing and installing new aluminum signs and hardware; reusing existing hardware (when applicable); removal of existing signs; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams, and stiffeners; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; salvaging and disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

Item 656

Foundations for Traffic Control Devices



1. DESCRIPTION

Construct concrete foundations for small roadside signs, traffic signal controller cabinets, pedestal poles, roadside flashing beacon assemblies, electrical services, and other small traffic control devices.

2. MATERIALS

Ensure materials and construction methods conform to the requirements of this Item and the pertinent requirements of the following Items.

- Item 400, "Excavation and Backfill for Structures"
- Item 416, "Drilled Shaft Foundations"
- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete"
- Item 432, "Riprap"
- Item 440, "Reinforcement for Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 447, "Structural Bolting"
- Item 449, "Anchor Bolts"
- Item 618, "Conduit"

Use Class A concrete for non-reinforced drilled shafts. Use Class C concrete for reinforced drilled shafts. Use Class B concrete or polymer concrete composed of borosilicate glass fiber, catalyzed polyester resin, and aggregate for traffic signal controller cabinet foundations. Use drilled shaft or galvanized steel screw-in type foundations for roadside flashing beacon assemblies.

Use reinforcing steel when required.

3. CONSTRUCTION

Stake and install foundations as shown on the plans. The Engineer may shift the foundation locations within design guidelines where necessary to secure a more desirable location or avoid conflict with utilities. Use established industry and utility safety practices when working near underground or overhead utilities. Consult the appropriate utility before beginning work.

Hold anchor bolts in place using templates during concrete placement. Hold embedded items such as conduit or other hardware in place during concrete placement using templates or other approved means. Cap conduits before placing concrete. Ream conduit to remove burrs and sharp edges. Install bell ends or bushings on the conduit.

Carefully align foundation, posts, and anchor bolts. Do not spring or rake posts or anchor bolts.

Remove the top template after concrete has achieved initial set. Keep forms and other bracing intact until the concrete has cured at least 1 curing day.

Allow concrete for pedestal poles and roadside flashing beacon assemblies to cure at least 7 days before placing bases and poles on the foundation, unless otherwise permitted in writing.

Allow concrete for traffic signal controller cabinet foundations and small roadside signs to cure at least 4 days before placing cabinets and posts on the foundation, unless otherwise permitted.

Provide an ordinary surface finish to the concrete foundation extending above ground in accordance with Section 420.4.13., "Ordinary Surface Finish."

Place concrete riprap around the foundation as shown on the plans.

Backfill disturbed surface with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

Item 662

Work Zone Pavement Markings



1. DESCRIPTION

Furnish, place, and maintain work zone pavement markings.

2. MATERIALS

Provide thermoplastic, paint and beads, raised pavement markers (RPMs), prefabricated pavement markings, temporary flexible reflective roadway marker tabs, or other approved materials for work zone pavement markings.

Supply materials in accordance with the following.

- [DMS-4200](#), "Pavement Markers (Reflectorized)"
- [DMS-4300](#), "Traffic Buttons"
- [DMS-8200](#), "Traffic Paint"
- [DMS-8220](#), "Hot Applied Thermoplastic"
- [DMS-8240](#), "Permanent Prefabricated Pavement Markings"
- [DMS-8241](#), "Temporary (Removable) Prefabricated Pavement Markings"
- [DMS-8242](#), "Temporary Flexible, Reflective Roadway Marker Tabs"
- [DMS-8290](#), "Glass Traffic Beads"

- 2.1. **Nonremovable Markings.** Use hot-applied thermoplastic, paint and beads, or permanent prefabricated pavement markings for nonremovable markings. Furnish Type II glass beads in accordance with [DMS-8290](#) for thermoplastic and paint and bead pavement markings.
- 2.2. **Removable and Short-Term Markings.** Use RPMs, traffic buttons, removable prefabricated pavement markings, temporary flexible reflective roadway marker tabs, or other approved materials for removable and short-term markings. Do not use hot-applied thermoplastic, multipolymer pavement markings, or traffic paint for removable markings. Use removable prefabricated pavement markings on the final pavement surface when the plans specify removable markings.

3. CONSTRUCTION

Apply pavement markings in accordance with the following Items.

- Item 666, "Retroreflectorized Pavement Markings"
- Item 668, "Prefabricated Pavement Markings"
- Item 672, "Raised Pavement Markers"

- 3.1. **Placement.** Install longitudinal markings on pavement surfaces before opening to traffic. Maintain lane alignment traffic control devices and operations until markings are installed. Install markings in proper alignment in accordance with the TMUTCD and as shown on the plans. Short-term markings will be allowed when standard markings (removable or nonremovable) cannot be placed before opening to traffic, if shown on the plans or directed.

When short-term markings are allowed for opening to traffic, place standard longitudinal markings no later than 14 calendar days after the placement of the surface. When inclement weather prohibits placement of markings, the 14-day period may be extended until weather permits proper application.

Place standard longitudinal markings no sooner than 3 calendar days after the placement of a surface treatment, unless otherwise shown on the plans.

Apply thermoplastic markings to a minimum thickness of 0.060 in. (60 mils). When paint and beads are allowed, apply to a minimum dry thickness of 0.012 in. (12 mils).

Place short-term markings in proper alignment with the location of the final pavement markings. Remove and replace short-term markings not in alignment at the Contractor's expense.

For removable placements, use of RPMs to simulate longitudinal markings is at the Contractor's option. Use side-by-side RPMs to simulate longitudinal lines wider than 4 in. Do not use RPMs for words, symbols, shapes, or diagonal or transverse lines.

- 3.2. **Marking Removal.** Remove markings that conflict with succeeding markings in accordance with Item 677, "Eliminating Existing Pavement Markings and Markers." Remove short-term markings that interfere or conflict with final marking placement immediately before placing final pavement markings, unless otherwise directed. Remove the remainder of the short-term markings before final acceptance.

Remove all temporary markings with minimal damage to the roadway to the satisfaction of the Engineer.

- 3.3. **Performance Requirements.** Ensure all markings are in accordance with [Tex-828-B](#) and are visible from a distance at least 320 ft. (eight skiplines) in daylight conditions and at least 160 ft. (four skiplines) in nighttime conditions when illuminated by automobile low-beam headlights. Determine visibility distances using an automobile traveling on the roadway under dry conditions.

Maintain the markings for 30 calendar days after installation. The end of the 30-day maintenance period does not relieve the Contractor from the performance deficiencies requiring corrective action identified during the 30-day period. Remove and replace markings at the Contractor's expense if they fail to meet the requirements of this Item during the 30-day period. The 30-calendar day performance requirement will begin again after replacement of the markings.

Ensure daytime and nighttime reflected color of the markings are distinctly white or yellow. Ensure markings exhibit uniform retroreflective characteristics.

4. MEASUREMENT

This Item will be measured by the foot or each word, shape, symbol, or temporary flexible reflective roadway marker tab. Each stripe will be measured separately. RPMs used to simulate a marking will be measured by the foot of marking or each RPM.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Work Zone Pavement Markings" of the type and color specified and the shape, width, and size specified as applicable. This price is full compensation for furnishing, placing, maintaining, and removing work zone pavement markings and for materials, equipment, labor, tools, and incidentals.

Elimination of nonremovable markings will be paid for under Item 677. Removal of short-term and removable markings will not be paid for directly, but will be subsidiary to this Item.

Type II work zone pavement markings (paint and beads) used as a sealer for Type I pavement markings (thermoplastic) will be paid for under this Item.

Item 677

Eliminating Existing Pavement Markings and Markers



1. DESCRIPTION

Eliminate existing pavement markings and raised pavement markers (RPMs).

2. MATERIALS

Furnish surface treatment materials in accordance with the following Items.

- Item 300, "Asphalts, Oils, and Emulsions"
- Item 302, "Aggregates for Surface Treatments"
- Item 315, "Fog Seal"
- Item 316, "Seal Coat"

Use approved patching materials for repairing damaged surfaces.

Use a commercial abrasive blasting medium capable of producing the specified surface cleanliness. Use potable water when water is required.

3. EQUIPMENT

Furnish and maintain equipment in good working condition. Use moisture and oil traps in air compression equipment to remove all contaminants from the blasting air and prevent the deposition of moisture, oil, or other contaminants on the roadway surface.

4. CONSTRUCTION

Eliminate existing pavement markings and markers on both concrete and asphaltic surfaces such that color and texture contrast of the removed area and surrounding pavement surface will be held to a minimum. Remove all markings and markers with minimal damage to the roadway to the satisfaction of the Engineer. Repair damage to asphaltic surfaces such as spalling and shelling greater than 1/8 in. deep resulting from the removal of pavement markings and markers. Dispose of markers in conformance with federal, state, and local regulations. Use any of the following methods unless otherwise shown on the plans. Refer to the *Pavement Marking Handbook* for additional information on removal types and best practices.

- 4.1. **Surface Treatment Method.** Apply surface treatment material at the rates shown on the plans, or as directed. Place a surface treatment at least 2 ft. wide to cover the existing marking. Place a surface treatment, thin overlay, or microsurfacing at least one lane in width in areas where directional changes of traffic are involved or other areas as directed.
- 4.2. **Burn Method.** Use an approved burning method. For thermoplastic pavement markings or prefabricated pavement markings, heat may be applied to remove the bulk of the marking material before blast cleaning. When using heat, avoid spalling pavement surfaces. Ensure the burning heads are not left in one place too long to prevent pavement damage. Sweeping or light blast cleaning may be used to remove minor residue.
- 4.3. **Blasting Method.** Use a blasting method such as high-pressure water blasting, abrasive blasting, water abrasive blasting, shot blasting, slurry blasting, water-injected abrasive blasting, or brush blasting as approved. Use high-pressure water blasting for removal of pavement markings for lane shifts on concrete surfaces.

- 4.4. **Mechanical Method.** Use any mechanical method except grinding. Do not use flail milling on grooved concrete or porous asphalt.
- 4.5. **Corrective Actions.** Whenever removed markings on asphalt surfaces continue to simulate pavement markings to an extent determined by the Engineer to cause driver confusion, apply a fog seal or slurry at least 2 ft. wide over the area where pavement markings were removed as approved.

5. MEASUREMENT

This Item will be measured by each word, symbol, or shape eliminated; by the foot of marking eliminated; or by any other unit shown on the plans.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Eliminating Existing Pavement Markings and Markers" of the type and width as applicable. This price is full compensation for the elimination method used and materials, equipment, tools, labor, and incidentals. Removal of RPMs will not be paid for directly, but will be subsidiary to pertinent Items.

Item 680

Highway Traffic Signals



1. DESCRIPTION

- **Installation.** Install highway traffic signals.
- **Upgrade.** Modify or change existing traffic signals as shown on the plans.
- **Removal.** Remove, store, and salvage traffic signals.

2. MATERIALS

Ensure electrical materials and construction methods conform to the NEC and additional local utility requirements.

Furnish new materials as shown on the plans. Ensure all materials and construction methods are as shown on the plans and in accordance with this Item and the following Items.

- Item 450, "Railing"
- Item 610, "Roadway Illumination Assemblies"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"
- Item 621, "Tray Cable"
- Item 625, "Zinc-Coated Steel Wire Strand"
- Item 628, "Electrical Services"
- Item 636, "Signs"
- Item 656, "Foundations for Traffic Control Devices"
- Item 682, "Vehicle and Pedestrian Signal Heads"
- Item 684, "Traffic Signal Cables"
- Item 686, "Traffic Signal Pole Assemblies"
- Item 687, "Pedestrian Pole Assemblies"
- Item 688, "Pedestrian and Vehicle Detectors"

Provide controller assemblies in accordance with [DMS-11170](#), "Fully Actuated, Solid-State Traffic Signal Controller Assembly," and as shown on the plans. When shown on the plans, anti-graffiti coating will be in accordance with [DMS-8111](#), "Anti-Graffiti Coatings."

Provide devices in accordance with [DMS-11171](#), "Malfunction Management Unit (MMU)," and as shown on the plans.

Provide controllers in accordance with [DMS-11172](#), "Preemption Controller," and as shown on the plans.

Provide controllers in accordance with [DMS-11173](#), "Traffic Controller," and as shown on the plans.

Provide prequalified controller assemblies from the Department's MPL.

Provide flasher assemblies in accordance with [DMS-11160](#), "Flasher Controller Assembly," and as shown on the plans.

Provide prequalified flasher assemblies from the Department's MPL.

Sampling and testing of traffic signal controller assemblies and internal devices will be in accordance with [Tex-1170-T](#).

3. CONSTRUCTION

3.1. **Installation.** Install traffic signal controller foundations in accordance with Item 656.

3.1.1. **Electrical Requirements.**

3.1.1.1. **Electrical Services.** Arrange for electrical services and install and supply materials not provided by the utility company as shown on the plans. Install 120V, single-phase, 60-Hz AC electrical service unless otherwise shown on the plans.

3.1.1.2. **Conduit.** Install conduit and fittings of the sizes and types shown on the plans. Conduit of larger diameter size than that shown on the plans may be used with no additional compensation, providing the same diameter size is used for the entire length of the conduit run. Extend conduit in concrete foundations 2–3 in. above the concrete. Seal the ends of each conduit with approved sealant, after all cables and conductors are installed.

3.1.1.3. **Wiring.** Furnish stranded XHHW conductors as shown on the plans. If a size is not shown on the plans, use a minimum No. 14 AWG. Install aboveground cables and conductors in rigid metal conduit, except for span wire suspended cables and conductors, drip loops, and electrical wiring inside signal poles, unless otherwise shown on the plans. Make power entrances to ground-mounted controllers through underground conduit. Wire each signal installation to operate as shown on the plans.

Attach ends of wires to properly sized self-insulated solderless terminals. Attach terminals to the wires using a ratchet-type compression crimping tool properly sized to the wire. Place pre-numbered identification tags of plastic or tape around each wire adjacent to wire ends in the controller and signal pole terminal blocks.

Do not strip traffic signal cable until it has passed into the location that requires termination.

Splices will not be permitted except as shown on the plans, unless each individual splice is approved in writing. Make all allowed splices watertight.

Ensure both neutral buses are located with one on the left and one on the right bonded together. Relocate neutral bus if not oriented in the cabinet in this manner.

Ensure gauge of wire size used to connect electrical equipment inside the cabinet is sized appropriately for amperage load for the specific device, circuit breaker, or duplex receptacle in accordance with the NEC.

Install Category 6 Ethernet communication cables in accordance with Special Specification, “Networking Intelligent Transportation System (ITS) Communication Cable,” and connect networked equipment inside the controller cabinet assembly to field Ethernet switch following the color scheme and assignment information as follows.

- **White.** Ethernet switch (1-ft. patch cord).
- **Blue.** Traffic signal controller.
- **Green.** Malfunction monitor unit (MMU).
- **Red.** Battery backup unit (BBU).
- **Yellow.** Accessible pedestrian system.
- **Black.** Detection (e.g., radar and video).
- **Purple.** Pan, tilt, and zoom (PTZ) camera.
- **Orange.** Other.
- **Gray.** Other.
- **Pink.** Broadband radio.

A standard bundle of cables provided by the cabinet vendor is identified in [DMS-11170](#). Additional CAT 6 Ethernet cables, provided as necessary, must follow the color scheme and assignment above to connect additional networked equipment.

Railroad connection between traffic cabinet and bungalow must be a minimum No. 14 AWG 15-conductor and follow the color code chart shown in Table 1.

Table 1
Railroad Preemption Color Code and Functional Connection

Conductor	Color Code	Railroad Interface Field Terminal Connections	Conductor Identification
1	Black	HLTH-	Health Status DC-
2	White	—	Spare
3	Red	HLTH+	Health Status DC+
4	Green	—	Spare
5	Orange	XR IN	Simultaneous DC-
6	Blue	TCR IN	Advance DC-
7	White/black stripe	—	Spare
8	Red/black stripe	GD/ISLD IN	Gate Down/Island
9	Green/black stripe	APP OUT	Advance Pedestrian Preemption
10	Orange/black stripe	XR OUT	Simultaneous
11	Blue/black stripe	TCR OUT	Advance Primary
12	Black/white stripe	—	Spare
13	Red/white stripe	GD/ISLD OUT	Gate Down/Island DC-
14	Green/white stripe	APP IN	Advance Pedestrian Preemption DC -
15	Blue/white stripe	SUPR	Advance Secondary

- 3.1.1.4. **Grounding and Bonding.** Ground and bond conductors in accordance with the NEC. Ensure the resistance from the grounded point of any equipment to the nearest ground rod is less than 1 ohm.

Install a continuous bare or green insulated stranded copper wire (equipment ground) throughout the electrical system that is the same size as the neutral conductor. If a size is not shown on the plans, use a minimum No. 8 AWG. Connect the equipment ground to all metal conduit, signal poles, controller housing, electrical service ground, ground rods, and all other metal enclosures and raceways. Inside the controller cabinet assembly, jumper between neutral bus and ground bus is not required. Remove jumper if provided by cabinet manufacturer.

Provide stranded copper wire bonding jumpers that are minimum No. 8 AWG.

- 3.1.2. **Controller Assemblies.** Construct controller assembly foundations in accordance with Item 656. Immediately before mounting the controller assembly on the foundation, apply a bead of exterior rated penetrating sealant to the cabinet base or cabinet riser. Seal any space between conduit entering the controller assembly and the foundation with exterior rated penetrating sealant.

Stake cabinet foundation forms and underground conduit entering the foundation before installation and secure Department approval before pouring foundation. Cabinet location may vary from that shown on the plans to accommodate field conditions as approved. For controller cabinet assemblies installed on a slope, ensure the cabinet primary door faces and opens to the low side of the slope. If safety rail is required as shown on the plans, it must be in accordance with Item 450. Furnish anchor bolts to mount the cabinet or cabinet riser to the foundation. Manufacturer to determine the appropriate size and type of anchor bolt by cabinet type and foundation size. Provide appropriate mounting plates and any other necessary hardware to mount the cabinet on a foundation.

Coordinate with the Department on delivery of cabinet keys. Place the instruction manual and wiring diagrams for all equipment in the controller cabinet inside the controller cabinet.

- 3.1.3. **Preservation of Sod, Shrubbery, and Trees.** Replace sod, shrubbery, and trees damaged during the Contract.

- 3.1.4. **Removal and Replacement of Curbs and Walks.** Obtain approval before cutting into or removing walks or curbs not shown on the plans to be removed or replaced. Restore any curbs or walks removed equivalent to original condition after work is completed, to the satisfaction of the Engineer.
- 3.1.5. **Intersection Illumination.** Install luminaires on signal poles as shown on the plans.
- 3.1.6. **Signal Timing Plan.** The traffic signal timing plan will be provided by the Department or local entity.
- 3.1.7. **Test Period.** Operate completed traffic signal installations continuously for at least 30 days in a satisfactory manner. Designate in writing a sufficiently skilled individual responsible for maintenance and operation of the traffic signals who is available 24 hr. per day, and able to be onsite within 24 hr. of notification by the Engineer, unless otherwise shown on the plans. If any Contractor-furnished equipment fails during the 30-day test period, repair or replace that equipment. This repair or replacement, except lamp replacement, will start a new 30-day test period.

Replace materials that are damaged or have failed before acceptance. Replace failed or damaged existing signal system components when caused by the Contractor. The Department will relieve the Contractor of maintenance responsibilities upon passing a 30-day performance test of the signal system and acceptance of the Contract.

- 3.2. **Upgrade.** Remove the existing items and install new items as shown on the plans or as directed. For newly installed items, refer to Section 680.3.1., "Installation." Ensure items designated for salvage are removed in a manner to avoid undue stress or damage. When the removed item leaves an opening, cover the opening with similar material to an equivalent condition. When the removed item leaves an unused signal cable, remove the cable. When the removed item leaves unused conductors within a signal cable still in use, trim back and tape off to ensure no electrical shorts by unused conductors. Store items designated for reuse or salvage at locations shown on the plans or as directed.
- 3.3. **Removal.** Remove existing electrical services, pedestal poles, strain poles, mast arm pole assemblies, luminaires, signal heads, vehicle detector equipment, controllers, cables, and other accessories. Remove materials so damage does not occur. Remove and store items designated for reuse or salvage at locations shown on the plans or as directed.

Remove abandoned concrete foundations, including steel, to a point 2 ft. below final grade. Backfill holes with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

4. MEASUREMENT

This Item will be measured by each traffic signal installed, upgraded, or removed. A traffic signal is a signalized intersection controlled by a single traffic signal controller.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Installation of Traffic Signals" of the type (traffic signal or flashing beacon) specified, or "Removing Traffic Signals."

- 5.1. **Installation.** This price is full compensation for furnishing, installing, and testing the completed installation of the traffic signal controller and associated equipment with network cabling, controller assembly, foundations, luminaires, damping plates, mounting hardware, and Department-provided items; preservation and replacement of damaged sod, shrubbery, and trees; removal and replacement of curbs and walks; and

materials, equipment, labor, tools, and incidentals. The Department will pay for electrical energy consumed by the traffic signal.

New drilled shaft foundations for traffic signal poles will be paid for under Item 416, "Drilled Shaft Foundations." New safety rail will be paid for under Item 450. New sidewalks or pedestrian ramps will be paid for under Item 531, "Sidewalks." New conduit will be paid for under Item 618. New electrical conductors will be paid for under Item 620. New ground boxes will be paid for under Item 624, "Ground Boxes." New span wire will be paid for under Item 625. Wire lashing or cable ties required to secure aerial cables to the messenger wire will be subsidiary. New electrical services will be paid for under Item 628. New signs will be paid for under Item 636. New internally illuminated signs will be paid for under Special Specification. New vehicle and pedestrian signal heads will be paid for under Item 682. New traffic signal cables will be paid for under Item 684. New traffic signal pole assemblies will be paid for under Item 686. New traffic signal detectors will be paid for under Item 688 or Special Specification.

If the design of the intersection control spans more than one intersection, such as a restricted crossing U-turn (RCUT), and requires more than one traffic signal cabinet, this Item will be measured by each traffic signal cabinet installed.

- 5.2. **Upgrade.** This price is full compensation for removing the various traffic signal components; removing the controller foundations; disposal of unsalvageable materials; hauling; and materials, equipment, labor, tools, and incidentals, as shown on the plans or as directed. This price is full compensation for furnishing, installing, and testing the completed installation, controller and associated equipment, controller foundations, luminaires, damping plates, and mounting hardware; preservation and replacement of damaged sod, shrubbery, and trees; removal and replacement of curbs and walks; and materials, equipment, labor, tools, and incidentals. The Department will pay for electrical energy consumed by the traffic signal.

New drilled shaft foundations for traffic signal poles will be paid for under Item 416. New sidewalks or pedestrian ramps will be paid for under Item 531. New conduit will be paid for under Item 618. New electrical conductors will be paid for under Item 620. New ground boxes will be paid for under Item 624. New span wire will be paid for under Item 625. Wire lashing or cable ties required to secure aerial cables to the messenger wire will be subsidiary. New electrical services will be paid for under Item 628. New signs will be paid for under Item 636. New internally illuminated signs will be paid for under Special Specification. New vehicle and pedestrian signal heads will be paid for under Item 682. New traffic signal cables will be paid for under Item 684. New traffic signal pole assemblies will be paid for under Item 686. New traffic signal detectors will be paid for under Item 688 or Special Specification.

- 5.3. **Removal.** This price is full compensation for removing the various traffic signal components; removing the controller foundations; disposal of unsalvageable materials; hauling; and materials, equipment, labor, tools, and incidentals.

Item 681

Temporary Traffic Signals



1. DESCRIPTION

Furnish, install, operate, maintain, reconfigure, and remove temporary traffic signals.

2. MATERIALS

Furnish new or used materials as shown on the plans and in accordance with this Item and the pertinent requirements of the following Items (except for "Measurement" and "Payment").

- Item 416, "Drilled Shaft Foundations"
- Item 610, "Roadway Illumination Assemblies"
- Item 617, "Temporary Roadway Illumination"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"
- Item 621, "Tray Cable"
- Special Specification, "Duct Cable"
- Item 624, "Ground Boxes"
- Item 625, "Zinc-Coated Steel Wire Strand"
- Item 627, "Treated Timber Poles"
- Item 628, "Electrical Services"
- Item 636, "Signs"
- Item 656, "Foundations for Traffic Control Devices"
- Item 680, "Highway Traffic Signals"
- Item 682, "Vehicle and Pedestrian Signal Heads"
- Item 684, "Traffic Signal Cables"
- Item 686, "Traffic Signal Pole Assemblies (Steel)"
- Item 687, "Pedestal Pole Assemblies"
- Item 688, "Pedestrian and Vehicle Detectors"

Obtain signal equipment at locations shown on the plans if the equipment is furnished by the Department. All materials determined to be in good working condition by the Engineer can be reused on temporary traffic signals. Do not use previously installed materials for permanent traffic signal installations.

3. CONSTRUCTION

Install traffic signal assemblies in accordance with Item 680 (except for "Measurement" and "Payment") as shown on the plans. Install electrical services in accordance with Item 628 (except for "Measurement" and "Payment") as shown on the plans. If the Department requires access to the signal by an advanced traffic management systems network, the Department will provide the equipment for installation by the Contractor.

- 3.1. **Operation and Maintenance (O&M).** Maintain and operate the temporary traffic signals for the duration of the Contract. The traffic signal timing plan will be provided by the Department or local entity. Set signal timing as shown on the plans or as directed. If the Department requires access to the signal by an advanced traffic management systems network, the Department will complete the required configuration of the software and hardware after the Contractor has installed the Department-provided equipment.

Designate in writing a sufficiently skilled individual responsible for O&M of the temporary traffic signals who is available 24 hr. per day and in transit to the project location within 2 hr. of notification by the Engineer, unless otherwise shown on the plans.

Provide backup power for each location at all times, when shown on the plans.

- 3.2. **Reconfiguration.** Reconfigure temporary traffic signals as shown on the plans and in accordance with this Item, as directed. Reconfiguration is any change made to an installed intersection, including relocation of poles, controller, signal heads, or luminaires.

- 3.3. **Removal.** Remove all equipment installed for temporary traffic signals as shown on the plans or as directed in writing.

Completely remove poles or other supports used for temporary traffic signals. When approved, concrete foundations may remain 2 ft. or more below finished grade. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

Retain all removed temporary signal components, except for those furnished by the Department, unless otherwise shown on the plans.

4. MEASUREMENT

This Item will be measured by each temporary signalized intersection. A signalized intersection is a group of signals operated by a single controller.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Traffic Signals." This price is full compensation for:

- picking up and returning materials furnished by the Department;
- installation, O&M, reconfiguration, and removal of the temporary traffic signal consisting of traffic signal pole assemblies, vehicle and pedestrian signal heads, vehicle detectors, pedestrian detectors, traffic signals, portable signals, flasher controllers, and associated equipment, signs, luminaires, ground boxes, conduit, traffic signal cables, conductors, wire strand, and electrical services;
- installation and removal of foundations; and
- materials, equipment, labor, tools, and incidentals.

Electrical energy consumed by the Contractor on an existing Department electrical service will be paid for by the Department. Applications for a temporary utility service will designate the Contractor as the service owner unless otherwise shown on the plans. The Department will reimburse the Contractor the amount billed by the utility for utility-owned service line extensions and consumption charges, plus an additional 5% of the invoice cost will be paid for labor, equipment, administrative costs, superintendence, and profit.

Item 682

Vehicle and Pedestrian Signal Heads



1. DESCRIPTION

- 1.1. **Installation.** Fabricate, furnish, and install vehicle and pedestrian signal heads.
- 1.2. **Removal.** Remove existing vehicle and pedestrian signal heads.

2. MATERIALS

Provide new materials as shown on the plans and in accordance with this Item.

2.1. Definitions.

- 2.1.1. **Back Plate.** A thin strip of material extending outward from all sides of a signal head.
- 2.1.2. **Light-Emitting Diode (LED) Optical Unit.** The LED lens and associated supporting parts in a signal section.
- 2.1.3. **Louver.** A device mounted to the visor restricting signal face visibility.
- 2.1.4. **Signal Section.** One housing case, housing door, visor, and optical unit.
- 2.1.5. **Signal Face.** One section or an assembly of two or more sections facing one direction.
- 2.1.6. **Signal Head.** A unidirectional face or a multidirectional assembly of faces, including back plates and louvers when required, attached at a common location on a support.

- 2.2. **General.** Provide vehicle signal heads in accordance with [DMS-11121](#), "Twelve-Inch LED Traffic Signal Lamp Unit." Provide prequalified vehicle signal heads from the Department's MPL.

Provide pedestrian signal heads in accordance with [DMS-11131](#), "Pedestrian LED Countdown Signal Modules." Provide prequalified pedestrian signal heads from the Department's MPL.

Supply either aluminum or polycarbonate signal head components of the same material and manufacturer for any one project.

Use galvanized steel, stainless steel, or dichromate sealed aluminum bolts, nuts, washers, lock washers, screws, and other assembly hardware. When dissimilar metals are used, ensure the metals are selected or insulated to prevent corrosion.

Use closed-cell silicone or closed-cell neoprene gaskets.

3. CONSTRUCTION

- 3.1. **Assembly.** Assemble individual signal sections in multi-section faces in conformance with the manufacturer's recommendations to form a rigid signal face. Assemble and mount signal heads, louvers, and back plates as shown on the plans to the mounting hardware or in conformance with the manufacturer's recommendations. Close any openings in an assembled signal head with a plug of the same material and color as the head.

- 3.2. **Wiring.** Wire each optical unit to the terminal block located in that signal section using solderless wire connectors or binding screws and spade lugs. Wire all sections of a multi-section signal face to the section terminal blocks in which the traffic signal cable is terminated. Maintain the color coding on leads from the individual optical units throughout the signal head, except for the traffic signal cable. Use solderless wire connectors or binding screws and spade lugs for connections to terminal blocks. Use binding screws and spade lugs for field wiring. The traffic signal cable will not be stripped until it has passed into the location that requires termination.
- 3.3. **Installation.** Install the signal head assemblies, as shown on the plans or as directed, to the required signal mast arm or pole. A drip loop is required when passing between signal hardware, as shown on the plans or as directed.
- 3.4. **Removal.** Remove the existing item as shown on the plans or as directed. Ensure the items designated for salvage are removed in a manner to avoid undue stress or damage. When the removed item leaves an opening, cover the opening with similar material to an equivalent condition. When the removed item leaves an unused signal cable, remove the cable. When the removed item leaves unused conductors within a signal cable still in use, trim back and tape off to ensure no electrical shorts by unused conductors.

4. MEASUREMENT

This Item will be measured by each vehicle signal section, pedestrian signal section, back plate, louver, or head assembly installed or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the installation or removal of the "Pedestrian Signal Section," "Vehicle Signal Section," "Back Plate," "Louver," or "Head Assembly," of the types and sizes specified.

- 5.1. **Installation.** This price is full compensation for furnishing, fabricating, assembling, and installing the signal sections, back plates and louvers, and lenses and optics; mounting attachments; and materials, equipment, labor, tools, and incidentals.
- 5.2. **Removal.** This price is full compensation for removing, salvaging, disassembling, and stockpiling vehicle or pedestrian signal head components removed as shown on the plans or as directed.

Item 684

Traffic Signal Cables



1. DESCRIPTION

- 1.1. **Installation.** Fabricate, furnish, and install traffic signal cables.
- 1.2. **Removal.** Remove existing traffic signal cables.

2. MATERIALS

Provide polyethylene-jacketed multi-conductor cables as shown on the plans. Individual conductors must be copper with polyethylene insulation rated for 600V. Furnish new materials. Provide traffic signal cables in accordance with [DMS-11110](#), "Traffic Signal Cable."

- 2.1. **Type A Cables.** Use Type A cables in accordance with IMSA 20-1 for underground conduit installation or aerial cable supported by a messenger wire. Messenger wire is defined under Item 625, "Zinc-Coated Steel Wire Strand."
- 2.2. **Type B Cables.** Use Type B cables in accordance with IMSA 20-3 as the integral messenger wire for aerial installations.
- 2.3. **Type C Cables.** Use Type C cables in accordance with IMSA 50-2 for loop detector lead-in installations consisting of two conductor shielded cables.
- 2.4. **Sampling.** The Engineer may take samples from each roll of each size of cable for establishing conformity to IMSA. The samples will be at least 3 ft. long. Replace any cable failing to meet IMSA requirements.

3. CONSTRUCTION

- 3.1. **Installation.** For each cable run in underground conduit, coil an extra 5 ft. of cable in each ground box. For aerial installations over span wire, coil 5 ft. of cable neatly at the top of the nearest span wire pole for pole-mounted cabinets. Coil an extra 5 ft. of cable for each vehicle signal head assembly as shown on the plans or as directed.

Splices are not permitted in Type A and Type B cables unless shown on the plans or approved in writing. Ensure splices are watertight.

Make splices between Type C cable and loop detector wires only in the ground box near the loop the cable is servicing. Use non-corrosive solder for splices. Ground the drain wire of Type C cable to earth only at the controller or detector cabinet. Ensure the resistance from the drain wire to the ground rod is less than 1 ohm.

Test the cables after installation and before any connection to the cables. Cables testing less than 50-megohm insulation resistance at 500V will be rejected.

- 3.2. **Removal.** Remove the existing cable as shown on the plans or as directed. When the removed item leaves an opening, cover the opening with similar material to an equivalent condition.

4. MEASUREMENT

This Item will be measured by the foot of traffic signal cables installed or removed.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for installation or removal of the "Traffic Signal Cables" of the types and sizes specified.

- 5.1. **Installation.** This price is full compensation for furnishing and installing materials, and for equipment, labor, tools, and incidentals, except as shown below.

Cables inside traffic signal pole and pedestal pole assemblies will be paid for under this Item.

Cables used for inside signal heads and controllers or coils in ground boxes, on pole bases, and on span wires will not be paid for directly, but will be subsidiary to pertinent Items. The wire lashing or cable tie used to secure aerial cables to messenger wires will be subsidiary to Item 680, "Highway Traffic Signals," or Item 690, "Maintenance of Traffic Signals and Illumination."

- 5.2. **Removal.** This price is full compensation for removing traffic signal cables as shown on the plans or as directed.

Item 685

Roadside Flashing Beacon Assemblies



1. DESCRIPTION

- **Installation.** Furnish, fabricate, and erect roadside flashing beacon assemblies.
- **Relocation.** Remove and relocate existing roadside flashing beacon assemblies.
- **Removal.** Remove existing roadside flashing beacon assemblies.

2. MATERIALS

Furnish new materials in accordance with the following Items and as shown on the plans.

- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 656, "Foundations for Traffic Control Devices"
- Item 687, "Pedestal Pole Assemblies"

Provide prequalified flasher controller assemblies from the Department's MPL in accordance with [DMS-11160](#), "Flasher Controller Assembly."

Provide prequalified pedestal pole bases from the Department's MPL in accordance with [DMS-11140](#), "Pedestal Pole Base."

When shown on the plans, provide prequalified solar-powered flasher controller assemblies from the Department's MPL in accordance with [DMS-11150](#), "Solar Power Flasher Controller Assembly."

3. CONSTRUCTION

Install foundations for installation and relocation in accordance with Item 656.

- 3.1. **Fabrication.** Provide poles and bases in accordance with Item 687. Provide mild steel anchor bolts in accordance with Item 449. Use galvanized bolts, nuts, and washers.
- 3.2. **Galvanizing.** Galvanize all fabricated parts in accordance with Item 445. Repair galvanizing for any steel part or member damaged in assembly, transit, or erection, or any steel part or member welded after galvanizing, in accordance with Section 445.3.4., "Repairs."
- 3.3. **Installation.** Install roadside flashing beacon assemblies at the locations shown on the plans or as directed. Stake the assembly locations for verification by the Engineer unless otherwise shown on the plans.

Install pole, breakaway base, connectors, wiring, signal beacons, sign, and foundation as shown on the plans, or as directed. Install the flasher controller assembly on the electrical service pole. Install watertight breakaway electrical fuse holders in all lines and neutral conductors at the breakaway base.

Use established industry and utility safety practices to erect assemblies near overhead or underground utilities. Consult with the appropriate utility company before beginning such work.

Install solar panels, batteries, and battery box (when required) as shown on the plans or as directed.

- 3.4. **Relocation.** Disconnect and isolate the electrical power supply before removal of the assembly. Remove existing assembly as directed. Salvage existing components, such as sign, beacons, pole, and base, unless otherwise directed. Repair or replace lost or damaged components as directed.

Relocate existing assembly to the location shown on the plans or as directed. Install existing assembly at new foundations in accordance with Section 685.3.3., "Installation." Remove existing foundations in accordance with Section 685.3.5., "Removal." Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

- 3.5. **Removal.** Disconnect and isolate existing electrical power supplies before removal of the assembly. Remove existing sign panel, beacons, pole, and base from existing assembly. Store items to be reused or salvaged without damaging. Store sign panels above the ground in a vertical position at locations shown on the plans or as directed. Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

Remove abandoned foundations, including steel, to 2 ft. below the finished grade unless otherwise shown on the plans. Backfill with material equal in composition and density to the surrounding area, and replace any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

4. MEASUREMENT

This Item will be measured by each installed, relocated, or removed roadside flashing beacon assembly.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Roadside Flashing Beacon Assemblies," "Install Roadside Flashing Beacon Assemblies (Solar Powered)," "Relocate Roadside Flashing Beacon Assemblies," "Relocate Roadside Flashing Beacon Assemblies (Solar Powered)," "Remove Roadside Flashing Beacon Assemblies," or "Remove Roadside Flashing Beacon Assemblies (Solar Powered)." The Department will pay for electrical energy consumed by the roadside flashing beacon.

New conduit will be paid for under Item 618, "Conduit," except for conduit in the foundation and within 6 in. of the foundation. New electrical conductors will be paid for under Item 620, "Electrical Conductors." New tray cable will be paid for under Item 621, "Tray Cable." New duct cable will be paid for under Item 622, "Duct Cable." New ground boxes will be paid for under Item 624, "Ground Boxes." New electrical services will be paid for under Item 628, "Electrical Services." New signs will be paid for under Item 636, "Signs." New signal heads will be paid for under Item 682, "Vehicle and Pedestrian Signal Heads." New traffic signal cable will be paid for under Item 684, "Traffic Signal Cables."

- 5.1. **Installation.** This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting the roadside flashing beacon assemblies, including poles and bases; solar power flashing controller assemblies, including batteries and battery box; foundations; conduit in the foundation and within 6 in. of the foundation; furnishing and placing anchor bolts, nuts, washers, and templates; controller; and materials, equipment, labor, tools, and incidentals.
- 5.2. **Relocation.** This price is full compensation for removing the roadside flashing beacon assemblies; removing battery box (when required); removing existing foundations; installing new foundations; installing new conduit in the foundation and within 6 in. of the foundation; furnishing, fabricating, and installing any new components as required and replacing the assembly on its new foundations with all manipulations and electrical work; controller; batteries; battery box; salvaging; disposal of unsalvageable materials; loading and hauling; and materials, equipment, labor, tools, and incidentals.
- 5.3. **Removal.** This price is full compensation for removing the various roadside flashing beacon assembly components; removing the foundations; storing the components to be reused or salvaged; disposal of

unsalvageable materials; backfilling and surface placement; loading and hauling; and materials, equipment, tools, labor, and incidentals.

Item 686

Traffic Signal Pole Assemblies



1. DESCRIPTION

- 1.1. **Installation.** Fabricate, furnish, and install steel traffic signal pole assemblies.
- 1.2. **Relocation.** Remove and relocate existing steel traffic signal pole assemblies.
- 1.3. **Removal.** Remove existing steel traffic signal pole assemblies.

2. MATERIALS

Provide new materials as shown on the plans and in accordance with this Item and the the following Items.

- Item 416, "Drilled Shaft Foundations"
- Item 421, "Hydraulic Cement Concrete"
- Item 441, "Steel Structures"
- Item 442, "Metal for Structures"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"

Furnish alloy steel or medium-strength mild steel anchor bolts in accordance with Section 449.2.1., "Bolts and Nuts," unless otherwise shown on the plans.

3. CONSTRUCTION

- 3.1. **Standard Design.** Fabricate pole assemblies in accordance with this Item to the designs shown on the plans. Alternate designs are not acceptable. Deviations that affect the basic structural behavior of the pole are considered alternate designs. For deviations that do not affect the basic structural behavior of the pole, electronically submit shop drawings in accordance with Item 441 to the Bridge Division for approval.
- 3.2. **Fabrication.** Fabricate and weld in accordance with Item 441, AWS D1.1 and this Item. Fabrication tolerances are shown in Table 1.

Table 1
Fabrication Tolerances

Part	Dimension	Tolerance (in.)
Pole and mast arm shaft	Length	±1
	Thickness	+0.12, -0.02
	Difference between flats or diameter	±3/16
	Straightness	1/8 in 10 ft.
	Attachment locations	±1
Base and mast arm mounting plates	Overall	±3/16
	Thickness	+1/4, -0
	Deviations from flat ¹	3/16 in 24 in.
	Spacing between holes	±1/8
	Bolt hole size	±1/16
Anchor bolts	Length	±1/2
	Threaded length	±1/2
	Galvanized length	-1/4
Assembled shafts	Angular orientation	1/16 in 12 in. ²
	Centering	±3/16
	Twist	3° in 50 ft.

1. For long mast arm assembly (LMA) structures, refer to plan sheets for mast arm mounting plate tolerance.
2. 1/8 in 12 in. between mounting plates and between mounting plates and base plates.

Fabrication plants that produce steel traffic signal pole assemblies must be approved in accordance with [DMS-7380](#), "Steel Non-Bridge Member Fabrication Plant Qualification." The Department maintains an MPL of approved traffic signal pole assembly fabrication plants.

Provide properly fitting components. Provide round or octagonal shafts for poles and mast arms tapered as shown on the plans. Fabricate mast arms straight in the unloaded condition unless otherwise shown on the plans. The Department will accept bolted slip joints overlapping by at least 1.5 diameters in mast arms 40 ft. and longer.

Provide circumferential welds only at the ends of the shafts. Provide no more than two longitudinal seam welds in shaft sections. Provide 100% penetration within 6 in. of circumferential base welds and 60% minimum penetration at other locations along the longitudinal seam welds. Provide longitudinal seam weld and fit-up that will minimize acid entrapment during later galvanizing.

For LMA structures, perform at least 10% ultrasonic testing (UT) of longitudinal seam welds on the arm and pole shafts. Use a Department-approved UT procedure to ensure 60% minimum penetration where specified. Perform testing at a minimum of three locations on each shaft (at both ends and middle). The minimum length of each test area must be 10 in. If minimum penetration is not achieved in any of the tested areas, test an additional 24 in. beyond the originally selected test areas requiring 60% penetration. Test the entire arm or pole shaft seam weld if any locations within the additional 24-in. test areas do not achieve 60% penetration. Repair the deficient areas using a Department-approved repair procedure and retest. Hot-dip galvanize all fabricated parts in accordance with Item 445. Provide punched, drilled, or mechanically guided thermal-cut holes in steel parts or members, when allowed, before galvanizing. Mechanically guided thermal-cut hole quality will be in accordance with Item 445.

Connect the luminaire arm to the pole using simplex fittings. Ensure the fittings have no defects affecting strength or appearance.

Permanently mark, at a visible location when erected, pole base plates and mast arm mounting plates with the design wind speed.

Permanently mark, at a visible location when erected, pole base plates and fixed mast arm mounting plates with the fabrication plant's insignia. Place the mark on the pole base plate adjacent to the hand-hole access compartment.

Deliver each traffic signal pole assembly with fittings and hardware either installed or packaged with its associated components.

- 3.3. **Installation.** Locate traffic signal pole assemblies as shown on the plans, unless otherwise directed, to secure a more desirable location or avoid conflict with utilities. Stake the traffic signal pole assembly locations for verification by the Engineer.

Use established industry and utility safety practices when working near overhead or underground utilities. Consult with the appropriate utility before beginning work.

Construct foundations for new traffic signal pole assemblies in accordance with Item 416 and as shown on the plans. Orient anchor bolts as shown on the plans.

Erect structures after foundation concrete has attained its design strength as shown on the plans and in accordance with Item 421. Coat anchor bolt threads and tighten anchor bolts in accordance with Item 449.

After the traffic signal pole assembly is plumb and all nuts are tight, tack weld each anchor bolt nut in two places to its washer. Tack weld each washer to the base plate in two places. Never weld components to the bolt. Tack weld in accordance with Item 441. After tack welding, repair galvanizing damage on bolts, nuts, and washers in accordance with Section 445.3.4., "Repairs."

Do not grout between the base plate and the foundation.

- 3.4. **Relocation.** Disconnect and isolate traffic signal cables before removing the pole. Remove existing traffic signal pole assemblies as directed. Ensure the poles or attached components suffer no undue stress or damage. Signs, signal heads, mounting brackets, and luminaires may be left on the poles. Repair or replace damaged components as directed.

Remove abandoned concrete foundations, including steel, to a point 2 ft. below final grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the hole with materials equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

Move existing pole assemblies to locations shown on the plans or as directed. Construct foundations for relocated traffic signal pole assemblies in accordance with Item 416 and as shown on the plans. Install existing pole assemblies on new foundations in accordance with Section 686.3.3., "Installation."

Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

- 3.5. **Removal.** Disconnect and isolate traffic signal cables before removing the pole. Remove existing traffic signal pole assemblies as shown on the plans or as directed. Ensure the poles or attached components that are salvaged suffer no undue stress or damage.

Remove abandoned concrete foundations, including steel, to a point 2 ft. below final grade unless otherwise shown on the plans or as directed. Cut off and remove steel protruding from the remaining concrete. Backfill the hole with materials equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

4. MEASUREMENT

This Item will be measured by each traffic signal pole assembly installed, relocated, or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Traffic Signal Pole Assemblies" of the types and sizes specified, "Relocate Traffic Signal Pole Assemblies" of the types specified, or "Remove Traffic Signal Pole Assemblies" of the types specified.

New drilled shaft foundations will be paid for under Item 416.

- 5.1. **Installation.** This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting the pole upon a foundation; furnishing and erecting required mast arms and luminaire arms; furnishing and placing anchor bolts, nuts, washers, and templates; and materials, equipment, labor, tools, and incidentals.
- 5.2. **Relocation.** This price is full compensation for removing traffic signal pole assemblies; removing existing foundations; backfilling and surface placement; storing the components to be reused or salvaged; furnishing, fabricating, and installing required new components including anchor bolts, nuts, washers, and templates; placing and securing traffic signal pole assemblies on new foundations; furnishing and placing conduit, ground rods, and wiring; disposing of unsalvageable materials; loading and hauling; and materials, equipment, labor, tools, and incidentals.
- 5.3. **Removal.** This price is full compensation for removing, salvaging, disassembling, and stockpiling signal pole assemblies; salvaging and relocating existing conduit; removing existing foundations; backfilling and surface placement; splicing existing conductors; disposing of unsalvageable materials; and materials, equipment, labor, tools, and incidentals.

Item 687

Pedestal Pole Assemblies



1. DESCRIPTION

- **Installation.** Furnish and install pedestal pole assemblies for vehicle and pedestrian signals.
- **Relocation.** Remove and relocate existing pedestal pole assemblies.
- **Removal.** Remove existing pedestal pole assemblies.

2. MATERIALS

Furnish new materials in accordance with the following Items and as shown on the plans.

- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 656, "Foundations for Traffic Control Devices"

2.1. **Pedestal Pole Base.** Provide prequalified pedestal pole bases with locking collar from the Department's MPL in accordance with [DMS-11140](#), "Pedestal Pole Base."

2.2. **Pedestal Pole.** Provide 4-in. diameter Schedule 40 steel pipe or tubing, aluminum pipe (Alloy 6061-T6), or rigid metal conduit, unless otherwise shown on the plans. Do not use aluminum conduit. Galvanize pedestal pole assemblies in accordance with Item 445, unless otherwise shown on the plans.

2.3. **Pedestrian Push Button Pole Assembly.** Provide diameter as shown on the plans, Schedule 40 steel pipe or tubing, aluminum pipe (Alloy 6061-T6), or rigid metal conduit. Do not use aluminum conduit. Galvanize pedestrian push button post in accordance with Item 445, unless otherwise shown on the plans.

3. CONSTRUCTION

Install foundations in accordance with Item 656.

3.1. **Pedestal Pole Base.** Ground the base with connectors to the 1/2-13 NC female threaded hole. Fabricate the base for four L-bend anchor bolts arranged in a square pattern with a 12-3/4 in. bolt circle. Provide mild steel anchor bolts in accordance with Item 449 for each base. Provide three 1/16-in. thick and three 1/8-in. thick U-shaped galvanizing steel shims for each base. Size shims to fit around the anchor bolts.

3.2. **Installation.** Install pedestal pole assemblies and pedestrian push button post assemblies as shown on the plans, or as directed. Pedestal pole assemblies include foundation, pole shaft, base, anchor bolts, anchor bolt nuts, anchor bolt template, shims, and miscellaneous components. Watertight breakaway electrical disconnects are required for pedestal pole assemblies used in conjunction with vehicle and pedestrian heads and components. Pedestrian push button post assemblies include foundation, pole, and post cap.

Use established industry and utility safety practices to erect assemblies near overhead or underground utilities. Consult with the appropriate utility company before beginning such work.

Repair damaged galvanizing in accordance with Section 445.3.4., "Repairs."

3.3. **Relocation.** Disconnect and isolate the electrical power supply before removal of the assembly. Remove existing assembly as directed. Salvage existing components, such as signs, heads, buttons, pole, and base, unless otherwise directed. Repair or replace lost or damaged components as directed.

Install foundations in accordance with Item 656.

Relocate existing assembly to the location shown on the plans or as directed. Install existing assembly at new foundations in accordance with Section 687.3.2., "Installation." Remove existing foundations in accordance with Section 687.3.4., "Removal." Accept ownership of unsalvageable materials, as determined by the Engineer, and dispose of them in conformance with federal, state, and local regulations.

Repair galvanizing for any damaged steel part or any steel part welded after galvanizing in accordance with Item 445.

- 3.4. **Removal.** Disconnect and isolate electrical power supplies before removal of the assembly. Remove existing sign panel, beacons, pole, and base from existing assembly. Store items to be reused or salvaged without damaging them. Store sign panels above the ground in a vertical position at locations shown on the plans or as directed. Accept ownership and dispose of unsalvageable materials in conformance with federal, state, and local regulations.

Disconnect and remove conductors from abandoned circuits. Remove abandoned conduit and ducts to a point 6 in. below final grade. Destroy existing transformer bases to prevent reuse. Remove abandoned foundations to 2 ft. below the finished grade unless otherwise shown on the plans. Cut off and remove steel protruding from the remaining concrete. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing with like material to equivalent condition.

- 3.5. **Painted Finish.** When required, paint pedestal pole and pedestrian push button post assemblies as shown on the plans.

4. MEASUREMENT

This Item will be measured by each pedestal pole assembly or each pedestrian push button post assembly installed, relocated, or removed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Pedestal Pole Assembly," "Install Pedestrian Push Button Post Assembly," "Relocate Pedestal Pole Assembly," "Relocate Pedestrian Push Button Post Assembly," "Remove Pedestal Pole Assembly," or "Remove Pedestrian Push Button Post Assembly."

New signal heads will be paid for under Item 682, "Vehicle and Pedestrian Signal Heads." New pedestrian detector buttons will be paid for under Item 688, "Pedestrian and Vehicle Detectors."

- 5.1. **Installation.** This price is full compensation for furnishing and installing the shaft; base, shims, anchor bolts, and foundation; and materials, equipment, labor, tools, and incidentals.
- 5.2. **Relocation.** This price is full compensation for removing the pedestal pole or pedestrian push button assemblies; removing existing foundations; installing new foundations; furnishing, fabricating, and installing any new components as required and replacing the assembly on its new foundations with all manipulations and electrical work; controller; salvaging; disposal of unsalvageable material; loading and hauling; and equipment, material, labor, tools, and incidentals.
- 5.3. **Removal.** This price is full compensation for removing the various pedestal pole assembly components; removing the foundations; storing the components to be reused or salvaged; disposal of unsalvageable material; backfilling and surface placement; loading and hauling; and equipment, materials, tools, labor, and incidentals.

Item 688

Pedestrian and Vehicle Detectors



1. DESCRIPTION

- 1.1. **Installation.** Fabricate, furnish, and install traffic signal detectors.
- 1.2. **Removal.** Remove existing traffic signal detectors.

2. MATERIALS

Provide new materials as shown on the plans and in accordance with this Item and the pertinent requirements of the following Items.

- Item 618, "Conduit"
- Item 624, "Ground Boxes"
- Item 682, "Vehicle and Pedestrian Signal Heads"
- Item 684, "Traffic Signal Cables"

- 2.1. **Pedestrian Detector.** Supply housing or an adapter (i.e., saddle) that conforms to the pole shape, fitting flush to ensure a rigid installation. Supply adapters of the same material and construction as the housing. Supply push button switches that have single-pole, single-throw contacts and screw-type terminals and have a design life of at least 1 million operations.

Ensure the internal components provide a push button with normal open contacts, and include all electrical and mechanical parts required for operation. Ensure the push button assembly is weather-tight and tamperproof, is designed to prevent an electrical shock under any weather condition, and has provisions for grounding in accordance with the NEC.

- 2.1.1. **Standard Pedestrian Detector.** Provide a two-piece cast aluminum housing unit consisting of a base housing and a removable cover. Provide threaded holes for 0.5-in. conduit in the housing for any necessary conduit attachment.

Ensure the manufacturer's name or trademark is located on the housing.

- 2.1.2. **Accessible Pedestrian Signals (APS).** Provide accessible pedestrian detectors in accordance with [DMS-11132](#), "Accessible Pedestrian Signals."

- 2.2. **Vehicle Loop Detectors.** Use stranded copper No. 14 AWG XHHW cross-linked-thermosetting-polyethylene-insulated conductor rated for 600V alternating current for vehicle detector loop wire unless otherwise shown on the plans. Ensure each length of wire shows the name or trademark of the manufacturer, insulation voltage rating, wire gauge, and insulation type at approximate 2-ft. intervals on the insulation surface.

When shown on the plans, use flexible vinyl or polyethylene tubing with 0.184-in. minimum inside diameter, 0.031-in. minimum wall thickness, 0.26-in. maximum outside diameter, and a smooth bore. Use tubing that does not adhere to the loop wire in any way and is capable of resisting deterioration from oils, solvents, and temperatures up to 212°F. Use tubing that is abrasion-resistant and remains flexible from -22–212 °F. Use orange or red tubing unless otherwise shown on the plans.

Use sealant for the vehicle detector loops in accordance with [DMS-6340](#), "Vehicle Loop Wire Sealant."

3. CONSTRUCTION

3.1. Pedestrian Detector.

- 3.1.1. **Push Button Unit.** Install push buttons in accordance with the TMUTCD. Wire the push button in conformance with manufacturer's installation instructions. Close unused housing openings with a weather-tight closure painted to match the housing. Verify that each button is communicating and fully functional.

Do not use terminal connections or splice wire leads except at approved locations. All allowed splices must be watertight.

Attach wires to terminal posts using solderless terminals unless otherwise advised by manufacturer's recommendations. Attach terminals to the wires using a ratchet-type compression crimping tool properly sized to the wire.

Mount a pedestrian push button sign near each push button as shown on the plans.

For installations where APS buttons are placed less than 10 ft. apart from one another, program the appropriate speech walk message (include the name of the appropriate street in the message) for these buttons. When two APS buttons are installed on the same pole, ensure that the APS buttons are insulated to eliminate vibrations from traveling to the other button.

- 3.1.2. **Controller Unit.** If a controller unit is required by the plans, integrate the pedestrian controller unit into the traffic signal controller cabinet assembly.

- 3.2. **Vehicle Loop Detector.** Provide the loop location, configuration, wire color, and number of turns as shown on the plans. Loops may be adjusted by the Engineer to fit field conditions.

- 3.2.1. **Saw-Cuts.** Cut the pavement using a concrete saw to form neat lines. Do not exceed 1-in. depth on concrete bridge slab saw-cuts. Cut all other saw-cuts deep enough to provide a minimum of 1-in. depth of sealant over the wire. Make a separate saw-cut from each loop to the edge of the pavement unless otherwise shown on the plans. Ensure the cut is clean and dry when the wire and sealant are placed.

- 3.2.2. **Conduit.** Place conduit between the pavement and ground box as shown on the plans.

- 3.2.3. **Loop Wire Color.** Use the following color code unless otherwise shown on the plans. Use white for the first loop on the right, followed by black, orange, green, brown, and blue. Use the same color for all loops in the same lane. Loops installed in multi-lanes will have the same color code in the order in which the loops are installed. When facing the same direction of traffic flow, the color code will read from right to left for all lanes carrying traffic in that direction. If traffic moves in two directions, the color code will be repeated for the other direction of traffic.

- 3.2.4. **Loop Wire Installation.** When shown on the plans, place the loop wire in a flexible vinyl or polyethylene tubing in accordance with Article 688.2., "Materials." The loop wire color requirements do not apply to wires in tubing.

Twist the wire from the loop to the ground box a minimum of five turns per foot. When only one pair of wires is in a saw-cut, it need not be twisted while in the saw-cut. Do not splice loop wire in the loop or in the run to the ground box.

Hold the loop wire in place every 2 ft. with strips of rubber, neoprene flexible tubing, or polyethylene foam sealant approximately 1 in. long. Leave these strips in place and fill the slot with loop sealant.

Splice the loop lead-in cable and loop detector wires only in the ground box near the loop it is serving. Use non-corrosive solder for splices and ensure the splice is watertight. Ground the drain wire of the loop lead-in

cable to earth ground only at the controller or detector cabinet. Ensure the resistance from the drain wire to the ground rod is less than 1 ohm.

3.3. **Installation.** Install the detectors as shown on the plans or as directed.

3.4. **Removal.** Remove the existing item as shown on the plans or as directed. Ensure the items designated for salvage are removed in a manner to avoid undue stress or damage. When the removed item leaves an opening, cover the opening with similar material to an equivalent condition. When the removed item leaves an unused signal cable, remove the cable. When the removed item leaves unused conductors within a signal cable still in use, trim back and tape off to ensure no electrical shorts by unused conductors.

4. MEASUREMENT

Vehicle loop detector will be measured by the foot of saw-cut containing loop wire installed or removed.

Pedestrian push button detector and controller unit will be measured by the each installed or removed.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for the installation or removal of the "Vehicle Detectors" of the type specified, "Vehicle Detector Controller Unit" of the type specified, "Pedestrian Detector Push Button Units" of the type specified, or "Pedestrian Detector Controller Unit."

5.1. **Installation.** This price is full compensation for furnishing, installing, detector hardware and software configuration, detector testing, detector controller units, saw-cutting, excavation, backfill, sealant, sealant placement, pavement repair associated with saw-cutting, materials, equipment, labor, and incidentals. Conduit and loop wire from the edge of pavement to the ground box used for the vehicle loop detectors will not be measured or paid for directly, but will be subsidiary to this item. New ground boxes will be paid for under item 624, and the new loop lead-in cable will be paid for under item 684.

5.2. **Removal.** This price is full compensation for removing, salvaging, disassembling, and stockpiling detector components removed as shown on the plans or as directed. Repairs to the pavement or signal poles required from the removal will be subsidiary to this item.

Item 690

Maintenance of Traffic Signals and Illumination



1. DESCRIPTION

Furnish, install, modify, repair, replace, reroute, or remove components of a traffic signal or illumination system.

2. LICENSES AND CERTIFICATIONS

Provide personnel with electrical licensing and electrical certification in accordance with Item 7, "Legal Relations and Responsibilities," and all applicable Special Provisions to Item 7.

3. MATERIALS

The Department will only furnish luminaires, luminaire poles, anchor bolts, transformer bases, traffic signal poles, mast arms, and controllers that become part of the final installation, unless otherwise shown on the plans. Submit a materials list to the Engineer for all poles, mast arms, and controllers needed. Pick up materials at the locations and times shown on the plans. Designate in writing the personnel authorized to pick up the materials.

Furnish all materials required to repair breaks or shorts in electrical conductors and cables including, but not limited to, all concrete, ground boxes, wire mesh, conduit, conductors, and pipe casing. Ensure materials furnished by the Contractor meet all Department standards and specification requirements.

When performing maintenance on luminaires, verify whether fixtures are covered under the manufacturer's warranty. If warranty applies, coordinate with the Department and follow any necessary procedures to have the manufacturer replace or repair fixtures.

Assume responsibility for all materials furnished by the Department. Use materials furnished by the Department for this Contract only. Return unused or removed materials deemed salvageable by the Engineer to the Department upon completion of the work and before final payment at location shown on the plans or as directed. Dispose of materials deemed unsalvageable by the Engineer in conformance with federal, state, and local regulations. When materials are required to be furnished by the Contractor, meet the "Materials" Article of the pertinent Item.

4. EQUIPMENT

Furnish all equipment, tools, and machinery necessary for the proper prosecution of the work including, but not limited to:

- an aerial device capable of reaching overhead work,
- trenching machine,
- boring machine,
- concrete saw,
- digger-boom truck,
- underground conductor detectors, and
- underground fault detectors and splicing tools.

Use only equipment, tools, and machinery in good repair and operating condition. Immediately repair or replace any equipment that, in the opinion of the Engineer, may affect the quality of work or safety.

5. WORK METHODS

Conform to the latest edition of the NEC as adopted by TDLR, local utility requirements, the requirements of this Item, and the pertinent requirements of the following Items.

- Item 104, "Removing Concrete"
- Item 400, "Excavation and Backfill for Structures"
- Item 416, "Drilled Shaft Foundations"
- Item 421, "Hydraulic Cement Concrete"
- Item 431, "Pneumatically Placed Concrete"
- Item 432, "Riprap"
- Item 440, "Reinforcement for Concrete"
- Item 445, "Galvanizing"
- Item 449, "Anchor Bolts"
- Item 450, "Railing"
- Item 476, "Jacking, Boring, or Tunneling Pipe or Box"
- Item 610, "Roadway Illumination Assemblies"
- Item 613, "High Mast Illumination Poles"
- Item 614, "High Mast Illumination Assemblies"
- Item 616, "Performance Testing of Lighting Systems"
- Item 618, "Conduit"
- Item 620, "Electrical Conductors"
- Item 621, "Tray Cable"
- Special Specification, "Duct Cable"
- Item 624, "Ground Boxes"
- Item 625, "Zinc-Coated Steel Wire Strand"
- Item 627, "Treated Timber Poles"
- Item 628, "Electrical Services"
- Item 636, "Signs"
- Item 656, "Foundations for Traffic Control Devices"
- Item 680, "Highway Traffic Signals"
- Item 682, "Vehicle and Pedestrian Signal Heads"
- Item 684, "Traffic Signal Cables"
- Item 685, "Roadside Flashing Beacon Assemblies"
- Item 686, "Traffic Signal Pole Assemblies"
- Item 687, "Pedestal Pole Assemblies"
- Item 688, "Pedestrian and Vehicle Detectors"

Perform the following work as directed. Maintain existing roadway illumination systems as directed. Perform a monthly inspection to determine whether any maintenance of the illumination system is needed and provide a detailed report to the Engineer. Provide proper maintenance or repairs within 48 hr. of notification. If the work requires time to procure materials, the Contractor must provide a purchase order with estimated delivery date and a schedule to complete the work. Submit completed maintenance log as directed. Coordinate electric power issues with local utility company.

The term "duct cable" as used herein consists of a complete assembly of conductors enclosed in a high-density polyethylene duct.

Perform maintenance, installation, removal, or replacement activities located near any overhead or underground utilities using established industry and utility safety practices. Consult with the appropriate utility company before beginning such work.

Maintain, install, repair, or replace the following items as shown on the plans, in accordance with the NEC, and as directed.

- 5.1. **Conduit.** Install, replace, remove, or modify conduits in accordance with Item 618, as shown on the plans, or as directed. Use 90° "sweep" type elbow on conduits entering a ground box or foundation.
- 5.2. **Foundations.** Install, replace, or remove concrete or screw-in foundations for traffic signal pole, pedestal pole, luminaire pole, and ground mount controller cabinets in accordance with Item 416 and Item 656, as shown on the plans, or as directed. Remove foundations in accordance with Item 610 and Item 104. Backfill in accordance with Item 400.
- 5.3. **Concrete.** Install concrete in accordance with Item 421.
- 5.4. **Ground Box.** Install ground boxes as shown on the plans and in accordance with Item 624. When shown on the plans, provide a Class A concrete apron in accordance with Item 421. Place ground box to line and grade as approved. All wiring connections required inside the ground box will be subsidiary to this bid item.

Remove ground box and fill hole with approved fill to at least 6 in. below conduit level. Remove conductors and cables from conduit back to the point of termination. Uncover enough conduit that 90° bends can be removed and conduit reconnected. Clean conduit in accordance with Item 618 and pull and terminate new conductors and cables. Conduit replaced within 5 ft. of the ground box will be subsidiary to this Item. Cleaning of conduit and pulling of conductors will be paid for under "Install or Replace Conductor" or "Install or Replace Cable." Backfill in accordance with Item 400. If more than 5 ft. of conduit or duct cable needs to be replaced, the additional will be paid for under "Replace Underground Conduit" or "Replace Duct Cable."

If applicable, ground box removal includes removing the existing riprap apron.
- 5.5. **Vehicle and Pedestrian Detectors.** Install, repair, replace, remove, or modify pedestrian push buttons and vehicle loop detectors in accordance with Item 688, as shown on the plans, or as directed.
- 5.6. **Electrical Service.** Install, repair, replace, remove, or modify an electrical service assembly in accordance with Item 628, as shown on the plans, or as directed. Mount any or all of the following on an electrical service support assembly.
 - Conduit
 - Weather head
 - Load center
 - Meter base
 - Lightning protection
 - Wiring
 - Associated hardware
- 5.7. **Signal Pole.** Install, repair, replace, remove, or modify signal poles in conformance with pertinent Items, as shown on the plans, or as directed. Comply with Item 627 for timber signal poles with guy wires and anchors and Item 686 for steel poles with concrete foundations. Remove timber poles and anchors completely, to 24 in. below ground level, or as directed. Remove concrete foundations to 2 ft. below ground level, or as directed.

Install, repair, replace, remove, or modify pedestrian signal pole assemblies in accordance with Item 687, as shown on the plans, or as directed. Install, repair, replace, remove, or modify roadside flashing beacons in accordance with Item 685, as shown on the plans, or as directed.
- 5.8. **Luminaire Poles.** Install, repair, replace, remove, or modify luminaire poles in accordance with Item 610, as shown on the plans, or as directed. Remove concrete foundations to 2 ft. below ground level, or as directed.
- 5.9. **Down Guy.** Install, replace, remove, or modify down guy with guard or down guy with anchor and guard.

- 5.10. **Steel Wire Strand.** Install, replace, or remove steel wire strand in accordance with Item 625, as shown on the plans, or as directed. Attach strain wire on timber poles using a 5/8-in. straight thimble-eye bolt. Attach steel strain wire on metal poles using at least two turns of wire around the pole. Place and properly tighten the three-bolt clamp as near as possible to the pole.
- 5.11. **Luminaire Head and Mast Arm.** Install, replace, remove, or modify luminaire heads, arms, bulbs, photocells, and hardware in accordance with Item 610, as shown on the plans, or as directed. Install material in conformance with manufacturer's specifications. Fuse luminaires individually in the signal pole hand-hole.
- 5.12. **Signal Head Assembly.** Install, repair, replace, remove, or modify pedestrian signal heads or vehicle signal head assemblies in accordance with Item 682, as shown on the plans, or as directed. Mount signal heads with a strain wire hanger clamp, bracket arm assembly, or mast arm bracket assembly. Signal head assemblies consist of 1–12 signal sections. Install signal heads as shown on the plans, or as directed.
- Assemble the signal heads with backplates, louvers, and brackets as needed. Mount all signal heads at the same elevation. Install signal head perpendicular to the travel lane it controls. Plumb all signal heads vertically and horizontally.
- 5.13. **Traffic Signal Controller Cabinet, Ground Mount.** Install, repair, replace, remove, or modify ground mounted cabinet. Plumb and tighten the cabinet. Apply silicone sealant around the base of the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans, or as directed.
- 5.14. **Traffic Signal Controller Cabinet, Pole Mount.** Install, repair, replace, remove, or modify pole-mounted cabinet. Plumb and tighten the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans, or as directed.
- 5.15. **Flashing Beacon Controller Cabinet.** Install, repair, replace, remove, or modify flasher cabinet. Plumb and tighten the cabinet. Coil all cabling that enters the cabinet neatly on the cabinet floor. Mark and terminate each cable as shown on the plans, or as directed.
- 5.16. **Cables.** Install, repair, replace, remove, reroute, or modify signal, loop lead-in, electrical, communication, or illumination cables in conduits or along messenger wires in accordance with Item 620, Item 621, and Item 684; as shown on the plans; or as directed.
- Attach aerial cable at 1-ft. intervals using approved cable ties or wire wrap along a messenger strain wire. Install a drip loop with at least two turns at each pole, signal head, and weather head.
- Label each cable brought into the controller cabinet. Coil 5 ft. of cable neatly on the traffic signal controller cabinet floor or in the closest ground box for each cable for ground mounted cabinets. Coil 5 ft. of cable neatly at the top of the nearest strain wire pole for pole mounted cabinets.
- Install solderless pressure connectors in accordance with the NEC for all wires attached to terminal posts. Use a ratchet-type full-circle crimper for insulated terminals to provide a solderless pressure connector.
- 5.17. **Sealing.** Install, repair, replace, remove, or modify sealant in detector saw slots, at the open end of all conduits terminated at the roadway edge, and in ground boxes. Apply sealant as shown on the plans or as directed.
- 5.18. **Salvage Operations.** Remove traffic signal when no replacement is required. Return unused or removed material deemed salvageable by the Engineer to the Department. Dispose of all other material.
- 5.19. **Signal-Related Signs.** Install, repair, replace, remove, or modify small post-mounted or overhead signs.
- 5.20. **Curbs, Ramps, and Sidewalks.** Install, repair, replace, remove, or modify curbs, ramps, and sidewalks. Secure permission to install traffic signal items before cutting into or removing curbs, ramps, and sidewalks.

Replace all curbs, ramps, and sidewalks as shown on the plans. Install pedestrian access ramps as shown on the plans.

- 5.21. **Protection of Utilities.** Locate and protect all public lines and utility customer service lines in the work area. Notify the utility company and locate and mark, uncover, or otherwise protect all such lines in the construction area. Obtain information pertinent to the location and grade of water, sewer, gas, telephone, electric lines, and other utilities in the work area from the utility company. This information does not relieve the Contractor of responsibility for protecting utilities.
- Reimburse the utility line owner for expenses or costs (including fines that may be levied against the utility company) that may result from unauthorized or accidental damage to any utility lines in work area.
- 5.22. **Preservation of Sod, Shrubbery, and Trees.** Preserve all sod, shrubbery, and trees at the site during the Contract. Obtain permission to remove any sod, shrubbery, or tree branches. Preserve and restore sod and shrubbery into their original position. Replace damaged sod or shrubbery at the Contractor's expense.
- 5.23. **Polyvinyl Chloride (PVC) Weatherproof Enclosures.** Install, remove, or replace 12 × 12 × 6-in. PVC weatherproof enclosure at locations shown on the plans or as directed. Use enclosure only for reconnecting or terminating traffic signal cables at the top of a timber or steel strain pole that has been replaced or reinstalled due to accidental knock down.
- 5.24. **Light-Emitting Diode (LED) Lamp Unit.** Install, replace, or remove LED optical unit in accordance with Item 682, as shown on the plans, or as directed.
- 5.25. **Spread Spectrum Radio Antennas.** Replace, repair, or install spread spectrum radio antenna in accordance with Special Specification, "Spread Spectrum Radios for Traffic Signals"; as shown on the plans; or as directed.
- 5.26. **Video Imaging Vehicle Detection System (VIVDS).** Install, repair, replace, remove, or modify VIVDS in accordance with Special Specification, "Video Imaging Vehicle Detection System"; as shown on the plans; or as directed.
- 5.27. **Controller Base.** Replace breakaway controller base in accordance with Standard Sheet TS-CF, as shown on the plans, or as directed.
- 5.28. **Battery Backup (BBU) System.** Install, replace, or remove BBU system in conformance with vendor specifications, as shown on the plans, or as directed.
- 5.29. **Vehicle Signal Tunnel Visor (12-in.).** Remove existing traffic signal visor from the signal head and replace it with a new visor at the locations shown on the plans.
- 5.30. **Duct Cable.** Install, remove, or replace duct cable in accordance with Special Specification, "Duct Cable."
- 5.31. **Conduit or Duct Cable Repair and Conductor Splices.** Notify the Engineer when an underground break in duct cable or conduit must be located or if a short in a conductor must be located.

Expose the break or short, install the ground box, repair the conduit or duct cable, perform the electrical splices, and backfill. Backfill in accordance with Item 400. New ground boxes will be paid for under "Install Ground Box."

When a ground box is not needed, expose the break or short, repair conduit or duct cable, remove damaged conductors, and install new conductors. Replace up to 3 ft. of conduit when repairing duct cable, regardless of the number of conduits in trench. Only one repair will be considered for payment per trench. If more than 3 ft. of conduit or duct cable needs to be replaced, the additional will be paid for under "Replace Underground Conduit" or "Replace Duct Cable." Replacement of conductors will be paid for under "Install or Replace Conductor." Backfill in accordance with Item 400.

An electrical splice will include the replacement of up to 3 ft. of conductor, regardless of the number of conductors in the conduit. Only one splice will be considered for payment per conduit. If more than 3 ft. of conductor needs to be replaced, the additional will be paid for under "Install or Replace Conductor."

Above-ground conduit repairs performed in conjunction with a bid item will be subsidiary to the pertinent bid item. Above-ground conduit repairs not performed in conjunction with a bid item will include the replacement of up to 3 ft. of conduit per repair. If more than 3 ft. of conduit must be replaced, the additional will be paid for under "Replace Above-Ground Conduit."

- 5.32. **Bore Operations.** Place underground wiring under roadways by boring in accordance with Item 476. Bore at least 60 in. below the roadway surface (and at least 36 in. below the ditch flowline) and extend 10 ft. outside the edge of the roadway or as directed. Placement of conduit for the length of the bore will be subsidiary to this bid item. Electrical conductors will be paid for under the bid item "Install or Replace Conductor."
- 5.33. **Roadway Illumination Assembly.** Install, remove, or replace roadway illumination assemblies, including the base, pole, luminaire arms, luminaire, and required wiring.
- 5.34. **Underpass Luminaire.** Install, remove, or replace underpass luminaires, including the luminaire, junction box, mounting hardware, and required wiring.
- 5.35. **Induction Fluorescent Fixture.** Install, remove, or replace induction fluorescent fixture.
- 5.36. **Luminaire.** Install, remove, or replace luminaire.
- 5.37. **High Mast Luminaires.** Replace high mast luminaires.
- 5.38. **Luminaire Arms.** Replace luminaire arms.
- 5.39. **Maintenance of Roadway Illumination.** Maintain roadway illumination assemblies, including replacement of lamps, fuses, fuse holder, starting aid, photocells, ballasts, and other work required to keep lights operational. Relevel the fixture. Clean the reflector and inside and outside of lens using an approved cleaning solution.
- 5.40. **Maintenance of High Mast Illumination.** Maintain high mast illumination assemblies, including lowering the ring assembly and the replacement of lamps, fuses, fuse holder, starting aid, photocells, ballasts, and other work required to keep lights operational. Re-aim the lights and clean the lenses and reflectors as directed. Clean the reflector and inside and outside of lens using an approved cleaning solution. Maintain mechanical and electrical equipment as directed.
- 5.41. **Maintenance of Overhead Sign Lighting.** Maintain overhead sign lighting for large signs mounted over the roadway, including replacing the ballast, lamps, fuses, and lamp sockets to properly restore the lighting to satisfactory operation. Install as shown on the plans or as directed. Clean the reflector and inside and outside of lens using an approved cleaning solution.
- 5.42. **Maintenance of Underpass Fixtures.** Maintain high-pressure sodium vapor (HPS) underpass fixtures, including the replacement of lamps, fuses, fuse holder, starting aid, photocells, ballasts, and other work required to keep lights operational. Relevel the fixture. Clean the reflector and inside and outside of lens using an approved cleaning solution.
- 5.43. **Maintenance of Induction Fluorescent Fixtures.** Maintain induction fluorescent fixtures, including the replacement of lamps, fuses, fuse holder, starting aid, photocells, ballasts, and other work required to keep lights operational. Relevel the fixture. Clean the reflector and inside and outside of lens using an approved cleaning solution.

- 5.44. **Scheduled Preventive Maintenance of Roadway Illumination Assembly.** Inspect and perform the following listed items in accordance with the schedule provided by the Engineer.
- Inspect and maintain all foundation anchor bolts, nuts, and washers.
 - Prepare and touch up rust spots using cold galvanizing spray.
 - Replace lamp and clean fixtures as directed.
 - Replace ballast as directed.
 - Level fixture.
 - Inspect electrical system.
 - Repair shorts or open circuits.
- 5.45. **Scheduled Preventive Maintenance of High Mast Assembly.** Complete and sign *Luminaire Preventive Maintenance for High Mast Lighting* reports. Fill out forms legibly and completely. List all materials used at each location.
- Inspect and perform the following listed items in accordance with the schedule provided by the Engineer.
- Inspect and fill gearbox lubrication reservoir.
 - Lubricate grease fittings.
 - Adjust brake mechanism to proper torque.
 - Inspect cable drum.
 - Inspect all wire rope and cables for deterioration or wear.
 - Inspect safety lanyard.
 - Lower ring and inspect mechanism.
 - Inspect all foundation anchor bolts, nuts, and washers.
 - Inspect welds around baseplate and ground sleeve for visible cracks.
 - Prepare and touch-up rust spots using cold galvanizing spray.
 - Replace lamps and clean fixtures as directed.
 - Replace ballasts as directed.
 - Replace aviation warning (obstruction) lamps as directed.
 - Inspect electrical system.
 - Repair short or open circuits as directed.
 - Raise ring to proper position.
- 5.46. **Replace Service Pole.** Replace service poles by removing the existing service pole; installing the new pole and related electrical service equipment; installing conduit, including the elbow below ground for underground service feed or the weatherhead for overhead service feed; and connecting and installing electrical service. Install in accordance with Item 628.
- 5.47. **Replace Transformer Base.** Replace transformer base as shown on the plans or as directed. The removal of the pole, mast arm, and luminaire for replacement of the transformer base only will be subsidiary to the pertinent bid items.
- 5.48. **Replace Transformer Base Cover.** Replace damaged or missing covers on existing transformer bases.
- 5.49. **Replace Hand Hole Cover.** Replace damaged or missing covers on existing illumination poles.
- 5.50. **Install Ground Rod.** The installation of ground rods will include running a properly sized copper grounding conductor to the ground connection.
- 5.51. **Replace Ballast.** Replace ballast for pole-mounted, underpass, sign, and wall pack fixtures as shown on the plans or as directed.
- 5.52. **Replace Ballast (High Mast Lighting).** Replace ballast for high mast fixtures.

- 5.53. **Install or Replace Fused Disconnect.** Install or replace fused disconnect.
- 5.54. **Replace Lamp Socket.** Replace lamp socket for pole-mounted, underpass, high mast, and wall pack fixtures.
- 5.55. **Replace Lamp.** Replace lamps for pole-mounted, underpass, sign, and wall pack fixtures. Clean the reflector and inside and outside of lens using an approved cleaning solution.
- 5.56. **Replace Lamp (High Mast Lighting).** Replace lamp for individual high mast fixtures. Clean the reflector and inside and outside of lens using an approved cleaning solution.
- 5.57. **Replace Wall Pack Luminaires.** Replace wall pack luminaires on structures, rest areas, maintenance warehouses, and other facilities.
- 5.58. **Replace Lens.** Replace pole-mounted, underpass, sign, wall pack, or high mast luminaire lenses.
- 5.59. **Replace Wall Pack Guard.** Replace wall pack guard.
- 5.60. **Replace Fuses.** Replace fuses for pole-mounted, underpass, sign, and wall pack fixtures, and fused disconnects.
- 5.61. **Replace Fuse Holders.** Replace fuse holder for pole-mounted, underpass, sign, and wall pack fixtures.
- 5.62. **Replace Breakaway Fuse Holders.** Replace breakaway fuse.
- 5.63. **Replace Starting Aid.** Replace starting aid for pole-mounted, underpass, sign, and wall pack fixtures.
- 5.64. **Replace Photocells and Brackets.** Replace photocells and brackets.
- 5.65. **Replace Control Transformer.** Replace the control transformer.
- 5.66. **Replace Control Circuit.** Replace the control circuit.
- 5.67. **Replace Aviation Warning Fixtures.** Replace the aviation warning (obstruction) fixtures.
- 5.68. **Replace Aviation Warning Lamp.** Replace the aviation warning (obstruction) fixture lamp.
- 5.69. **Replace Hand-Off-Auto Switch.** Replace three-position hand-off-auto control switch.
- 5.70. **Replace Contactor.** Replace electromagnetic contactors.
- 5.71. **Replace Meter Bases.** Replace meter bases in conformance with electrical service provider's requirements.
- 5.72. **Replace Time Clocks.** Replace time clocks.
- 5.73. **Replace Breaker Panel.** Replace breaker panel.
- 5.74. **Install or Replace Circuit Breaker.** Install or replace circuit breakers.
- 5.75. **Replace Flexible Power Cable or Cord.** Replace flexible power cable or cord.
- 5.76. **Replace Twist Lock Connectors.** Replace twist lock connectors.
- 5.77. **Replace Safety Lanyard.** Replace safety lanyard.

- 5.78. **Raise and Lower Ring (High Mast Lighting).** Raise and lower ring to perform various maintenance and repair items.
- 5.79. **Restrap Existing Conduit.** Restrap existing conduit as shown on the plans or as directed.
- 5.80. **Replace Missing Nuts, Washers, and Other Hardware.** Replace missing nuts, washers, and other miscellaneous hardware.
- 5.81. **Troubleshoot for Repairs.** Troubleshoot location as directed to identify work needed for repairs.
- 5.82. **Project Inspections.** Inspect and review the project to determine whether any items need repair and provide the Engineer with a list of these items. Make repairs to those items as approved. All repairs will be paid for under their respective pay items.
- 5.83. **Install or Replace Safety Switch.** Install or replace safety switch.
- 5.84. **Replace 5/16-in. Wire Rope.** Replace 5/16-in. wire rope with swaged terminals.
- 5.85. **Replace 3/8-in. Wire Rope.** Replace 3/8-in. wire rope with swaged terminals.
- 5.86. **Replace High Mast Winch.** Replace high mast winch.
- 5.87. **Replace Wire Rope Pulley.** Replace wire rope pulley.
- 5.88. **Replace Electrical Cable Pulley.** Replace electrical cable pulley.
- 5.89. **Install or Replace Access Hole Cover.** Replace damaged or missing access covers on existing high mast poles.
- 5.90. **Replace High Mast Springs.** Replace high mast spring set.
- 5.91. **Remove and Reinstall High Mast Pole for Repairs.** Remove and reinstall high mast pole from the foundation to perform any repairs to internal components.
- 5.92. **Remove, Replace, or Install Pedestrian Rail.** Remove, replace, or install pedestrian rail as shown on the plans, or as directed.
- 5.93. **Remove, Replace, or Install Cabinet Lock.** Remove, replace, or install cabinet lock as shown on the plans, or as directed.
- 5.94. **Remove, Replace, or Install Anti-Graffiti Coating.** Remove, replace, or install anti-graffiti coating as shown on the plans, or as directed.
- 5.95. **Remove, Replace, or Install Sunshield.** Remove, replace, or install sunshield as shown on the plans, or as directed.
- 5.96. **Remove, Replace, or Install Preemption System.** Remove, replace, or install preemption system as shown on the plans, or as directed.
- 5.97. **Remove, Replace, or Install Network Rack Assembly.** Remove, replace, or install network rack assembly as shown on the plans, or as directed.
- 5.98. **Remove, Replace, or Install Fiber Housing.** Remove, replace, or install fiber housing as shown on the plans, or as directed.
- 5.99. **Replace Traffic Signal Controller.** Replace traffic signal controller as shown on the plans, or as directed.

- 5.100. **Replace Malfunction Management Unit.** Replace malfunction management unit as shown on the plans, or as directed.
- 5.101. **Complete Preventive Maintenance.** Complete preventive maintenance as shown on the plans, or as directed.

6. MEASUREMENT

Measurement will be as follows.

- 6.1. **Conduit.** By the foot of conduit installed, removed, or replaced, including the installation of all hardware necessary to attach and connect the conduit, and any excavation, backfill, and compaction.
- "Install Above-Ground Conduit"
 - "Remove Above-Ground Conduit"
 - "Replace Above-Ground Conduit"
 - "Install Underground Conduit"
 - "Remove Underground Conduit"
 - "Replace Underground Conduit"
- 6.2. **Cable.** By the foot of electrical conductor or cable installed, removed, replaced, or rerouted.
- "Install Cable"
 - "Remove Cable"
 - "Replace Cable"
 - "Reroute Cable"
- 6.3. **Duct Cable.** By the foot of duct cable installed, removed, or replaced, including excavation, backfill, and compaction.
- "Install Duct Cable"
 - "Remove Duct Cable"
 - "Replace Duct Cable"
- 6.4. **Conduit or Duct Cable Repair and Conductor Splices.**
- "Install Electrical Splice." By each electrical splice installed per conduit.
 - "Repair Above-Ground Conduit." By each conduit location repaired, including installation of all hardware necessary to attach and connect the conduit.
 - "Repair Underground Conduit." By each conduit location repaired, including excavation, placement of conduit, backfill, and compaction.
 - "Repair Underground Duct Cable." By each duct cable location repaired, including excavation, placement of duct cable, backfill, and compaction.
- 6.5. **Road Bore.** By the foot of road bore, including conduit installed.
- 6.6. **Install, Remove, or Replace Roadway Illumination Assembly.** By each assembly installed, removed, or replaced. This item includes all wiring and hardware connections above the foundation.
- "Install Roadway Illumination Assembly (LED)"
 - "Remove Roadway Illumination Assembly (LED)"
 - "Replace Roadway Illumination Assembly (LED)"
- 6.7. **Install, Remove, or Replace Underpass Luminaire.** By each luminaire installed, removed, or replaced.
- "Install Underpass Luminaire (HPS)"
 - "Remove Underpass Luminaire (HPS)"

- "Replace Underpass Luminaire (HPS)"
 - "Install Underpass Luminaire (LED)"
 - "Remove Underpass Luminaire (LED)"
 - "Replace Underpass Luminaire (LED)"
- 6.8. **Install, Remove, or Replace Induction Fluorescent Fixture.** By each fixture installed, removed, or replaced.
- "Install Induction Fluorescent Fixture"
 - "Remove Induction Fluorescent Fixture"
 - "Replace Induction Fluorescent Fixture"
- 6.9. **Install, Remove, or Replace Luminaire.** By each luminaire installed, removed, or replaced.
- 6.10. **Install, Remove, or Replace High Mast Luminaire.** By each high mast luminaire installed, removed, or replaced.
- 6.11. **Install, Remove, or Replace Luminaire Pole.** By each pole installed, removed, or replaced.
- 6.12. **Install, Remove, or Replace Luminaire Arm.** By each luminaire arm installed, removed, or replaced.
- 6.13. **Maintain Roadway Illumination.** By each luminaire pole maintained.
- 6.14. **Maintain High Mast Illumination.** By each high mast pole maintained.
- 6.15. **Maintain Overhead Sign Lighting.** By each sign light maintained.
- 6.16. **Maintain Underpass Fixture.** By each underpass fixture maintained.
- 6.17. **Maintain Induction Fluorescent Fixture.** By each induction fluorescent fixture maintained.
- 6.18. **Scheduled Preventive Maintenance (Roadway Illumination Assembly).** By each roadway illumination pole. (Replacing lamp and ballast will be subsidiary to this bid item.)
- 6.19. **Scheduled Preventive Maintenance (High Mast Assembly).** By each high mast pole regardless of the number of luminaires on the ring. (Replacing lamps and ballast will be subsidiary to this bid item.)
- 6.20. **Install, Remove, or Replace Electrical Service.** By each electrical service installed, removed, or replaced.
- 6.21. **Replace Service Pole (Timber, Steel, or Concrete).** By each service pole replaced.
- "Replace Timber Service Pole"
 - "Replace Steel Service Pole"
 - "Replace Concrete Service Pole"
- 6.22. **Install, Remove, or Replace Ground Box.** By each ground box installed.
- 6.23. **Install Foundation.** By each foundation installed.
- 6.24. **Remove Foundation.** By each foundation removed.
- 6.25. **Replace Transformer Base.** By each base replaced.
- 6.26. **Replace Transformer Base Cover.** By each cover replaced.
- 6.27. **Replace Hand Hole Cover.** By each cover replaced.

- 6.28. **Install, Remove, or Replace Ground Rod.** By each ground rod installed, removed, or replaced.
- 6.29. **Replace Ballast.** By each ballast replaced.
- 6.30. **Replace Ballast (High Mast Lighting).** By each high mast ballast replaced.
- 6.31. **Install or Replace Fused Disconnect.** By each fused disconnect installed or replaced.
- 6.32. **Replace Lamp Socket.** By each lamp socket replaced for pole-mounted, underpass, wall pack, or high mast fixture.
- 6.33. **Replace Lamp.** By each lamp replaced for pole-mounted, underpass, wall pack, or high mast fixture.
- 6.34. **Replace Lamp (High Mast Lighting).** By each lamp replaced.
- 6.35. **Install, Remove, or Replace Wall Pack Luminaire.** By each wall pack installed, removed, or replaced.
- 6.36. **Install, Remove, or Replace Lens.** By each lens installed, removed, or replaced.
- 6.37. **Install, Remove, or Replace Wall Pack Guard.** By each guard installed, removed, or replaced.
- 6.38. **Replace Fuse.** By each fuse replaced.
- 6.39. **Replace Fuse Holder.** By each fuse holder replaced.
- 6.40. **Replace Breakaway Fuse Holder.** By each breakaway fuse holder replaced.
- 6.41. **Replace Starting Aid.** By each starting aid replaced.
- 6.42. **Replace Photocell and Bracket.** By each photocell and bracket replaced.
- 6.43. **Replace Control Transformer.** By each transformer replaced.
 - "Replace Control Transformer for High Mast"
 - "Replace Control Transformer for Electrical Service"
- 6.44. **Replace Control Circuit.** By each control circuit replaced.
 - "Replace Control Circuit for High Mast"
 - "Replace Control Circuit for Electrical Service"
- 6.45. **Replace Aviation Warning Fixture.** By each obstruction fixture replaced.
- 6.46. **Replace Aviation Warning Lamp.** By each obstruction lamp replaced.
- 6.47. **Replace Hand-Off-Auto Switch.** By each hand-off-auto control switch replaced.
- 6.48. **Replace Contactor.** By each electromagnetic contactor replaced.
- 6.49. **Replace Meter Base.** By each meter base replaced.
- 6.50. **Replace Time Clock.** By each time clock replaced.
- 6.51. **Replace Breaker Panel.** By each breaker panel replaced.

- 6.52. **Install or Replace Circuit Breaker.** By each circuit breaker installed or replaced.
- "Install Circuit Breaker"
 - "Replace Circuit Breaker"
- 6.53. **Replace Flexible Power Cable or Cord.** By foot of cable or cord replaced.
- 6.54. **Replace Twist Lock Connector.** By each twist lock connector replaced.
- 6.55. **Replace Safety Lanyard.** By foot of chain replaced. Associated hardware will be subsidiary to this item.
- 6.56. **Raise and Lower Ring (High Mast Lighting).** By each ring raised and lowered (not part of scheduled preventive maintenance).
- 6.57. **Restrap Existing Conduit.** By each strap installed.
- 6.58. **Replace Missing Nuts, Washers, and Other Hardware.** By each nut, washer, or miscellaneous hardware replaced.
- 6.59. **Troubleshoot for Repairs.** By the man-hour of troubleshooting.
- 6.60. **Project Inspections.** By the month.
- 6.61. **Install or Replace Safety Switch.** By each safety switch installed or replaced.
- "Install Safety Switch"
 - "Replace Safety Switch"
- 6.62. **Replace 5/16-in. Wire Rope.** By each 5/16-in. wire rope with swaged terminals replaced.
- 6.63. **Replace 3/8-in. Wire Rope.** By each 3/8-in. wire rope with swaged terminals replaced.
- 6.64. **Replace High Mast Winch.** By each winch replaced.
- 6.65. **Replace Wire Rope Pulley.** By each wire rope pulley replaced.
- 6.66. **Replace Electrical Cable Pulley.** By each electrical cable pulley replaced.
- 6.67. **Install or Replace Access Hole Cover.** By each access cover installed or replaced.
- "Install Access Hole Cover"
 - "Replace Access Hole Cover"
- 6.68. **Replace High Mast Springs.** By each high mast spring set replaced.
- 6.69. **Remove and Reinstall High Mast Pole for Repairs.** By each high mast pole removed and reinstalled.
- 6.70. **Removal, Replacement, or Installation of Cable.** By the foot of cable removed, replaced, rerouted, or installed in a run, regardless of the number of conductors per cable. Measurement will not be made for cable inside signal heads and controllers or cable coiled in ground boxes, in pole bases, and on strain wires.
- 6.71. **Installation of Duct Cables.** By the foot of trench containing duct cable.
- 6.72. **Removal, Replacement, or Installation of Cable by Messenger Strain Wire.** By the foot of aerial cable removed, replaced, or installed, regardless of number of conductors per cable.

- 6.73. **Removal, Replacement, or Installation of Strain Wire Assembly.** By the foot of strain wire removed, replaced, or installed. Strain wire quantity is defined as the distance from one pole to the next pole for each strain wire.
- 6.74. **Removal, Replacement, or Installation of Timber Poles.** By each timber pole removed, replaced, or installed. Attachment of required hardware will be subsidiary to this Item.
- 6.75. **Removal, Replacement, or Installation of Signal Head Assemblies.** By each head removed, replaced, or installed. Assembly and wiring will be subsidiary to this Item.
- 6.76. **Removal, Replacement, or Installation of Signal Related Signs.** By each sign assembly removed, replaced, or installed.
- 6.77. **Removal, Replacement, or Installation of Pedestrian Push Buttons.** By each push button removed, replaced, or installed.
- 6.78. **Removal, Replacement, or Installation of Traffic Signal Pole Foundations.** By the foot of the type of foundation removed, replaced, or installed.
- 6.79. **Installation of Foundations for Ground Mount or Pole Mount Cabinets.** By each foundation installed.
- 6.80. **Removal, Replacement, or Installation of Controller Cabinet, Ground Mount.** By each cabinet removed, replaced, or installed.
- 6.81. **Removal, Replacement, or Installation of Controller Cabinet, Pole Mount.** By each cabinet removed, replaced, or installed.
- 6.82. **Removal, Replacement, or Installation of Flasher Cabinet.** By each cabinet removed, replaced, or installed.
- 6.83. **Installation of Foundations for Roadside Flashing Beacon Assemblies.** By each foundation installed.
- 6.84. **Removal, Replacement, or Installation of Roadside Flashing Beacon Assemblies.** By each assembly removed, replaced, or installed.
- 6.85. **Removal, Replacement, or Installation of Signal Pole Assemblies.** By each assembly removed, replaced, or installed. Wiring in the pole and hardware will be subsidiary to this Item. The removal of the top of the foundation and steel to at least 2 ft. below grade will be subsidiary to the removal of the pole. Removal of foundation should be paid for only by the foot if a pole is not removed or replaced, or when more than 2 ft. of foundation removal is required when removing or replacing a pole.
- 6.86. **Removal, Replacement, or Installation of Curbs.** By the foot removed, replaced, or installed.
- 6.87. **Removal, Replacement, or Installation of Pedestrian Ramps.** By each ramp removed, replaced, or installed.
- 6.88. **Removal, Replacement, or Installation of Sidewalks.** By the square foot removed, replaced, or installed.
- 6.89. **Removal of Concrete Foundations.** By each foundation removed.
- 6.90. **Removal, Replacement, or Installation of Down Guy with Guard.** By each down guy with guard removed, replaced, or installed.
- 6.91. **Removal, Replacement, or Installation of Down Guy with Guard and Anchor.** By each down guy with guard and anchor removed, replaced, or installed.

- 6.92. **Remove and Salvage Traffic Signals.** By each signalized intersection salvaged. A signalized intersection is a group of traffic signals operated by a single controller.
- 6.93. **Removal, Replacement, or Installation of 12 × 12 × 6-in. PVC Weatherproof Enclosure.** By each PVC weatherproof enclosure removed, replaced, or installed.
- 6.94. **Removal, Replacement, or Installation of LED Lamp Unit.** By each LED lamp unit removed, replaced, or installed.
- 6.95. **Removal, Replacement, or Installation of Spread Spectrum Radio Antennas.** By each radio antenna removed, replaced, or installed.
- 6.96. **Removal, Replacement, or Installation of Vehicle Detection System.** By each assembly removed, replaced, or installed. The mounting hardware and detector controller card required to make the system function will be subsidiary to the item.
- 6.97. **Removal, Replacement, or Installation of Screw-In Foundation.** By each screw-in foundation removed, replaced, or installed.
- 6.98. **Replacement of Breakaway Controller Base.** By each breakaway base replaced.
- 6.99. **Removal, Replacement, or Installation of Battery Backup (BBU) System.** By each BBU system removed, replaced, or installed.
- 6.100. **Removal, Replacement, or Installation of Detection Cable.** By the linear foot of each cable removed, replaced, or installed. For loop detectors, the saw-cut and grout filler will be subsidiary to the installation.
- 6.101. **Removal, Replacement, or Installation of Vehicle Signal Tunnel Visor (12-in.).** By each vehicle signal tunnel visor (12-in.) removed, replaced, or installed.
- 6.102. **Removal, Replacement, or Installation of Wrapping of Signal Cable.** By the linear foot of wrapped cable removed, replaced, or installed.
- 6.103. **Removal, Replacement, or Installation of Anti-Graffiti Coating.** By each anti-graffiti coating removed, replaced, or installed.
- 6.104. **Removal, Replacement, or Installation of Sunshield.** By each sunshield removed, replaced, or installed.
- 6.105. **Removal, Replacement, or Installation of Preemption System.** By each preemption system removed, replaced, or installed.
- 6.106. **Removal, Replacement, or Installation of Network Rack Assembly.** By each network rack assembly removed, replaced, or installed.
- 6.107. **Removal, Replacement, or Installation of Fiber Housing.** By each fiber housing removed, replaced, or installed.
- 6.108. **Replacement of Traffic Signal Controller.** By each traffic signal controller replaced.
- 6.109. **Replacement of Malfunction Management Unit.** By each malfunction management unit replaced.
- 6.110. **Complete Preventive Maintenance.** For each hour to complete preventive maintenance.

7. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the various designations. This price is full compensation for furnishing all materials, equipment, labor, fines, tools, and incidentals. The Department will pay for electrical energy consumed by the traffic signal.

Wiring in the pole; splices; backfill (soil or concrete); sealing of conduit ends and loop detector saw slots; installation of loop wire and PVC for encased loops; protection of utilities; and preservation of sod, shrubbery, and trees will not be measured or paid for directly, but will be subsidiary to pertinent Items.

The required traffic control will be paid for separately as shown on the plans, or as directed.

Item 772

Post and Cable Fence



1. DESCRIPTION

Install, repair, or remove post and cable fence.

2. MATERIALS

Furnish materials as follows, unless otherwise shown on the plans.

- 2.1. **Posts.** Furnish timber posts in accordance with [DMS-7200](#), "Timber Posts and Blocks for Metal Beam Guard Fence."
- 2.2. **Cable.** Furnish wire cable in accordance with ASTM A475 and the following requirements.
 - 3/8-in. nominal strand diameter
 - Seven-wire strand, common grade
 - Minimum breaking strength of 4,000 lb.
 - 0.30-oz. per square foot minimum weight of zinc coating
- 2.3. **Fittings and Anchors.** Furnish fittings and anchors galvanized in accordance with ASTM A153.
- 2.4. **Concrete.** Furnish concrete in accordance with Item 421, "Hydraulic Cement Concrete," of the class shown on the plans.
- 2.5. **Reflectors.** Furnish reflectors as shown on the plans.
- 2.6. **Backfill.** Furnish backfill material as approved.
- 2.7. **Gate.** Furnish gates as shown on the plans.

3. WORK METHODS

Install, repair, or remove post and cable fence, including reflectors and related items as shown on the plans.

- 3.1. **Removal.** Remove concrete anchors, posts, and cable. Backfill and thoroughly compact post and anchor holes. Accept ownership of removed materials, unless otherwise shown on the plans. Dispose of removed materials in conformance with federal, state, and local regulations.
- 3.2. **Installation.** Place new anchors, posts, and cable as shown on the plans. Set posts on firm foundation and plumb to the required lines and grades. Thoroughly compact backfill in 4-in. layers. Space pull posts as shown on the plans. Lengthen or shorten one pull post space per continuous section if necessary to accommodate site conditions. Cover or fill open holes at the end of each workday.

Maintain current pull post spacing of existing installations if approved. Straighten undamaged posts that are more than 1 in. out of plumb. Stretch cable to remove sag between posts. One cable splice will be allowed between posts, adjacent to the post, but no more than two splices in any 100 ft. of cable. Painting is not required, unless otherwise shown on the plans.
- 3.3. **Repair.** Plumb and realign post in a vertical and horizontal position. Stretch cable to remove sag between posts. One cable splice will be allowed between posts, adjacent to the post, but no more than two splices in

any 100 ft. of cable. Removal and replacement of posts, anchors, or cable will be paid for under the appropriate bid item.

4. MEASUREMENT

This Item will be measured as follows.

- 4.1. **Post and Cable Fence Removal.** By the foot from center to center of pull posts.
- 4.2. **Concrete Anchor Removal.** By each anchor removed.
- 4.3. **New Installation of Post and Cable Fence.** By the foot of fence from center to center of pull posts for each continuous section installed.
- 4.4. **New Concrete Anchor.** By each anchor installed.
- 4.5. **Replace Posts.** By each post removed and replaced.
- 4.6. **Replace Concrete Anchors.** By each anchor removed and replaced.
- 4.7. **Replace Cable.** By the foot of cable removed and replaced.
- 4.8. **New Installation of Post and Cable Fence (Gate).** By each gate installed.
- 4.9. **Repair.** By the foot of fence from center to center of pull posts for each repair.

5. PAYMENT

The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Post and Cable Fence (Removal)," "Post and Cable Fence (Remove Concrete Anchor)," "Post and Cable Fence (New Installation)," "Post and Cable Fence (New Concrete Anchor)," "Post and Cable Fence (Replace Posts)," "Post and Cable Fence (Replace Concrete Anchors)," "Post and Cable Fence (Replace Cable)," "Post and Cable Fence (Gate) (New Installation)," or "Post and Cable Fence (Repair)." This price is full compensation for cable splices, straightening posts, realignments of posts, tightening cable, backfilling posts and anchor holes, installation of reflectors, bollards, foundations, backfilling, gate and hardware, paint, materials, equipment, labor, tools, and incidentals.

Special Provision to Item 300

Asphalts, Oils, and Emulsions



Item 300, "Asphalts, Oils, and Emulsions," is amended with respect to the clause cited below. No other clause or requirements of this Item are waived or changed.

Section 300.2.2., Table 3 Polymer-Modified Asphalt Cement has been voided and replaced by the following:

Table 3
Polymer-Modified Asphalt Cement

Property	Test Procedure	Polymer-Modified Viscosity Grade											
		AC-12-5TR		NT-HA ¹		AC-15P		AC-20XP		AC-10-2TR		AC-20-5TR	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Polymer		TR		–		SBS		SBS		TR		TR	
Polymer content, % (solids basis)	Tex-533-C or Tex-553-C	5.0	–	–	–	3.0	–	–	–	2.0	–	5.0	–
Dynamic shear, $G^*/\sin \delta$, 82°C, 10 rad/s, kPa	T 315	–	–	1.0	–	–	–	–	–	–	–	–	–
Dynamic shear, $G^*/\sin \delta$, 64°C, 10 rad/s, kPa	T 315	–	–	–	–	–	–	1.0	–	–	–	1.0	–
Dynamic shear, $G^*/\sin \delta$, 58°C, 10 rad/s, kPa	T 315	1.0	–	–	–	–	–	–	–	1.0	–	–	–
Viscosity 140°F, poise	T 202	1,200	–	–	–	1,500	–	2,000	–	1,000	–	2,000	–
275°F, poise	T 202	–	–	–	–	–	8.0	–	–	–	8.0	–	10.0
275°F, Pa-s	T 316	–	–	–	4.0	–	–	–	–	–	–	–	–
Penetration, 77°F, 100 g, 5 sec.	T 49	110	150	–	25	100	150	75	115	95	130	75	115
Elastic recovery, 50°F, %	Tex-539-C	55	–	–	–	55	–	55	–	30	–	55	–
Polymer separation, D, %	Tex-540-C	-10	+10	–	–	-10	+10	-10	+10	-10	+10	-10	+10
Flash point, C.O.C., °F	T 48	425	–	425	–	425	–	425	–	425	–	425	–
Dynamic shear (@ 0.2 rad/sec.) G^* , -18°C MPa	Tex-554-C ²	–	220	–	–	–	220	–	220	–	220	–	220
δ , -18°C, deg.		22	–	–	–	22	–	22	–	22	–	22	–
Tests on residue from RTFOT aging and pressure aging: Creep stiffness S, -18°C, MPa m-value, -18°C	T 240 and R 28 T 313	– 0.300	300 –	– –	– –	– 0.300	300 –	– 0.300	300 –	– 0.300	300 –	– 0.300	300 –

1. This is a hot-applied TRAIL product.
2. Bending beam rheometer, BBR (T313) is not required unless the low. temp. DSR ([Tex-554-C](#)) do not meet the afore specified requirements. BBR will be used for the acceptance criteria in this instance.

Section 300.2.4., Table 8 Cationic Emulsified Asphalt has been voided and replaced by the following:

Table 8
Cationic Emulsified Asphalt

Property	Test Procedure	Type-Grade							
		Rapid-Setting		Medium-Setting		Slow-Setting			
		CRS-2		CMS-2		CSS-1		CSS-1H	
		Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol 77°F, sec. 122°F, sec.	T 72	–	–	–	–	20	100	20	100
Sieve test, %	T 59	–	0.1	–	0.1	–	0.1	–	0.1
Cement mixing, %	T 59	–	–	–	–	–	2.0	–	2.0
Coating ability and water resistance: Dry aggregate/after spray Wet aggregate/after spray	T 59	–	–	Good/Fair Fair/Fair	–	–	–	–	–
Demulsibility, 35 mL of 0.8% Sodium dioctyl sulfosuccinate, %	T 59	70	–	–	–	–	–	–	–
Storage stability, 1 day, %	T 59	–	1	–	1	–	1	–	1
Particle charge	T 59	Positive		Positive		Positive		Positive	
Distillation test: Residue by distillation, % by wt. Oil distillate, % by volume of emulsion	T 59	65	–	65	–	60	–	60	–
		–	0.5	–	7	–	0.5	–	0.5
Tests on residue from distillation: Penetration, 77°F, 100 g, 5 sec. Solubility, % Ductility, 77°F, 5 cm/min., cm	T 49 T 44 T 51	90 97.5 100	160 – –	90 97.5 100	200 – –	90 97.5 100	160 – –	40 97.5 80	110 – –

Section 300.2.11. This section has been voided and replaced by the following.

2.11 Performance-Graded Binders. Provide PG binders that are smooth and homogeneous, show no separation when tested in accordance with [Tex-540-C](#) (i.e., D<10%), and meet the requirements shown in Table 18.

Separation testing is not required if:

- a modifier is introduced separately at the mix plant by injection in either the asphalt line or mixer,
- the binder is blended onsite in continuously agitated tanks, or
- binder acceptance is based on field samples taken from an in-line sampling port at the hot-mix plant after the addition of modifiers.

Table 18
Performance-Graded Binders

Property and Test Method	Performance Grade																	
	PG 58			PG 64			PG 70			PG 76			PG 82					
	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
Average 7-day max pavement design temperature, °C ¹	58			64			70			76			82					
Min pavement design temperature, °C ¹	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28	-34	-16	-22	-28
Original Binder																		
Flash point, T 48, Min, °C	230																	
Viscosity, T 316 ^{2,3} : Max, 3.0 Pa s, test temperature, °C	135																	
Dynamic shear, T 315 ⁴ : G*/sin(δ), Min, 1.00 kPa, Max, 2.00 kPa ⁵ , Test temperature @ 10 rad/sec., °C	58			64			70			76			82					
Elastic recovery, D6084, 50°F, % Min ⁶	–	–	30	–	–	30	50	–	30	50	60	30	50	60	70	50	60	70
Rolling Thin-Film Oven (RTFO) (T 240)																		
Mass change, T 240, Max, %	1.0																	
Dynamic shear, T 315: G*/sin(δ), Min, 2.20 kPa, Max, 5.00 kPa ⁵ , Test temperature @ 10 rad/sec., °C	58			64			70			76			82					
MSCR, T350, Recovery, 0.1 kPa, High Temperature, % Min ⁶	–	–	20	–	–	20	30	–	20	30	40	20	30	40	50	30	40	50
Pressure Aging Vessel (PAV) Residue (R 28)																		
PAV aging temperature, °C	100																	
Dynamic shear, T 315 G*.sin(δ), Max, 5,000 kPa (Max, 6,000 kPa for δ ≥ 42°) Test temperature @ 10 rad/sec., °C	25	22	19	28	25	22	19	28	25	22	19	28	25	22	19	28	25	22
Dynamic shear, Tex-554-C ⁷ : G*, Max, 220 MPa δ, min. 22° (Test temperature @ 0.2 rad/sec., °C)	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18
Creep stiffness, T 313 ^{8,9} : S, max, 300 MPa, m-value, Min, 0.300 Test temperature @ 60 sec., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18
Direct tension, T 314 ⁹ Failure strain, Min, 1.0% Test temperature @ 1.0 mm/min., °C	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18	-24	-6	-12	-18

- Pavement temperatures are estimated from air temperatures and using an algorithm contained in a Department-supplied computer program, may be provided by the Department, or may be obtained following the procedures outlined in AASHTO MP 323 and R 25.
- This requirement may be waived at the Department's discretion if the supplier warrants that the asphalt binder can be adequately pumped, mixed, and compacted at temperatures that meet all applicable safety, environmental, and constructability requirements. At test temperatures where the binder is a Newtonian fluid, any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
- Viscosity at 135°C is an indicator of mixing and compaction temperatures that can be expected in the lab and field. High values may indicate high mixing and compaction temperatures. Additionally, significant variation can occur from batch to batch. Contractors should be aware that variation could significantly impact their mixing and compaction operations. Contractors are therefore responsible for addressing any constructability issues that may arise.
- For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be substituted for dynamic shear measurements of G*/sin(δ) at test temperatures where the asphalt is a Newtonian fluid. Any suitable standard means of viscosity measurement may be used, including capillary (T 201 or T 202) or rotational viscometry (T 316).
- Max values for unaged and RTFO-aged dynamic shear apply only to materials used as substitute binders, as described in Item 341, "Dense-Graded Hot-Mix Asphalt," and Item 344, "Superpave Mixtures."
- Elastic recovery (D6084) is not required unless MSCR (T 350) is less than the Min % recovery. Elastic recovery will be used for the acceptance criteria in this instance.
- Bending beam rheometer, BBR (T313) is not required unless the low. temp. DSR ([Tex-554-C](#)) do not meet the afore specified requirements. BBR will be used for the acceptance criteria in this instance.
- Silicone beam molds, as described in AASHTO TP 1-93, are acceptable for use.
- If creep stiffness is below 300 MPa, direct tension test is not required. If creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used instead of the creep stiffness requirement. The m value requirement must be satisfied in both cases.

Special Specification 4005-MOD

Relocate Existing Truss Bridge



1. DESCRIPTION

Remove and relocate the existing truss bridge as shown on the plans.

2. CONSTRUCTION

Remove existing truss bridge from the original site and relocate to a final location as shown on the plans and as directed. Dimensions shown on the plans for setting the existing truss bridge in its final position must be verified in the field, adjusted as necessary by the Contractor, and approved.

Lift and move the truss bridge from the existing location in one piece as shown on the plans and as directed. Provide footings adequate to support the truss at the storage location according to the plans. Set footings to support the truss bridge in a level orientation. Obtain and provide to the Engineer documentation for permits, escorts and utility adjustments required to make the move.

Submit lifting and moving plan to the Engineer of record for review and approval. The lifting and moving plan must be signed and sealed by a licensed Engineer in the State of Texas. Include on the plan details for any bracing or lifting attachments to the original bridge members. No welding to any bridge member is permitted. No drilling through any bridge member is permitted. Temporary or permanent attachments to the truss bridge must be made by clamping or bolting through original rivet holes as approved. Flame cutting of any member must not be allowed unless approved.

Extreme care must be taken when lifting the truss from the supports, transporting the bridge to the new site, and placing the bridge on the new supports. Any damage caused by the Contractor's operations will be repaired as directed, and at the Contractor's expense.

If both ends of the bridge are lifted at once, all four corners of the bridge must be lifted simultaneously and symmetrically. If only one end of the bridge is lifted at a time, then both corners must be lifted simultaneously and symmetrically. If only a single truss is lifted at a time, lift from both ends of the truss as specified on the plans or as directed.

3. MEASUREMENT

The work as provided for by this Specification will be measured by the lump sum.

4. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the price bid for "Relocate Existing Truss Bridge." This price is full compensation for all excavation, backfilling, bracing, lifting, moving, escorts, permits, utility adjustments, temporarily supporting, and furnishing all equipment, tools, labor, and incidentals necessary to complete the work.

Special Specification 6001

LED Internally Lighted Street Name Signs



1. DESCRIPTION

Furnish, fabricate, and install light emitting diode (LED) internally lighted street name (ILSN) signs attached to traffic signal poles as shown on the plans.

2. MATERIALS

Provide new materials as shown on the plans and in accordance with this Item and the pertinent requirements of the following Items.

- Item 445, "Galvanizing"
- Item 446, "Field Cleaning and Painting Steel"
- Item 620, "Electrical Conductors"

Furnish and fabricate LED ILSN sign assemblies and associated mounting hardware from new materials in accordance with this specification. Provide single- or double-faced message signs as shown on the plans.

Furnish electronic submittals of the LED ILSN sign assemblies and mounting hardware to the Engineer at the project address. Do not begin work or purchase materials before the submittals are approved.

- 2.1. **General Requirements.** Ensure sign assembly standard lengths are between 6 ft. and 10 ft. and standard viewable heights are between 15 in. and 30 in. Use single- or double-faced signs as shown on the plans. Ensure maximum weight of the sign does not exceed maximum capacity of ILSN support arms.

Construct sign fixture housing from 5000 or 6000 series aluminum. Powder-coat paint all exterior fixture housing glossy black or as shown on the plans. Ensure paint exceeds 1,000-hr. salt-spray test in accordance with ASTM B117. Provide ILSN housing rated as NEMA, Type 3R. Use stainless steel screws and hardware.

Ensure sign panels, light sources, light engines, and power supplies can be replaced without sign removal. Provide sign that is capable of continuous operation over a range in temperatures from -10°F to +140°F.

- 2.2. **LED Requirements.** Provide high flux LEDs that are rated to maintain a minimum 70% of their initial lumens after 60,000 hr. at 25°C in accordance with IESNA LM-80-08. Ensure the LED arrays or modules will continue to operate if one LED goes out.

- 2.3. **Sign Panel Requirements.** Ensure the front panel of the sign is ultraviolet-, weather-, abrasion-, and impact-resistant high-impact strength polycarbonate, acrylic, or glass-fiber reinforced polyester fluoride. Ensure the front panel is replaceable for future maintenance purposes. Provide translucent reflective Type D sheeting and colored transparent acrylic film in accordance with [DMS-8300](#), "Sign Face Materials."

In accordance with the TMUTCD, Section 2D.43, street name signs must have a white legend on a green background. A border, if used, will be the same color as the legend. Ensure letter font type and letter height are in accordance with the *Standard Highway Sign Designs for Texas*, D3-1 Overhead Mount.

- 2.4. **Electrical and Illumination Requirements.** Provide ILSN that will operate at 120V AC. Ensure product meets standard for electric signs UL 48. Provide voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients in accordance with NEMA Standard TS 2-2003, Section 2.1.8. Locate the power supply inside the sign enclosure. Provide power supply with UL Class 2 limited output voltage and current plus isolation for safe operation, and UL-rated for outdoor damp locations.

Provide power supply with an Ingress Protection 64 outdoor rating. Ensure the light source evenly illuminates the sign panel and the average luminance over the entire panel surface is uniform.

- 2.5. **Support Requirements.** Design and construct the sign to withstand 110-mph wind loads in accordance with the AASHTO publication *Standard Specifications for Structural Supports of Highway Signs, Luminaires and Traffic Signals* (6th Edition 2013).

Supply the sign with mounting brackets from the manufacturer (swinging or rigid mounting) as shown on the plans.

- 2.6. **Color.** The color of the legend, symbols, and background must fall within the International Commission on Illumination (CIE) color coordinates and reflectance values shown in Table 1.

Table 1
CIE Chromaticity Coordinates and Reflectance Values

White			Green		
x	y	Reflectance	x	y	Reflectance
0.300	0.290	40 Min	0.255	0.330	3.5–10
280	0.310		0.255	0.520	
0.360	0.360		0.020	0.540	

- 2.7. **Workmanship.** The panels must exhibit good workmanship and be free of objectionable marks or defects that would adversely affect appearance or serviceability.

- 2.8. **Warranty.** The manufacturer will replace failed ILSNs, when non-operable due to defect in material or workmanship, within 5 yr. of installation, with a new ILSN that passes all testing, delivered and installed at the project location.

3. CONSTRUCTION

Fabricate and install ILSN signs as shown on the plans. Install in accordance with the Electrical Detail Standards. Install signs level and plumb using brackets or clamps. Attach ILSN to traffic signal pole in conformance with the manufacturer's instructions and as shown on the plans.

Use established industry and utility safety practices when installing ILSNs located near overhead or underground utilities. Consult with the appropriate utility company before beginning work.

Prevent scarring or marring of the poles, mast arms, and ILSNs. Replace damaged components. Repair damaged galvanizing in accordance with Section 445.3.5., "Repairs." Repair damaged painted areas of a roadway illumination assembly in accordance with Item 446.

4. MEASUREMENT

This Item will be measured as each LED ILSN sign installed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "LED Internally Lighted Street Name Signs" of the sizes and types specified. This price is full compensation for furnishing, fabricating, and installing the signs; support arm clamp assembly; liquid-tight flexible metal conduit; and equipment, labor, tools, and incidentals.

New conduit will be paid for under Item 618, "Conduit." New conductors, except the conductors internal to the pole, will be paid for under Item 620. New tray cable, except the tray cable internal to the pole, will be paid for under Item 621, "Tray Cable."

Special Specification 6006

Video Imaging Vehicle Detection System



1. DESCRIPTION

Furnish, install, relocate, or remove video imaging vehicle detection system (VIVDS) at locations shown on the plans, or as directed. Use VIVDS listed on the Department's prequalified products list.

2. MATERIALS

- 2.1. **General.** Furnish, assemble, and install only new materials except as allowed for relocation of VIVDS equipment. Ensure all VIVDS within the project are from the same manufacturer.

VIVDS must analyze video images and produce vehicle detector outputs that can serve as inputs to a traffic signal controller. Provide VIVDS field equipment that is compatible with existing infrastructure and software located in the Department's Traffic Management Control Centers across the state as directed. VIVDS must meet Department TSS Protocol requirements when integration with Traffic Management Center software or systems is shown on the plans.

VIVDS equipment must include the following:

- camera and mounting hardware (fixed or variable focal length; infrared; or 360° "fish-eye"),
- VIVDS processor,
- cabinet control unit and associated devices required for system integration, and
- data, power, and communication cable, connectors, and assemblies.

The VIVDS must use one or more cameras and video processing equipment to accurately provide detector calls for the intersection, approach, or roadway segment where they are installed, and provide detection as shown on the plans. A single camera placed per manufacturer recommendations must be capable of monitoring and detecting five lanes of traffic simultaneously.

Ensure the system is designed and constructed with subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Ensure field replaceable parts are accessible for inspection and maintenance. Provide test points for checking essential voltages and waveforms.

VIVDS devices must self-recover from power failure once power is restored.

- 2.2. **Configuration and Management.** Ensure that the VIVDS allows local and remote configuration and monitoring. The VIVDS must allow the user to fully configure the system and place detection zones using a mouse, monitor, and keyboard (or keypad) connected to the VIVDS. Provide each VIVDS with all associated equipment required to configure and operate the system in a field environment including a video monitor, mouse, keyboard (or keypad), software, and interface cables as applicable. The VIVDS must also support local configuration and monitoring using a laptop computer but must not require a computer for local configuration, monitoring, and operation.

Ensure that the system can display detection zones and detection activations overlaid on live video from VIVDS cameras.

Ensure that the VIVDS allows a user to edit previously defined configuration parameters, including size, placement, and sensitivity of detection zones.

Ensure that the VIVDS retains its programming in nonvolatile memory. Ensure that the detection system configuration settings can be saved to a computer and restored from a saved file locally and remotely. The system must allow stored configurations to be modified for fine-tuning and optimization. The VIVDS must continue to detect vehicles and operate normally while configuration and detection zone modifications are made.

Ensure the VIVDS does not require adjustment or recalibration to maintain performance once initial calibration and configuration is complete.

- 2.3. **Detection Zones.** The VIVDS must allow a user to configure detection zones using a graphical user interface (GUI) superimposed on a video image of the roadway. Ensure detection zones can be placed anywhere within a camera field of view. Ensure VIVDS detection zones can detect vehicle presence and collect traffic data, such as traffic counts.

Detection zones must appear as lines or polygons in the field of view. The system must allow a minimum of eight detection zones per field of view. VIVDS detection zones must be able to provide detection equivalent to a 6 ft. by 6 ft. loop. Ensure zones can be sized, shaped, and overlapped to accurately detect vehicles at the locations shown on the plans.

The system must allow zones to be configured with directionality, delay, extension, and logic functions including "AND" and "OR." If each detection zone provides a unique output to the signal controller and the controller includes logical functions, then the VIVDS is not required to support logic functions.

Ensure zones displayed on a monitor provide a visual indication when vehicles are detected during configuration and operation.

- 2.4. **Detection.** VIVDS processor must compensate for minor camera movement. Movement up to 2% of field of view at 400 ft. must not produce a false detection.

Ensure VIVDS processor operates regardless of whether monitoring equipment is connected. If monitoring equipment is connected to the processor unit, vehicle detections are displayed real-time as they occur.

VIVDS must simultaneously detect vehicles in all lanes. VIVDS must be able to accurately detect approaching and departing vehicles in multiple lanes. VIVDS is configurable for which direction of travel to detect. Ensure vehicles traveling in any direction other than the configured direction of travel (e.g., cross-street and wrong-way traffic) do not activate a call to the controller.

Ensure a constant call is placed on outputs associated with zones or cameras that are in an error state or failed. Ensure a constant call is placed on assigned outputs whenever the system is unable to provide accurate detection.

- 2.5. **Accuracy.** Ensure VIVDS individual lane accuracy for vehicle presence detection is within 5% of actual.

- 2.6. **Camera.** Use color or thermal cameras that are provided as part of an engineered system by the VIVDS processor manufacturer or approved for use by the VIVDS processor manufacturer. Ensure that analog cameras provide NTSC composite video with a minimum resolution of at least 480 TVL.

Cameras must produce useable video suitable for detection in low light. Cameras with day and night modes must automatically and seamlessly transition between modes without producing vehicle detection errors such as false calls and missed calls. Nighttime monochrome operation must produce feature resolvable video with luminance as low as 0.1 lux. Nighttime color operation must produce feature resolvable video with luminance as low as 1.0 lux.

Cameras must produce resolvable features in the video with luminance as high as 10,000 lux.

Visual spectrum cameras must include automatic electronic shutter and iris control based on average scene luminance.

Variable focal length lenses must be adjustable from 6 mm to 34 mm.

Processed images produced by the VIVDS must use a standard encoding format such as H.264 or MJPEG unless otherwise shown on the plans.

- 2.6.1. **Thermal cameras.** Thermal imaging cameras must use a long-life, uncooled vanadium oxide microbolometer thermal detector with a spectral range of 7.5 to 13.5 μm .

Ensure analog video is compliant with National Television System Committee (NTSC) standard and has a minimum NTSC array format of 320 x 240 with a 76,800 pixel effective resolution.

- 2.6.2. **Camera enclosure.** Camera and lens assembly must be housed in an enclosure designed for outdoor use. The housing must be light in color to limit solar heating and prolong equipment life. Enclosure, including cable connections, must be waterproof and dust tight with a NEMA Type 4 rating.

Ensure enclosures for visual spectrum cameras include a sunshield. Sunshield must protrude beyond the front edge of the enclosure and divert water away from the camera's field of view. Ensure the sunshield overhang is adjustable. Any plastics used in the construction of the enclosure must include ultraviolet inhibitors.

Ensure the enclosure allows the camera horizon to be rotated in the field during installation. Ensure camera focus and zoom can be adjusted, if necessary, without entering the camera enclosure.

The camera enclosure must be provided with mounting bracket designed to mount directly to a pole, mast-arm, or other structure. Ensure the bracket allows the camera to be panned and tilted for alignment and then locked into place once properly positioned.

The camera enclosure with camera and lens installed must weigh 10 lb. or less.

Camera housing must include a means to prevent the formation of ice or condensation. If camera housing includes a heater, wiper, or other electronically controlled mechanism, such mechanism does not interfere with the camera operation or video signal.

- 2.7. **Video Processor.** Ensure the VIVDS includes a machine vision processor that provides video analysis, presence detection, and interfaces for inputs and outputs. VIVDS must provide data collection features, including storage and reporting of collected vehicle detection data, when shown on the plans.

VIVDS must be able to interface with the traffic controller unit (CU) via the detector rack, SDLC, or another detector interface described in NEMA TS2-2016, unless otherwise shown on the plans. Solid state detection outputs must meet the requirements of NEMA TS2-2016, 6.5.2.26.

Each VIVDS detector rack card must have a minimum of four detector outputs. The system must be able to provide a total of 24 detection outputs. Ensure each zone and output is user definable, and previously saved zones can be redefined.

The system must be capable of functioning as a detector BIU using an RS-485 SDLC connector. TS2 Type 1 VIVDS must include indicators that display detector output status for verification of calls.

Analog video inputs must use BNC connectors or be routed through existing loop inputs using connections designed for that purpose. Analog video outputs must use BNC or RCA connectors. Use of external cable connections to create a combined video output is not allowed.

Ensure processor includes provisions to view video image in the field and remotely.

VIVDS processors installed in the traffic controller cabinet must utilize digital video or accommodate asynchronous, synchronous, and line-locked analog video as part of a complete system engineered by the VIVDS manufacturer.

- 2.8. **Camera Interface Panel.** Supply the VIVDS with a camera interface panel as required by the manufacturer that provides a cabinet connection point between field wiring from VIVDS cameras and VIVDS equipment in the cabinet. The interface panel must be provided by the VIVDS manufacturer as part of a complete engineered system. The panel must include terminal facilities and surge suppression for all conductors used to connect VIVDS field equipment, including camera power and communications. Interface panels for analog cameras must include a 10-amp breaker or blade type fuses and a power terminal strip with a minimum of eight 8/32 binder head screws for camera power connections. The panel must also have, as a minimum, four coax protectors (EDCO CX06 or equivalent). Additional lightning and transient protection will be allowed. All components that reside on the panel must be Department approved. For cameras utilizing POE the interface panel must consist of surge protection meeting GR 1089 standards.

Ensure interface panel is capable of being mounted on the side walls of the controller cabinet. Video connections must be isolated from earth ground.

- 2.9. **Cabling.** Supply the VIVDS with connector cables of the appropriate length for each installation site. Connector cables must include all conductors necessary for power, video, and communication. All cabling used must meet the minimum recommended specifications of the VIVDS manufacturer.

Ensure the power and data cable connectors are IP 67 to protect against intrusion of solids and water. External connectors must be quick disconnect and keyed to prevent improper connections. All wiring must be color coded and marked appropriately. Ensure all conductors that interface with the connector are encased in a single jacket.

Fiber optic cable, if used, must meet the Department requirements as shown in the plans.

If coaxial cable is used, it must be low loss, 75 ohm, precision video cable suited for outdoor installation and approved by the VIVDS manufacturer.

RS-485 and RS-232 communication cable must meet the requirements of Special Specification 6005, "Networking Intelligent Transportation System (ITS) Communications Cable."

- 2.10. **Communication.** Ensure that the VIVDS includes a minimum of one serial or Ethernet communications interface.

Ensure serial interfaces and connectors conform to Telecommunications Industry Association (TIA)-232 standards. Ensure that the serial ports support data rates up to 115200 bps; error detection utilizing parity bits (i.e., none, even, and odd); and stop bits (1 or 2).

Ensure that wired Ethernet interfaces provide a 10/100 Base TX connection. Verify that all unshielded twisted pair or shielded twisted pair network cables and connectors are in accordance with TIA-568.

Ensure wireless communications are secure and that wireless devices are Federal Communications Commission (FCC) certified. Ensure that the FCC identification number is displayed on an external label and that all detection system devices operate within their FCC frequency allocation.

Ensure the system can be configured and monitored via one or more communications interface. Ensure that all communication addresses are user programmable.

- 2.11. **Software.** Ensure the VIVDS manufacturer includes all software required to configure and monitor operation of VIVDS field equipment locally and remotely. VIVDS software must be a stable production release approved by the Department's Traffic Operations Division.

Ensure VIVDS computer software includes a GUI that displays all configured lanes and provides visual representation of all detected vehicles. Server software must be designed to run on the Windows Server operating system (Windows Server 2012 or newer). Client workstation software must be designed to run on Microsoft Windows 7 Professional and newer.

VIVDS software must allow the user to program, operate, exercise, diagnose, and read status of all VIVDS features and functions using a laptop computer.

VIVDS computer software must be able to communicate with VIVDS field devices using TCP/IP and serial connections. The software must provide for local and remote configuration and monitoring, including display of detection zone activations on live video and modification of existing detection zone layouts.

System software must provide the user complete control over the configuration process for VIVDS devices and allow the user to load new firmware into non-volatile memory of VIVDS field devices locally and over any supported communication channel including TCP/IP networks.

The system software must include the ability to retrieve and store data collected by VIVDS field devices.

Ensure all licenses required for operation and use of software are included at no additional cost.

Software updates must be provided at no additional cost during the warranty period.

- 2.12. **Mechanical.** VIVDS detector card rack units must be in accordance with dimensions specified in NEMA TS2-2016, 6.5.2.2.2.

Ensure that all parts are fabricated from corrosion resistant materials, such as plastic, stainless steel, aluminum, or brass.

Ensure that all screws, nuts, and locking washers are stainless steel. Do not use self-tapping screws.

Ensure equipment is clearly and permanently marked with manufacturer name or trademark and part number as well as date of manufacture or serial number.

Ensure VIVDS is modular in design for ease of field replacement and maintenance.

All printed circuit boards must have conformal coating to protect against moisture and fungus.

- 2.13. **Electrical.** Ensure equipment is designed to protect personnel from exposure to high voltage during installation, operation, and maintenance. Ensure all connections include the manufacturer recommend surge protective device (SPD). SPDs must not interfere with the performance of the VIVDS. VIVDS electrical design must be modular.

Ensure the VIVDS operates on nominal 120 V_{AC}. A power converter must be provided for devices that do not operate on nominal 120 V_{AC}. Camera sensors must operate between 12 V_{DC} and 28 V_{DC}.

- 2.14. **Environmental.** All VIVDS devices must operate properly during and after being subjected to the environmental testing procedures described in NEMA TS2, Section 2. VIVDS cameras must be able to

withstand the maximum wind load defined in the Department's basic wind velocity zone map standard without any damage or loosening from structure.

- 2.15. **Connectors and Harnesses.** External connections exposed to the outdoor environment must be made with weatherproof connectors. Connectors must be keyed to ensure correct alignment and mating.

Ensure all conductors are properly color coded and identified. Ensure that every conductive contact surface or pin is gold-plated or made of a noncorrosive, nonrusting, conductive metal.

RS-485 and RS-232 communication cables must:

- be shielded, twisted pair cable with a drain wire;
- have a nominal capacitance conductor to conductor @ 1Khz $\geq 26\text{pF/ft.}$;
- have nominal conductor DC resistance @ 68°F $\leq 15\text{ ohms/1,000 ft.}$;
- be one continuous run with no splices; and
- be terminated only on the two farthest ends of the cable.

- 2.16. **Documentation.** Provide hardcopy operation and maintenance manuals, along with a copy of all product documentation on electronic media. Include the following documentation for all system devices and software:

- operator manuals,
- installation manuals with installation procedures,
- maintenance and troubleshooting procedures, and
- manufacturer's specifications (functional, electrical, mechanical, and environmental).

Provide certification from an independent laboratory demonstrating compliance with NEMA TS2 environmental requirements for temperature, humidity, transients, vibration, and shock.

Provide certification that VIVDS electronic equipment meets FCC Class B requirements for electromagnetic interference and emissions.

Ensure the VIVDS system manufacturer has a quality assurance program for manufacturing VIVDS as described in this specification. Manufacturer of the VIVDS must be ISO 9001 certified or provide a copy of the company quality manual for review.

The VIVDS must pass testing to ensure functionality and reliability before delivery. Test results and supporting documentation, including serial number tested, must be submitted for each VIVDS. If requested, manufacturing data per serial number must be provided for each VIVDS.

- 2.17. **Warranty.** Warrant the equipment against defects or failure in design, materials, and workmanship for a minimum of 5 yr. or in accordance with the manufacturer's standard warranty if that warranty period is greater. The start date of the manufacturer's standard warranty will begin after the equipment has successfully passed all tests contained in the final acceptance test plan. Any VIVDS equipment with less than 90% of its warranty remaining after the final acceptance test is completed will not be accepted by the Department. Guarantee that equipment furnished and installed for this project performs per the manufacturer's published specifications. Assign, to the Department, all manufacturer's normal warranties or guarantees on all electronic, electrical, and mechanical equipment, materials, technical data, and products furnished for and installed on the project.

Malfunctioning equipment must be repaired or replaced at the Contractor's expense before completion of the final acceptance test plan. Furnish replacement parts for all equipment within 10 days of notification of failure by the Department.

During the warranty period, technical support must be available via telephone within 4 hr. of the time a call is made by a user, and this support must be available from factory certified personnel.

- 2.18. **Training.** Conduct a training class for a minimum of 8 hr., unless otherwise directed, for up to 10 representatives designated by the Department on installation, configuration, operation, testing, maintenance, troubleshooting, and repair. Submit a training session agenda, a complete set of training material, the names and qualifications of proposed instructors, and proposed training location for approval at least 30 days before the training. Conduct training within the local area unless otherwise directed. Provide one copy of course material for each attendee. Ensure that training includes:
- “hands-on” operation of system software and equipment;
 - explanation of all system commands, their function and usage; and
 - system “troubleshooting,” operation, and maintenance.

3. CONSTRUCTION

- 3.1. **System Installation.** Install VIVDS devices and configure detection zones and settings as shown on the plans, in accordance with the manufacturer’s recommendations, and as directed. Provide configuration file backups, including detector placement, names, communication settings, and output assignments. Completion of the work must present a neat, workmanlike, and finished appearance.
- VIVDS installer must be certified by VIVDS manufacturer in proper installation setup and procedures. VIVDS integrator must be certified by the manufacturer for training end users in the maintenance, configuration, and operation of VIVDS.
- Ensure VIVDS detector rack cards are properly installed and seated in the controller cabinet detector rack and use the card edge connector to obtain power and provide outputs. Rewiring the backplane or any other cabinet panel for the system is not permitted except for power and grounding for camera interface panels, wiring from the video camera sensor to the loop detector panel for the video signal inputs, as applicable, and wiring to obtain power for the VIVDS cameras.
- Mount and aim cameras in a manner that eliminates as much environmentally generated glare as possible.
- All wiring must be cut to proper length before assembly. Provide cable service loops. All cable slack must be neatly laced and placed in the bottom of the cabinet. Ensure cables are secured with clamps. Ensure cables between the controller cabinet and VIVDS cameras are continuous with no splices.
- Provisions must be made for installation and configuration of software on Department computers.
- 3.2. **Temporary Use.** When shown on the plans, the VIVDS equipment must be used to provide vehicle detection on a temporary basis. When the permanent vehicle detection system and related equipment are installed and made operational, the VIVDS equipment must be carefully removed and delivered to the location shown on the plans.
- 3.3. **Mechanical Components.** Ensure that all fasteners, including bolts, nuts, and washers with a diameter less than 5/8 in. are Type 316 or 304 stainless steel and meet the requirements of ASTM F593 and ASTM F594 for corrosion resistance. Ensure that all bolts and nuts 5/8 in. and over in diameter are galvanized and meet the requirements of ASTM A307. Separate dissimilar metals with an inert dielectric material.
- 3.4. **Wiring.** All wiring and electrical work supplying the equipment must meet the requirements of the most current version of the National Electrical Code (NEC). Supply and install all wiring necessary to interconnect VIVDS cameras to the controller cabinet and incidentals necessary to complete the work. If additional cables are required, the Contractor must furnish and install them at no additional cost to the Department. Provide conductors at least the minimum size indicated on the plans and insulated for 600 V.
- Cables must be cut to proper length before assembly. Provide cable slack for ease of removal and replacement. All cable slack must be neatly laced with lacing or straps in the bottom of the cabinet. Ensure cables are secured with clamps and include service loops.

- 3.5. **Electrical Service.** The Contractor is responsible for checking the local electrical service to determine if a modification is needed for the equipment.
- 3.6. **Grounding.** Ensure all VIVDS devices and supports are grounded in conformance with the NEC and manufacturer recommendations.
- 3.7. **Relocation of VIVDS Field Equipment.** Perform the relocation in strict conformance with the requirements herein and as shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during relocation.
- Inspect the existing VIVDS field equipment with a representative from the Department and document any evidence of damage before removal. Conduct a pre-removal test in conformance with the testing requirements contained in this Item to document operational functionality. Remove and deliver equipment that fails inspection to the Department.
- Before removal of existing VIVDS field equipment, disconnect and isolate the power cables from the electric power supply and disconnect all communication cabling from the equipment located inside the cabinet. Coil and store power and communication cabling inside the cabinet until such time that it can be relocated. Remove existing VIVDS field equipment as shown on the plans only when authorized.
- Use care to prevent damage to any support structures. Any equipment or structure damaged or lost must be replaced by the Contractor (with items approved) at no cost to the Department.
- Make all arrangements for connection to power and communications including any permits required for the work to be done under the Contract. Provide conductors for the power connection at least the minimum size indicated on the plans and insulated for 600 V. Meet the requirements of the NEC most current version.
- 3.8. **Removal of VIVDS Field Equipment.** Perform the removal in strict conformance with the requirements herein and as shown on the plans. Completion of the work will present a neat, workmanlike, and finished appearance. Maintain safe construction practices during removal.
- Disconnect and isolate any existing electrical power supply before removal of existing field equipment.
- Use care to prevent damage to any support structures. Any equipment or structure damaged or lost must be replaced by the Contractor (with items approved) at no cost to the Department.
- All materials not designated for reuse or retention by the Department will become the property of the Contractor and be removed from the project site at the Contractor's expense. Deliver items to be retained by the Department to a location shown on the plans or General Notes. The Contractor is fully responsible for any removed equipment until released.
- 3.9. **Contractor Experience Requirements.** Contractor or designated subcontractor must meet the following experience requirements:
- 3.9.1. **Minimum Experience.** Three years of continuous existence offering services in the installation of VIVDS.
- 3.9.2. **Completed Projects.** Three completed projects where personnel installed, tested, and integrated VIVDS field equipment. The completed installations must have been in continuous satisfactory operation for a minimum of 1 yr.
- 3.9.3. **Equipment Experience.** One project (may be 1 of the 3 projects in the preceding paragraph) in which the personnel worked in cooperation with technical representatives of the equipment supplier to perform installation, integration, or acceptance testing of the work. The Contractor will not be required to furnish equipment on this project from the same supplier who was referenced in the qualification documentation.

Submit the names, addresses, and telephone numbers of the references that can be contacted to verify the experience requirements given above.

4. TESTING

Ensure that the following tests are performed on equipment and systems unless otherwise shown on the plans. The Department may witness all the tests.

- 4.1. **Test Procedures Documentation.** Provide an electronic copy of the test procedures and blank data forms 60 days before testing for each test required on this project. Include the sequence of the tests in the procedures. The Engineer must approve test procedures before submission of equipment for tests. Conduct all tests in conformance with the approved test procedures.

Record test data on the data forms as well as quantitative results. Ensure the data forms are signed by an authorized representative (company official) of the equipment manufacturer.

- 4.2. **Design Approval Test.** Ensure that the VIVDS has successfully completed a design approval test that confirms compliance with the environmental requirements of this Specification.

Provide a certification and test report from an independent testing laboratory as evidence of a successfully completed design approval test. Ensure that the testing by this laboratory is performed in conformance with the requirements of this Specification.

- 4.3. **Demonstration Test.** Conduct a demonstration test on applicable equipment at an approved Contractor facility. Notify the Engineer 10 working days before conducting this testing. Perform the following tests:

- 4.3.1. **Examination of Product.** Examine each unit carefully to verify that the materials, design, construction, markings, and workmanship comply with the requirements of this Specification.

- 4.3.2. **Continuity Tests.** Check the wiring to determine conformance with the requirements this Specification.

- 4.3.3. **Operational Test.** Operate each unit for at least 15 min. to permit equipment temperature stabilization and observation of a sufficient number of performance characteristics to ensure compliance with this Specification.

- 4.4. **Stand-Alone Test.** Conduct a stand-alone test for each unit after installation. The test must exercise all stand-alone (non-network) functional operations. Notify the Engineer 5 working days before conducting this test.

- 4.4.1. **Performance Test.** Ensure the VIVDS meets functional performance requirements of Section 2.55. using the following methods:

Verify presence detection accuracy at installed field sites by comparing sample data collected from the detection system with ground truth data collected by human observation. Collect samples and ground truth data for each detection zone for a minimum of 5 min. during a peak period and 5 min. during an off-peak period. Ensure the sample period for each zone includes a minimum of three vehicles. Perform tests in the presence of the Engineer.

Recorded video of all cameras showing vehicle detections during a 24-hr. period at each intersection must be provided within 30 days upon request. This video must allow verification of proper camera placement, field of view, focus, detection zone placement, and operation.

- 4.5. **System Integration Test.** Conduct a system integration test on the complete functional system. Demonstrate all control and monitor functions for each system component and operate the system for 72 hr. Supply two copies of the system operations manual before the system integration test. Notify the Engineer

10 working days before conducting this testing. The Department may witness all the tests. Conduct a system integration test on the complete functional system. Demonstrate all control and monitor functions for each system component for 72 hr. Supply two copies of the system operations manual before the system integration test. Notify the Engineer 10 working days before conducting this testing.

- 4.6. **Consequences of Test Failure.** If a unit fails a test, submit a report describing the nature of the failure and the actions taken to remedy the situation before modification or replacement of the unit. If a unit requires modification, correct the fault and then repeat the test until successfully completed. Correct minor discrepancies within 30 days of written notice to the Engineer. If a unit requires replacement, provide a new unit and then repeat the test until successfully completed. Major discrepancies that will substantially delay receipt and acceptance of the unit will be enough cause for rejection of the unit.

If a failure pattern develops in similar units within the system, implement corrective measures, including modification or replacement of units, to all similar units within the system as directed. Perform the corrective measures without additional cost or extension of the contract period.

- 4.7. **Final Acceptance Test.** Conduct a final acceptance test on the complete functional system. Demonstrate all control, monitor, and communication requirements and operate the system for 90 days. The Engineer will furnish a letter of approval stating the first day of the final acceptance test. The completion of the final acceptance test occurs when system downtime due to mechanical, electrical, or other malfunctions to equipment furnished or installed does not exceed 72 hr. and any individual points of failure identified during the test period have operated free of defects.

- 4.8. **Consequences of Final Acceptance Test Failure.** If a defect within the system is detected during the final acceptance test, document and correct the source of failure. Once corrective measures are taken, monitor the point of failure until a consecutive 30-day period free of defects is achieved.

If after completion of the initial test period, the system downtime exceeds 72 hr. or individual points of failure have not operated for 30 consecutive days free of defects, extend the test period by an amount of time equal to the greater of the downtime more than 72 hr. or the number of days required to complete the performance requirement of the individual point of failure.

- 4.9. **Relocation and Removal.**

- 4.9.1. **Pre-Test.** Tests may include, but are not limited to, physical inspection of the unit and cable assemblies. Include the sequence of the tests in the procedures along with acceptance thresholds. Contractor to resubmit, if necessary, rejected test procedures for final approval within 10 days. Review time is calendar days. Conduct all tests in conformance with the approved test procedures.

Conduct basic functionality testing before removal of VIVDS field equipment. Test all functional operations of the equipment in the presence of representatives of the Contractor and the Department. Ensure that both representatives sign the test report indicating that the equipment has passed or failed each function. Once removed, the equipment becomes the responsibility of the Contractor until accepted by the Department. Compare test data before removal and test data after installation. The performance test results after relocation must be equal to or better than the test results before removal. Repair or replace those components within the system that failed after relocation but passed before removal.

- 4.9.2. **Post-Test.** Testing of the VIVDS field equipment is for relieving the Contractor of maintenance of the system. The Contractor will be relieved of the responsibility for maintenance of the system in accordance with Item 7, "Legal Relations and Responsibilities," after a successful test period. The Contractor will not be required to pay for electrical energy consumed by the system.

After all existing VIVDS field equipment has been installed, conduct approved continuity, stand alone, and performance tests. Furnish test data forms containing the sequence of tests including all the data taken as well as quantitative results for all tests. Submit the test data forms to the Engineer at least 30 days before the

day the tests are to begin. Obtain Engineer's approval of test procedures before submission of equipment for tests. Send at least one copy of the data forms to the Engineer.

Conduct an approved stand-alone test of the equipment installation at the field sites. At a minimum, exercise all stand-alone (non-network) functional operations of the field equipment installed per the plans as directed. Complete the approved data forms with test results and turn over to the Engineer for review and either acceptance or rejection of equipment. Give at least 30 working days' notice before all tests to permit the Engineer or his representative to observe each test.

The Department will conduct approved VIVDS field equipment system tests on the field equipment with the central equipment. The tests will, as a minimum, exercise remote control functions and confirm communication with field equipment.

If any unit fails to pass a test, prepare a report and deliver it to the Engineer. Describe the nature of the failure and the corrective action needed. If the failure is the result of improper installation or damage during reinstallation, reinstall or replace the unit and repeat the test until the unit passes successfully, at no additional cost to the Department or extension of the Contract period.

5. MEASUREMENT

The VIVDS will be measured as each major system component furnished, installed, relocated, made fully operational, and tested or removed in accordance with this Special Specification or as directed.

The VIVDS communication cable will be measured by the foot of the appropriate media type furnished, installed, made fully operational, and tested in accordance with this Specification, other referenced Special Specifications, or as directed.

When the VIVDS is used on a temporary basis, the VIVDS will be measured as each system furnished, installed, made fully operational, including reconfiguration and removal if required by the plans, and tested in accordance with this Special Specification or as directed.

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

When recorded, video is required. It will be paid for by each camera recorded.

6. PAYMENT

- 6.1. **Furnish and Install.** The work performed, materials, and all accompanying software furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "VIVDS Processor System," "VIVDS Camera Assembly" of the various types, "VIVDS Central Control Software," "VIVDS Temporary," "VIVDS Cabling," and "VIVDS Video Recording." These prices are full compensation for furnishing, configuring, placing, and testing all materials and equipment, and for all tools, labor, equipment, hardware, operational software packages, supplies, support, personnel training, shop drawings, documentation, and incidentals.

These prices include all interfaces required for the field and remote communications links along with any associated peripheral equipment, including cables; all associated mounting hardware and associated field equipment; and incidentals required for a complete and fully functional video imaging vehicle detection system.

- 6.2. **Install Only.** The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "VIVDS Processor System (Install Only)," "VIVDS Camera Assembly (Install Only)," "VIVDS Temporary (Install Only)," and "VIVDS Cabling (Install Only)." This price is full compensation for installing,

configuring, integrating, and testing the completed installation, including VIVDS equipment, voltage converters or injectors, cables, connectors, associated equipment, and mounting hardware; and for all labor, tools, equipment, documentation, testing, training, software, and incidentals necessary to complete the work.

- 6.3. **Relocate.** The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "VIVDS Processor System (Relocate)," "VIVDS Camera Assembly (Relocate)," "VIVDS Temporary (Relocate)," and "VIVDS Cabling (Relocate)." This price is full compensation for relocating and making fully operational existing equipment; furnishing and installing additional cables or connectors; testing, delivery, and storage of components designated for salvage or reuse; and all labor, tools, equipment, and incidentals necessary to complete the work.
- 6.4. **Remove.** The work performed and materials furnished in accordance with this Item will be paid for at the unit bid price for "VIVDS Processor System (Remove)," "VIVDS Camera Assembly (Remove)," "VIVDS Temporary (Remove)," and "VIVDS Cabling (Remove)." This price is full compensation for removing existing equipment as shown on the plans; testing, delivery, and storage of components designated for salvage; and all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Special Specification 6007

Battery Back-Up System for Signal Cabinets



1. DESCRIPTION

Install a battery back-up (BBU) system for traffic signals that provides reliable emergency power in case of utility power failure or interruption. The BBU system should also function as a power conditioner or voltage regulation device.

The BBU system should consist of inverter/charger, manual bypass switch, power transfer switch or automatic bypass switch, batteries, battery monitoring device, wiring, external cabinet or stand-alone cabinet, concrete pad, all necessary hardware and software, and any associated equipment required to operate in a field environment.

The BBU system should be able to operate a light-emitting diode- (LED-) only signalized intersection (700-W load) for 4 hr. of full runtime when utility power is disabled and under ambient temperature of 25°C. The BBU system should switch the intersection to flash mode of operation when approximately 40% of battery charge is remaining, using relay contact connection points on the front panel of the unit. The BBU system should operate the intersection in the flash mode of operation (300-W load) for an additional 2 hr. BBU system components must be rated for a minimum 1,400-W load capacity.

Design the BBU system for outdoor applications in accordance with NEMA TS2-2003, Section 2. All components of the BBU system should be rated to operate under temperature extremes of -34°C—+74°C.

2. DEFINITIONS

- 2.1. **Automatic Bypass Switch.** A unit connected between the utility power supply and the inverter/charger that can automatically switch power to the controller cabinet service panel from inverter output power to utility line power.
- 2.2. **BBU System.** Includes, but is not limited to, a manual bypass switch, automatic bypass switch or power transfer switch, inverter/charger, batteries, battery monitoring device, wiring, external cabinet, and any necessary hardware for system operation.
- 2.3. **BBU System Software.** All software associated with operation, programming, and functional requirements of the BBU system.
- 2.4. **Battery Monitoring Device.** The device that monitors battery temperatures and charge rate of the batteries used in the BBU system.
- 2.5. **Batteries.** Standard 12-V batteries wired in series to create 36-V DC – 96-V DC storage.
- 2.6. **Boost.** When enabled, the BBU system inverter/charger should automatically switch into this mode to raise the utility line voltage when it drops below a preset limit. The limit may be user-defined or use manufacturer default settings (typically 100 V AC).
- 2.7. **Buck.** When enabled, the unit should automatically switch into this mode to reduce the utility line voltage when it rises above a preset limit. The limit may be user-defined or use manufacturer default settings (typically 135 V AC).
- 2.8. **External or Stand-Alone Cabinet.** The structure that houses the system components or batteries.

- 2.9. **Inverter/Charger.** The unit that converts the DC voltage input into 120-V AC output for the traffic signal cabinet to operate. At minimum, the inverter/charger should be rated for 1,400 W.
- 2.10. **Inverter Line Voltage.** The power supplied from the BBU system inverter to the traffic signal cabinet.
- 2.11. **Manual Bypass.** Manual switch that allows user to bypass BBU power to service system equipment. The manual bypass switch switches utility line power directly to cabinet.
- 2.12. **Power Transfer Switch.** A unit connected between the utility power supply and the inverter/charger that can automatically switch from utility line power to inverter output power. The power transfer relay may be a separate unit or combined with the manual bypass switch. In case of battery voltage loss, the power transfer switch must automatically return to utility line power.
- 2.13. **Signal Operation Mode.** A signalized intersection generating a 700-W load when running in normal operation.
- 2.14. **Signal Flash Mode.** A signalized intersection generating a 300-W load when running in the flash mode of operation.
- 2.15. **Utility Line Voltage.** The 120-V AC power supplied to the BBU system.

3. EQUIPMENT

Ensure electrical materials and construction methods conform to NEC and additional local utility requirements. Furnish BBU systems prequalified by the Department. The Traffic Operations Division maintains an MPL of prequalified BBU systems. Ensure all materials and construction methods conform to the details shown on the plans, this Specification, and the pertinent requirements of the following Items.

- Item 420, "Concrete Substructures"
- Item 620, "Electrical Conductors"

Provide and install a BBU system that can fulfill the following requirements.

- 3.1. **Method of Operation.** The BBU system should operate using one or more of the following methods.
- 3.1.1. **Buck-and-Boost Method.** When the buck-and-boost functions are enabled, they should set the upper and lower control limit allowable for the utility line voltage.
- If the utility line voltage fluctuates above or below the buck-and-boost values, the BBU system should raise or lower the voltage by approximately 10%–15% of the utility line voltage to bring the voltage back within the upper and lower control limits. Provide a buck-and-boost system with preset manufacturer defaults.
- If the utility line voltage falls above or below the functional capabilities of buck and boost, then the BBU system must transfer power from the utility line voltage to the inverter line voltage.
- 3.1.2. **Standby Method.** The standby method should set upper and lower control limits for the utility line power. If the utility line voltage falls above or below the upper or lower control limits, then the BBU system should transfer power from the utility line voltage to the inverter line voltage.
- 3.1.3. **Continuous Operating Mode, Double Conversion Method.** The continuous method always supplies the cabinet with inverter line voltage. This method requires the disabling of buck-and-boost functions.
- 3.2. **BBU System Capabilities.** The BBU system should be able to provide 1,400-W peak load, with at least 80% inverter efficiency, for at least 10 sec.

The BBU system should be able to provide 700-W signal operation load for at least 4 hr., and then switch to and provide 300-W signal flash load for an additional 2-hr. minimum, when batteries are fully charged.

When the BBU system runs on battery power, the inverter/charger should enable a user to select the voltage at which the transition from normal operating load to flash mode occurs (usually 47.5 V), using relay contacts and connection points on the front panel of the inverter/charger.

The allowed transfer time, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, should be less than 65 milliseconds. The same allowable transfer time must also apply when switching from inverter line voltage to utility line voltage.

The BBU system should bypass utility line voltage whenever the voltage is outside the manufacturer's default, or a user-programmed voltage range, ± 2 V AC.

When the utility line power has been restored to a normal operating voltage for more than a user-defined setting (default 30 sec.), the BBU system should transfer from inverter line voltage to utility line voltage. The BBU system should be equipped to prevent malfunction feedback to the cabinet or the utility service.

Provide a BBU system that is compatible with TS1, TS2, and Model 170/2070 controllers and cabinet components for full runtime operation.

Unless the plans indicate otherwise, provide a BBU system in an external battery cabinet. When indicated by the plans, provide a BBU system that can be shelf-mounted in NEMA TS-1 and NEMA TS-2 cabinets, or rack-mounted for Model 170/2070 332 cabinets. Provide a manual bypass that can be shelf-mounted or attached to the side of the signal cabinet. Provide interconnect cables that are no less than 10 ft. long.

Relay contact wiring for each set of NO/NC relay contact closure terminals should be no less than 6 ft. long and #18 AWG wire. Use manufacturer recommendations for size of wire for any cable's lengths greater than 10 ft.

The BBU system should have lightning surge protection compliant with IEEE/ANSI C 62.41 and UL 1449. Provide lightning surge protection to the utility line voltage entering the inverter/charger. The surge protection device should be easily accessible and mounted externally from the inverter/charger.

The BBU system, including batteries and hardware, should be easily replaceable and should not require any special tools for installation.

The BBU system should operate in automatic fail-safe mode. Should a breaker trip the inverter/charger or power transfer switch on, the system must automatically operate from utility line power and bypass the BBU system.

As stated above, in addition to the inverter/charger, provide BBU with an external manual bypass switch and either an external automatic transfer switch or external automatic bypass switch.

The BBU system must be able to log up to 100 events. Events should date- and time-stamp faults with utility line voltage and battery voltages. At a minimum, the BBU system should log an event when:

- the utility line voltage falls above or below the upper or lower control limits,
- the BBU system automatically switches to battery power, or
- self-monitoring BBU system components fail.

3.3. **Displays, Controls, Diagnostics, and Maintenance.** The BBU system should include a front panel display. All applicable programmable functions of the operational methods described in this Specification should be viewable from the front panel display.

All events described in Section 3.2., "System Capabilities," should be viewable from the front panel display.

The BBU system software should be programmable from the front panel of the inverter/charger using a keyboard or momentary buttons, allowing user to step through menu-driven software.

Provide a 10/100 Ethernet port on the front panel of the inverter/charger.

Provide a RS232 port on the front panel of the inverter/charger.

Include software for the BBU system's operational needs. The user/operator should be able to access the system software via the Ethernet and RS232 ports on the front panel of the inverter/charger. The user should be able to read logged events and change programmable parameters from the keyboard, laptop, or local area network by the Ethernet port.

System software must be upgradeable by the RS232 port on the front panel of the inverter/charger.

- 3.4. **Inverter/Charger.** The inverter/charger is the unit that provides voltage regulation, conditioning of utility line power, DC voltage input conversion into 120-V AC output for the traffic signal cabinet to operate, emergency backup power upon loss of utility power, and temperature-compensated battery charging. At a minimum, the inverter/charger should be rated for 1,400 W. Provide at least six sets of Normally Open (NO) and Normally Closed (NC) single-pole double-throw dry contact relay closures on the front face of the inverter/charger, labeled to identify each contact. The relay closures should consist of NO/NC contact closures energized whenever the unit switches to battery power (label or mark contacts as "on battery" or equivalent), and a second set of NO/NC contact closures should be energized whenever the battery approaches 40% remaining capacity (label or mark contact as "low battery" or equivalent), which must determine when the unit will switch from normal operation to flash. A third set of NO/NC contact closures should be energized after a user-settable time after the unit switches to battery power. The contact may be labeled "timer." The remaining relays should be user-definable.

Operating temperature range for the inverter/charger and power transfer relay should be -34°F--74°F. When battery power is used, the BBU system output voltage must be between 110 V AC and 125 V AC, pure sine wave output, ≤3% THD, 60 Hz ±3 Hz.

- 3.5. **Manual Bypass Switch.** The manual bypass switch should be provided as a separate unit external to the inverter/charger unit. The manual bypass switch must consist of housing, two-position switch, terminal blocks, internal wiring, service outlet, circuit breakers, and mounting hardware. The components should be rated at least 240 V AC/30 A. Provide the manual bypass switch with No. 8 terminal blocks. The manual bypass switch should be two-position and allow the user to switch utility line power directly to the cabinet service panel. The switch positions must provide the following functions.
- In the "Bypass" position, the inverter is bypassed, and utility power is removed from the BBU and passed directly to the signal power panel.
 - In the "UPS" position, the inverter/switch is powered, and the signal circuits are supplied by the output of the inverter.

When the manual bypass switch is in the "Bypass" position, the user may replace the automatic bypass switch (or transfer switch) and the inverter/charger without interrupting power to the intersection. Provide the manual bypass switch with overcurrent protection (20-A circuit breaker).

- 3.6. **Power Transfer Switch.** These requirements are for BBU systems provided with a power transfer switch. The power transfer switch must operate such that the inverter/charger input and cabinet power panel are supplied with power from the utility line. If the utility line power is lost or requires conditioning (buck or boost), the power transfer switch must automatically connect the inverter/charger output to the cabinet power panel such that the inverter/charger output provides the power. In case of inverter/charger failure, battery failure, or complete battery discharge, the power transfer should revert to the NC (de-energized) state, where utility line power is connected to the cabinet service panel.

Size the wire going to the power transfer switch from the manual bypass switch, to and from the inverter/charger, and from the manual bypass switch to utility power service according to the system requirements.

- 3.7. **Automatic Bypass Switch.** These requirements are for BBU systems provided with an automatic bypass switch. The automatic bypass switch must operate such that the inverter/charger input is supplied with power from the utility line and the cabinet power panel is supplied with power from the output of the inverter/charger. In case of inverter/charger failure, battery failure, or complete battery discharge, or other loss of power from the output of the inverter/charger, the automatic bypass switch should revert to the NC (de-energized) state, where utility line power is connected to the cabinet service panel.

- 3.8. **Batteries.** Provide batteries from the same manufacturer and vendor as the BBU system.

Individual batteries should be 12-V type, easily replaceable, and available for purchase, or common off-the-shelf equivalent.

Select batteries sized and rated to operate a 700-W load for 4 hr. (normal operation) followed by a 300-W load for 2 hr. (flash operation), for a total of 6 hr.

Battery configuration should consist of 12-V batteries arranged for total voltages of 36, 48, 60, 72, 84, or 96.

Batteries should be deep-discharge, sealed prismatic lead-calcium based, valve-regulated, and maintenance-free.

Batteries should operate over a temperature range of -34°F—+74°F.

Batteries should indicate maximum recharge data and recharging cycles, and manufacturer defaults on the inverter/charger should not allow the recharging process to exceed the batteries' maximum values.

Connect the battery interconnect wiring to the inverter unit using a modular harness with red and black cabling that terminates into a typical power-pole style connector. Equip the harness with mating power flag-style connectors for batteries and a single insulated plug-in style connection to inverter/charger unit. Harness should allow batteries to be quickly and easily connected in any order, and keyed to ensure proper polarity and circuit configuration. Size the fusible link or device accordingly with BBU system requirements. To protect against currents exceeding each battery current rating, provide links within 3 in. of the negative and positive leads of each battery. Provide fusible links made of insulated stranded wire.

Provide insulated covers at the connection points (posts) to prevent accidental shorting.

Provide battery cables to connect battery to battery harness main cable at least 18 in., or long enough to accommodate the battery covers provided with the battery ground box, whichever is longer. Size the battery harness accordingly with BBU system requirements.

- 3.9. **Battery Monitoring System.** The BBU system should use a temperature-compensated battery charging system. The charging system should compensate over 2.5 mV/°C–4.0 mV/°C per cell.

Use a temperature sensor to monitor the temperature and regulate the charge rate of the batteries. Unless required otherwise by the plans, provide a temperature sensor wire as follows.

- 8 ft. long if external side-mounted cabinet is attached to existing controller cabinet
- 8 ft. long if batteries are housed in traffic signal base used for cabinet foundation and are stored on shelf within base
- 8 ft. long if a stand-alone cabinet is used

Should the temperature sensor fail, the inverter/charger should not allow the BBU system to overcharge the batteries. The BBU system should provide an alarm should the temperature sensor fail.

Recharge time for the batteries to obtain 80% or more of full battery charge capacity should not exceed 20 hr. at 70°F.

Batteries should not be allowed to charge when the battery temperature exceeds 50°F.

The BBU system should monitor battery strings within a system and set a fault indicator if the battery voltage falls below normal operating voltage.

- 3.10. **Battery Housing.** Unless plans require otherwise, provide an external battery cabinet or stand-alone BBU and battery cabinet as specified below.

- 3.10.1. **External Battery Cabinet.** The external cabinet should be NEMA Type 3R all-aluminum with stainless steel hardware, or approved equivalent. Design the external cabinet to attach on the side of a TS2 Size 6 base-mount cabinet. Mount the batteries, inverter, transfer switches, manual bypass, and associated hardware in the external cabinet.

Equip the external cabinet with proper ventilation, electric fan, and air filter in accordance with NEMA TS2.

Equip external cabinets with a door opening to the entire cabinet. Attach the door to the cabinet with a full-length stainless steel piano hinge or four two-bolts-per-leaf hinges. Provide a door with the same latch and lock mechanism as required for a standard traffic signal cabinet. In addition, provide a padlock clasp.

When using battery ground boxes, an external cabinet is required for the non-battery components.

- 3.10.2. **Stand-Alone BBU and Battery Cabinet.** When required for installation by the plans, provide a stand-alone cabinet conforming to the specifications of the external BBU and battery cabinet, except that it must not mount to the controller cabinet. Design the stand-alone cabinet to attach to a concrete pad.

- 3.11. **Concrete Pad.** Provide a Class B concrete pad as a foundation for stand-alone cabinets. For external cabinets, extend the controller foundation to provide a Class B concrete pad under the external cabinet.

- 3.12. **Documentation.** Provide operation and maintenance manuals. The operation manual should include a block diagram schematic of system hardware components. The manual should include instructions for programming and viewing software features. The manual should also include uploading and downloading (communications protocol) requirements by RS232 or Ethernet port.

Provide board-level schematics when requested.

Provide battery documentation and replacement information.

- 3.13. **Testing.** The Department reserves the right to test BBU systems to ensure quality assurance on unit before installation and random sampling of units being provided to the State. BBU systems that fail must be removed from the Qualified Products List (QPL).

Department QPL testing procedures must check compliance with the criteria of this Specification, including the following.

- Event logging for fault and alarm conditions
- Demonstrated use of one or more of the operating methods described in Section 3.1., "Method of Operation"
- Testing of ability to power a 700-W load for 4 hr., transfer to flash mode, and power a 300-W load for additional 2 hr., at an ambient temperature of +75°F
- Testing of all components in environmental chamber (temperature ranges from -30°F to +74°F) following NEMA TS2 2003, Section 2.

- 3.14. **Warranty, Maintenance, and Support.** Provide a BBU with a warranty that requires the manufacturer to replace failed BBUs when non-operable due to defect in material or workmanship within 5 yr. of date of purchase from manufacturer. Supply a BBU with no less than 95% of the manufacturer's warranty remaining on the date when the BBU is installed and begins operating. The replacement BBU must meet this Specification. The Contractor must manage any warranty issues until the date of final acceptance.

Batteries should be warranted for full replacement for 5 yr. Batteries must be defined as bad if they are not able to deliver 80% of battery rating.

4. MEASUREMENT

This Item will be measured by each BBU system installed.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "BBU System" of the type of BBU cabinet specified. This price is full compensation for furnishing, installing, and testing the completed BBU system and associated equipment; mounting hardware; Class B concrete pad; software; conduit; conductors; and equipment, labor, tools, and incidentals.

Special Specification 6043

Spread Spectrum Radios for Traffic Signals



1. DESCRIPTION

Furnish and install spread spectrum radios.

2. MATERIALS

Supply complete manufacturer specifications for radio, antennas, cables, connectors, power supply, mounting hardware, and lightning surge protector, including the exact gain of the antenna.

3. SPREAD SPECTRUM RADIO

Furnish spread spectrum radios with the following operating minimum characteristics:

Table1
Radio Characteristics

Radio Parameters	Radio Requirements
Frequency	902–928 MHz
Range	15 mi. line of sight
Repeat Capabilities	Store and Forward Repeater Capabilities
Power	1.0 Watt Transmitting Power
Environment	Temperature -22°F to 140°F
Fcc Approval	No License Requirements Type acceptance under FCC Part 15.247
Data Characteristics	Half or Full Duplex Operation RS232C interface Selectable 1,200 thru 19,200 bps
Regulated Power Supply	Voltage: 12 DC Amperage: 3 Amp Operating Temp: -22°F to 140°F

Install radios as shown on the plans or as directed.

Supply radios with diagnostic software capable of testing the link between the master radio and the remote radios. Provide software capable of detecting channels which are not adequate for the transmission of data and allow for the exclusion of these frequencies in the selection of frequencies to be scanned.

4. RADIO ANTENNA

Furnish radio antennas with the following minimum characteristics.

Table2
Antenna Characteristics

Antenna Parameters	Antenna Requirements
Remote Site	Unidirectional (Yagi), Min 9 dB gain (dB reference to half wave dipole)
Master Site	Omni-directional, Minimum 6 dB gain (dB reference to half wave dipole)
Range	15 mi.
Impedance	50 Ohm
Wind Rating	125 mi. per hour
Connectors	Type "N" Female

Mount the antenna on a traffic signal pole, an illumination pole, or a separate steel pole as directed. Ground the antenna to the metal support. Do not use a wood pole or support.

5. CABLE

Furnish low loss coaxial cable with the following minimum characteristics.

Table3
Coaxial Cable Characteristics

Cable Parameters	Cable Requirements
Nominal Impedance	50 Ohm
Max Attenuation	4.2 dB/100 ft. at 900 MHz

Furnish heliax type cable for runs over 100 ft. in length. Furnish cable connectors with a type "N" male connector. Install cable connectors in conformance with manufacturer's recommendations. Install cable as shown on the plans or as directed.

Furnish a coaxial protector (PolyPhaser IS-50NX-C2, Andrew APG-BNFF- 090, Huber Suhner 3400-41-0048, or equivalent). Mount coaxial protector adjacent to and bonded to the cabinet ground bus.

6. TESTING, TRAINING, AND WARRANTY

Provide a factory certified representative for installation and testing of the equipment. Conduct a test site survey before the installation of the equipment. The Department reserves the right to conduct their own site survey as needed.

When required, provide up to two days of training to Department personnel in the operation, setup, and maintenance of the spread spectrum radio system. Provide instruction and materials for a maximum of 20 persons and at a location selected by the Department. Provide instruction personnel certified by the manufacturer. The User's Guide is not an adequate substitute for practical classroom training and formal certification.

Provide equipment with no less than 95% of the manufacturer's standard warranty remaining when equipment invoices are submitted for payment. Any equipment with less than 95% of its warranty remaining will not be accepted.

Provide updates of the spread spectrum radio software free of charge during the warranty period, including the update to National Transportation Communications for ITS Protocol (NTCIP) compliancy.

7. MEASUREMENT

This Item will be measured by each spread spectrum radio, antenna and by the foot of cable furnished and installed.

8. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Spread Spectrum Radio," "Antenna" of the type specified, "Coaxial Cable," and "Heliac Cable." The price is full compensation for furnishing, assembling, and installing the spread spectrum radios, antennas, and cable; for mounting attachments; and for testing, labor, tools, equipment, and incidentals.