ORD-0573

Discuss and consider action an ordinance on the first reading with the caption reading: An Ordinance of the City of Pflugerville amending Section 2 - Street Subsection DG2.4 Pavement Design of the 2014 Engineering Design Manual and Construction Standards, replacing all Engineering and Construction Standards in conflict; containing a severability clause; and providing for publication and an effective date.

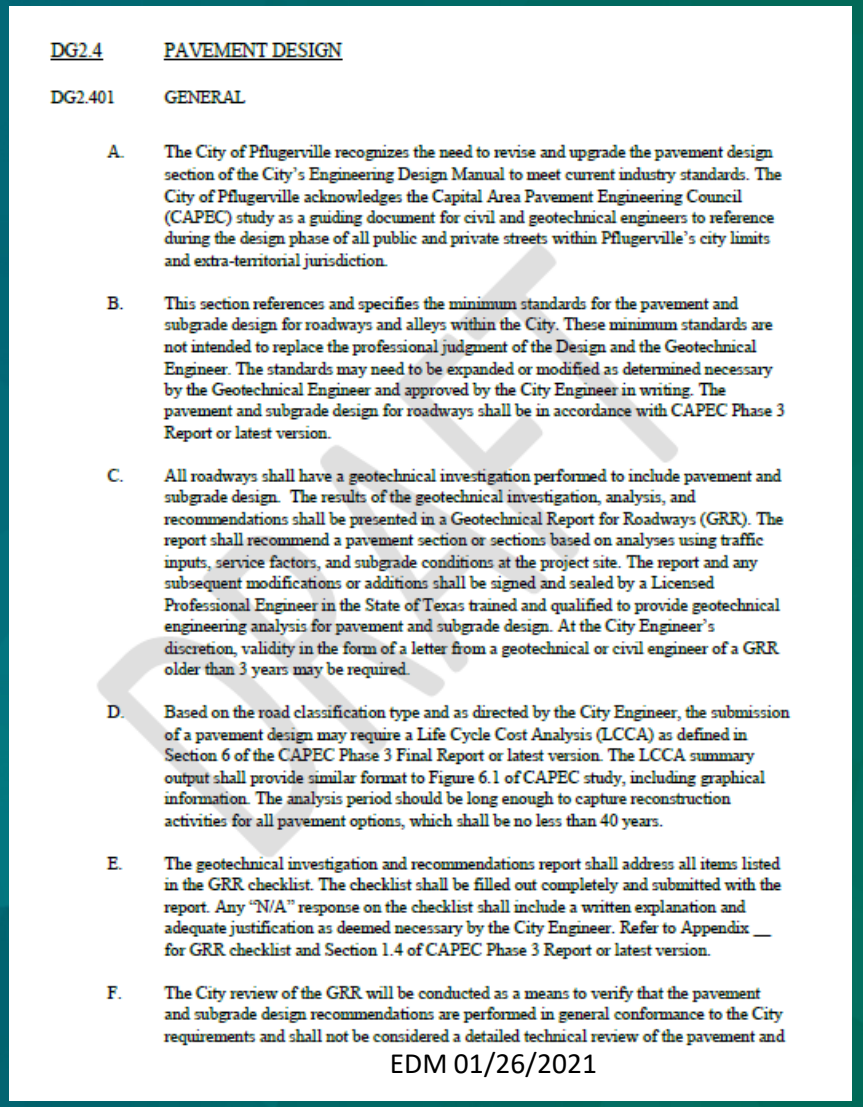
DRAFT Pavement Design Guidelines

The City of Pflugerville recognizes the need to revise and upgrade the pavement design section of the City's Engineering Design Manual to meet current industry standards.

- Capital Area Pavement Engineering Council (CAPEC)
- EDM Guiding document for civil and geotechnical
- Applicable for design of all public streets within Pflugerville's city limits and extra-territorial jurisdiction.

The structural design of a pavement system must be done with a clear understanding of the factors that affect the life and serviceability of the pavement. The objective is to obtain the best quality pavement system considering factors such as: subgrade, traffic loads, pavement material and future maintenance.

City Council 3-9-2021



DG2.4 PAVEMENT DESIGN

DG2.401 GENERAL

A. The City of Pflugerville recognizes the need to revise and upgrade the pavement design section of the City's Engineering Design Manual to meet current industry standards. The City of Pflugerville acknowledges the Capital Area Pavement Engineering Council (CAPEC) study as a guiding document for civil and geotechnical engineers to reference during the design phase of all public and private streets within Pflugerville's city limits and extra-territorial jurisdiction.

B. This section references and specifies the minimum standards for the pavement and subgrade design for roadways and alleys within the City. These minimum standards are not intended to replace the professional judgment of the Design and the Geotechnical Engineer. The standards may need to be expanded or modified as determined necessary by the Geotechnical Engineer and approved by the City Engineer in writing. The pavement and subgrade design for roadways shall be in accordance with CAPEC Phase 3 Report or latest version.

C. All roadways shall have a geotechnical investigation performed to include pavement and subgrade design. The results of the geotechnical investigation, analysis, and recommendations shall be presented in a Geotechnical Report for Roadways (GRR). The report shall recommend a pavement section or sections based on analyses using traffic inputs, service factors, and subgrade conditions at the project site. The report and any subsequent modifications or additions shall be signed and sealed by a Licensed Professional Engineer in the State of Texas trained and qualified to provide geotechnical engineering analysis for pavement and subgrade design. At the City Engineer's discretion, validity in the form of a letter from a geotechnical or civil engineer of a GRR older than 3 years may be required.

D. Based on the road classification type and as directed by the City Engineer, the submission of a pavement design may require a Life Cycle Cost Analysis (LCCA) as defined in Section 6 of the CAPEC Phase 3 Final Report or latest version. The LCCA summary output shall provide similar format to Figure 6.1 of CAPEC study, including graphical information. The analysis period should be long enough to capture reconstruction activities for all pavement options, which shall be no less than 40 years.

E. The geotechnical investigation and recommendations report shall address all items listed in the GRR checklist. The checklist shall be filled out completely and submitted with the report. Any "N/A" response on the checklist shall include a written explanation and adequate justification as deemed necessary by the City Engineer. Refer to Appendix __ for GRR checklist and Section 1.4 of CAPEC Phase 3 Report or latest version.

F. The City review of the GRR will be conducted as a means to verify that the pavement and subgrade design recommendations are performed in general conformance to the City requirements and shall not be considered a detailed technical review of the pavement and

EDM 01/26/2021

TABLE OF CONTENTS – Added subsections

1. GENERAL GUIDANCE

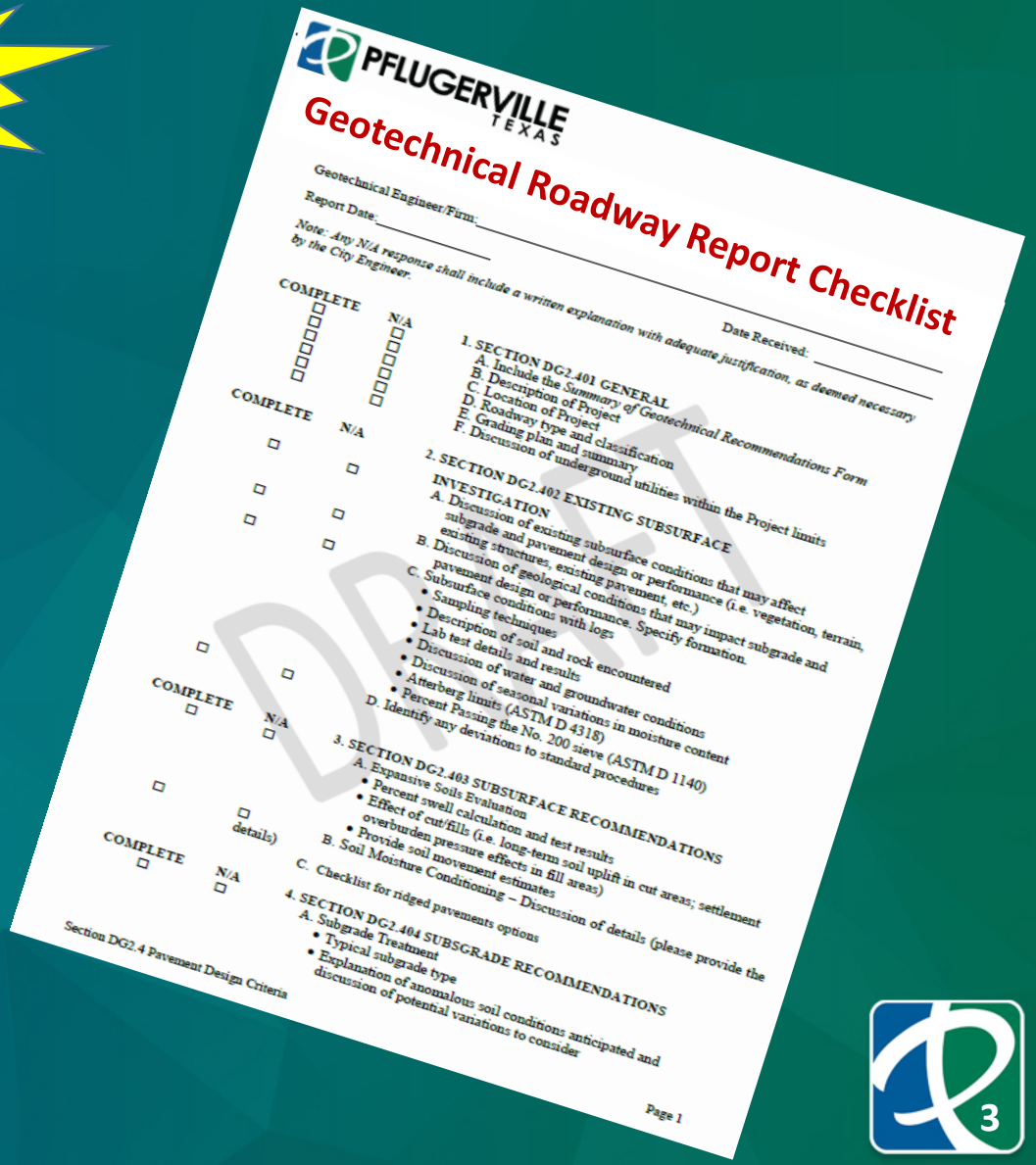
New!

2. SUBSURFACE INVESTIGATION

3. SUBSURFACE RECOMMENDATIONS

4. SUBGRADE RECOMMENDATIONS

5. PAVEMENT RECOMMENDATIONS



PFLUGERVILLE TEXAS

Geotechnical Roadway Report Checklist

Geotechnical Engineer/Firm: _____

Report Date: _____ Date Received: _____

Note: Any N/A response shall include a written explanation with adequate justification, as deemed necessary by the City Engineer.

COMPLETE	N/A	
☐	☐	**1. SECTION DG2.401 GENERAL**
☐	☐	A. Include the *Summary of Geotechnical Recommendations Form*
☐	☐	B. Description of Project
☐	☐	C. Location of Project
☐	☐	D. Roadway type and classification
☐	☐	E. Grading plan and summary
☐	☐	F. Discussion of underground utilities within the Project limits
COMPLETE	N/A	
☐	☐	**2. SECTION DG2.402 EXISTING SUBSURFACE INVESTIGATION**
☐	☐	A. Discussion of existing subsurface conditions that may affect subgrade and pavement design or performance (i.e. vegetation, terrain, existing structures, existing pavement, etc.)
☐	☐	B. Discussion of geological conditions that may impact subgrade and pavement design or performance. Specify formation.
		C. Subsurface conditions with logs
		• Sampling techniques
		• Description of soil and rock encountered
		• Lab test details and results
☐	☐	• Discussion of water and groundwater conditions
		• Discussion of seasonal variations in moisture content
		• Atterberg limits (ASTM D 4318)
		• Percent Passing the No. 200 sieve (ASTM D 1140)
		D. Identify any deviations to standard procedures
COMPLETE	N/A	
☐	☐	**3. SECTION DG2.403 SUBSURFACE RECOMMENDATIONS**
		A. Expansive Soils Evaluation
		• Percent swell calculation and test results
		• Effect of cut/fills (i.e. long-term soil uplift in cut areas; settlement overburden pressure effects in fill areas)
☐	☐	• Provide soil movement estimates
		B. Soil Moisture Conditioning – Discussion of details (please provide the details)
		C. Checklist for ridged pavements options
COMPLETE	N/A	
☐	☐	**4. SECTION DG2.404 SUBSGRADE RECOMMENDATIONS**
		A. Subgrade Treatment
		• Typical subgrade type
		• Explanation of anomalous soil conditions anticipated and discussion of potential variations to consider

Section DG2.4 Pavement Design Criteria

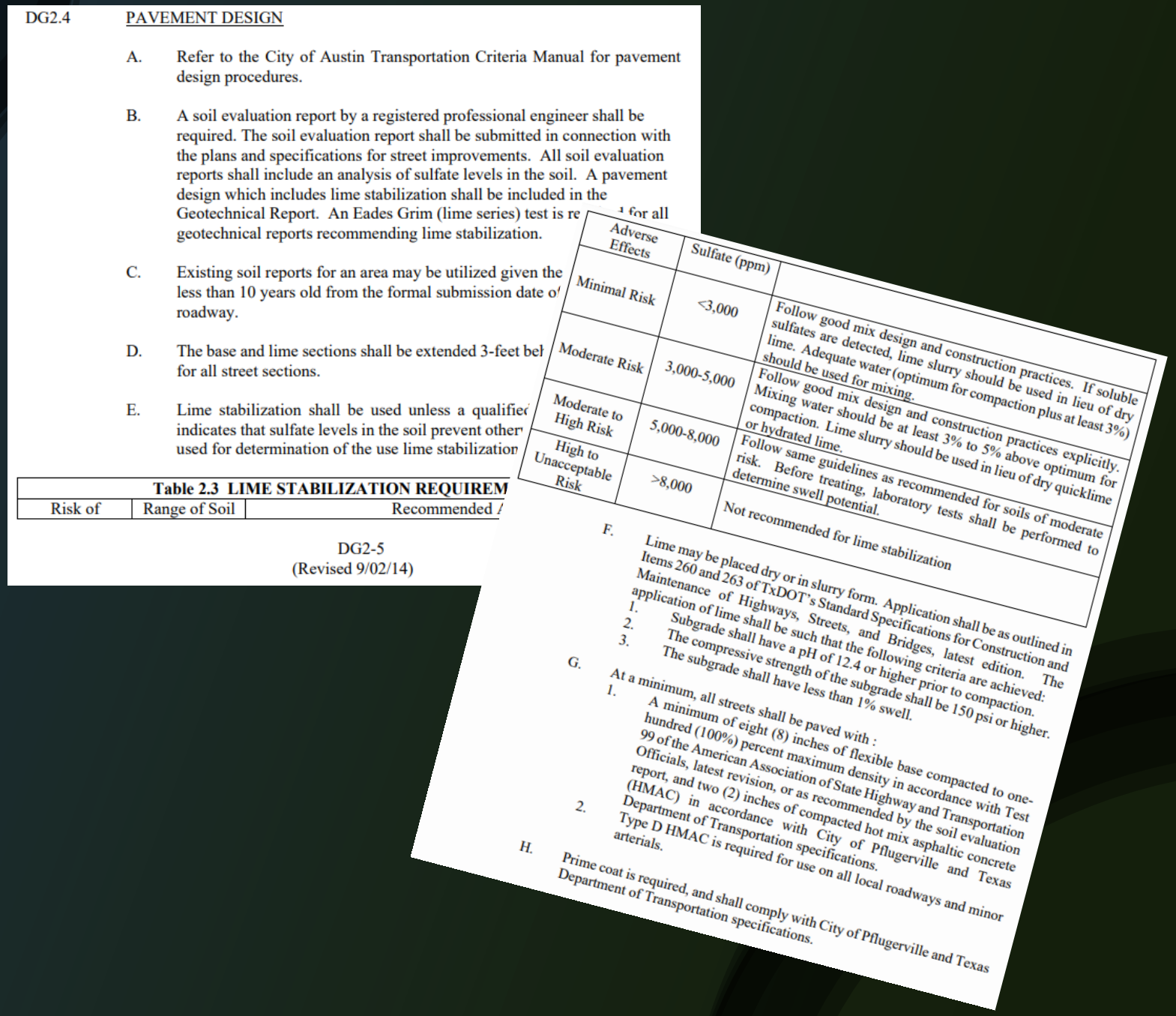
Page 1

DRAFT

BACKGROUND

ENGINEERING DESIGN MANUAL
Section DG2.4

- Provides valuable yet limited pavement design information



DG2.4 PAVEMENT DESIGN

A. Refer to the City of Austin Transportation Criteria Manual for pavement design procedures.

B. A soil evaluation report by a registered professional engineer shall be required. The soil evaluation report shall be submitted in connection with the plans and specifications for street improvements. All soil evaluation reports shall include an analysis of sulfate levels in the soil. A pavement design which includes lime stabilization shall be included in the Geotechnical Report. An Eades Grim (lime series) test is re 1 for all geotechnical reports recommending lime stabilization.

C. Existing soil reports for an area may be utilized given the less than 10 years old from the formal submission date o roadway.

D. The base and lime sections shall be extended 3-feet bel for all street sections.

E. Lime stabilization shall be used unless a qualifie indicates that sulfate levels in the soil prevent other used for determination of the use lime stabilizatio

Table 2.3 LIME STABILIZATION REQUIREM

Risk of Adverse Effects	Range of Soil Sulfate (ppm)	Recommended
Minimal Risk	<3,000	Follow good mix design and construction practices. If soluble sulfates are detected, lime slurry should be used in lieu of dry lime. Adequate water (optimum for compaction plus at least 3%) should be used for mixing.
Moderate Risk	3,000-5,000	Follow good mix design and construction practices explicitly. Mixing water should be at least 3% to 5% above optimum for compaction. Lime slurry should be used in lieu of dry quicklime or hydrated lime.
Moderate to High Risk	5,000-8,000	Follow same guidelines as recommended for soils of moderate risk. Before treating, laboratory tests shall be performed to determine swell potential.
High to Unacceptable Risk	>8,000	Not recommended for lime stabilization

DG2-5
(Revised 9/02/14)

F. Lime may be placed dry or in slurry form. Application shall be as outlined in Items 260 and 263 of TxDOT's Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, latest edition. The application of lime shall be such that the following criteria are achieved:
1. Subgrade shall have a pH of 12.4 or higher prior to compaction.
2. The compressive strength of the subgrade shall be 150 psi or higher.
3. The subgrade shall have less than 1% swell.

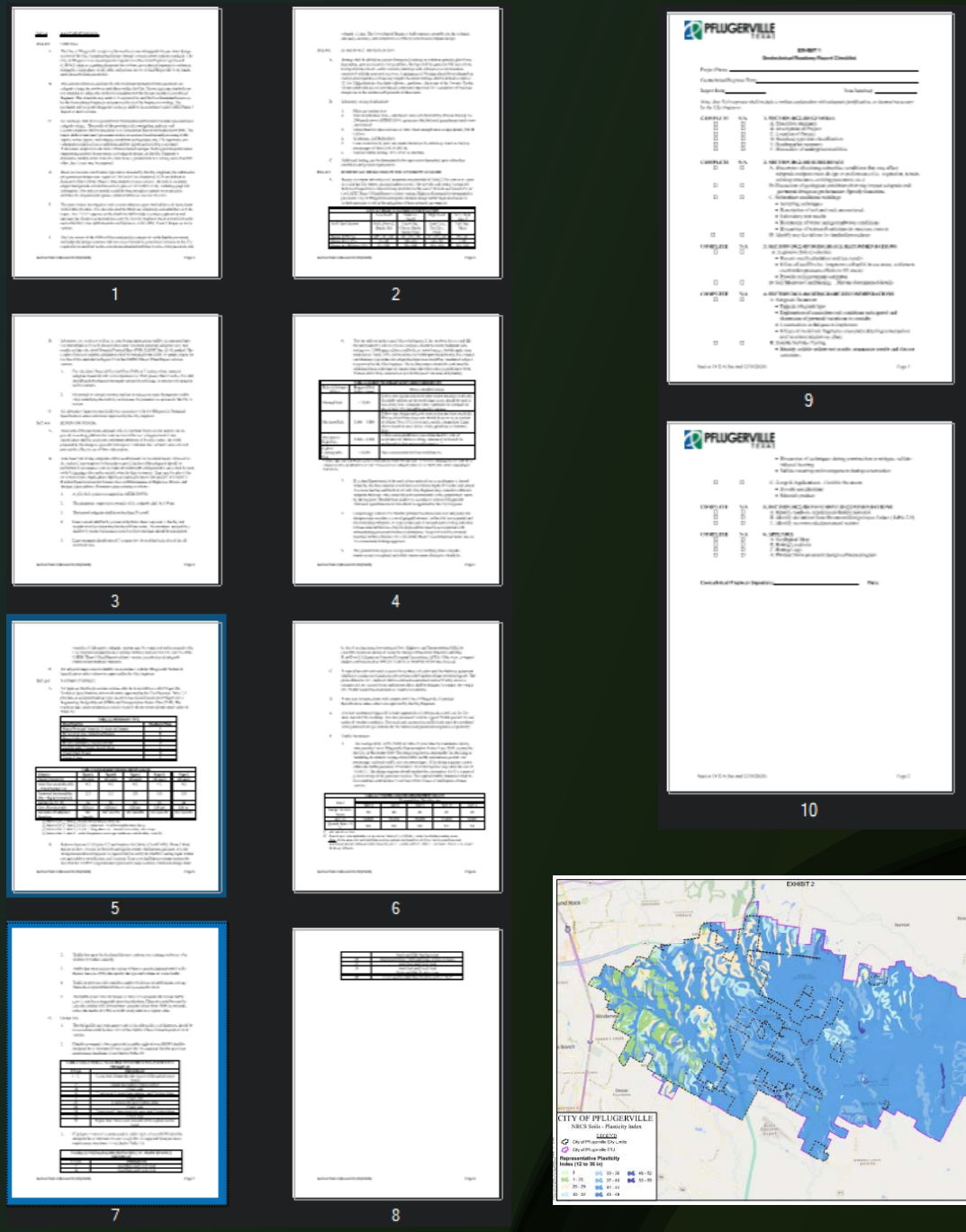
G. At a minimum, all streets shall be paved with :
1. A minimum of eight (8) inches of flexible base compacted to one-hundred (100%) percent maximum density in accordance with Test 99 of the American Association of State Highway and Transportation Officials, latest revision, or as recommended by the soil evaluation report, and two (2) inches of compacted hot mix asphaltic concrete (HMAC) in accordance with City of Pflugerville and Texas Department of Transportation specifications.
2. Type D HMAC is required for use on all local roadways and minor arterials.

H. Prime coat is required, and shall comply with City of Pflugerville and Texas Department of Transportation specifications.

PURPOSE

ENGINEERING DESIGN MANUAL
REVISION - Section DG2.4

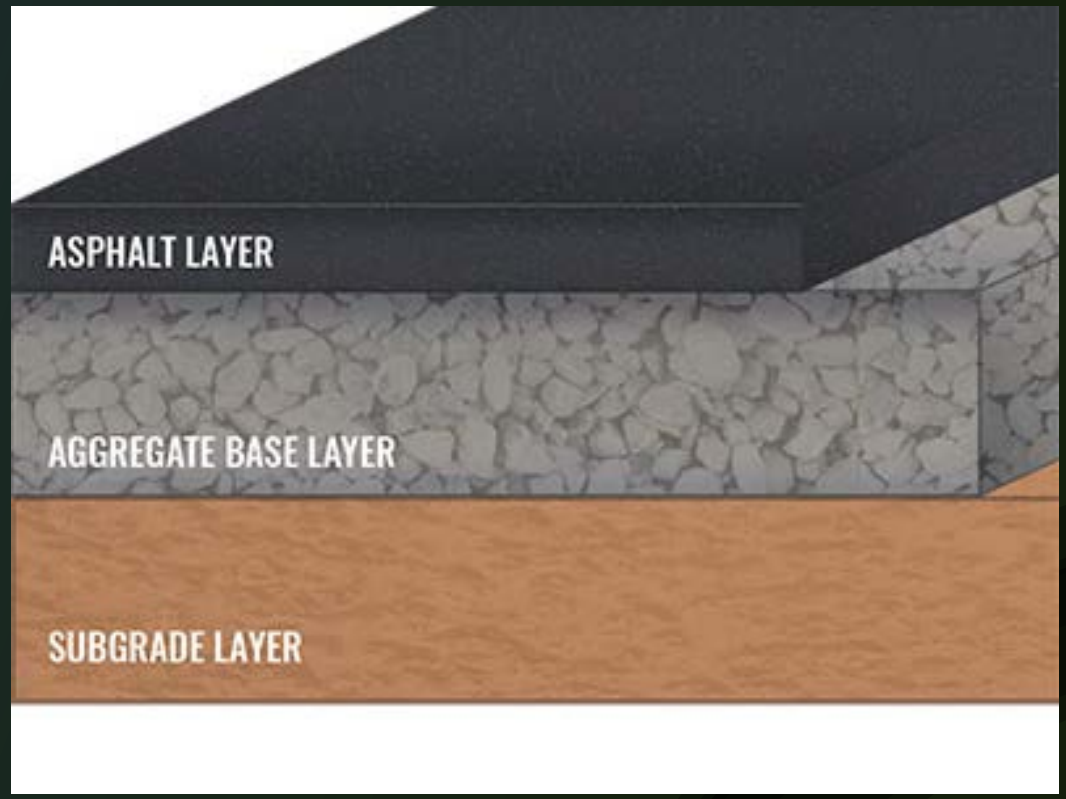
- ✓ Uniformity of design and standardization
- ✓ Benefit to design engineer
  - Basis for roadway design
- ✓ Benefit to City
  - Regulate roadway design (public infrastructure)
  - Guidelines for reviewing and approving designs
- ✓ Correlation with CAPEC guidelines and City's TMP



PAVEMENT DESIGN

Procedure to find the *best combination of pavement layer thickness and material type* that *satisfies a selected criterion* considering the properties of the *subgrade and the traffic*

FLEXIBLE PAVEMENT SECTION



RECOMMENDATION

ENGINEERING DESIGN MANUAL
Section DG2.405 A

TABLE 2.5 ROADWAY TYPE	
Classification	**Roadway Type**
Major/Principal Arterials / Industrial Streets	A
Minor Arterials / Industrial Streets	B
Major Collectors	C
Minor Collectors / Rural Collector	D
Local Streets / Typical Rural / Alley	E
Urban Main Street	D
Urban 3-Lane	C

DESIGN INPUT VALUES

Table 2.6 PAVEMENT DESIGN INPUT VALUES					
Criteria	**Type A**	**Type B**	**Type C**	**Type D**	**Type E**
Design Period (1) Flexible	20 years	20 years	20 years	20 years	20 years
Initial Serviceability (Pi) – Rigid/Asphalt (2)	4.5 – 4.2	4.5 – 4.2	4.5 – 4.2	4.5 – 4.2	4.5 – 4.2
Terminal Serviceability (Pt) – Rigid/Asphalt (3)	2.5	2.5	2.0	2.0	2.0
Reliability (%) (4)	95	95	90	90	85
Conc Flex strength	620 psi	620 psi	620 psi	620 psi	620 psi
Modulus of Subgrade Reaction	Site Specific	Site Specific	Site Specific	Site Specific	Site Specific

(1) Refer to CAPEC Table 1.1 for guidance on Design Life values for flexible and rigid pavement
(2) Refer to CAPEC Table 1.3 & 3.2 for guidance on Initial Serviceability Index Range
(3) Refer to CAPEC Table 1.3, 3.3, & 4.1 for guidance on Terminal Serviceability Index Range
(4) Refer to CAPEC Table 3.1 and 4.2 for guidance on Design Confidence and Reliability Levels (%)

RECOMMENDATION

ENGINEERING DESIGN MANUAL
Section DG2.405 F

TABLE 2.5 ROADWAY TYPE	
Classification	**Roadway Type**
Major/Principal Arterials / Industrial Streets	A
Minor Arterials / Industrial Streets	B
Major Collectors	C
Minor Collectors / Rural Collector	D
Local Streets / Typical Rural / Alley	E
Urban Main Street	D
Urban 3-Lane	C

TMP

Figure 15	LOS A-C (<0.65 V/C)
6 Lane Divided Arterial	< 32,760
4 Lane Divided / 5 Lane	< 21,840
4 Lane Undivided Arteria	< 18,720
4 Lane Collector	< 17,160
2 or 3 Lane Roadway	< 8,320
Frontage Road 3 Lanes	< 16,380
Frontage Road 2 Lanes	< 10,920
Frontage Road 1 Lane	< 5,460
Urban 3 Lane Roadway	< 9,360

DESIGN INPUT VALUES

Table 2.7 TRAFFIC LOADING DESIGN INPUT VALUES					
Input	Thoroughfare Classification				
	Type A	Type B	Type C	Type D	Type E
Design Period – Years (Flexible)	20	20	20	20	20
ADT (1)	32,760	21,840	17,160	8,320	4,000
Growth Rate - % (2)	4.0	4.0	4.0	3.5	3.0
Percent Trucks (%)	4.5	4.5	4.0	3.5	3.0

(1) LOS ADT value from Transportation Master Plan (TMP)
(2) Growth rate is not applicable to alley section. Refer to City's GIS information for all other roadway types
Note: All the values in Input Data Table must be applicable to StreetPave 12 (American Concrete Pavement Association, ACPA) and AASHTO (WinPAS ACPA), FPS-21 (TxDOT). Refer to Table 2.1.3 of CAPEC Phase 1 Final Report for design software

HOW?

TRAFFIC COMPARISON

TYPE C MAJOR COLLECTOR

CAPEC REFERENCE DATA

% Trucks	Vehicle Type	Traffic Mix %	ADT CAPEC	No. of Vehicle / Type	Growth Rate 4% @ 20 YR	Growth Rate 4% @ 30 YR
4.0	PC	95.7	8000	7656	13781	16843
	BUS	0.3	8000	24	43	53
	SUT	2.1	8000	168	302	370
	ST	1.5	8000	120	216	264
	MT	0.4	8000	32	58	70
		100		8000	14342	17530

	20 YR	30 YR
Asphalt Cement Concrete	1.5	1.5
Asphalt Treated Aggregate Base	2.5	3.5
Crushed Stone Base	14	14
Lime Treated Subgrade	9	9

PFLUGERVILLE ANALYSIS

Picadilly Drive	3749
Immanuel Rd	8833
Pfenning Lane	7044
Central Commerce	7145

% Trucks	ADT - TXDOT 2019	TXDOT Traffic Mix %	No. of Vehicle / Type	Growth Rate 4% @ 20 YR	Growth Rate 4% @ 30 YR
4.0	8833	95.7	8453	15216	18597
	8833	0.3	26	48	58
	8833	2.1	185	334	408
	8833	1.5	132	238	291
	8833	0.40	35	64	78
		100	8833	15899	19433

	20 YR	30 YR
Asphalt Cement Concrete	1.5	1.5
Asphalt Treated Aggregate Base	2.5	3.5
Crushed Stone Base	14	14
Lime Treated Subgrade	9	9

RESULTS

PAVEMENT COMPARISON
CAPEC & TXDOT

ROADWAY TYPE FUNCTIONAL CLASSIFICATION	DESIGN INPUT PARAMETERS		FLEXIBLE PAVEMENT						RIGID PAVEMENT	
			20 YEAR			30 YEAR			30 YEAR	
			LIME STAB. SUBGRADE	CRUSHED STONE BASE	PAVEMENT THICKNESS	LIME STAB. SUBGRADE	CRUSHED STONE BASE	PAVEMENT THICKNESS	LIME STAB. SUBGRADE	PAVEMENT THICKNESS
Type E Local Street Typical Rural Alley	**PAVEMENT ANALYSIS**		ESAL = 961,422			ESAL = 1,702,249			ESAL = 2,818,452	
	Growth Rate	3%								
	TXDOT AADT	4452	8	9	3.5	8	11	3.5	8	7
	CAPEC		**ESAL = 1,270,518**			ESAL = 2,249,519			**ESAL = 3,722,012**	
	Growth Rate	3%								**7.37**
	ADT	3000	**8**	**10**	**3.5**	8	12	3.5	**8**	**(7.5)**
Type D Minor Collector Rural Collector Urban Main Street	**PAVEMENT ANALYSIS**		**ESAL = 1,337,995**			ESAL = 2,442,422			**ESAL = 4,019,631**	
	Growth Rate	3.5%								**7.90**
	TXDOT AADT	4941	**8**	**12**	**3.5**	8	13	4	**10**	**(8)**
	CAPEC		ESAL = 1,125,888			ESAL = 2,055,233			ESAL = 3,340,201	
	Growth Rate	3.5%								7.65
	ADT	4000	8	11	3.5	8	14	3.5	10	(8)
Type C Major Collector Urban 3-Lane	**PAVEMENT ANALYSIS**		**ESAL = 3,604,073**			ESAL = 6,788,020			**ESAL = 11,374,215**	
	Growth Rate	4.0%								**9.39**
	TXDOT AADT	8833	**9**	**14**	**4**	9	14	5	**12**	**(9.5)**
	CAPEC		ESAL = 3,280,933			ESAL = 6,179,409			ESAL = 10,353,585	
	Growth Rate	4.0%								9.25
	ADT	8000	9	14	4	9	14	5	12	(9.5)
Type B Minor Arterial Industrial Streets	**PAVEMENT ANALYSIS**		**ESAL = 7,662,157**			ESAL = 14,431,138			**ESAL = 23,890,729**	
	Growth Rate	4.0%								**10.79**
	TXDOT AADT	22470	**9**	**15**	**6**	8	16	7	**12**	**(11)**
	CAPEC		ESAL = 3,079,503			ESAL = 5,800,029			ESAL = 9,601,573	
	Growth Rate	4.0%				9	15	5.5		9.30
	ADT	9000	8	14	5				12	(9.5)
Type A Major/Principal Arterial Industrial Streets	**PAVEMENT ANALYSIS**		**ESAL = 11,845,683**			ESAL = 22,310,520			**ESAL = 36,938,042**	
	Growth Rate	4.0%								**11.56**
	TXDOT AADT	37179	**9**	**16**	**6.5**	9	16	7.5	**12**	**(12)**
	CAPEC		ESAL = 7,962,898			ESAL = 14,997,564			ESAL = 24,828,647	
	Growth Rate	4.0%								10.85
	ADT	25000	9	15	6	9	16	7	12	(11)

CONCLUSION #1

PAVEMENT COMPARISON

ROADWAY TYPE FUNCTIONAL CLASSIFICATION	DESIGN INPUT PARAMETERS		FLEXIBLE PAVEMENT						RIGID PAVEMENT	
			20 YEAR			30 YEAR			30 YEAR	
			LIME STAB. SUBGRADE	CRUSHED STONE BASE	PAVEMENT THICKNESS	LIME STAB. SUBGRADE	CRUSHED STONE BASE	PAVEMENT THICKNESS	LIME STAB. SUBGRADE	PAVEMENT THICKNESS
Type B Minor Arterial Industrial Streets	**PAVEMENT ANALYSIS**		ESAL = 7,662,157			ESAL = 14,431,138			**ESAL = 23,890,729**	
	Growth Rate	4.0%								**10.79**
	TXDOT AADT	22470	9	15	6	8	16	7	**12**	**(11)**
	CAPEC		ESAL = 3,079,503			ESAL = 5,800,029			ESAL = 9,601,573	
	Growth Rate	4.0%				9	15	5.5		9.30
	ADT	9000	8	14	5				12	(9.5)

18 KIP ESAL EQUIVALENT SINGLE AXLE LOAD

CAPEC Guidance & **TXDOT** Data

- Layer thickness impacts using TxDOT data
  - + 1” crush stone base
  - + 0.5 – 1” asphalt pavement

RESULTS

PAVEMENT COMPARISON

TXDOT & DEVELOPMENT DESIGN COMMUNITY

Roadway Type / Classification	Source	FLEXIBLE				
		Lime stabilized subgrade	Crushed Limestone	Asphalt Thickness	Total Pavement Thickness	Cost Impact
Type A	Design Consultants	NA	NA	NA		
Major/Principal Arterial	CAPEC Guidance	10	14	9.5	34	
Industrial Streets	Analysis	9	16	6.5	32	
Type B	**Design Consultants**	**8.00**	**14.25**	**4.25**	27	
Minor Arterial	CAPEC Guidance	10	10	6.5	27	
Industrial Streets	**Analysis**	**9**	**15**	**6**	30	**4.44%**
Type C	**Design Consultants**	**8**	**16**	**3**	27	
Major Collector	CAPEC Guidance	10	10	6	26	
Urban 3-Lane	**Analysis**	**9**	**14**	**4**	27	**4.54%**
Type D	**Design Consultants**	**9**	**13.5**	**2.42**	25	
Minor Collector/Rural Collector	CAPEC Guidance	10	10	3	23	
Urban Main Street	**Analysis**	**8**	**12**	**3.5**	24	**4.61%**
Type E	**Design Consultants**	**8.40**	**11.00**	**2.20**	22	
Local Street/Typical Rural	CAPEC Guidance	10	8	2	20	
Alley	**Analysis**	**8**	**10**	**3.5**	22	

CONCLUSION #2

PAVEMENT COMPARISON

Roadway Type / Classification	Source	FLEXIBLE				
		Lime stabilized subgrade	Crushed Limestone	Asphalt Thickness	Total Pavement Thickness	Cost Impact
Type B	**Design Consultants**	**8.00**	**14.25**	**4.25**	27	
Minor Arterial	CAPEC Guidance	10	10	6.5	27	
Industrial Streets	Analysis	9	15	6	30	4.44%

TXDOT and Development Design Community

- Layer thickness impacts using TxDOT data
  - 1” Lime treated base
  - 0.75” Crush stone base
  - 1 – 1.75” Asphalt pavement
- Average estimated roadway cost increase = **4.5%**

QUESTIONS