CITY OF CORPUS CHRISTI

Engineering Services Department

INFRASTRUCTURE DESIGN MANUAL

JULY 2021

Chapter 6 - Street Design Requirements

6.01 Roadway Geometric Design Standards

6.01.1 Urban Transportation Plan Guidelines

a. Designers shall adhere to the Urban Transportation Plan Guidelines as shown in the UTP and in Table 6.1 below:

Table 6.1: Urban Transportation Plan Guidelines

STREET CLASSIFICATION	MINIMUM R.O.W. WIDTH	MIN. PAVEMENT WIDTH	DESIGN FEATURE	NUMBER OF LANES
URBAN STREET COLLECTORS				
C1	60-FT.	28-FT.	-	2
C2	65-FT.	36-FT.	CONTINUOUS LEFT TURN LANE	3
C3	75-FT.	48-FT.	-	4
PARKWAYS + BEACH ACCESS				
P1	80-FT.	28-FT.	DRAINAGE/BIKEWAY	2
BEACH ACCESS	80-FT.	28-FT.	BEND/DUNE HUMP/GATE	2
PED. BEACH ACCESS	-	-	BEND/DUNE HUMP/GATE	-
ARTERIALS				
A1	95-FT.	65-FT.	CONTINUOUS LEFT TURN LANE	5
A2	100-FT.	48-FT.	MEDIAN	4 w/LEFT TURN LANES
A3	130-FT.	48-FT.	MEDIAN	6 w/LEFT TURN LANES
RURAL ARETERIALS				
RA-1	125-FT.	28-FT.	-	2
RA-2	165-FT.	65-FT.	CONTINUOUS LEFT TURN LANE	5
RA-3	240-FT.	48-FT.	MEDIAN	4
FREEWAYS/EXPRESSWAYS				
F1	400-FT.	48-FT.	CENTER BARRIER	4 - 10

b. Collectors, Parkways, and Arterials shall be designed with curb and gutter and underground storm drainage systems to the appropriate design year storm as indicated in Chapter 3.
c. Rural Arterials shall be designed with above ground storm drainage systems to the appropriate design year storm as indicated in Chapter 3.
d. Center medians shall be designed with a minimum of 16-feet to accommodate shelter for dedicated left turn lanes.
e. Roadway geometric design shall follow AASHTO and NACTO guidelines and the UDC.
f. Roadway geometric design criteria are shown in the table below:

Table 6.2: Geometric Design Criteria

DESIGN ELEMENT WIDTH	PREFERRED (FEET)	MINIMUM (FEET)
TRAVEL LANES	11	10
TURN LANES	12	10
MEDIAN WIDTH AT TURN LANES	17	15
MEDIAN WIDTH FACE OF CURB TO FACE OF CURB	17	4
CENTER TURN LANE WIDTH	12	10
STANDARD BIKE LANE	7	6
BUFFERED BIKE LANE	10	8
BUFFERED SIDEWALK	5	5
TIED-SIDEWALK	5	5
MULTI-USE SIDE PATH	10	8
SHARED USE PATH/HIKE N BIKE TRAIL	12	10
ONE-WAY CYCLE TRACK, BOTH SIDES	6	6
LANDSCAPE/PARKING BUFFER	5	2

6.01.2 Pedestrian accommodations

a. Sidewalks shall be minimum of 5 feet
b. Curb Ramps shall be to the Texas Accessibility Standards
c. Driveways shall have the appropriate cross slope per TAS
d. Medians shall be designed with pedestrian shelter where appropriate
e. Bus Stops shall be designed to RTA standards such that they do not encroach into the required sidewalk passage area per TAS

6.01.3 Curb Radii

a. The curb radius is the radius of curvature, measured from the center of curvature, of a physical curb-return at the corner of a street intersection.
b. In selection of curb radii, the designer shall consider the needs of all roadway and pedestrian traffic and use appropriate representative design vehicle templates.
c. Curb radii around cul-du-sacs shall be as follows:
    i. Single-Family Residential = 48-ft.
    ii. All other areas = 50-ft.

d. Other curb radii shall be as in Table 6.3 below:

Table 6.3: **Standard Curb Radius by Intersection Type and Angle**

INTERSECTION TYPE			STANDARD CURB RADIUS BY INTERESCTION ANGLE	
			90°	80° TO 90°
LOCAL	TO	LOCAL	15-FT.	15-FT.
LOCAL	TO	COLLECTOR	20-FT.	20-FT.
LOCAL	TO	ARTERIAL	20-FT.	20-FT.
COLLECTOR	TO	COLLECTOR	25-FT.	25-FT.
COLLECTOR	TO	ARTERIAL	25-FT.	25-FT.
ARTERIAL	TO	ARTERIAL	30-FT.	35-FT.
INDUSTRIAL ZONE			45-FT.	50-FT.

6.01.4 Curb and Gutter

a. Curb and Gutter shall be considered a stormwater appurtenance for estimating cost
b. For most roadways, a 6-in. curb is required.
c. For hot-mixed asphaltic concrete roadways, a 2-ft. wide Portland cement concrete curb and gutter is required, to include 6-inches of curb width and 1 ½-feet of gutter width.
d. For Portland cement concrete pavement, the gutter area is integral with the pavement panel, and the 6-inch curb is placed on top of the pavement panel per City Standard Details.

6.01.5 Objects in the R.O.W.

a. Above ground infrastructure such as fire hydrants, trees, traffic signal controller cabinets, blow-off valves, power poles, light poles, traffic/pedestrian signage, or other such appurtenances shall not be placed within the sidewalk, or otherwise encroach on ADA/TAS pedestrian space or RTA bus stops and pads.
b. Designers shall coordinate with the RTA in regard to placement and design of benches, pads, turnouts, and bus stop locations. Bus stops can only be placed, moved, or removed with RTA concurrence.

6.01.6 Design Speed

a. Design speed shall be set by City Ordinance
b. The minimum design speed shall be 30 m.p.h.

6.01.7 Sight Distance

a. **Intersection Sight Distance**
   i. Approach and Departure Sight Triangles shall be Per American Association of State Highway and Transportation Officials (AASHTO) *Green Book* and National Association of City Transportation Officials (NACTO) *Urban Street Design Guide* latest editions.
   ii. Designers, Engineers, and Constructors shall not obstruct sight triangles.
   iii. The design vehicle for sight distance is a passenger car.
   iv. Easement dedications shall be required as needed to accommodate appropriate sight triangles.
   v. Designers, Engineers, and Constructors shall utilize decision points derived from sight triangles combined with stopping sight distance when designing intersection treatments and advance warning signs, signals, striping, and devices.
b. **Stopping Sight Distance**
   i. Per AASHTO *Green Book* and TxDOT/FHWA *Texas MUTCD*:

Table 6.4: Minimum Required Stopping Sight Distances for Dry Conditions

Vehicle Speed	Reaction Distance	Breaking Distance	Summed Distance	Stopping Sight Distance
(mph)	(feet)	(feet)	(feet)	(feet)
15	55.1	21.6	76.7	80
20	73.5	38.4	111.9	115
25	91.9	60.0	151.9	155
30	110.3	86.0	196.7	200
35	128.6	117.6	246.2	250
40	147.0	153.6	300.6	305
45	165.4	194.4	359.8	360
50	183.8	240.0	423.8	425
55	202.1	290.3	492.4	495

c. Passing Sight Distance
   i. Passing Sight Distance per AASHTO and TxDOT/FHWA where applicable.

6.01.8 Left Turn Lanes

a. Left turn lanes are required at all signalized intersection approaches
b. Left turn lanes are required at all median openings

c. Queueing capacity shall be determined by appropriate traffic studies and 30-year projections and accommodated in the design of the queue lane.
d. Dual left turn lanes shall be approved only after an appropriate traffic study that includes alternatives assessment to handle the anticipated volumes.

6.01.9 Intersection Standards

a. Through-lane offsets from entering lane to receiving lane shall not exceed 3-feet.
b. Roundabout intersections shall be considered for any intersection with an appropriate traffic study considering traffic volumes and directions, as well as alternative treatments such as all-way stops and traffic signalization, to include 30-year projections and appropriate design vehicles in the approach roadways to ensure required roundabout radius.
    - **i.** All roundabouts will feature splitter islands with pedestrian shelter upon entry, appropriate signage, appropriate lighting, appropriate pedestrian elements, and a truck curb and mow strip in the central island.
    - **ii.** Central island art or landscaping shall not obstruct safe site zones or be a hazard to vehicles that may leave the roadway.

6.01.10 Curve Radii

a. Curve Radii design shall be based on the design speed of the roadway and any super-elevation that may be part of the design.
b. Minimum curve radii for collectors and arterials is 500 feet.
c. Minimum curve radii for neighborhood streets is 300 feet.
d. Maximum super-elevation will be 4%
e. Reverse super-elevation shall not be allowed on any City roadways

6.01.11 Vertical Geometric Requirements

a. Minimum grade line shall be 0.3%
b. Grades for curb returns shall be determined on a case by case basis.
c. Arterials shall feature super-elevation per AASHTO requirements
d. Vertical curves
    - **i.** shall be designed and constructed when the algebraic difference exceeds 1%
    - **ii.** elevations shall be shown at 10-foot intervals in plans
    - **iii.** maintain a minimum of 0.03-foot elevation change at 10-foot intervals
    - **iv.** determine minimum vertical curve lengths based on AASHTO design criteria with minimum not less than 3 times design speed.
e. Minimum grade line around a cul-du-sac shall be 0.70 percent
f. Pavement cross-slopes shall be
    - i. Minimum 2%
    - ii. Maximum 4%

6.02 Pavement Design and Construction Standards.

6.02.1 Pavement Structure.

a. Through The design of pavement structures shall be in accordance with the AASHTO *Guide for Design of Pavement Structures*, 1993 or latest approved edition.
b. The pavement design report shall be prepared and signed by, or under the supervision of, a professional engineer registered in the State of Texas.
c. The minimum design requirements as outlined herein shall be used for pavement design.

6.02.2 Length of Service Life.

a. Pavement shall be designed with a thirty-year service life.

6.02.3 Traffic Load, Reliability and Pavement Structures.

a. The traffic load is the cumulative expected 18-Kip equivalent single axle loads (ESAL) for the service life.
b. The following 18-Kip ESAL and Reliability Level shall be used in the design of streets for each street classification.

Table 6.5: Pavement Design Specifications

Street Classification	**18-Kip ESAL***	**Reliability Level**
Primary and Secondary Arterials	5,000,000	R-95
Collector Streets	2,000,000	R-90
Local (non-residental) traffic	1,000,000	R-80
Local (residential collector) traffic	100,000	R-75
Local (residential) traffic	50,000	R-70

*This is the minimum 18-KIP ESAL value. For all arterials, collectors and non-residential local streets (based on zoning) the engineer shall evaluate the existing ADT and traffic type distribution and use the greater of the 30-year projection of the field verified ESAL or the ESAL value established in this Table. For City of Corpus Christi projects, the Traffic Engineer will provide a traffic count for design purposes.

c. The Traffic loads for primary and secondary arterials, collector and local residential collector streets shall include bus traffic.
d. The lane distribution factor shall be as follows:
    i. Total number of lanes in both directions 4 or less, the Lane Distribution Factor is 1.0.
    ii. Total number of lanes in both directions 6, then lane Distribution Factor is 0.7
    iii. Total number of lanes in both directions less than 8, then Lane Distribution Factor is 0.6

6.02.4 Input Design Values:

a. Serviceability
    i. The serviceability of a pavement is defined as the pavement's ride quality and its ability to serve the type of traffic (automobiles and trucks) which use the facility.
    ii. The initial serviceability index (p0) for flexible pavements shall be 4.2 and for rigid pavement shall be 4.5.
    iii. The minimum terminal serviceability index (Pt) for flexible pavements shall be:
        1. local streets shall be 2.0
        2. collectors and arterials shall be 2.5
        3. for rigid pavements the Pt shall be 2.5 for all streets
        4. A standard deviation (S0) for flexible pavement shall be 0.45 and for rigid pavement shall be 0.39.

b. 28-day Concrete Modulus of Rupture, (Mr)

    i. An Mr of 680 psi at 28 days should be used with the current statewide specification for concrete pavement design.
    ii. If the engineer selects an alternate value for Mr, it must be documented with an explanation.

c. 28-day Concrete Elastic Modulus, psi

    i. A modulus of 5,000,000 psi should be used for pavement design.
    ii. The use of a different value must be documented with an explanation.

d. Effective Modulus of Subgrade Reaction, pci
    i. For Arterials and Collector Streets one of the following base layer combinations for concrete slab support shall be used
        1. 4in. of asphaltic concrete pavement (ACP) or asphalt stabilized base (ASB)

2. A minimum of 1 in. asphalt concrete bound breaker over 6 in. of a cement stabilized base or crushed limestone base material.
3. A k-value of 300 psi/in. should be used in the rigid pavement design procedure with one of the stabilized base layer combinations listed above.
4. For all local streets on clay subgrade soils with 8-inches of lime stabilized subgrade a k-value of 110 pci shall be used and for local streets on sand subgrade a k-value of 200 pci shall be used.

Table 6.6: Load Transfer Coefficient

Load Transfer Coefficients		
CRCP or Load Transfer Devices at Transverse Joints	**Tied PCC Shoulders, Curb and Gutter, or Greater Than Two Lanes in One Direction**	
	Yes	**No**
Yes	2.6 for CRCP 2.9 for JCP	3.2
No	3.7	4.2

e. **Drainage Coefficient**
   i. 1.0 for heavy clay (Type A) soils and 1.05 for sand (Type B) soils. If the sands will be subject to tidal influence or saturation then a lower coefficient is warranted.

6.02.5 Rigid Pavement Thickness

a. The computed concrete slab thickness usually contains fractions of inches, round the thickness up or down to the nearest full or half inch. For example, use slab thickness of 11.5in. for computed thickness of 11.4 in. and use slab thickness of 10 in. for computed thickness 10.24 in. Use 6 in, for slab thickness if the computed thickness is less than 6 in., i.e., minimum rigid pavement thickness is 6 in.

6.02.6 Subgrade Soil

a. A soil investigation must be performed for the design of pavement structures.
b. The number of borings and locations shall be sufficient to accurately determine the natural in-situ soil strata and the thickness of the existing pavement constituents along the route.
c. Any existing soil information that is available either from the City or private sources will be evaluated and if determined to be applicable and valid, will be allowed in place of new soil tests.

6.02.7 Pavement Structural Section

a. Roadbed soil having a plasticity index (P.I.) greater than 20 shall be treated with lime to reduce the P.I. below 20.
b. The following test method shall be used to determine the percent lime to be used:
    i. pH Determination for Minimum Lime Content: ASTM D 6276 (Eads - Grim Test) - Min amount of lime to raise soil pH level to 12.4.
    ii. For design of the stabilized subgrade TxDOT Test Method 121-E Figure 3 "RECOMMENDED AMOUNTS OF LIME FOR STABILIZATION OF SUBGRADES AND BASES" shall be used.
    iii. Application rate of lime shall be determined based on laboratory testing.
    iv. In no case shall the lime be less than 8%.
    v. Percent lime will be based on the maximum dry unit weight of the raw subgrade soils as determined by the standard proctor (ASTM D698).
    vi. Lime treated subgrade will be included as a structural layer within the pavement design calculations.
    vii. The use of a City-approved geogrid is an acceptable option in lieu of up to 8 inches of lime-modified subgrade only for Type A soils with a pre-modified PI < 20 and with prior approval of the City Engineer.
    viii. Considerations for using geogrid in place of lime-modification include speed of construction, same day restoration of access to driveways, protection from plastic deformation or loss of soil strength in soil layers below the improved zones, and other considerations.
    ix. City-approved geogrid includes any geogrid classified as Type 2 geogrid by TxDOT under the most current version of TxDOT Departmental Materials Specification DMS-6240 per City Standard Specification Section 022040 *Street Excavation*.
c. Cement Stabilized Sand
    i. (P.I. < 20) for stabilization of utility trenches
    ii. shall contain a minimum of 2 sacks of Standard Type I Portland cement per cubic yard of sand and compacted to not less than 95% Standard Proctor density per City Standard Specification Section 022020 *Excavation and Backfill for Utilities*.

d. Pavement Materials
    i. Alternative pavement materials may be used where the existing soil or subsurface conditions, or the alternative materials, provide a level of drivability comparable to the materials otherwise required by this section.
    ii. Proposals for alternative pavement materials with supporting engineering documentation may be submitted to the City for consideration for use.
    iii. Alternative materials will not be allowed unless otherwise approved by the Director of Engineering.
    iv. The combination of materials will be allowed for the various layers of the pavement structure as shown in Table 6.7:

Table 6.7: Pavement Materials by Pavement Type and Layer

Type	Layer	Material/Treatment		Standard or Specification
All	Subgrade Stabilization	Density Controlled	95% Standard Proctor Density	ASTM D698
		Moisture Controlled	+/- 3% of optimum moisture content	
		Lime Stabilization	Type A (clay) Soils only	TxDOT 260 Tex 121-E
		Cement Stabilization	Type B (sandy) Soils only	TxDOT 275
		Lime Modification w/Cement Stabilization	Type A (clay) Soils only if PI<20	
	Flexible Base	Only TxDOT Type A, Grade 1-2 crushed limestone base allowed on City roadway projects without pre-approval.		
		Density Controlled	98% Modified Proctor Density	ASTM D1558
		Moisture Controlled	+/- 2% of optimum moisture content	
		Cement Stabilization	Optional	TxDOT 275
		Geogrid	Only when pre-modified subgrade 10<PI<20	TxDOT DMS-6240 City of CC Section 022040
Flexible	Seal Coat	One-Course Surface Treatment		TxDOT 306/316
	Prime Coat	MC-30		TxDOT 310
	HMACP Base Course	Type B	2.5-in. (min.)	TxDOT 300/334
	Tack Coat			-
	HMACP Surface Course	Type D	1.5-in. (min)	TxDOT 300/334
Rigid	HMACP Bond Breaker	Type D	1.0-in. (min)	TxDOT 300/334
	Portland Cement Concrete Pavemet	Reinforcement	Continuously Reinforced	TxDOT 360
			Jointed Reinforced	TxDOT 360

e. Private Development Pavement
   i. The Director of Development Services in consultation with the Director of Engineering Services in accordance with the standards provided herein must approve the pavement combination for private development.

f. Public Roadway Pavement
   i. The Director of Engineering must approve the pavement combination for public work.
   ii. The detailed material specifications of these materials are outlined in the City of Corpus Christi Standard Specifications and Details.

g. Minimum Layer Thickness (Compacted)
   i. If the following components are utilized in proposed pavement sections, the minimum thickness for the components shall be as shown in Table 6.8 below:

Table 6.8: Minimum Pavement Layer Thickness

Pavement Type	Roadway Type	Material & Type	Minimum Thickness	Additional Guidance
All	All	Flexible Base	6-in.	1 foot behind curb for urban roads and 2 feet beyond edge of pavement for rural roads
All	All	Asphalt Treated Base	4-in.	-
All	All	Lime-Treated Subgrade	8-in.	for stabilization or modification
HMACP	All	One-Course Surface Treatment	One Course	for all flexible base under HMACP
HMACP	All	Base Course (Type B)	2.5-in.	-
HMACP	All	Surface Course (Type D)	1.5-in.	-
HMACP	Left and Right Turn Lanes	Flexible Base	12-in.	-
HMACP		Asphalt Paving Surface Course (Type D)	4-in.	-
PCCP	All	Bond Breaker (Type D)	1-in.	per geotech report
PCCP	All	Portland Cement Concrete Pavement	6-in.	-

h. **Curb and Gutter:** Curb and gutter shall be installed as shown on the City Standard Details and as required in the appropriate road section. Both the lime-treated subgrade and flexible base shall extend 1 foot beyond the back of curb. Transitions between the curb and gutter sections to either existing curb and gutter sections or roadside ditches shall be detailed in such a way as to ensure positive drainage to the nearest drainage system.

i. **Cross-slopes**

i. The road section cross-slope from the crown to the gutter shall be a consistent 2% minimum
ii. the maximum acceptable cross-slope on new construction or full depth reconstruction is 4%.
iii. Crown to crown transitions are required at intersections and neither concrete or asphalt valley gutters are allowed.

j. **Minimum Pavement Section for Residential Streets**

i. In the event that the developer would prefer to install a pavement section on a residential road without design, the structural section as outlined in the following tables shall be used.
ii. These sections were developed to meet the 30-year design life as required by Section 8.2 of the UDC. In general, the Type A soils (clays) are found throughout Corpus Christi with the exception of North Beach, Flour Bluff, and North Padre Island, which instead primarily have Type B soils (sands).

Table 6.9: Minimum Residential Structural Section on Type A (clay) Soils using HMACP

Structural Material	Section L-1 (A-F)	Minor Res. Collector	C-1 Collector
HMAC pavement (Type D)	2"	2"	4"
Flexible Base (Type A Grade 1-2)	6"	8"	11"
Subgrade	8" lime stabilized	8" lime stabilized	8" lime stabilized

Table 6.10: Minimum Residential Structural Sections on Type A (clay) Soils using PCCP

Structural Material	Section L-1 (A-F)	Minor Res. Collector	C-1 Collector	Section L-1 (A-F)	Minor Res. Collector	C-1 Collector
Concrete (4400 psi min)	6"	6"	7"	6"	6"	6"
HMAC Bond Breaker (Type D)	1"	1"	1"	1"	1"	1"
Flexible Base (Type A Grade 1-2)	6"	6"	6"	6"	6"	6"
Subgrade	8" lime stabilized	8" lime stabilized	8" lime stabilized	12" compacted	12" compacted	12" compacted

Table 6.11: Minimum Residential Structural Sections on Type B (sandy) Soils using HMACP

Structural Material	Section L-1 (A-F)	Minor Res. Collector	C-1 Collector
HMAC pavement (Type D)	2"	2"	3"
Flexible Base (Type A Grade 1-2)	6"	6"	6"
Subgrade	8" cement stabilized	8" cement stabilized	10" cement stabilized

Table 6.12: Minimum Residential Structural Sections on Type B (sandy) Soils using PCCP

Structural Material	Section L-1 (A-F)	Minor Res. Collector	C-1 Collector
Concrete (4400 psi min)	6"	6"	6"
HMAC Bond Breaker (Type D)	1"	1"	1"
Subgrade	8" cement stabilized	10" cement stabilized	12" cement stabilized

k. **Guidance for Designers, Engineers, Bidders, and Contractors:**

i. Roadway Designers and Geotechnical Engineers

Roadway designers and geotechnical engineers shall utilize a combination of subgrade treatments, road base, road base treatments, bond breaker, and HMACP or PCCP pavement to form the structural design section for City roadways. All layers in the section shall contribute to the structural strength of the pavement based on typical design practices. Some layers contribute to moisture control, such as lime-modified subgrade, bond breakers, and seal coats, while other layers contribute to structural strength or structural stability in the section such as moisture-controlled/density-controlled subgrade, cement-treated subgrade, geogrid, lime-stabilized subgrade, moisture-controlled/density-controlled base, cement-treated base, and HMACP and PCCP. All layers should be working together to reduce or eliminate differential movements, deformations, and failures based on design guidance for level of service/reliability level for each roadway type in the City's Unified Development Code (UDC), Unified Transportation Plan (UTP), and as shown in the IDM. For all types of paving, rigid paving or flexible paving, a stable platform for building the roadway must be achieved ahead of pavement construction. One key requirement to achieve a stable roadbed platform is the required use of cement-stabilized sand in utility trenches per City Standard Specification Section 022020 *Excavation and Backfill for Utilities* to prevent settlement and deformation of utility trenches under the roadway pavement.

For sandy soils, such as low PI Type B soils primarily in North Beach, Flour Bluff, and Padre and Mustang Islands, it is a requirement to cement stabilize the subgrade, which is a very fine sand, to avoid issues with localized collapses and deformations for both flexible and rigid pavements. Cement stabilization of roadway base may also be considered. Cement stabilization for a stable subgrade platform and a bond breaker for moisture control is required for rigid pavements in the Type B soil areas to reduce tilt and failure of pavement panels from subgrade material pumping or blowing out from between joints or cracks over time. Cement stabilization of Type A clay soils is not allowed unless the PI has been modified to below 10 and organics are less than 1%. In all cases of cement stabilization, whether for subgrade or base, microcracking must be employed ahead of applying the bond breaker/seal coat to prevent reflective cracking from moving up throughout the entire pavement profile to affect level of service or reliability at the pavement surface.

For clay soils, it is a requirement to add lime to keep the improved compacted subgrade layer from shrink/swell cycles or loss of soil strength and bearing capacity. The addition of lime is either to achieve lime modification to create a stable building platform or to achieve lime stabilization to reach a specified contribution to the pavement structural value. For lime modification of lower PI clay soils (PI < 20) for flexible pavements, geogrid can be considered to combat pavement deformations during loss of soil strength events such as supersaturation or complete loss of soil moisture through wet and dry meteorological cycles. Geogrid structural strength contributions will be based on published strengths for the approved TxDOT Type 2 geogrids. Lime-modified subgrades (PI < 20) can also be stabilized with cement after a PI < 10 has been achieved. Lime-modified subgrade requires the contractor to work the lime into the specified subgrade layer rather than just proof-rolling, thereby providing a firm, dry, and stable platform on which to build up the pavement structure. In order for cement to be activated as a stabilizing agent, PI < 10 is required and organic material < 1%. Lime modification alone may be insufficient to prevent differential movement in extreme wet/dry events and the addition of geogrid or cement stabilization shall be considered to improve pavement performance and life for lime-modified subgrade. Geogrid can also replace up to 8 inches of lime-modified subgrade under certain circumstances and with prior approval of the City Engineer.

For higher PI clays (PI > 20), the addition of lime sufficient to achieve lime stabilization is required to minimize shrink/swell and the potential for loss of soil strength in the improved layer and to create a stable building platform. Lime stabilization is also required to achieve a specified soil strength in the pavement section to bridge over areas of varying soil strength in the soil layers below the improved zone, as well as to prevent supersaturation of the subgrade that would lead to loss of soil strength followed by rutting and pumping. Lime stabilization does not require the use of geogrid. Lime-only pavement sections with no geogrid layer shall be designed by the geotechnical engineer for all roadways. Lime-stabilized sections should be designed to achieve the specified soil strength within the improved layer and to achieve the calculated contribution to the overall pavement structural section. For lime-stabilized sections, geogrid is not required and shall not be substituted for lime stabilization. The minimum thickness for lime stabilized subgrade is 8-inches.

For the pavement design of a particular roadway segment, geotechnical engineers will provide a variety of pavement sections for use by the City and the design engineer during the pavement selection process. All geotechnical reports will include both flexible and rigid pavement section options for roadways unless specifically scoped otherwise. These pavement sections will include cement-stabilized subgrade in sandy areas, lime-stabilized subgrade in mid to high PI clay areas and lime-modified subgrade with or without geogrid in mid to low PI clay areas. The geotechnical engineer has the option of offering sections with cement stabilized base in sandy or lime-modified clay areas. The geotechnical engineer has the option of offering geogrid stabilized sections in lieu of lime-modified sections only when pre-treated PI < 20.

Geotechnical engineers will use a representative PI based on the mean of PI measurements plus ½ their standard deviation. For Example, a site with a mean PI of 20 and a standard deviation of 10 is assigned a representative PI of 25. Subgrade improvements will be for a minimum of 8-inches thickness for all roadways. Typical guidance on the application of subgrade treatments is as shown below in Table 6.11:

Table 6.13: Typical Pavement Structural Section per Plasticity Index (PI) for Flexible Pavements

Subgrade PI	Subgrade Treatment	Subgrade Replacement	Geogrid	Base Course	Seal Coat	Asphalt Base Course	Asphalt Surface Course
1 to 10	Cement Stabilized	None	None	Type A, Grade 1-2	1-course surface treatment	2.5-in HMAC Type B	1.5-in HMAC Type D
10 to 20	Lime Modified	Select Fill	Option	Type A, Grade 1-2	1-course surface treatment	2.5-in HMAC Type B	1.5-in HMAC Type D
20 to 75	Lime Stabilized	Select Fill	None	Type A, Grade 1-2	1-course surface treatment	2.5-in HMAC Type B	1.5-in HMAC Type D

ii. Bidders

Bidders are to bid per plan and specification. Bidders should seek to clarify any questions about alternate products or materials during the question-and-answer period. Bidders should not anticipate approval of alternate products or materials after award.

iii. Contractors

Contractors shall install the product specified or called in the plans unless a value-engineering proposal has been presented by the Contractor through the Change process outlined in Specification Section 00 72 00 *General Conditions* and accepted by the City Engineer as indicated by his signature on the change agreement. All credits back to the City must be accounted for in any value-engineering agreement per 00 72 00, to include contract time and labor.

The addition of geogrid to a lime-modified layer will be expected to add time and cost. For flexible pavement on low PI clays, the subtraction of lime modification and replacement by geogrid would be expected to subtract time and cost.

Consideration for the use of geogrid in lieu of lime can be made to expedite construction, protect commercial or residential property, or to quickly restore traffic as long as the in-situ subgrade PI is below 20 before lime modification.

Lime stabilization shall be executed according to TxDOT Specification Section 260 and TxDOT standard Tex 121-E.

Cement stabilization shall be executed according to TxDOT Specification Section 275.

Geogrid stabilization shall be provided according to TxDOT DMS-6240 and City Standard Specification Section 022040 - *Street Excavation*.