CITY OF FRIENDSWOOD

DESIGN CRITERIA MANUAL

DEPARTMENT OF ENGINEERING

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APPROVED BY
RESOLUTION NO. R2021-01
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Changes in the 2021 revision of the City of Friendswood Design Criteria Manual shall be listed here by Section.

Changes to Section I – Graphic and Design Requirements: NONE

Changes to Section II – Wastewater Collection System Design Requirements:

1.04.F.4 – Delete *"VII"* and replace with *"III 1.04.B.4"*.

1.04.F.16 – Delete *"SDR 26"* and replace with *"SDR 26 PVC pipe (ASTM D 3034, latest edition)"*.

1.04.J.2.d.5.b – Delete *"(ATSM"* and replace with *"ASTM"*.

Changes to Section III – Water Line Distribution System Design Requirements:

1.02.G – Delete "*www.friendswood.com/publications"* and replace with "*www.ci.friendswood.tx.us/350/Publications-Forms"*.

1.04.B.3 – Delete *"as in the following sections"* and replace with *" as in Section II – Wastewater Collection System Design Requirements"*.

1.04.B.4.a – Insert *"Refer to Section II – Wastewater Collection System Design Requirement."* after *"shall be located above the sewer."*.

1.04.B.4.b – Delete *" long)]"* and replace with *"long)]"*.

1.04.F.1 – Delete this subsection.

1.04.F.2 – Update outline numbering sequence to "*1.04.F Stream Ditch Crossings.*".

1.04.F.1.b – Delete *"Elevated crossings are preferred rather than underground crossings."* and replace with *"Underground crossings via bored polyethylene pipe preferred to elevated crossings."*.

1.04.N.1.a – Insert *"to create a physical loop"* after *"subdivision"*.

1.04.N.1.b – Delete this subsection.

1.04.N.1.c – Update outline numbering sequence to *"1.04.N.1.b"*.

1.04.N.1.d – Delete this subsection.

1.04.N.1.e – Update outline numbering sequence to *"1.04.N.1.c"*.

1.04.N.1.f – Update outline numbering sequence to *"1.04.N.1.d"*.

1.04.N.1.g – Delete *"In an unavoidable"* and replace with *"Dead-ends shall be avoided whenever possible; In an unavoidable"*, and update outline numbering sequence to *"1.04.N.1.e"*.

1.04.O.3.b – Delete *"twenty (20) foot section of C-900 PVC pipe [0ne hundred fifty (150) psi"* and replace with *"eighteen (18) foot section of class 150 pipe"*.

1.05.D.2.a – Delete *"and 1b"*.

1.05.D.5 – Insert *"be of specified type"* after *"pressure,"*.

1.05.E.1 – Insert *"Refer to City Standard Details for additional requirements."* after *"construction plans."*.

1.06.G – Delete this subsection.

1.06.H – Update outline numbering sequence to "1.06.G".

2.02.A – Insert *"Minimum pipe size is 8"*, and replace with *"10 also being common."*.

Changes to Section IV – Street Paving:

1.02.E – Delete "*www.friendswood.com/publications"* and replace with "*www.ci.friendswood.tx.us/350/Publications-Forms"*.

1.04.A.2 – Insert *"The Major Thorough Plan may be found at www.ci.friendswood.tx.us/350/Publications-Forms."* after *"additional considerations."*

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1.04.B.5 – Delete *"but not less than sixty (60) feet"* and replace with *"no less than sixty (60) feet"*.

1.04.C.1.a – Delete *"a fc"* and replace with *"an fc"*. Delete *"(3000 psi, reinforcement"* and replace with *"four thousand (4,000) psi. Reinforcement"*. Delete *"bars shall be spaced"* and replace with *"bars, spaced"*. Delete *"eighteen (18)"* and replace with *"twenty-four (24)"*. Delete *"sixteen (60)"* and replace with *"forty (40)"*. Delete *"twelve (12)"* and replace with *"ten (10)"*.

1.04.C.2.a – Delete *"fc = 3,000 psi and reinforcement"* and replace with *"an fc equal to four thousand (4,000) psi. Reinforcement"*. Delete *"bars shall be spaced"* and replace with *"bars, spaced"*. Delete *"eighteen (18)"* and replace with *"twenty-four (24)"*. Delete *"sixty (60)"* and replace with *"forty (40)"*. Delete *"twelve (12)"* and replace with *"ten (10)"*.

1.04.J.8 – Delete *"#5 reinforcing bars"* and replace with *"smooth dowel bars"*. Insert *"Concrete slab thickness shall be at least matching the existing slab thickness, and be a high strength early yield with fc = 5,000 psi."* after *"unless otherwise specified."*.

2.01 – Delete *"- Reserved"* from the section title, and insert the following subsection:

A. "Research existing utility and right-of-way information.

B. Verify that no restrictions exist that will deny approval of the project concept.".

Changes to Section V – Storm Drainage:

1.02.C – Insert *",the latest version"* after *"Manual"*.

1.02.D – Delete *"Design Criteria Manual. Ordinance No. T2007-20 amends the Flood Damage Prevention Ordinance by adopting the Harris County floodplain maps as revised on June 18, 2007"* and replace with *"Hydrology and Hydraulics Guidance Manual. Updated June 2019"*.

1.02.E – Delete *"Bridge Division"* and insert *"Design"* after *"Hydraulic"*.

1.02.F – Delete *"National Weather Service Documents – TP-40 Rainfall Frequency Atlas of the United States"* and replace with *"Atlas 14 Rainfall Depths for Galveston County Consolidated Drainage District 10/2019."*.

1.02 – Insert the following subsection:

H. "Harris County Flood Control District Policy Criteria and Procedure Manual. Includes Revisions to Chapters 2, 3, 6, 7 & 8 from Interim Guidelines and Criteria for Atlas 14 Implementation revised July 2019.

I. "Harris County. Recommendation on Minimum Standards for Communities in Harris County and Draining to Harris County. May 12, 2020.

J. "National Oceanic and Atmospheric Administration (NOAA) Atlas 14. Precipitation – Frequency Atlas of the United States. Volume 11 Version 2.0: Texas. (Atlas 14).

K. "Kronkosky Blake, Gauge Engineering, Atlas 14 Rainfall Depths for Galveston County Consolidated Drainage District, October 2019.

L. "Federal Emergency Management Agency. Flood Insurance Study Galveston County, Texas and Incorporated areas, August 15, 2019." .

1.03.A – Insert *"or other drainage facilities entering their system"* after *"ponds"*.

1.03.C – Delete *"A change in land use that alters the impervious coverage of the tract of land. Impervious cover includes, but is not limited to, concrete, asphalt, stabilized soil, tennis courts, water features, pools, sidewalks, crushed concrete, limestone, and roofing."* and replace with *"any manmade change in improved and unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations."*.

1.03.E – Insert *"In order to meet this requirement all standards in the Harris County Recommendation on Minimum Standards for Communities in Harris County and Draining to Harris County letter released May 12, 2020 must be met."* after *"Section."*.

1.03.N – Delete *"Weather Service"* and replace with *"Oceanic and Atmospheric Administration"*. Insert *"The City uses the Atlas 14 Point Precipitation rainfall depths."* after *"Administration"*.

1.03.O – Insert *"Engineering Department"* after *"Public Works Department,"*. Insert *"(when development occurs within Galveston County)"* after *"Drainage District"*.

1.04.A – Insert *"based on Atlas 14-point rainfall"* after *"frequencies"*. Delete *"City of Friendswood, Galveston County Consolidated Drainage District, and Harris County Flood Control District"* and replace with *"National Oceanic and Atmospheric Administration for Harris County Region III"*. Insert *"*All City or District maintained facilities shall be designed for the 100-year storm independent of the amount of acreage served."* after the Type of Facility and Frequency list.

1.04.B.2 – Insert *"Allowable"* before *"Values"*. Delete *"typically used in"* and replace with *"for"*. Replace *"Rainfall Intensity Allowable Values Parameters chart with updated chart":*

t_c <= 60 min			
Rainfall			
Frequency	b	d	e
3-year	51.4	8.1	0.705
5-year	46.6	7.0	0.656
10-year	51.9	6.5	0.647
25-year	61.5	6.4	0.644
50-year	67.9	6.1	0.640
100-year	76.2	6.2	0.641

t_c > 60 min			
Rainfall			

Frequency	b	d	e
3-year	69.9	11.9	0.768
5-year	86.1	19.4	0.775
10-year	110.3	30.9	0.776
25-year	154.0	47.5	0.783
50-year	211.5	67.7	0.798
100-year	318.6	96.0	0.826

1.04.B.3 – Replace *"Land Use Type and Run-off Coefficient chart with updated chart":*

Land Use Type	Run-off Coefficient
Raw Undeveloped Acres	0.20
Improved Undeveloped Acres (i.e., mowed, filled, re-graded, etc.)	0.30
Parkland	0.40
Residential:	
SFR-Estates (>= 1 acre)	0.45
SFR (< 1 acre)	0.55
Multi-family	0.85
Commercial/Industrial	0.90
Pond (detention and amenity)	1.00

1.04.D.6 – Insert *"For developments less than five (5) acres, show contours of adjacent properties within fifty (50) feet, and account for natural and existing overland flow or channelized flows. Contour lines shall provide an indication on whether or not adjacent off-site areas drain toward or away from the subject tract."* after *"channelized flows."*.

1.04.E.3 – Delete *"Bridge Division"*. Insert *"8"* in front of *"4"*.

1.04.H.2 – Delete *"one hundred (100)"* and replace with *"fifty (50)"*.

1.04. H.2.a – Delete *"one hundred (100)"* and replace with *"fifty (50)"*.

1.04.H.2.a.3 – Delete *"five-tenths (0.5)"* and replace with *"fifty-five hundredths (.55)*.

1.04.H.2.a.4 – Delete *"No"*. Delete *"shall apply"* and replace with *"of fifty-five hundredths (0.55) ac. ft. per acre."*.

1.04.H.2.a.6 – Insert the following subsection:

> *6) "Single family residential and accessory buildings on existing lots and developments under one (1) acre do not have a minimum detention requirement."*

1.04.H.2.d – Delete *"one hundred (100)"* and replace with *"fifty (50)"*.

1.04.H.2.e – Insert the following subsection:

e. "Triangular Hydrograph Method for projects fifty (50) acres or less
The volume of storage required may be computed as follows:

$$B = \frac{43560\,V}{0.5\,I}$$

$$S = \frac{0.5\,B\,(I-O)}{43560}$$

Where,
B = Duration of inflow (sec)
V = Total inflow volume in ac-ft (24 hr duration even use SCS Curve Number)
S = Required storage volume (ac-ft)
I = Peak inflow rate (cfs)
O = Peak outflow rate (cfs)"

1.04.H.2.f – Insert the following subsection:

f. "Unit Hydrograph Method (Small Watershed Method) may be used for projects with drainage areas between 0 acres and 100 acres a technique developed by Dr. H.R. Malcom may be utilized in determining inflow hydrographs. The maximum inflow rate shall be determined by use of the rational formula. With the peak flow and volume of runoff, the equations presented below may be used to determine the inflow hydrograph for the proposed detention facility.

The maximum allowable outflow rate from the detention facility shall be restricted to the existing flow rate from the undeveloped tract. Outflow control shall be designed for the 5-year, 25-year and 100-year storm frequencies. In cases where the outfall for the detention facility is to be an existing roadside ditch, storm sewer, etc., the allowable outflow rate may need to be restricted to less than the maximum allowable so as to no overload the outfall.

1. $T_p = \frac{V}{1.39\,Q_p}$

Where,
T_p = Time to peak in seconds
V = Total volume of runoff for the design storm (ft^3)

Q_p = *Peak runoff for the design storm (cfs)*

$$V = Dr \cdot A * \left(\frac{43{,}560}{12}\right)$$

Where,
Dr = Runoff Depth (in)
A = Runoff Area (acres)

2. $q_i = \frac{Q_p}{2}\left[1 - cos\left(\frac{\pi\, t_i}{T_p}\right)\right] \qquad [t_i \leq 1.25\, T_p]$

**Note: The argument of the cosine function shown above must be expressed in radians.*

Where,
t_i *= Time of Interest (sec)*
q_i *= Runoff at Time of Interest (cfs)*

3. $q_i = 4.34 Q_p e^{\frac{-1.3 t_i}{T_p}} \qquad [t_i > 1.25 T_p]$

** Note: The argument of the cosine function shown above must be expressed in radians.*

4. $T = \frac{T_p}{10}$ *= Time Interval"*

1.04.H.3 – Delete *"The Triangular Hydrograph Method may be used; or"* and replace with *"Detention Storage Methodology for Projects over 50 acres.*

For drainage areas over 50 acres, a detailed hydraulic analysis utilizing the effective FEMA models will use as a minimum HEC-HMS v. 3.2 and HEC-RAS v. 3.0 (or more current version) for windows. This methodology also applies to properties out of tracts of 50 acres or more. A Drainage Impact Assessment report will be required to detail all design assumptions and parameters.".

1.04.H.3 – Insert the following subsections:

a. "Watershed Modeling Methodology

1. For HEC-HMS watershed analysis, the following parameters shall be used:

Loss Method: Green and Ampt
Transform Method: Clark Unit Hydrograph

Initial Loss: 0.1 Inches
Moisture Deficit: 0.385
Suction: 12.45 inches
Conductivity: 0.024 inches/hour

Percent Impervious Cover

Land Use	***Percent Impervious (%)***
Water	*100*
Isolated Transportation	*90*
High Density	*85*
Light Industrial	*60*
Airport	*50*
Residential Small Lot	*40*
Residential Large Lot	*20*
Development Green Acres	*15*
Residential Rural Lot	*5*
Undeveloped	*0*
Unknown	*0*

Atlas 14 Annual Exceedance Probability Rainfall Data (Inches) - Region III

Duration	*3-Year*	*5-Year*	*10-Year*	*25-Year*	*100-Year*
5-min	*0.7*	*0.8*	*0.9*	*1.1*	*1.4*
15-min	*1.4*	*1.50*	*1.8*	*2.1*	*2.7*
30-min	*2.0*	*2.2*	*2.5*	*3.0*	*3.8*
1-hr	*2.6*	*2.9*	*3.4*	*4.1*	*5.2*
2-hr	*3.3*	*3.8*	*4.5*	*5.6*	*7.5*
3-hr	*3.7*	*4.3*	*5.2*	*6.6*	*9.2*
6-hr	*4.5*	*5.2*	*6.5*	*8.4*	*12.2*
12-hr	*5.3*	*6.2*	*7.8*	*10.2*	*15.0*
24-hr	*6.2*	*7.3*	*9.2*	*12.1*	*17.9*

2. *Indicate on a map drawn to scale the existing and proposed watershed areas. All major features such as major roads and drainage entries shall be indicated. Node locations shall be provided in the base model with corresponding nodes at identical points in the model for the proposed system.*

3. *The model shall include the 5-year, 25-year and 100-year pre-development and post development runoff analysis. If a proposed development is to be constructed in phases, the analysis should address any intermediate developed conditions.*

4. *When time series data or pared data are used in the model, briefly discuss the source of the data in the report or show the calculations. Whenever possible, provide a copy of the calculations, source and model files via file sharing or on an external thumb drive.*

5. *Time of concentration and storage coefficients shall be calculated as outlined in HCFCD and GCCDD methodology.*

6. *If a different model than the FEMA effective hydraulic model is utilized, written justification must be provided, and approval granted by the City prior to beginning. At a minimum HEC-HMS v 3.2 shall be used.*

b. Water Surface Profile Modeling

1. *Water surface profile models shall be created using as a minimum HEC-RAS v 3.1.3 (or more current version) for windows. Alternative approaches to modeling shall be discussed with the City prior to commencing the study.*

2. *The use of one-dimensional steady flow and unsteady flow approach may be utilized with proper justification.*

3. *Provide information and data for the base model which must be included in the report. If the base model is different than the FEMA effective model, written justification must be provided, and approval granted before modeling commences. Base models shall be updated using HEC-RAS v 3.1.3 (or more current version).*

4. *Provide a plan view schematic for the existing and proposed systems. The schematics shall indicate channel designations, node labels and river stations. The river stations and node label so the existing model shall match any identical points on the proposed models whenever possible. Physical reference points shall also be used.*

5. *All models shall include the 5-year, 25-year and 100-year pre-development and post development runoff analysis. If a proposed development is to be constructed in phases, the analysis should address any intermediate development conditions. Proposed bridge and/or culvert crossing analyses shall include an extreme event.*

6. *For any steady flow or unsteady flow data used in the model(s), briefly explain how the data was calculated or the source of the data. Whenever available, these separate data files or calculations shall be included on the required external thumb drive and file share transfer with all submittals.*

7. *All existing bridge or culvert crossing shall be modeled based upon actual on the ground survey data correctly tied to a GCCDD or HCFCD benchmark, datum and year of adjustment unless otherwise authorized.*

8. *Bridge and/or culvert crossing shall be analyzed using the highest energy answer obtained using the energy and momentum equations.*

9. *The model should include a reasonable number of cross sections based upon current elevation data to ensure that the actual drainage system is properly represented. The spacing of cross sections may be approximated by using Samuel's equation. The use of numerous interpolated sections between two surveyed cross sections that are too far apart is not an acceptable way of producing additional cross sections.*

10. *Some portions of channels within the City are tidally influenced. In those reaches, the models shall account for tidal conditions.*

11. *For HEC-RAS models, the following contraction and expansion Coefficients are required. Any variance from these values must be preapproved by the City.*
    Contraction Coefficient: 0.1
    Expansion Coefficient: 0.3

12. *Manning's "n" values will follow GCCDD design criteria on the Galveston County side and Harris County criteria on the Harris County side. See the latest versions of the GCCDD Drainage Criteria Manual and the HCFCD Policy, Criteria, and Procedure Manual. Any deviation from these "n" values must be approved by the City before modeling begins."*

1.04.H.4 – Delete "*The Unit Hydrograph Method may be used.*

For developments with more than one hundred (100) acres, a detailed hydrologic analysis utilizing the HEC-1 or HEC-HMS Flood Hydrograph method shall be required per the applicable governing entities."

1.04.H.5 – Update outline numbering sequence to "1.04.H.4".

1.04.H.6 – Update outline numbering sequence to "1.04.H.5".

1.04.H.7 – Update outline numbering sequence to "1.04.H.6".

1.04.H.7 – Insert the following subsection:

c. "Contact the Galveston County Consolidated Drainage District for the latest regional detention rates."

1.04.H.8 – Update outline numbering sequence to "1.04.H.7".

1.04.H.9 – Update outline numbering sequence to I"1.04.H.8".

1.04.H.8 – Replace *"Detention Requirements Summary"* with updated chart:

Lot or Tract Type	Acreage	Off-Site Detention Available	Engineered Drainage Plans	Detention Volume Calculation Method	Rates	Attachment #4* Required	GCCDD Board Approval
SFR	0-5	Yes	Not Required	Purchase Regional Detention Based On: New Impervious Coverage Calculation of Detention Volume Unnecessary	Contact GCCDD for fees	Yes	Not Required
	5-8	Yes	Required	Engineer Determines the Detention Volume by an Approved Method	Contact GCCDD for fees	No	Required
	8+	No	Required	Engineer On-Site Detention	NA	No	Required

MFR	0-5	Yes	Required	Engineer Determines the Detention Volume by an Approved Method	Contact GCCDD for fees	No	Required
	5+	No	Required	Engineer On-Site Detention	NA	No	Required
COM	0-5	Yes	Required	Engineer Determines the Detention Volume by an Approved Method	Contact GCCDD for fees	No	Required
	5+	No	Required	Engineer On-Site Detention	NA	No	Required

1.04.H.10 – Update outline numbering sequence to I"1.04.H.9".

1.04.H.9 – Insert the following subsection:

d. "Hydrograph timing as a substitute for detention on any project is prohibited."

1.04.H.10 – Insert the following subsection:

10. "Lowest Floor Elevation:

a. Refer to the City of Friendswood Flood Ordinance (December 2020) section 34-63 for special lowest floor elevation requirements.

b. The latest FEMA FIRM panel and Flood Insurance Study (FIS) should be referred to for the base flood elevation and the 0.2 percent flood elevation."

1.05 – Delete *"RESERVED"* and replace with *"COMPUTER MODELS AND PROGRAMS"*.

1.05 – Insert the following subsections:

A. *"Current effective models use the HEC-HMS and HEC-RAS computer programs. Guidance for applying these programs is in the HCFCD Hydrology*

and Hydraulics Guidance Manual and the Galveston County Consolidated Drainage District Criteria Manual. The current effective FEMA model must be used. Any departure from using this model must be submitted in written format and approved by the City prior to submittal.

B. In some cases, HEC-HMS and HEC-RAS cannot accurately model some projects or hydraulic conditions. Alternative models may be used only with consent by the City's Engineering Department. All models selected must be freeware or prepared in a form such that the Engineering Department can open and review the models. The Engineering Department must be notified in writing of the program that will be used with justification early in the design process.

C. All models must be accompanied by a Letter Report or Drainage Impact Assessment describing any assumptions and changes due to the project. All projects larger than 50 acres required a Drainage Impact Assessment."

1.06 – Insert subsection title *"A. Drainage Plan Submittals"*.

1.06.A – Update outline numbering sequence to *"1.06.A.1 Preliminary Submittals – Submit for Review and Comment:"*.

1.06.A.1 – Update outline numbering sequence to *"1.06.A.1.a – One line drawings are required as part of the platting process. One line drawings shall include:"*.

1.06.B – Update outline numbering sequence to *"1.06.A.2 – Final Design – Submit the following for approval:*

a. Copies of any documents which show approval of exceptions to the City Design Criteria.

b. Design calculations for storm line sizes and grades, and for detention facilities, if any.

c. Design calculations for the hydraulic grade line of each line or ditch, and for detention facilities, if any.

d. Contour map and drainage area map of the project.

e. Plan and profile sheets showing storm sewer or open ditch design (public facilities only).

f. Projects located within a floodplain boundary or within a floodplain management area shall show the floodplain boundary or floodplain area, as appropriate, on the one-line drawing or drainage area map.

g. Soil boring logs.

h. All drainage plans shall have a current FEMA flood zone determination statement.

i. Fill calculations are required for projects located in the FEMA floodway, 100-year floodplain and the 500-year floodplain."

1.06.C – Update outline numbering sequence to *"1.06.A.3 – Signature State – Submit the following for approval:*

a. Review prints.

b. Original drawings.

c. Storm water detention maintenance agreement letters."

1.06 – Insert the following subsection:

A. "National Flood Insurance Program (NFIP) Compliance

1. The City of Friendswood is a participant in the National Flood Insurance program's (NFIP's) Community Rating System (CRS). As a CRS community, the City is required to develop and implement various programs intended to reduce flood risk such as identifying drainage problem areas, maintenance of existing drainage systems, construction of drainage projects, outreach to the community, etc. As a result of the community's commitment to reduce the flood risk, the residents of the City are entitled to receive discounted flood insurance premiums based on the City's CRS ranking as evaluated by CRS.

2. All runoff impacts created by development shall be mitigated, so post-project runoff rates and flooding levels are equal to or less than equivalent pre-project conditions.

3. Fill placed in the floodway, 100-year floodplain, or 500-year floodplain as designated on the current Flood Insurance Rate Map, and below the 500-year flood elevation shall be mitigated by the removal of a like amount of compensating cut in the vicinity of the fill, while maintaining hydraulic connectivity to the existing floodplain.

4. Any new development in the floodway will require a No Rise study. All calculations and/or models must be submitted with No Rise study via the City's permitting process."

1.06 – Insert the following subsection:

B. "Drainage Report/Drainage Impact Assessment Requirements

Drainage Report/Drainage Impact Analysis must be approved prior to submittal and approval of Construction Plans. The drainage report must include minimum of the following items listed in the drainage report:

1. Executive Summary: To include detention summary table for projects with detention.

2. Introduction: Inclusion of project name and purpose, map and description of project limits, project objectives, assumptions and constraints and any existing prior studies. Any data used must be fully described.

3. Existing Conditions: Include location and topography, land use, FEMA floodplains, right-of-way, pipelines and utilities, survey datum, brief discussion of impact of historical storm events at the project site. Include and Existing Condition Drainage Area Map Exhibit.

4. Hydrology and Hydraulics: Include Design Criteria guidelines used, storm frequencies analyzed, mitigation requirements etc. Include a listing of programs and software used. Include discussion of the hydrologic and hydraulic methodologies used. Include Pre-Project and Post-Project conditions. For projects that will be built in a phased approach include an Interim condition. Include analysis of an extreme event. Exhibits will include Overall Drainage Area Map, Existing Drainage Area Map with 5, 25, 100-year flows and water surface elevations at Major Outfall Nodes; Extreme Condition Map; Floodplain Maps with project boundary.

5. Proposed Drainage Plan. Include a description of the proposed drainage plan, results of the hydrological and hydraulics analyses, channel and/or detention layout, right-of-way requirements, pipeline and utility conflicts, geotechnical requirements, and any environmental issues. Exhibits required include Overall Drainage Area Map, Proposed Drainage Area Map with 5, 25 and 100 year flows and water surface elevations at Major Outfall Nodes, Floodplain Maps with project boundaries shown, Detention Pond layout with detention summary, and Plan and Profile with 5-year, 25-year and 100-year waster surface elevations in case of roadway.

6. Fill Results. Include fill calculations for the floodway, 100-year floodplain and the 500-year floodplain and a discussion of any mitigation. Include a Fill Exhibit showing all areas of cut and fill.

7. Conclusions.

When a detention facility is part of the proposed project, include the following detention summary table:

Project Name				
Detention Basin Area				*Acres*
Detention Storage Rate				*Acres-Feet/Acre*
Detention Storage Required				*Acre-Feet*
Detention Storage Provided				*Acre-Feet*
Floodplain Fill Mitigation Volume				*Acre-Feet*
Storm Event	*20% (5 Yr)*	*10% (25-Year)*	*1% (100-Year)*	*Pond Maximums*
Design Water Surface Elevation (-----Datum, ----- Adjustment)				
Maximum Allowable Outflow 9cfs)				
Maximum Outflow Provided (cfs)				

8. Appendix. Include detailed hydrological and hydraulic calculations. Include models and Geospatial data on an external drive.

1.07 – Delete "*and*" before "*all design*" and replace with a comma. Insert "*and any submitted reports*" after "*calculations*". Insert "*All hydrologic and hydraulic calculations and/or models used during design must be submitted to the City via electronic transfer and on an external hard drive.*" after "*information.*".

2.02 – Insert the following subsection:

F. "All projects located in the floodway, 100-year floodplain, or 500-year floodplain require fill calculations and fill exhibit indicating areas of fill and cut."

Changes to Section VI – Site Development:

1.02.C – Delete "*www.friendswood.com/publications*" and replace with "*www.ci.friendswood.tx.us/350/Publications-Forms*".

1.04.A.2.d.2.g – Add a line spacing after subsection *"g. Once the site plan is approved, the developer may begin the building permitting process. Approval from the appropriate drainage entity is required prior to the issuance of building permits."*

1.04.A.2.d.4 – Delete *"set out in the"* and replace with *"set out in Section III –"*.

1.04.A.2.d.5 – Delete *"refer to the"* and replace with *"refer to Section II –"*.

1.04.A.2.d.6 – Insert *"Refer to Section V – Storm Drainage Design Requirements for more details."* after *"facilities in the area."*.

1.04.A.2.d.7.O.1 – Add a line spacing after subsection *"b) Ten (10) feet on collector streets, major thoroughfares and boulevards, and local streets greater than twenty-eight (28) feet in width."* .

1.04.A.2.d.11.a – Delete *"Concrete pavement thickness shall be a minimum of five (5) inches with eight (8) inches of stabilized subgrade. Reinforcement shall be Grade 60, fy = 60,000 psi, #4 deformed reinforcing bars spaced at sixteen (16) inches center to center both ways and a minimum lap lengths of eighteen (18) inches."* and replace with *"Minimum concrete slab thickness shall be five (5) inches with an fc equal to four thousand (4,000) psi. Reinforcement shall be Grade 60, fy = 60,000 psi, #4 deformed reinforcing bars, spaced at sixteen (16) inches center to center, both ways with a minimum lap length of twenty-for (24) inches. Minimum stabilized subgrade thickness shall be eight (8) inches."* .

1.04.A.2.d.11.f – Delete *"Appendix C – Design Criteria Manual"* and replace with *"Appendix C of this Design Criteria Manual"*.

12.03.J – Delete *"Concrete sidewalks [a minimum of four (4) feet wide and four (4) inches thick with steel reinforcement] shall be required along all street frontages."* and replace with *"Sidewalks are required as set out in Section III of the Subdivision Ordinance and Section 70-64 of the Code of Ordinances. Where sidewalks are required, they shall have a minimum width of four (4) feet, except on TxDOT rights-of-way where the minimum width shall be five (5) feet."*.

Changes to Appendix A – Attachments: NONE

Changes to Appendix B – Figures: NONE

Changes to Appendix C – Parking Group Tables: NONE

Changes to Appendix D – Qualified Tree List: NONE

Changes to Appendix E – Downtown District Amenities: NONE

Changes to Appendix F – Culverts and Driveways Policy:

III.A.vii – Add a line spacing after subsection *"vii. Alternate sizes and styles may be used as long as they meter the same square inch area of the required pipe size, and is approved by the City Engineer."*.

III.B.xi – Delete "*www.friendswood.com/publications"* and replace with "*www.ci.friendswood.tx.us/350/Publications-Forms"*.

Changes to Appendix G – Traffic Control Sign Policy:

Header of document – Delete *"Engineering Department of Public Works"* and replace with *"Engineering Department"*.

TABLE OF CONTENTS.ATTACHMENTS.F – Delete *"32"* and replace with *"33"*.

SCOPE – Delete *"Engineering Department of Public Works"* and replace with *"Engineering Department"*.

TERMS.Traffic Committee – Delete *"Department of Public Works Administration and Public Works Engineering Division"* and replace with *"the Public Works Department and Engineering Department"*.

PROCEDURES.1 – Delete *"Traffic Concern request forms may be obtained from the City of Friendswood Engineering or downloaded at www.friendswood.com/publications."* and replace with *"Traffic concerns may be submitted directly to Engineering via a fillable form at www.ci.friendswood.tx.us/350/Publications-Forms under Traffic."*.

PROCEDURES.2 – Delete *"Public Works"* and replace with *"Engineering"*.

PROCEDURES.7 – Delete *"will share"* and replace with *"shall attempt to convey"*.

No Parking/Parking Zone Implementation Requests – Delete "*will share"* and replace with "*shall attempt to convey*".

No Parking/"Parking" Zone Removal Requests – Delete *"will share"* and replace with *"shall attempt to convey"*.

Commercial Truck Cut-Through Traffic Mitigation Requests – Delete *"will share"* and replace with *"shall attempt to convey"*.

Pedestrian Facility Requests – Delete *"will share"* and replace with "*shall attempt to convey"*.

School Zone Safety Requests – Delete *"Traffic Engineering and Operations will share"* and replace with *"Engineering shall attempt to convey"*.

Speed Control Requests – Delete *"www.friendswood.com"* and replace with *"www.ci.friendswood.tx.us"*. Delete *"Traffic Engineering and Operations will share"* and replace with *"Engineering shall attempt to convey"*.

Intersection Control Requests (Multi-way Stops, Traffic Signals, and Roundabouts) – Delete *"City Traffic Engineer"* and replace with *"City Traffic Director"*. Delete *"Traffic Engineering and Operations will share"* and replace with *"Engineering shall attempt to convey"*.

Other Public Safety and Traffic Issue Requests – Delete *"Traffic Engineering and Operations will share"* and replace with *"Engineering shall attempt to convey"*.

Attachment B.Possible Solutions – Delete *"and sending it to the Engineering Division"* and replace with *"at www.ci.friendswood.tx.us/350/Publications-Forms"*. Delete *"Engineering Division"* and replace with *"Engineering"*.

Attachment D.II.Parking Regulations – Delete *"Department of Public Works"* and replace with *"Engineering Department"*.

Attachment F.III.Purpose – Delete *"Engineering Division of the Department of Public Works"* and replace with *"Engineering Department at www.ci.friendswood.tx.us/350/Publications-Forms"*.

Attachment G – Delete *"Department of Public Works"* and replace with *"Engineering Department"*. Delete *"The Department of Public Works will install"* and replace with *"The City will install"*.

Attachment H – Delete *"speeds down, Engineering Studies"* and replace with *"speeds down, engineering studies"*.

Changes to Appendix H – Streetlight Policy:

VI.b – Add a line spacing after subsection *"• Spacing in rural areas that have large acreage lots may be extended to five hundred (500) foot spacing and staggered along both sides of the roadway."*.

VII.a – Delete *"Department of Public Works Engineering Division"* and replace with *"Engineering Department at www.ci.friendswood.tx.us/350/Publications-Forms"*.

VII.b – Delete *"Division"*.

VII.c – Delete *"Division"*.

VII.e – Delete *"Division"*. Delete *"Approves"* and replace with *"approves"*.

VII.g – Delete *"Division"*.

VIII – Delete *"Department of Public Works"* and replace with *"Public Works Department"*.

Streetlight Request Form – Delete page titled *"Streetlight Request Form"*.

TABLE OF CONTENTS

REVISION CHANGES

Changes to this revision of the Design Criteria Manual.

SECTIONS

APPENDICES

SECTION I

GRAPHIC AND DESIGN REQUIREMENTS

1.0 GENERAL

A. Should any portion of this Section conflict with any provisions of the Subdivision Ordinance or Zoning Ordinance, the more stringent of the three (3) shall govern.

B. The City Engineer shall have the final interpretation of any provisions in this Design Criteria Manual.

C. The City Engineer has the right to issue administrative orders or design criteria modifications for just cause related to any provisions or conditions in this Design Criteria Manual.

1.01 CHAPTER INCLUDES

Graphic and design requirements for construction drawings.

1.02 REFERENCES

The City of Friendswood Standard Details and City of Friendswood Technical Specifications, latest versions. These can be downloaded from the City's website at: www.friendswood.com/publications

1.03 DEFINITIONS

A. CADD (Computer Aided Drafting Design) – the preparation of documents utilizing computer facilities for the production of drawings, plans, prints, and other related documents.

B. GCCDD – Galveston County Consolidated Drainage District.

C. HCFCD – Harris County Flood Control District.

D. PDF – a file format that provides an electronic image of text or text and graphics that looks like a printed document and can be viewed, printed and electronically transmitted.

1.04 DESIGN REQUIREMENTS

A. Provide a cover sheet for all projects involving three or more design drawings (excluding standard detail sheets). Drawing sheet numbers shall be shown on the

cover sheet or area key map. Include a vicinity map to identify project locations. Also provide current City of Friendswood Standard Details Signature Block that has a note stating that approval is valid for only one (1) year from the date of signatures.

B. Preliminary drawings shall be prepared on nominal twenty-four (24) inches by thirty-six (36) inches.

C. Final drawings shall be produced by CADD on paper stock. The engineer shall also submit, at the time of plan approval, an electronic PDF and DWG version of the CADD drawings on CD-ROM of the development showing all lot lines and associated lot information, rights-of-way, easements, contour-lines, utilities, and all drainage and paving improvements.

D. Details of special structures (not covered by approved standard drawings such as stream or gully crossings, special manholes, or junction boxes, etc.) shall be drawn with vertical and horizontal scales equal to each other, and shown on a separate sheet(s) from the Standard Detail sheets.

E. Each set of construction drawings shall contain paving and utility key drawings indexing specific plan and profile sheets. City of Friendswood Standard Detail drawings, where applicable, shall be included. All sheets shall have standard title blocks and be sequentially numbered. Where applicable, show HCFCD or GCCDD key drawings and numbers.

F. A drawing index shall be shown on the overall cover sheet.

G. Overall project layouts shall be drawn to a minimum scale of 1 inch = 100 feet and provided with a drawing index.

H. A north arrow shall be shown on all sheets (except standard or special detail sheets) and shall be located either toward the top or to the right.

I. Plan and profile sheet stationing must run from left to right.

J. Standard scales permitted for plans and profiles of paving and utility construction drawings are as follows:

1. Major thoroughfares, major collectors, and boulevards over four hundred (400) feet in length, or special intersections/situation.

   a. 1 inch = 20 feet horizontal, 1 inch = 2 feet vertical

2. Minor collectors or local streets.

a. 1 inch = 20 feet horizontal, 1 inch = 2 feet vertical

b. 1 inch = 50 feet horizontal, 1 inch = 5 feet vertical

3. Scales in Paragraph No. 2 above are a minimum; larger scales may be used to show details of construction.

K. Each plan and profile sheet shall have a benchmark elevation and description of the benchmark, along with a current flood zone determination statement. Also include the temporary benchmark (TBM) with their elevation and coordinates.

L. The seal, date, and original signature of the Professional Engineer licensed to practice engineering in the State of Texas, and who is responsible for the drawings, shall be required on each sheet developed by the engineer, along with their firm's registration information. The engineer may use a stamped or embossed imprint for his/her seal; however, the embossed imprint must be shaded such that it will reproduce on prints.

M. A copy of the final plat for new developments shall be included with the final drawings when submitted for final approval.

N. If a roadway exists where drawings are being prepared to improve or construct new pavement or a utility, label the existing roadway width, surface type, and thickness. Pavement thickness shall be ascertained by coring with the core hole and grout filled to protect pavement prior to construction.

O. Show all street and/or road alignments on drawings.

P. End and beginning of alignment shall include coordinates based upon State Plane.

Q. Develop drawings to accurate scale showing proposed pavement, typical cross sections, details, lines and grade, and all existing topography within street rights-of-way, and any easement contiguous with the rights-of-way. At the intersection, the cross street details shall be shown at a sufficient distance [twenty (20) foot minimum distance outside the primary roadway rights-of-way] in each direction along the cross street in order to design adequate street crossings or transitions.

R. Match lines between plan and profile sheets shall not be placed or shown within cross street intersections including cross street rights-of-way.

S. Natural ground profiles shall be shown as follows:

1. For privately-funded projects, center line profiles are satisfactory except where a difference of one-half (0.5) foot or more exists from one (1) rights-

of-way or easement line to the other, in which case, dual profiles are required.

2. For City of Friendswood projects, provide natural ground profiles at each rights-of-way line. Easement profiles shall conform to S.1 below.

T. Basic plan and profile sheets shall contain the following information:

1. Identify all lot lines, property lines, easements, and/or rights-of-way.

2. Label each plan sheet as to street/easement widths, pavement widths, pavement thickness where applicable, type of roadway materials, curbs, intersection radii, curve data, stationing, existing utilities (type and location), and any other pertinent feature affecting design.

3. Show all utility lines four (4) inches in diameter or larger within the rights-of-way or construction easement in profile view. Show all utility lines, regardless of size, including franchise utility lines, in the plan view.

4. Graphically, show flow line elevations and direction of flow for all existing ditches.

5. Label proposed left and right top of curb elevations and grades, except at railroad crossings. Centerline elevation and grades are acceptable only for paving without curb-and-gutters.

6. Curb return elevations and grades for turnouts shall be shown in profile.

7. The centerline elevation at the property line of all existing driveways shall be shown in profile.

8. Station all esplanade noses or the centerline of all esplanade openings with esplanade width shown, both existing and proposed.

9. The design of both roadways is required on all paving sections with an esplanade.

10. Station all Points of Curvature (PCs), Points of Tangency (PTs), radius returns, and grade change Points of Intersection (PIs) in the plan view. Station all radius returns and grade change Points of Intersection (PIs) in profile with their respective elevations.

U. Provide a Storm Water Pollution Prevention Plan (SWPPP) with legend. See Section VI – Site Development under Design Requirements.

V. The Drainage Plan shall have a current FEMA flood zone determination statement.

W. All “No Objection” letters expire one (1) year after issuance.

SECTION II

WASTEWATER COLLECTION SYSTEM DESIGN REQUIREMENTS

1.0 GENERAL

A. Should any portion of this Section conflict with the Subdivision Ordinance or the Zoning Ordinance, the more stringent of the latter two (2) shall govern.

B. The City Engineer shall have the final interpretation of any provisions in this Design Criteria Manual.

C. The City Engineer has the right to issue administrative orders or design criteria modifications for just cause related to any provisions or conditions in this Design Criteria Manual.

D. Sanitary sewers located on private property that are not in a dedicated easement, are under the jurisdiction of the International Plumbing Code, as adopted and amended by ordinance, and will be addressed/reviewed by the Building Official.

1.01 CHAPTER INCLUDES

Criteria for the design of wastewater collection systems.

1.02 REFERENCES

A. Texas Commission on Environmental Quality (TCEQ) – "Design Criteria for Sewerage Systems" – Texas Administration Code – Chapter 217 (current revision).

B. Galveston County Health Department.

C. City of Friendswood Standard Details and Technical Specifications, latest version. These can be downloaded from www.friendswood.com/publications.

1.03 DEFINITIONS

Where used in these regulations, the following terms shall be construed to carry the meanings given below:

A. Public Sanitary Sewer – A closed conduit which conveys wastewater flow and which is located within the public rights-of-way or dedicated public easement. A public sanitary sewer (or public sewer system) is intended to serve more than one (1) "owner".

B. Private Sanitary Sewer – A closed conduit which conveys wastewater flow and is constructed and maintained by a private entity (ies) (i.e., homeowner's association). Private sanitary sewers may be located in areas such as a private street or common area, and are subject to the design and construction requirements of the International Plumbing Code, as adopted and amended by ordinance. Private sanitary sewers must discharge to a public sanitary sewer.

C. Sanitary Sewer Main – A sanitary sewer which receives the flow from one (1) or more lateral sanitary sewers.

D. Lateral Sanitary Sewer – A sanitary sewer running laterally down a street, alley, or easement, which receives only the flow from the abutting property.

E. Service Lead – A sanitary sewer which branches off a public sanitary sewer and extends to the limits of the public rights-of-way. It shall be construed as having reference to a public sanitary sewer branching off from a main or lateral sanitary sewer to serve one (1) or more houses, single-family lots, or other types of small land tracts situated in the same block with the said main or lateral sanitary sewer, but not directly adjacent thereto. Such a line shall never exceed one hundred fifty (150) feet in length. If the sanitary sewer is designed to serve more than two (2) houses, or the equivalent of two single-family residences along a street, a lateral sanitary sewer as defined above shall be constructed.

F. Service Connection – A private sanitary sewer from a single source to the main or lateral sanitary sewer in the street, alley, or easement adjacent thereto. Service connections are covered by the International Plumbing Code, as adopted and amended by ordinance. It will be owned and maintained by the owner of the property being served by said sanitary sewer.

G. Project Area – The area within the immediate vicinity of the public sanitary sewer to be constructed. For example, if a public sanitary sewer were to be constructed within the public rights-of-way, the project area would extend ten (10) feet to either side of the public rights-of-way. If as an example, a public sanitary sewer is to be constructed within a dedicated easement adjacent to the public rights-of-way, the project area would extend ten (10) feet to either side of the dedicated easement, depending upon the existing topographical elements, unless impacted by a permanent structure (i.e., telephone pole, trees, drainage ditches, etc.) If, as

an example, a public sanitary sewer is to be constructed within a side lot easement (if approved by the City), the same criteria would apply as for a dedicated easement adjacent to public rights-of-way.

H. Stack – A riser pipe constructed on main or lateral sanitary sewers which are deeper than six (6) feet, measured from finished grade at manhole to facilitate construction of service leads or service connections.

I. Force Main – A pressure-rated conduit (i.e. ductile iron pipe, pressure-rated PVC, etc.) that conveys wastewater from a pump station to a discharge point.

J. All references hereafter to sewer, public sewer, private sewer, sewer main, lateral sewer, service lead, service connections, stack, and force mains shall mean elements of a sanitary sewer system.

1.04 DESIGN REQUIREMENTS

A. Drawings to be furnished:

Before any main or lateral sewer is constructed and before a permit shall be issued for the construction of same, plans and profiles of the proposed sewer shall be prepared and submitted to the City for approval. All reproducible drawings, PDF, and CADD files shall become the property of the City and shall remain on file in the City for the use of any person who may be interested in such information.

B. Details to be shown on drawings:

The detailed plan view will show the exact location of public sewer lines in the street, alley, or easement with respect to the edge of the particular rights-of-way, the survey base line, and any nearby utilities, major landscaping, and other structures affecting construction.

C. Main and Lateral Sewers

1. Sewers in curved easements, easements defined by property lines, and combined easements containing other public utilities shall be shown both in detailed plan and profile views.

2. The profile shall show other underground and surface utilities, and facilities, both in parallel and at crossings; the size, grade of the proposed line, the elevation of same to hundreds of a foot at all manholes, changes of grade and dead-ends, and the proposed finished grade over the sewer.

It shall show the actual ground line as it exists prior to construction of the sewer. Where proposed fill or cut is contemplated, the proposed new ground line shall be shown as a separate line from the actual ground line. Type of pipe and bedding shall comply with City of Friendswood Technical Specifications and Standard Details.

3. Where public sewers are to be placed between existing pavement and the street rights-of-way (or interior easement line) or under existing pavement or shoulders of pavement, show the existing ground line at both sides (or the closest side for sewers near the edge) of the rights-of-way or adjacent sewer easement.

D. Sewer mains – plan and profile required

1. Sanitary sewer layouts for single-family residential subdivisions should use a scale of one hundred (100) feet or less per inch. A scale of two hundred (200) feet per inch may be used provided the following information is shown on the layout:

a. All easements containing or buffering sanitary sewers shall have points of size change shown, and all manhole locations shall be shown.

b. The sewer alignment shall accurately reflect the relative location of the sewer as shown on the detailed plan view.

c. All service leads that cross street pavement or serve adjacent property shall be shown on the layout. The detail plans and profiles shall show the flow lines of all service leads at the street or easement rights-of-way.

d. The number and size of the lots depicted on both the overall sewer layout sheet and the individual plan and profile sheets shall match the number and size of the lots depicted on the final plat after recordation.

e. On the overall sanitary sewer layout sheet the size and direction of flow for all existing and proposed sewers shall be shown.

f. The location of the proposed sewer within the public rights-of-way, a dedicated easement adjacent to the public rights-of-way, or side lot easement (if allowed by the City).

g. The overall sanitary sewer layout sheet shall show the area, in acres, which the proposed sewer(s) is (are) designed to serve. A location map shall be included that references the average proximity to nearby major thoroughfare and boulevard streets. The scale of the location map shall be 1 inch = 2,000 feet or less.

2. Non-residential subdivision sanitary sewer layouts for large areas, and with a scale of four hundred (400) feet or more per inch, shall have an additional set of layouts at not more than two hundred (200) feet per inch, with match lines and a small index map showing which portion of the overall layout that each sheet's layout represents.

3. Acceptable horizontal scales for the detailed plan and profile views shall be ten (10) feet, twenty (20) feet, forty (40) feet, and not more than fifty (50) feet maximum per inch. Horizontal scale for major thoroughfares and boulevards shall be 1 inch = 20 feet or less.

4. Acceptable vertical scales for detailed profile views shall be two (2) feet, four (4) feet, and not more than five (5) feet maximum per inch unless otherwise approved. Vertical scale for major thoroughfares and boulevards shall be 1 inch = 2 feet or less.

5. The plan view shall show, at a minimum, the following information for the project area:

   a. All topographical features;

   b. Stationing for the proposed sewers;

   c. All existing underground and overhead utilities (i.e. telephone, gas, power, etc.);

   d. Any significant landscaping and/or other structures which might impact construction and/or construction related activities;

   e. The width and type of all existing and proposed easements;

   f. All proposed service leads;

   g. The limits of bore and/or tunnel;

h. Locations where pressure rated pipe is to be installed at water line crossings;

i. Drawings for single-family residential subdivisions shall show the proposed location by stations of all service leads, service connections, and stacks. The distance from the sewer or survey base line station to the nearest existing manhole shall be shown in the plan view or on an additional sewer layout sheet with a scale no more than 1 inch = 100 feet.

6. The profile view shall show, at a minimum, the following information for the project area:

a. Underground and/or surface utilities/facilities which are either parallel to the proposed sewer or cross the proposed sewers;

b. The proposed sewer's diameter and grade for each manhole section;

c. The flow line elevation for all sanitary sewers at each manhole;

d. The rim elevation of all existing and proposed manholes;

e. The flow line elevation at each sheet "break" [i.e., from one (1) sheet to another];

f. Type of pipe bedding/backfill shall be noted on each plan/profile sheet;

g. The finished grade for proposed and existing pavement where "fill" and/or "cut" is proposed, the proposed new ground elevation line shall be shown as a separate line from the existing ground elevation line;

h. The existing ground elevation line for the "near side" of the public rights-of-way where a sewer is to be placed between the edge of existing pavement and the edge of the public rights-of-way;

i. The existing ground elevation line at the centerline of the proposed sanitary sewer where a sanitary sewer is to be placed within an existing easement;

j. Show any proposed and/or existing pavement;

k. The flow line elevation of all service leads where they cross the edge of the public rights-of-way or the dedicated easement adjacent to the public rights-of-way;

l. The limits of bore and/or tunnel;

m. Locations where pressure rated pipe is to be installed at water line crossings;

n. The location of special backfill and/or proposed stacks shall be identified by "stations" indicated on the design plans;

o. The location of stacks shall be labeled with stations.

E. Service leads

1. Service leads shall be sized in accordance with Paragraph 1.04.G of this Section.

2. Service leads shall be at the property line between two (2) adjoining lots, or as directed by the City. A single six (6) inch service lead located at the property line between two (2) adjoining lots would serve two (2) single-family residences with a wye placed at the end of the service lead. Do not extend the wye clean-outs beyond the edge of either the public rights-of-way or dedicated easement.

3. Any service lead extension of more than fifty (50) feet parallel to the street rights-of-way shall be treated as a lateral sewer.

4. Service leads from developments with more than seventeen thousand five hundred (17,500) gallons-per-day flow shall discharge into a proposed or existing manhole. Where the flow line of the service is thirty (30) inches or greater above the flow line of the manhole, provide a standard drop to manhole.

a. Service leads shall be provided to serve each lot within a proposed development;

b. Service leads shall be six (6) inches in diameter (minimum). If the length of a service lead exceeds one hundred (100) feet or the

width of the public rights-of-way by more than twenty (20) feet, the minimum diameter shall be eight (8) inches and a manhole shall be utilized for connection to the public sewer;

c. Service leads with a diameter of six (6) inches shall utilize "full body" fitting (extruded or factory-fabricated) for connection to the proposed public sewer or an approved saddle-type connector for connection to an existing public sewer;

d. Saddle-type connectors shall be installed with the "stub" oriented between the "spring line" (3 o'clock and 9 o'clock positions) and forty-five (45) degrees from the "spring line" ("1:30" and "10:30" positions). Tees (aka, "full body fittings") shall be oriented in the same manner;

e. The service lead shall be designated to minimize the use of bends as site conditions will permit;

f. Service leads exceeding the limits defined in 1.04.E.3 shall have a manhole at each end; as well as, a plan/profile drawing for each rights-of-way crossing. All, or part, of these service leads which are located in a public rights-of-way, alley or dedicated sanitary sewer or public utility easement may be treated as a public sewer, depending upon the location of the terminal manhole and any intermediate manholes;

g. For all existing lots (which are not served in accordance with these guidelines) that need a service lead, if the distance to the nearest existing sewer is less than fifty (50) feet, the service lead falls under the jurisdiction of the International Plumbing Code, as adopted and amended by ordinance, and the Building Official.

F. General Requirements

1. Sanitary sewers shall allow for orderly expansion of the system and shall conform to the comprehensive water and sewer plan for the City of Friendswood.

2. Sewers shall be sized based on the minimum requirements set out in this standard and the standard wastewater flow rates as established by the City of Friendswood;

3. All sewers shall conform to the minimum requirements of the Title 30 of the Texas Administrative Code, Chapter 217 of Texas Commission on Environmental Quality (TCEQ), and Galveston County Health District.

4. Sewers shall be separated from water lines by a minimum of nine (9) feet. Where the minimum separation is not maintained, refer to Section III 1.04.B.4 for allowable clearances. Sewers crossing utilities other than water, a minimum of six (6) inches of clearance must be maintained and called out on plan and profile.

5. As maintained by the City of Friendswood, the public sanitary sewer shall be defined as all sewers, including stacks and service leads, that serve more than one sewer connection, and that are located in public easements or street rights-of-way, and that are installed in accordance with these Standards.

6. Sanitary lines greater than six (6) feet deep shall require stacks to facilitate construction of service leads or service connections. Stacks shall be shown on plans with station numbers. Place stacks and wyes or tees as shown. Where no stacks are shown, it is the responsibility of the licensed plumber to place a City approved saddle for connection to the line and the responsibility of the City Engineer or his designated appointee to determine that such saddle is water tight and properly installed.

7. Materials and construction shall conform to latest City of Friendswood specifications with all amendments thereto, including standard leak test.

8. Unless noted otherwise, all public sewers and service leads shall be completely embedded in cement-stabilized sand to six (6) inches below the pipe, twelve (12) inches above the pipe and to six (6) inches on each side. All such bedding shall be compacted to ninety-five (95) percent standard proctor density. The cross-section so described herein shall be termed the "embedment zone."

9. Backfill all excavation areas/trenches under or within twelve (12) inches of existing or proposed pavement or shoulder of pavement with cement-stabilized sand from the top of the pipe "embedment zone" to the bottom of the subgrade. Cement-stabilized sand must develop one hundred (100) psi compression at forty-eight (48) hours. Backfill shall be compacted to ninety-five (95) percent standard proctor density.

10. The location of all special backfill and of proposed stacks shall be shown by stations in the drawings.

11. Construction notes shall designate the kind and class of pipe with exceptions to the construction notes to be shown on the plan and profile sheets.

12. Non-sanitary sewer easements or fee strips such as pipeline, power company, drainage district, railroad, etc., are in and of themselves insufficient and unacceptable to permit laying of sanitary sewers and/or force mains across or along the underlying private property or restricted non-sanitary use type of public property.

13. The final determination as to that portion of a street, alley, or easement to be occupied by a proposed sewer rests with the City Engineer who will take into consideration existing, planned and proposed facilities such as manholes, pavement, pipe/conduits, along with existing trees, shrubs, or other unique surface conditions when arriving at a decision.;

14. Where an easement for a public sewer ends at a public rights-of-way, the last manhole shall be extended into the public rights-of-way at a minimum of two (2) feet beyond the property line; or as close to the public rights-of-way as possible due to acceptable clearances required for other utilities (i.e., water line and storm sewers).

15. The drawings for the sewer shall show the location of any existing known pipe, duct, or other obstacles that might interfere with the construction of the sewer and call such to the attention of the City any known obstacles that might be encountered in constructing the sewer in any location under consideration. The Professional Engineer for the project, who shall be licensed to practice engineering in the State of Texas, shall determine the existence of pipes, ducts, and/or obstacles from a visual survey on the ground plus research of all public records and private records when available.

16. All sanitary sewer mains shall be constructed utilizing pressure rated pipe SDR 26 PVC pipe (ASTM D 3034, latest edition), unless specifically approved otherwise by the City Engineer.

17. In new developments, sanitary sewer lines shall be centered in sanitary sewer line easements.

G. Line Size

1. The minimum pipe diameter for a public sanitary sewer shall be eight (8) inches.

2. Four (4) inch service leads shall be confined to the limits of the lot which they serve and shall serve only the equivalent of one (1) single-family lot. No four (4) inch sewer shall be laid in any street, alley, or rights-of-way.

3. Six (6) inch service leads shall not serve more than the equivalent of two (2) single-family lots or other types of small land tracts.

4. Four (4) inch and six (6) inch service leads for single-family residential lots shall have a minimum grade of one (1.0) percent and one-half (0.5) percent, respectively.

5. For commercial service leads such as street bores, submit a copy of the approved plumbing drawings to establish the required size of the line. The minimum size lead shall be six (6) inch.

6. All main and lateral sewers shall end in manholes, except for special and/or unusual situations that are subject to specific approval by the City Engineer.

7. All sewer lines shall be laid at a size and depth to conform to designs permitting an orderly expansion of the sewer system of the City, and so as to avoid a duplication of lines in the future.

8. The City Engineer shall have final approval as to what sizes and depths are required, along with exceptions to "lateral service leads" as previously defined.

H. Line Depth

1. The sewer should be laid with the top of the pipe a minimum of three (3) feet below finished grade or top of curb, whichever is lower.

2. Sewer laid in street rights-of-way with curb-and-gutter paved streets shall have a minimum cover of four (4) feet from the top of the pipe to the top of the curb to anticipate future sewer extension.

3. Sewers laid in street rights-of-way with crowned roads and side ditches shall have a minimum cover of five (5) feet from the average ground elevation line at the adjacent street rights-of-way to the top of pipe.

4. Where the minimum cover as specified in paragraphs H.1, H.2, and H.3 above is not possible, the sewer shall be laid in Class 150 [one hundred fifty (150) psi] pressure pipe or rigid factory made pipe with cement-stabilized sand backfill as shown on the City's Standard Details. Ductile iron pipe shall be lined with either a polyethylene or polyurethane coating as approved by the pipe manufacturer and applied by either the pipe manufacturer or an approved application. The minimum liner thickness shall be forty (40) mils.

5. Maximum depth for eight (8) inch, ten (10) inch, and twelve (12) inch collection lines shall be twenty (20) feet from average ground surface to pipe invert. Depths greater than twenty (20) feet are subject to approval by the City Engineer if justified for site-specific reasons during the preliminary engineering phase of the project design and shall be constructed of Class 150 [one hundred fifty (150) psi] pressure pipe.

I. Line Grades

The following table lists the minimum and maximum grades for six (6) inch through twenty-seven (27) inch public sewers. The minimum grade is based on a minimum full pipe velocity of two (2) feet per second. The maximum grade is based on a maximum full pipe velocity of ten (10) feet per second. In both cases, the Manning Formula has been used with an "n" of thirteen-thousandths (0.013). The use of different pipe materials will not alter the use of thirteen-thousandths (0.013) for the purpose of the Design Criteria Manual.

Inside Dimension (I.D.) of Pipe in Inches	Minimum Slope (in Percent) to Develop V=2.0 ft./sec.	Maximum Slope (in Percent) to Develop V=10.0 ft./sec.
6	0.50	12.35
8	0.33	8.40
10	0.25	6.23
12	0.20	4.88
15	0.15	3.62
18	0.11	2.83
21	0.09	2.30
24	0.08	1.93
27	0.06	1.65

For sewers larger than twenty-seven (27) inches in diameter, the Professional Engineer of record, who shall be licensed to practice engineering in the State of Texas, shall determine the appropriate grade utilizing the Manning Formula, n = 0.013 and a full pipe velocity of two (2.0) fps minimum and ten (10.0) fps maximum.

J. Manholes

1. All manholes shall be precast concrete, unless the Professional Engineer of record, who is licensed to practice engineering in the State of Texas, submits a "cast in place" manhole design for review and approval by the City Engineer. All precast manholes are required to incorporate a "boot type connector" for sewer diameters up to twenty-four (24) inches. For sewer diameters greater than twenty-foot (24) inches, utilize either the "boot" type connector (if available) or an integral gasket. All precast manholes shall conform to the latest ASTM requirements. No manholes may be placed in the paved portion of the City rights-of-way unless approved by City Engineer.

2. For all public sewers, manholes shall be placed at all changes in alignment, changes in grade, junction points, dead-end mains, laterals, and at street, alley, or easement intersections as designs may require.

    a. Sewers laid in easements shall have a manhole in each street crossed by the sewer.

    b. The maximum distance between manholes shall be three hundred fifty (350) feet for eight (8) inch to forty-eight (48) inch pipe

diameters. Spacing for lines of a diameter larger than forty-eight (48) inches shall be determined on an individual project basis.

c. Sewers with the same or approximate flow line elevation shall intersect each other at a ninety (90) degree angle. However, where a true perpendicular intersection cannot be obtained, and where the entering sewer intersects the receiving sewer at or about the same flow line, one (1) or more manholes shall be utilized to maintain a minimum eighty (80) degree angle at the point of intersection. When the entering sewer is on the upstream side of the manhole, the minimum angle between the sewers may be reduced to a forty-five (45) degree angle; provided:

1) A distinct flow channel can be maintained within the manhole when the flowline elevations of the sewers are at, or within, one (1) pipe diameter of the smaller pipe; or

2) When the flow line elevation of the "entering" pipe is above the crown of the "primary" sewer and clearance can be provided between the sewers.

d. Criteria for connections to, and utilization of, manholes:

1) Where manholes are utilized to facilitate connections between public sewers, when possible the sewers shall either match the manhole's flow line or match the elevation of each other's crown or utilize a manhole drop.

2) Connections between public sewers at the manhole shall adhere to the following criteria when possible:

a) The elevation of the crown of the discharging sewer shall either match the elevation of the crown of the receiving sewer or be approved as special cases by the City Engineer.

b) A standard drop connection is required when the difference in elevation between discharging sewer flowline and receiving flowline is greater than thirty (30) inches.

3) The routing of service connection directly to manholes is the preferred method of termination. Where the flowline elevation of the existing sanitary sewer is more than ten (10) feet below grade and there is no available stack, and either:

   a) The lot to be so connected is a single-family, owner-occupied, single lot residence connection to an existing manhole; or

   b) The lot to be so connected is a single-family, owner- occupied, single lot residence connecting to a proposed manhole at the end of a cul-de-sac.

4) When routing an approved service connection to a manhole (see Item 3 above), the wall penetration shall not be greater than ten (10) inches in diameter and shall be cored and sealed using approved grout.

5) When routing an approved service connection to a manhole (see Item 3 above), the connections shall utilize a "drop (either inside or outside) and shall adhere to the following criteria:

   a) The manhole wall penetration shall be a minimum of ten (10) feet below the manhole rim elevation and shall not be greater than ten (10) inches in diameter;

   b) The drop shall be six (6) inches in diameter and shall be constructed of SDR 26 PVC pipe (ASTM D 3034, latest edition);

   c) The drop shall be located forty-five (45) degrees from the upstream side of the main sewer;

   d) An internal drop shall be affixed to the manhole wall utilizing stainless steel bands and anchor bolts.

   e) An internal drop shall terminate with a forty-five (45) degree bend. Said forty-five (45) degree bend

shall not extend below the "top of pipe" elevation of receiving sanitary sewer and;

f) The wall penetration (core) shall be sealed using a "grout" as approved by the City Engineer.

g) All public sewers shall terminate in a manhole. Clean-outs will not be utilized except at the end of each service lead.

h) The manhole cover shall have a minimum diameter of thirty-two (32) inches.

i) All sanitary sewer manholes shall have inflow protectors.

j) All manhole covers shall have the City of Friendswood seal and “SANITARY SEWER” imprinted on the lid as shown in the City of Friendswood Standard Sanitary Sewer Details.

k) Commercial pressured discharge lines terminating in a manhole shall result in the manhole being protected by either a coating or concrete admixture to the interior walls of the manhole.

K. Lift Stations

1. Lift station design shall comply with the City of Friendswood Technical Specifications. In addition, it shall be confirmed that a storage volume, in the design of the wet well, shall equal to one and one-half (1.5) times the peak design flow to the lift station. Add ten (10) percent to account for volume displaced by pumps.

2. A natural gas standby generator shall be required for all new lift stations. The generator is required to be sized to operate all pumps during an emergency power failure.

3. A startup package for the pumps shall be submitted to the City Engineer before final acceptance. This package should also include a completed start up log sheet with field and product data. See Attachment 1.

4. Minimum site size shall be forty (40) feet by forty (40) feet. Smaller sites that are adjacent to public rights-of-way and are contiguous to green space or similar land use areas, may be approved when adequate odor control provisions are provided.

5. Pumps shall be sized to operate at optimum efficiency. Minimum acceptable efficiency at the operating point will be sixty (60) percent unless specifically approved by the City Engineer.

6. Operation and maintenance shall be considered in the design of the station and the location of the station.

7. Wet well working volume shall be sized to allow for the recommended pump cycle of six (6) minutes for each pump.

8. Prior to installation, controls and equipment shall be approved by the City Engineer.

9. Emergency operations shall be considered. Provide fittings and a blind flange that will be readily accessible for emergency bypass pumping.

10. The inlet structure shall be designed to minimize turbulence.

11. The velocity in the force main and riser pipes shall be less than 8 feet per second and greater than three (3) feet per second.

12. The wet well shall be sized to provide adequate clearance between the pumps (refer to manufacturers recommended clearances).

13. A peak factor of four (4) shall be used for lift station design.

14. A minimum of two (2) feet of clearance shall be provided between pumps and between pump and wall.

15. Low water levels shall be at least six (6) inches above impeller, or higher if required by manufacturer.

16. Complete immersion of submersible pump motor at low water level is preferred, if possible.

17. Tie reinforcing steel in lift station bottom to wall reinforcing steel (includes caisson construction situation) to provide watertight wetwell.

18. Nuts, bolts, chains, and all other metal components within wetwell shall be stainless steel, not carbon steel.

19. Vent pipe shall be eight (8) inch minimum diameter equipped with odor control system.

20. The following Hazen-Williams Coefficient shall be used for various pipe types:

PVC	New	C = 160
	10-year	C = 140
DIP	New	C = 140
	10-year	C = 100

21. Unless City Zoning regulations mandate another material, provide board fence (either cedar or heart redwood 6" width) with steel posts set in concrete. Fence shall be at least eight (8) feet high and include a 2"x12" rot board.

22. Fence design shall be certified by a Texas-licensed engineer.

23. Entrance drive to be at least fourteen (14) feet wide concrete pavement. Provide enough room to park vehicles inside lift station site.

24. Indicate method of drainage of site on site plan. Internal drainage, sheet flow and valley gutter driveways are acceptable. Drain to street or storm sewer, never onto adjacent private property.

25. Under no circumstances may a lift station be located within a regulatory floodway.

26. Locate the control panel and wetwell hatch above the One Hundred (100) Year Flood Plain. Call out the One Hundred (100) Year Flood Plain elevation on the plans.

27. Stainless steel guide rails (or other pump removal method that avoids entering wetwell) are required for submersible pumps.

28. A tee, plug valve (or gate valve), and blind flange assembly is required on the force main on the downstream side of the discharge valves and header.

This is required so truck-mounted pumps can bypass the lift station pumps and piping while maintenance work is being done on lift station.

29. Bedding for PVC force main shall be bank sand.

30. PVC force mains shall be AWWA C-900.

31. Ductile Iron Pipe (DIP) force mains shall be bedded in bank sand and polyethylene wrapped.

32. When calculating headloss in force main and piping, use of K factors on fittings, with the Hazen-Williams formula, is preferred.

33. Backfill structural excavations (wetwell, etc.) with cement-stabilized sand.

34. Lift station site plans shall be submitted in scales of 1 inch = 5 feet or 1 inch = 10 feet.

35. Provide a protective coating or concrete additive to the interior walls of the wetwell. The City Engineer shall approve coating or additive used.

36. Lift station shall be equipped with a telemetry system, approved by the City Engineer, and shall be compatible with existing systems in the City. A submersible transducer for SCADA shall be installed and connected to telemetry system to monitor status of lift station.

37. Power supply to lift station shall be three (3) phase and four hundred eighty (480) volts where possible.

38. A system of floats shall be provided to control pumps.

39. A pressure gauge suitable for application shall be installed on each discharge pipe.

40. A 1 inch minimum water service equipped with backflow prevention shall be provided at the lift station site.

L. Grease Traps/Grease Interceptors

Gravity grease interceptors shall be designed to remove grease from effluent and shall be sized in accordance with this section. Gravity grease interceptors shall

also be designed to retain grease until accumulations can be removed by pumping the interceptor.

1. Each grease trap/grease interceptor shall be installed in such a manner that it can be easily accessible for inspection, cleaning, and removal of the intercepted grease. All permitting, construction, design, and inspection activities must be completed in accordance with the manufacturer's instructions and the International Plumbing Code. Additionally, the following specifications must be incorporated into grease trap design:

    a. The grease trap/grease interceptor shall be constructed with a minimum of two baffles.

    b. Grease traps/grease interceptors are to be installed at a minimum distance of 10 feet from sinks and dishwashers to allow for adequate cooling of the wastewater. Water temperatures must be less than one hundred twenty (120) degrees prior to entering grease trap.

    c. All grease bearing waste streams should be routed through an appropriate grease traps/grease interceptor, including: three-compartment sinks, pot/pan sinks, soup kettles, hand-washing sinks, dishwashers, mop sinks, and floor drains. *Notable Exception*s: Drains that receive "clear waste" only, such as from ice machines, condensate from coils, and drink stations, may be plumbed to the sanitary system without passing through the grease trap.

    d. All exterior or recessed grease traps/grease interceptors are to be installed with an effluent sampling well.

2. Requirements for traps are as follows:

    a. Equipment and facilities of a type and capacity approved by the approving authority shall be provided.

    b. The trap shall be located in a manner that provides ready and easy accessibility for cleaning and inspection.

    c. The trap shall be maintained in effective operating condition so as to meet an effluent oil/grease test parameter of less than one hundred (100) mg/l.

d. Traps shall conform to a minimum detention time of thirty (30) minutes and a maximum of sixty (60) minutes.

e. The minimum size shall be one thousand (1,000) gallons or greater as determined by the design engineer.

1.05 APPURTENANCES – Reserved

1.06 SUBMITTALS

A. Preliminary design – submit the following for review and comment:

1. Copies of any documents which grant approval of exceptions to the City's Design Criteria.

2. Design calculations for line sizes and grades.

3. Contour map for overall area.

4. Plan and profile sheets showing proposed improvements (City projects only).

5. Geotechnical soils report for the project (City projects only).

B. Final design – submit the following for approval:

1. Final documents of the above plus plan and profile sheets and Geotechnical soils reports for non-City projects.

2. Review prints.

3. Original drawings.

4. Copy of Engineer's Summary Transmittal Letter to TCEQ.

1.07 QUALITY ASSURANCE

Prepare calculations and construction drawings under the supervision of a Professional Engineer licensed to practice engineering in the State of Texas and trained in the disciplines required by the drawings. The final construction drawings must be sealed,

signed, and dated by the Professional Engineer licensed to practice engineering in the State of Texas, and shall be responsible for the development of the drawings along with their firm's registration information.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS

A. Research existing utility and rights-of-way information.

B. Verify that no restrictions exist that will deny approval of the project concept.

2.02 DESIGN ANALYSIS

Calculations of design flows for overall development project.

2.03 DRAWINGS

Drawings shall include layout sheets with contours, plan and profile sheets, and detail sheets for special items and treatment plants.

SECTION III

WATER LINE DISTRIBUTION SYSTEM DESIGN REQUIREMENTS

1.0 GENERAL

A. Should any portion of this Section conflict with the Subdivision Ordinance or the Zoning Ordinance, the more stringent of the latter two (2) shall govern.

B. Should any section conflict with TCEQ Regulations, the more stringent of the two (2) shall govern.

C. The City Engineer shall have the final interpretation of any provisions in this Design Criteria Manual.

D. The City Engineer has the right to issue administrative orders or design criteria modifications for just cause related to any provisions or conditions in this Design Criteria Manual.

1.01 CHAPTER INCLUDES:

Criteria for the design of water lines.

1.02 REFERENCES:

A. Texas Commission on Environmental Quality (TCEQ), Water Utilities Division "Rules and Regulations for Public Water Systems," latest revision.

B. American Water Works Association (AWWA).

C. National Sanitation Foundation (NSF).

D. Texas Department of Health.

E. Texas State Board of Insurance.

F. International Fire Code (IFC).

G. City of Friendswood Standard Details and Technical Specifications, latest version. These can be downloaded from: www.ci.friendswood.tx.us/350/Publications-Forms.

1.03 DEFINITIONS:

Water Line – Closed conduits designed to distribute potable water for human consumption to various areas and provide fire protection. Line size and fire protection accessory locations are dependent on distance from primary source and quantity of demand.

1.04 DESIGN REQUIREMENTS:

A. Easements for water lines.

1. Lines shall be located within street rights-of-way, permanent access easements with overlapping public utility easements, easements adjacent to street rights-of way or recorded water line easements.

2. When outside of a public street rights-of-way or permanent access easement with an overlapping public utility easement, easements must be dedicated and restricted for water lines only.

3. When possible, easements shall be contiguous with public rights-of-way.

4. Except for side lot easements, water line easements shall be contiguous to a paved access.

5. For water lines twelve (12) inches or smaller located outside of street rights-of-way, minimum width of easement shall be ten (10) feet.

6. For water lines fourteen (14) inches or larger located outside of street rights-of-way, the minimum width of easement shall be fifteen (15) feet.

7. For water mains located less than five (5) feet from the rights-of-way line, the outside edge of a water line easement shall be located from the rights-of-way line as follows:

Twelve (12) inch and smaller pipe – five (5) feet
Fourteen (14) inch and larger pipe – ten (10) feet

8. Water lines along State rights-of-way shall be installed outside of the rights-of-way whenever possible and in a separate ten (10) foot minimum contiguous easement.

9. No back lot easements shall be allowed for the installation of water lines, unless specifically approved by the City.

10. Commercial developments requiring on-site fire hydrants must provide a minimum fifteen (15) foot water line easement for the water line and fire hydrant.

11. In new developments, water lines shall be centered in water line easements.

12. When using side lot easements, such easements shall be a minimum of ten (10) feet in width, located on one (1) lot or centered between lots. If centered between lots, the water line may be centered within the five (5) foot easement on one (1) lot, or centered in the full ten (10) foot easement.

13. Location of water lines in an easement not adjoining a public rights-of-way shall be prohibited, except as specifically approved by the City Engineer. When approved, these water mains will be centered in a fifteen (15) foot wide exclusive easement restricted to water only.

B. Location of water lines.

1. Locate within street rights-of-way.

2. Location of water lines within an easement – locate water lines in the center of a ten (10) foot minimum width dedicated waterline easement. Within a commercial development, center water lines within a fifteen (15) foot easement. Obtain approval for lines to be located in wider or multi-use easements.

3. When a water main is placed parallel to another utility line at or near the same grade, it shall have a minimum of nine (9) feet of horizontal separation. When the other utility is a sanitary sewer and a minimum of nine (9) feet cannot be maintained, the sanitary sewer must be constructed of pressure type pipe with watertight joints as used in water main construction and the clearances must be defined as in Section II – Wastewater Collection System Design Requirements or as specifically approved by the City Engineer. When a water main crosses a utility other than sanitary sewer, a minimum of six (6) inches of clearance must be maintained, and the water main shall have one (1) joint of pipe, a minimum of eighteen (18) feet long, centered on the other utility.

4. When water mains and sanitary sewers are installed, they shall be installed no closer to each other than nine (9) feet in all directions, and parallel lines

must be installed in separate trenches. Where the nine (9) foot separation distance cannot be achieved, the following procedures shall be used:

a. Where a sanitary sewer parallels the water main, the sanitary sewer shall be constructed of ductile iron, or PVC pipe meeting AWWA specifications, having a minimum working pressure rating of one hundred fifty (150) psi or greater, and equipped with pressure type joints. The water mains and sanitary sewer shall be separated by a minimum vertical distance of two (2) feet, and a minimum horizontal distance of four (4) feet, measured between the nearest outside diameters of the pipes, and the water main shall be located above the sewer. Refer to Section II – Wastewater Collection System Design Requirements.

b. Where a sanitary sewer crosses the water main, and that portion of the sewer is constructed within nine (9) feet of the water, as described above, the water line may be placed no closer than six (6) inches from the sewer. The separation distance must be measured between the nearest outside pipe diameters and the water line shall be located at a higher elevation than the sewer, and one (1) joint [a minimum of eighteen (18) feet long)] of the new pipe must be centered on the existing line.

C. Water line size.

1. Six (6) inch lines may be used on dead-end lines within cul-de-sacs, or if the line is less than one thousand (1,000) feet in length and interconnected between two (2) lines which are eight (8) inches in size or larger. The maximum number of fire hydrants on any length of six (6) inch line is one (1).

2. Eight (8) inch lines may be used for lines over one thousand (1,000) feet long, or when two (2) or more fire hydrants are required.

3. Twelve (12) inch and larger lines – line length, usage, etc., to be determined by a Professional Engineer of record licensed to practice engineering in the State of Texas, and approved by the City Engineer.

D. Dead-end lines.

1. Dead-end lines within public rights-of-way.

a. On permanent dead-end lines, other than on cul-de-sacs, the dimension of the line shall be six (6) inches and shall not exceed more than five hundred (500) feet in length from the closest interconnecting main line. In addition, it shall terminate with a fire hydrant.

b. On permanent dead-end lines on cul-de-sacs it will be required to reduce the pipe size successively. It is required to carry an eight (8) inch pipe to the next to last hydrant, then from that point use a six (6) inch pipe to the line's end. It is required to place the last service as near as possible to the end, and install a fire hydrant or two (2) inch blow-off at the end of the six (6) inch line. The maximum length of this reduced line size configuration shall not exceed eight hundred (800) feet.

2. Dead-end lines with one (1) on-site fire hydrant.

a. Six (6) inch lines may be used for lengths less than two hundred (200) feet provided domestic service is taken from the end of the line.

b. Eight (8) inch lines may be used for lengths greater than two hundred (200) feet but less than five hundred (500) feet, provided domestic service is taken from the end of the line.

E. Depth of cover.

1. Fourteen (14) inch and smaller mains shall have a minimum cover of four (4) feet from top of curb. For open ditch roadway sections, lines fourteen (14) inches and smaller shall be installed at least three (3) feet below the ultimate flowline of the ditch or six (6) feet below natural ground at the rights-of-way line, whichever is deeper and maintain the elevation throughout that section of line.

2. Sixteen (16) inch and larger mains shall have minimum cover of five (5) feet from top of curb. For open ditch roadway sections, lines sixteen (16) inches and larger shall be installed at least three (3) feet below the flow line of the ditch or seven (7) feet below natural ground at the rights-of-way line, whichever is deeper and maintain the elevation throughout that section of line.

3. Changes in grade, to clear other utilities or underground features, may be made by deflecting pipe joints. The maximum designed deflection shall

be one-half (0.5) of the manufacturer's allowable deflection. If a depth greater than eight (8) feet to the top of the pipe is required, a welded steel section shall be used. The standard depth of cover is to be maintained above the water main, and the grade change shall be made using the welded steel section. The installation of fittings for vertical deflections, or changes in elevation, shall not be allowed except with specific approval by the City Engineer.

F. Stream and Ditch Crossings.

1. Elevated Crossings.

a. All water lines shall be steel or restrained-joint metallic pipe, and shall extend a minimum of fifteen (15) feet beyond the last bend or to the rights-of-way line, whichever is greater.

b. Underground crossings via bored polyethylene pipe preferred to elevated crossings.

c. Use a separate elevated supporting structure for sixteen (16) inch and larger water lines, unless otherwise approved by the City Engineer. The structure shall be located a minimum of ten (10) feet from any other existing or proposed structure.

d. Support water lines on existing or proposed bridges. The following criteria may be used for fourteen (14) inch and smaller lines when approved in advance by the City Engineer.

i. Adequate structural capacity shall be required.

ii. Sufficient clearance above the bent cap elevation shall be required for installation under a bridge.

e. Design elevated crossings with the elevation of the bottom of the water line above the low chord of the nearest adjacent bridge, or a minimum of one and one-half (1.5) feet above the One Hundred (100) Year Flood Plain elevation, whichever is higher.

f. Extend pipe from rights-of-way to rights-of-way for crossings.

g. Provide sufficient span length to accommodate for the cross section of any future widening of the stream or ditch, if available.

h. Support the line on columns spaced to accommodate the structural capacity of the pipe, considering deflection and loading.

i. Base column support design on soil capacity, spacing, loading, and structural requirements.

G. Underground crossings.

1. Provide a minimum three (3) foot clearance above the top of the pipe to the ultimate flow line of the ditch.

2. Provide sufficient length to exceed the ultimate future development of the stream or ditch.

3. All water lines shall be steel, restrained joint, or polyethylene pipe and shall extend a minimum of fifteen (15) feet beyond the last bend or to the rights-of-way, whichever is greater. In addition, the water lines shall have valves located on both sides of the crossing.

H. TxDOT highway and county road crossings

1. Extend carrier pipe from rights-of-way to rights-of-way.

2. Use welded steel pipe, or restrained joint pipe in steel casing, under existing and future roadways. The pipe shall be installed from a point fifteen (15) feet outside of the service road, or outside of pavement toward the rights-of-way, to a similar point on the other side of the highway across the rights-of-way. For highway or roadway crossings with open ditch sections, extend the casing from rights-of-way to rights-of-way.

3. Highway and county road crossings shall be constructed in conformance with the applicable requirements of where the line is located. (i.e. Texas Department of Transportation, Galveston County or Harris County)

4. When additional rights-of-way has been acquired, or will be required for future widening, the casing where required, shall be carried to within ten (10) feet of each future rights-of-way line.

I. Street crossings

1. All water mains and sprinkler line crossings, under major thoroughfare boulevards, shall be encased using a minimum SDR rated or PVC pipe as required by the City's construction detail for "Water Main Encasement." Welded steel pipe may be substituted on street crossings, when specifically approved by the City Engineer.

2. Crossings under existing concrete streets, other than major thoroughfares, shall be constructed by boring and jacking. PVC and SDR rated pipe shall be jacked into place with equipment designed for that purpose. Water may be used to facilitate boring and jacking operations. Jetting the pipe main into place shall not be permitted. When conditions exist that warrant an open cut across the existing street, approval by the City Engineer shall specifically be required.

3. All open cut installations, under existing or proposed streets, shall be backfilled as required by City's Standard Details.

4. All street crossings shall be constructed in accordance with construction plans approved by the City. All street crossings shall be inspected by a City Project Manager, and shall meet the requirements of these standards.

J. Oil and gas pipeline crossings.

Metallic pipe shall not be used when crossing oil or gas transmission lines, unless a properly designed cathodic system is approved by the City Engineer and it is properly installed. Other pipe may be used, regardless of depth, subject to approval by the City Engineer. There must be a minimum of two (2) feet of separation between the pipeline and waterline.

K. On-site fire loops within commercial and multi-family developments.

1. For commercial and multi-family developments, requiring on-site fire hydrants, the following requirements shall be complied with to allow maintenance and future repair operations:

a. Placement of structures or equipment pads within the easement shall not be permitted.

b. Provide a ten (10) foot wide longitudinal pavement joint along the easement lines where the water line is located under a driveway, paved parking, or street pavement.

L. Additional requirements.

1. The carrier line shall extend a minimum of one (1) foot beyond the end of the casing to allow flanged joints to be connected.

2. For welded steel bends, extend steel pipe a minimum of five (5) feet beyond the bend.

M. Auger (bore) construction.

a. Use the following general criteria for establishing auger or bore sections:

a. Auger or bore sections shall be clearly shown on drawings.

b. Improved streets – use auger construction to cross the street regardless of surface. Auger length shall be calculated utilizing the roadway width, at the proposed bore location, plus an additional five (5) feet to either side of the roadway, as applicable.

c. Sidewalks – when the water line crosses under a sidewalk, four (4) feet or more in width and in good condition, the sidewalk shall be bored and jacked or the sidewalk shall be removed and replaced to the City of Friendswood Standard Details requirements, whichever is most cost effective. Bore and jack length shall be at least the width of the sidewalk. The proposed type of construction shall be noted on the plans.

d. Bore Pits – Bore pits shall be at least three (3) feet from back of curb and shall be at least five (5) feet from the back of curb on a boulevard or major thoroughfare. All bore pits shall be shored in accordance with OSHA requirements. Bore pits and/or receiving pits to be located in a street or driveway paving, shall be shown on the plans.

N. Water quality – overall system layout.

1. Circulation and flushing – The layout of the overall water distribution system shall provide the maximum circulation of water to prevent future problems of odor, taste, or color due to stagnant water.

    a. Provide a source of fresh water at each end, or at multiple points of a subdivision to create a physical loop. Provide ways to create circulation, and valves and fire hydrants shall be located to allow simple flushing of all lines.

    b. Where stubs are provided for future extensions, isolate the stub with a valve, and place one (1) full pipe joint beyond the valve, plug end of pipes. Service connections are to not be connected to the stub.

    c. All materials which come in contact with public drinking water in any stage shall conform to ANSI/NSF Standard 60.

    d. Layout and size of all water mains shall be consistent with the overall layout and phasing plan of the City's water system. The overall water system shall be designed to maintain adequate pressure throughout the system.

    e. Dead-ends shall be avoided whenever possible; in an unavoidable permanent dead-end situation, reduce the sizes of pipe successively. Carry an eight (8) inch pipe to the next to last fire hydrant and use a six (6) inch PVC to the end of the line. Provide a fire hydrant or two (2) inch blow-off at the end of the main.

O. Clearance of water line from other utilities. (New water lines constructed near sanitary sewers and force mains).

1. New water lines parallel to sanitary sewers and force mains.

    a. Water lines shall be located a minimum of nine (9) feet horizontally, outside wall to outside wall, when parallel to sanitary sewers or force mains. Use the following procedure when nine (9) feet of separation cannot be achieved:

    When a new water line is to parallel to an existing sanitary sewer force main and/or gravity sanitary sewer, and the nine (9) foot minimum separation distance cannot be maintained, the existing sanitary sewer shall be replaced with lined ductile iron or PVC

pipe meeting ASTM specifications. In addition, the waterline shall have a minimum working pressure rating of one hundred fifty (150) psi or greater, and be equipped with pressure type joints. The water lines and sanitary sewer shall be separated as per the design requirements of TCEQ, at a minimum horizontal distance of four (4) feet measured between the nearest outside walls of the pipe. In all cases, the water line shall be located above the sanitary sewer. When a water main crosses a utility other than sanitary sewer, a minimum of six (6) inches of clearance must be maintained, and the water main shall have one (1) joint of pipe [a minimum eighteen (18) feet long] centered along the other utility line.

b. Where a sanitary sewer crosses a water main and that portion of the sanitary sewer within nine (9) feet of the water is constructed as described in Section 290.44(e) of the TCEQ Rules and Regulations, the water line may be placed no closer than six (6) inches from the sewer. The separation distance must be measured between the nearest outside pipe diameters. The water line shall be located at a higher elevation than the sanitary sewer wherever possible and one (1) joint of the new pipe [a minimum of eighteen (18) feet long] shall be centered on the existing line.

2. When water lines are installed in areas which have existing sanitary sewers, every effort should be made to maintain nine (9) feet of separation between the outside pipe diameters of the two (2) lines. Where this separation cannot be achieved because of local conditions, which must be fully documented in any planning material submitted, the following spacing's shall be observed:

a. Where a new water line is to cross or be installed parallel with an existing sanitary sewer and the sanitary sewer is constructed as described in Section 290.44(e) of the TCEQ Rules and Regulations, the separation distances specified in those rules shall apply as though the sanitary sewer was new.

b. Where a new water line is to be installed parallel to an existing clay, truss, or concrete gravity sanitary sewer showing no evidence of leakage vertically and horizontally for a distance of four (4) feet, the sanitary sewer is not to be disturbed. Should excavation for the water line produce evidence that the sanitary sewer is leaking; the sanitary sewer shall be repaired.

c. Where a new water line is to cross an existing clay, truss, or concrete gravity sewer showing no evidence of leakage vertically or horizontally for a distance of four (4) feet, the sewer is not to be disturbed if the water line is installed at least twenty-four (24) inches above the existing sanitary sewer. One (1) full joint of the water line [at least eighteen (18) feet long] shall be centered over the sanitary sewer crossing, so as to provide maximum protection against contamination.

d. Where there is an existing clay, truss or concrete sanitary sewer pipe showing no evidence of leakage, and because of physical limitations shall remain at a higher elevation than the proposed intersecting water line, an exception to the nine (9) foot requirement may be granted as long as the water line is inserted in a joint of pressure type carrier pipe at least eight (8) feet and two (2) nominal sizes larger than the waterline. The carrier pipe shall be centered on the sanitary sewer crossing and both ends sealed with cement grout. In lieu of this procedure, that portion of the sanitary sewer within nine (9) feet of the water line may be replaced with cast iron or ductile iron pipe with water-tight joints as described in Section 290.44(e) of the TCEQ Rules and Regulations, above.

3. Sanitary sewer manholes – provide a minimum nine (9) foot horizontal clearance from outside wall of existing or proposed sanitary sewer manholes, unless manholes and connecting sanitary sewers can be made water-tight and tested for no leakage. If a nine (9) foot clearance cannot be obtained, the water line may be located closer to a manhole when prior approval has been obtained from the City Engineer using one (1) of the procedures below; however in no case shall the clearance be less than four (4) feet:

   a. A steel water line may be encased in a steel carrier pipe. Open cut and backfill with compacted cement-stabilized sand.

   b. The water line may be augured past the manhole, as long as one (1) - eighteen (18) foot section of class 150 pipe, is installed centered on the existing sanitary sewer manhole and a bentonite/clay mixture is utilized during the auguring process.

4. Fire hydrants shall not be installed vertically or horizontally within nine (9) feet of sanitary sewer mains, service leads, and force mains regardless of construction.

1.05 APPURTENANCES:

A. Valves.

1. Shall be set at maximum distances along water lines as follows:

a. Six (6) inch through fourteen (14) inch – one thousand (1,000) feet.

b. Sixteen (16) inch through twenty (20) inch – two thousand (2,000) feet.

c. The total number of valves at any intersection shall equal the total number of lines leading out from the intersection point minus one (1), three (3) valves for a cross, and two (2) valves for a tee, unless otherwise specified.

B. Valve Types.

1. Valve types (all valves shall open counterclockwise and have mechanical joints):

a. Six (6) inch through fourteen (14) inch – gate valves.

b. Sixteen (16) inch through twenty (20) inch – butterfly valves.

C. Valve Location.

1. All water lines shall be valved within the street rights-of-way. Valves shall not be placed under or within two (2) feet of ultimate pavement, except as specifically approved by the City Engineer.

2. Valves shall be located on the projection of intersecting street rights-of-way lines, or at the curb return adjoining a paved street across the main. Tapping Sleeves and Valves are excluded from this requirement.

3. Fire hydrants shall be isolated from the service line with a valve located at the fire hydrant branch. This valve shall not be located in the slope or flowline of ditches on open ditch streets.

4. Intermediate valves, not located on the projection line of the rights-of-way line, shall be located on lot lines or five (5) feet from the fire hydrants. The valves are not set in driveways or sidewalks.

5. Locate valves a minimum of nine (9) feet horizontally from sanitary sewer crossings.

D. Fire Hydrants.

1. Spacing.

a. Hydrant spacing shall be governed by the International Fire Code as adopted and amended by the City of Friendswood.

2. Location in or along street rights-of-way.

a. Fire hydrants shall be located at street intersections where possible, but in any case, not more than the spacing noted in 1a.

b. Locate fire hydrants at P.C.'s of the intersection curb radius, three (3) feet behind the existing curb or location of a future curb.

c. On all TxDOT highways, county roads and open-ditch streets, fire hydrants shall be set within three (3) feet of rights-of-way lines. Fire hydrants lead valves shall not be located in the slopes or flowlines of ditches.

d. Fire hydrants located between rights-of-way intersections should be set at a lot line, however, this location may be adjusted five (5)

feet either way to miss driveways or other obstructions, in which case the fire hydrant should not be closer than three (3) feet from curbed driveways or five (5) feet from non-curbed driveways.

e. Fire hydrants shall not be installed within nine (9) feet of a sanitary sewer system under any condition.

3. Location of fire hydrants outside the street rights-of-way.

a. The City Fire Marshal will establish and approve the location of fire hydrants in apartment complexes, and platted private street developments within the City.

b. Locate fire hydrants in protected, easily accessible areas behind curb lines.

c. For fire hydrants, which are located adjacent to water lines constructed in ten (10) foot wide waterline easements, the fire hydrant shall be centered in a minimum ten (10) foot by ten (10) foot separate easement.

d. For commercial and multi-family developments, provide isolation valves at each end of fire loops requiring on-site fire hydrants.

4. Fire Flow Requirements for Buildings.

a. The minimum fire flow requirements for one (1) and two (2) family dwellings, having a fire-flow calculation area which does not exceed three thousand six hundred (3,600) square feet, shall be one thousand (1,000) gallons per minute. Fire flow and flow duration for dwellings having a fire-flow calculation area in excess of three thousand six hundred (3,600) square feet shall not be less than that specified in Exhibit A – Table B105.1 of the International Building Code, as adopted and amended by ordinance.

5. Fire hydrants should be audited for flow and pressure, be of specified type, and painted per City Technical Specifications.

E. Fittings.

1. All fittings shall be identified and described on the construction plans. Refer to City Standard Details for additional requirements.

2. Fittings are not permitted in fire hydrant leads, except as specifically approved by the City Engineer.

3. Water line fittings shall be mechanical joints only. Push-on joints may be used at special locations, if specifically approved by the City Engineer.

4. All plugs shall be provided with retention clamps.

5. Polyethylene tube encasement shall conform to the minimum requirements of "Polyethylene Encasement for Gray and Ductile Cast-Iron Piping for Water and Other Liquids", ANSI/AWWA C105, current revision. Soils within the project shall be tested in accordance with Appendix A of ANSI/AWWA C105 to adequately determine the requirements for encasement.

6. Concrete thrust blocking shall be required on all bends, tees, plugs and combinations thereof.

7. All fittings and fire hydrants shall be tied together with three-quarter (0.75) inch stainless steel all-threads and I-bolts or approved equal (i.e., Mega Lug Fittings).

F. Water main service.

1. Water main service for lines in or along street rights-of-way.

a. Meters two (2) inch and smaller – shall be located in rights-of-way, water line easements, or in a minimum five (5) foot x five (5) foot separate water meter easement on private property.

b. Meters three (3 inches and larger – shall be located at the property line or in a minimum ten (10) foot x twenty (20) foot separate water meter easement if necessary.

c. Meters shall be located in areas with easy access and protected from traffic and adjacent to rights-of-way whenever possible.

d. Meters shall not be located in areas enclosed by fences.

e. Separate tap and service leads shall be designed for each meter.

f. Meters larger than two (2) inches must have a bypass assembly and coupling for easy change out. Contact the Department of Engineering and Projects for additional requirements.

g. The minimum sized line for two (2) meters shall be three (3) inches or larger.

2. For proposed apartments or town homes in private street developments, provide one (1) master meter sized for the entire development. Exceptions may be granted by the City Engineer for unusual circumstances. If an exception is approved, multiple meters shall not be interconnected.

3. All sprinkler and irrigation lines shall be equipped with a backflow prevention device according to its application as required by current TCEQ regulations. The backflow assembly shall be located after the water meter for an irrigation system, and in a vault near the building for a sprinkler system. A certified technician shall test applicable backflow prevention assemblies annually, and submit the results to the City.

1.06 SUBMITTALS:

A. General – Conform to the following submittal requirements in addition to those of general procedure of the City of Friendswood.

B. Water Line Sizes – Submit justification, calculations, and locations for proposed six (6) inch lines, and for lines twelve (12) inch and larger, for approval by the City Engineer, unless water line sizes are provided by the City in advance.

C. Valves – Submit information for approval by the City Engineer with justification and locations for the use of sixteen (16) inch and twenty (20) inch gate valves proposed as substitutes for butterfly valves.

D. Water Meter Service.

1. A permit shall be obtained from the Building Division for meter services and metered sprinkler connections prior to construction.

2. Requests for more than one (1) service meter on a proposed private street, or a multi-family development, shall be submitted to the Department of Public Works.

E. Elevated stream or ditch crossings – Submit design calculations for support columns and column spacing.

F. Master Development Plan – For multiple-phase developments, submit a master development plan along with construction plans.

G. A double check backflow prevention assembly is required for three (3) inch and larger lines.

1.07 QUALITY ASSURANCE

Prepare calculations and construction drawings under the supervision of a Professional Engineer licensed to practice engineering in the State of Texas and trained in the disciplines required by the drawings. The final construction drawings must be sealed, signed, and dated by the Professional Engineer licensed to practice engineering in the State of Texas, shall be responsible for the development of the drawings along with their firm's registration information.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS:

A. Research existing utility and rights-of-way information.

B. Verify that no restrictions exist that will deny approval of the project concept.

2.02 DESIGN ANALYSIS:

A. Water line sizes – Minimum pipe size is 8", with 10" also being common. Prepare narrative justification and calculations for proposed six (6) inch lines, and for lines twelve (12) inches and larger, unless sizing is provided by the City in advance.

B. Elevated stream or Ditch Crossings – Prepare design calculations for support columns and column spacing.

2.03 DRAWINGS:

A. General: Conform to the following drawing requirements, in addition to those identified within the City's Standard Water Line Details, the City's Technical Specifications, and within "Section I – Graphic Requirements" of this manual.

B. Appurtenances – Identify, describe, and enclose in rectangular box on drawings.

1. Valves

a. Designate six (6) inch through twelve (12) inch gate valves with box as GV&B.

b. Provide complete description and size for other valves.

2. Water meters, service leads, and metered sprinkler connections.

a. Show the location of service line tees, tapping sleeve valves, valve boxes, and temporary plugs to be installed to serve future three (3) inch or larger meters.

b. Develop plan and profile sheets for four (4) inch and larger leads, and connections that cross public rights-of-way or other utilities.

C. Construction features.

Show all special construction features required to complete the project, in a safe, convenient, and economical manner.

D. Auger Construction.

1. If the construction is predominately open cut, all portions of the street that must be augured shall be clearly shown on drawings by location and length. Include designation of sections at trees with six (6) inches or larger diameters, located within ten (10) feet of a water line.

2. Curbs – Include a requirement on drawings for construction of ADA ramps at street intersections where curbs are to be removed, or are damaged by water line construction. Conform to the City's Standard Details for ADA ramps.

SECTION IV

STREET PAVING DESIGN REQUIREMENTS

1.0 GENERAL

A. Should any portion of this Section conflict with the Subdivision Ordinance or the Zoning Ordinance, the more stringent of the latter two (2) shall govern.

B. The City Engineer shall have the final interpretation of any provisions in this Design Criteria Manual.

C. The City Engineer has the right to issue administrative orders or design criteria modifications for just cause related to any provisions or conditions in this Design Criteria Manual.

1.01 CHAPTER INCLUDES

Geometric design guidelines for streets, criteria for street paving, and standard paving notes for drawing call outs.

1.02 REFERENCES

A. ASHTO – American Association of State Highway and Transportation Officials.

B. ASTM – American Society for Testing Materials.

C. ACI – American Concrete Institute.

D. TMUTCD – Texas Manual on Uniform Traffic Control Devices.

E. City of Friendswood Standard Details and Technical Specifications, latest version. These can be downloaded from www.ci.friendswood.tx.us/350/Publications-Forms.

1.03 DEFINITIONS

A. Geotechnical Engineer – An engineer certified by the American Association for Laboratory Accreditation (A2LA).

B. HMAC – Hot Mix Asphaltic Concrete.

C. Curb-and-Gutter Streets – Full-width reinforced concrete pavement or asphaltic pavement with curbs. Curb-and-gutter streets require inlets and underground storm sewers.

D. Open-Ditch Streets – Full-width reinforced concrete pavement or asphaltic pavement with open ditches. Open-ditch streets do not require underground storm sewers; however, the ditches shall be designed to accommodate the storm water runoff.

1.04 DESIGN REQUIREMENTS

The following design requirements are applicable to all street pavement constructed within rights-of-way.

A. General:

1. Paving and construction plans for all streets shall be approved by the City Engineer.

2. Street design shall conform to all applicable planning tools, such as the Texas Manual on Uniform Traffic Control Devices, major thoroughfare plans, master plans, etc. Other considerations for design shall include street function, street capacity, service levels, traffic safety, pedestrian safety, and utility locations. These additional considerations may affect the minimum requirements set forth herein. Refer to the City of Friendswood Major Thoroughfare Plan for streets requiring additional considerations. The Major Thoroughfare Plan may be found at www.ci.friendswood.tx.us/350/Publications-Forms.

3. Designs shall conform to the City of Friendswood Standard Details and Technical specifications.

4. The use of individual pavers are not allowed in the City of Friendswood rights-of-way. The only exception for use of individual pavers in the rights-or-way is for sidewalks in the Downtown District. Stamped concrete is allowed in the City of Friendswood rights-of-way.

5. No asphalt turnouts are allowed in the City of Friendswood rights-of-way.

6. Concrete mix design shall conform to the City of Friendswood Technical Specifications.

B. Minimum Width Requirements for Concrete Paving:

1. Curb-and-gutter concrete and HMAC streets for low-density residential developments such as SFR, MFR-L, and MFR-GHD: twenty-eight (28) feet from back of curb to the back of curb.

2. Pavement for open-ditch streets used for only SFR residential developments with minimum one hundred twenty (120) foot wide lots: twenty-six (26) feet from edge of pavement to edge of pavement.

3. Streets for medium to high density residential, commercial, and collector streets: forty-one (41) feet from back of curb to back of curb, or from edge of pavement to edge of pavement.

4. Streets for major thoroughfares or boulevards: two (2) divided pavement sections of twenty-five (25) feet from back of curb to back of curb [Four (4) lane divided roadway], or two (2) pavement sections thirty-four (34) feet from back of curb to back of curb [six (6) lane divided].

5. Radius for cul-de-sac pavement on any street shall be a minimum of fifty (50) feet, measured from the face of curb. Radius of rights-of-way for cul-de-sacs shall be ten (10) feet greater than the cul-de-sac pavement, no less than sixty (60) feet.

C. Minimum Thickness and Reinforcement Requirements for Concrete and HMAC Pavement:

The following requirements shall be the minimum allowable. Pavement thickness and reinforcement, not less than the minimum requirements, shall be designed by a Professional Engineer licensed to practice engineering in the State of Texas and who is responsible for the project. The design shall be based on a current soils analysis and recommendations conducted by a qualified geotechnical engineer.

1. For pavement widths twenty-eight (28) feet from back of curb to back of curb or twenty-six (26) feet from edge of pavement to edge of pavement:

   a. Minimum concrete slab thickness shall be six (6) inches with an fc equal to three thousand four thousand (4,000) psi. Reinforcement shall be Grade 60, fy = 60,000 psi, #4 deformed reinforcing bars, spaced at sixteen (16) inches center to center, both ways and with a minimum lap length of twenty-four (24) inches. Expansion joints

shall be placed at the end of each curb return, and at a maximum spacing of forty (40) feet with control joints no greater than every ten (10) feet.

b. Minimum stabilized subgrade thickness shall be six (6) inches.

2. For pavement widths greater than twenty-eight (28) feet from back of curb to back of curb, or twenty-six (26) feet from edge of pavement to edge of pavement, and for boulevard or major thoroughfare sections:

a. Minimum concrete slab thickness shall be seven (7) inches with an fc equal to four thousand (4,000) psi. Reinforcement shall be Grade 60, fy = 60,000 psi, #4 deformed reinforcing bars, spaced at sixteen (16) inches center to center, both ways, and with minimum lap length of twenty-four (24) inches. Expansion joints shall be placed at the end of each curb return, at a maximum spacing of forty (40) feet on both residential and collector streets, boulevards, and major thoroughfares, with control joints no greater than every ten (10) feet.

b. Minimum stabilized subgrade thickness shall be eight (8) inches.

3. For HMAC pavements:

a. Minimum thickness shall be two (2) inches.

b. Minimum subgrade thickness shall be eight (8) inches of stabilized crushed concrete or limestone, and six (6) inches of lime-stabilized subgrade.

D. Subgrade Treatment: The geotechnical engineer shall base the depth of the subgrade stabilization on the structural number (SN) in conjunction with pavement thickness design. The following is general guidance for subgrade treatment:

1. For subgrade soil conditions with a clay content of ten (10.0) percent or higher, and a plasticity index (PI) of ten (10) or more, the subgrade shall be stabilized with lime. Subgrade shall be stabilized with a minimum six (6) percent lime by weight at required thickness, and compacted to ninety-five (95) percent standard Proctor density. Alternative subgrade stabilization may be substituted when specific recommendations are made

by the geotechnical engineer for the project, and when specifically approved by the City Engineer.

2. For subgrade soil conditions containing clean sand with no clay content, the subgrade shall be stabilized with cement.

E. Requirements for Intersections, Turnouts, Transitions, and Boulevards or Thoroughfares:

1. At a "T" intersection with a street that has not been improved to its ultimate width, the concrete pavement shall be stopped either at the rights-of-way line, or the end of the curb return, whichever would require less concrete removal at a future date.

2. For roadway turnouts placed at an existing street intersection, the turnout shall be designed to fit the ultimate pavement width of the intersecting cross street and then transitioned to the existing roadway.

3. The transition length for meeting an open-ditch street, shall be fifty (50) feet for street widths less than or equal to twenty-eight (28) feet from back of curb to back of curb; seventy-five (75) feet for twenty-nine (29) feet to forty (40) feet from back of curb to back of curb; and one hundred (100) feet for forty-one (41) feet from back of curb to back of curb or greater.

   a. Streets other than concrete shall have transitions with a minimum thickness of eight (8) inches of lime-stabilized subgrade, six (6) inches of hot-mix asphaltic concrete base, or approved equal, with two (2) inches of hot-mix asphaltic surfacing.

   b. Concrete streets shall have transitions with a minimum thickness of six (6) inches of stabilized subgrade and six (6) inches of concrete pavement.

4. When paving only one section of a proposed two-section thoroughfare or boulevard (boulevard section), all left-turn lanes and esplanade crossovers shall be paved to the centerline of the street right-of-way.

F. Requirements for Ditches on Open-Ditch Streets:

1. Minimum grade on ditches shall be two-tenths (0.2) percent.

2. Ditch capacity shall be designed to handle the storm water runoff as determined within "Section V – Storm Drainage" section of this manual.

3. The maximum side slope shall not be steeper than three (3) horizontal to one (1) vertical.

4. Culverts for roadside ditches only shall be designed to carry the storm water runoff, but shall not be less than eighteen (18) inch diameter pipe constructed of reinforced concrete.

G. Requirements for Pavement on Curb-and-gutter Streets:

1. Inlet spacing:

a. Curb inlets shall be spaced and sized to intercept the calculated storm water runoff for the design storm. The design water surface elevation for the design storm flow at the inlet, shall be less than or equal to the top of curb adjacent to the inlet.

b. Maximum travel distance of water in the street from a high point to a curb inlet shall be three hundred (300) feet on major thoroughfares, boulevards, commercial streets and collector streets unless otherwise approved by the City Engineer. The maximum travel distance of water in the street from a high point to a curb inlet permitted on residential streets shall be three hundred (300) feet unless otherwise approved by the City Engineer.

c. Maximum drop of grade tangents from opposite directions to a common inlet shall be one and one-half (1.5) feet.

d. Curb inlets shall be located on the intersecting side street at an intersection with a higher classification street. Location of curb inlets required on a major thoroughfare, at intersections, shall be specifically approved by the City Engineer.

e. Backfill around inlets below grade shall be one and one-half (1.5) sacks per cubic yard of cement-stabilized sand, and to the top of the first stage of inlet.

2. Design gutter grade shall be three-tenths (0.3) percent; if the gutter grade is less than three-tenths (0.3) percent and approved by the City Engineer,

then the City Engineer shall determine the required inlet spacing. The minimum acceptable gutter grade shall be two-tenths (0.2) percent.

3. Maximum cut from finished grade at property line to top of curb, shall be one and three-quarters (1.75) feet.

4. Minimum grade shall be one (1.0) percent fall around intersection turnout for a minimum radius of twenty-five (25) feet. Grades for larger radius shall be determined on an individual basis.

5. Vertical curves shall be installed when algebraic differences in intersecting grades exceed one (1.0) percent. Elevations shall be shown at ten (10) foot intervals through vertical curves. Maintain a minimum of three-hundredths (0.03) foot elevation change at ten (10) foot intervals by altering the calculated elevations.

6. When a curb-and-gutter intersects a drainage ditch, the elevation of the adjacent gutter shall be above the design water surface elevation in the ditch.

7. Minimum gutter grade around a cul-de-sac shall be six-tenths (0.6) percent.

8. Curves on major thoroughfares shall be superelevated in accordance with AASHTO whenever the centerline radius of any lane of pavement is less than two thousand (2,000) feet.

9. The amount of cross slope over the pavement section shall be shown on the drawings. The required cross slope shall be three-eighths (3/8) inch per foot from curb line to quarter point, and one-quarter (1/4) inch per foot from quarter point to the center line, and one-quarter (1/4) inch per foot for left-turn lanes.

10. A minimum grade of four-tenths (0.4) percent around the longest radius is required on an L-Type street intersection.

11. When meeting an existing upright curbed street, top of new curb elevations shall be designed to meet an elevation six (6) inches above the existing gutter/pavement, or gutters shall be matched and new top of six (6) inch curb transitioned to top of existing curb. At existing inlets, top of new curb elevations shall be designed to match existing top of existing inlets.

12. When the curb elevations are not established below the natural ground, fill lines shall be shown on the drawings and shall be of sufficient height to ensure a minimum of three-eighths (3/8) inch per foot transverse slope toward the curb from the property line between a point, two (2) feet outside the rights-of-way and the top of curb. If this type of fill is required, and the pavement is adjacent to a nonparticipating property owner, fill easements from this property owner shall be obtained, filed, and a copy of the easements shall accompany the final drawings. Construction of this nature will require back-slope drainage design to prevent trapping storm water runoff.

13. Elevations and grades shall be labeled for all tops of curb. Centerline elevations and grades are acceptable for open-ditch sections only.

H. Requirements for Inlets on Curb-and-gutter Streets:

1. Type "BB," with grate or plate tops, or type "H-2" inlets, shall be used on all curb-and-gutter streets depending on storm water runoff requirements, unless otherwise approved by the City Engineer.

2. Inlets shall be placed at the end of pavement in order to eliminate direct drainage of storm water from the pavement gutter into an open-ditch or onto adjacent property.

3. On open-ditch streets, place stub-outs with ring grates from inlets to ditches.

I. Requirements for Curbs and Sidewalks:

1. For curbs located along the outside edges of residential streets, the standard dimensions shall be four (4) inches tall and twelve (12) inches wide. Curb height for streets other than residential shall be six (6) inches tall. The curb height on all esplanades shall be six (6) inches.

2. Sidewalks are required as set out in Section III of the Subdivision Ordinance and Section 70-64 of the Code of Ordinances. Where sidewalks are required, they shall have a minimum width of four (4) feet, except on TxDOT rights-of-way where the minimum width shall be five (5) feet.

3. Sidewalk wheelchair ramps shall be required at all intersections, and at or through all driveways where required. The design and installation of such ramps shall comply with Texas Accessibility Standards Architectural Barriers requirements.

4. All sidewalks shall be constructed in accordance with the City of Friendswood Standard Details, including through all driveways where required. The design and installation of such sidewalks shall comply with the Texas Accessibility Standards Architectural Barriers requirements.

5. The location of all proposed and existing sidewalks shall be shown on the construction drawings.

J. Requirements for Miscellaneous Items:

1. The type and amount of subgrade treatment shall be shown on the drawings.

2. Paving headers shall be placed at the end of all concrete pavements.

3. All concrete to be removed, shall be saw cut one half of the pavement depth before removal.

4. Sight distance requirements shall be based on the latest version of the AASHTO design practices.

5. Standard City of Friendswood barricades shall be placed at the end of all dead-end streets not terminating in a cul-de-sac.

6. The appropriate drainage agency approval shall be obtained before City approval is granted if the design involves a drainage way or other drainage facility.

7. A letter of agreement from the affected pipeline company(s) is required when any paving is placed over a transmission pipeline or any utility line is placed over or under such lines.

8. When new concrete pavement meets existing concrete pavement, horizontal dowels shall be used if no exposed reinforcing steel for interconnection with new pavement exists. Horizontal dowels shall be Grade 60, smooth dowel bars, twenty-four (24) inches long, drilled and embedded twelve (12) inches into the center of the existing slab and

epoxied. Dowels shall be spaced at sixteen (16) inches center to center, unless otherwise specified. Concrete slab thickness shall be at least matching the existing slab thickness, and be a high strength early yield with fc = 5,000 psi.

9. Dead-end streets or ends of concrete streets designed to be extended in the future shall have paving headers and twelve (12) inches of reinforcing steel exposed beyond the pavement, coated with asphalt and wrapped with burlap, or shall have paving headers and dowel type expansion joint for future pavement tie-in.

10. Pavement extensions shall connect to the existing pavement as shown on the City of Friendswood Standard Details.

11. A design for concrete pavement thickness is required for all pavements within industrial areas and on major thoroughfares. Concrete pavement thickness design shall be based on the latest version of the AASHTO design procedures for rigid pavements.

12. The pavement structure for each roadway shall be designed based on soil data from the site, and based on the anticipated traffic volume, loading, and service life of the proposed pavement structure. The design engineer is responsible for ensuring that the pavement structure is designed to withstand the anticipated loads on the roadway.

1.05 APPURTENANCES – Reserved

1.06 SUBMITTALS – Reserved

1.07 QUALITY ASSURANCE

A. All construction drawings and specifications shall be prepared by or under the supervision of a Professional Engineer licensed to practice engineering in the State of Texas, and all documents shall be sealed, dated, and signed by the engineer responsible for their preparation along with their firm's registration information.

B. All geotechnical testing, environmental, and similar services for design and testing shall be performed by or under the supervision of a Professional Engineer licensed to practice engineering in the State of Texas, and trained in the science of soil analysis. All design and testing reports and documents shall be sealed, dated,

and signed by the engineer responsible for their preparation along with their firm's registration information.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS

A. Research existing utility and right-of-way information.

B. Verify that no restrictions exist that will deny approval of the property concept.

2.02 DESIGN ANALYSIS

A. All pavement design shall be supported by calculations to establish the required thickness and reinforcement.

B. The appropriate geotechnical soils report shall be the basis for design considering the use, loading, and life span of the proposed pavement.

C. All drainage improvements shall be designed to accommodate the anticipated storm runoff.

2.03 DRAWINGS

A. Construction drawings shall be prepared in compliance with the City of Friendswood Design Criteria Manual, Section I – Graphic and Design Requirements.

B. Refer to The City of Friendswood Design Criteria Manual, Appendix B, Figure 1 "Geometric Street Design Standards" for additional information and guidance.

SECTION V

STORM DRAINAGE DESIGN REQUIREMENTS

1.0 GENERAL

A. Should any portion of this Section conflict with any provisions of the Subdivision Ordinance, Zoning Ordinance, the Galveston County Consolidated Drainage District or the Harris County Flood Control District, the more stringent of the latter four (4) will govern.

B. The City Engineer shall have the final interpretation of any provisions in this Design Criteria Manual.

C. The City Engineer has the right to issue administrative orders or design criteria modifications for just cause related to any provisions or conditions in this Design Criteria Manual.

1.01 CHAPTER INCLUDES

Criteria for the design of storm drainage improvements.

1.02 REFERENCES

A. City of Friendswood Standard Details and Technical Specifications, latest version. These can be downloaded from www.friendswood.com/publications.

B. City of Friendswood Flood Damage Prevention Ordinance, Chapter 34 of the Code of Ordinances, and any subsequent revisions.

C. Galveston County Consolidated Drainage District Criteria Manual, the latest version.

D. Harris County Flood Control District Hydrology and Hydraulics Guidance Manual. Updated June 2019.

E. TX DOT Hydraulic Design Manual, the latest edition.

F. Atlas 14 Rainfall Depths for Galveston County Consolidated Drainage District 10/2019.

G. Harris County/City of Friendswood Memorandum of Understanding regarding maintenance of Harris County Hydraulic and Hydrologic models.

H. Harris County Flood Control District Policy Criteria and Procedure Manual. Includes Revisions to Chapters 2, 3, 6, 7 & 8 from Interim Guidelines and Criteria for Atlas 14 Implementation revised July 2019.

I. Harris County Recommendation on Minimum Standards for Communities in Harris County and Draining to Harris County. May 12, 2020.

J. National Oceanic and Atmospheric Administration (NOAA) Atlas 14. Precipitation – Frequency Atlas of the United States. Volume 11 Version 2.0: Texas. (Atlas 14).

K. Kronkosky Blake, Gauge Engineering, Atlas 14 Rainfall Depths for Galveston County Consolidated Drainage District, October 2019.

L. Federal Emergency Management Agency. Flood Insurance Study Galveston County, Texas and Incorporated Areas, August 15, 2019.

1.03 DEFINITIONS

A. Acceptance Procedures – For projects in Galveston County, the Galveston County Consolidated Drainage District must accept and approve all detention ponds or other drainage facilities entering their system before the City of Friendswood accepts the infrastructure. The acceptance of the facility shall be placed on the next available Board agenda for approval and acceptance subject to the contractor's one (1) year maintenance period. For projects in Harris County, the Harris County Flood Control District will accept and approve all detention ponds or other drainage facilities entering their system as applicable.

B. Conduit – any open or closed device for conveying storm water.

C. Development – any manmade change in improved and unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations.

D. Drainage Area Map – Area map of a watershed which is subdivided to show each area served by each subsystem.

E. Design requirements – The drainage criteria developed by the City of Friendswood, and complemented by those of the Galveston County Consolidated Drainage District and the Harris County Flood Control District, are intended to provide design guidelines for protection of all areas of the City from structural flooding resulting from a one hundred (100) year storm event. This is accomplished with the application of various drainage enhancements such as storm sewers, roadside ditches,

open channels, detention, and sheet flow runoff. The combined system is intended to prevent structural flooding from extreme events up to a one hundred (100) year storm; all development must account for the one hundred (100) year storm event as further detailed in this Section. In order to meet this requirement all standards in the Harris County Recommendation on Minimum Standards for Communities in Harris County and Drainage to Harris County letter released May 12, 2020 must be met.

F. FEMA – Federal Emergency Management Agency

G. Flood Control – The City of Friendswood is a participant in the National Flood Insurance Program. The intent of the flood insurance program is to make insurance available at a reasonable cost by providing for measures that may reduce the likelihood of structural flooding.

H. GCCDD – Galveston County Consolidated Drainage District.

I. HCFCD – Harris County Flood Control District.

J. Hydraulic Grade Line – A line representing the pressure head available at any given point within the drainage system.

K. In-Fill Development – Development of open tracts of land in areas where the storm drainage infrastructure is already in place and takes advantage of the existing infrastructure as a drainage outlet.

L. Public storm sewers – Defined as sewers and appurtenances that provide drainage for public rights-of-way, more than one private tract, and are located in public rights-of-way or drainage easements.

M. Private storm sewers – Defined as sewers and appurtenances that provide drainage for a private development, one or more than one private tract, and are located in private drainage easements.

N. Rainfall frequency – Probability of a rainfall event defined by a percent chance of occurring in any given year. Information on rainfall frequency is published by the National Oceanic and Atmospheric Administration. The City uses the Atlas 14 Point Precipitation rainfall depths. For the purpose of storm drainage design, the following frequencies are applicable:

1. Five (5) year frequency – a rainfall intensity having a twenty (20) percent probability of occurrence in any given year or nominally likely to occur once every five (5) years.

2. Ten (10) year frequency – a rainfall intensity having a ten (10) percent probability of occurrence in any given year or nominally likely to occur once every ten (10) years.

3. Twenty-five (25) year frequency – a rainfall intensity having a four (4) percent probability of occurrence in any given year or nominally likely to occur every twenty-five (25) years.

4. One hundred (100) year frequency – a rainfall intensity having a one (1) percent probability of occurrence in any given year or nominally likely to occur every one hundred (100) years.

O. Relationship to the Platting Process – Approval and review of storm drainage is a part of the review process for planning and platting of new developments. The review of storm drainage is overseen by the Community Development Department, Public Works Department, Engineering Department and the Galveston County Consolidated Drainage District (when development occurs within Galveston County).

P. Sheet Flow – Overland storm water run-off that is not conveyed in a defined conduit.

Q. Storm Sewer – Storm sewers and roadside ditch conduits are designed as a balance of capacity and economics. These conduits are designed to convey less intense, more frequent rainfalls with the intent of allowing for traffic movement on streets during these events.

R. Street Drainage – When rainfall events exceed the capacity of storm sewer systems, the additional runoff is intended to be stored, detained, or conveyed overland in a manner that reduces the threat of flooding to structures. Street ponding of a short duration is anticipated and street drainage is designed accordingly to contribute to the overall capability of the drainage system.

1.04 DESIGN REQUIREMENTS

All designs of drainage facilities shall meet the requirements of the City of Friendswood Standard Details and Technical Specifications.

A. Determination of Runoff

Design Storm Events – All drainage improvements shall be designed for the following storm frequencies based on Atlas 14-point rainfall as established by the National Oceanic and Atmospheric Administration for Harris County Region III.

Type of Facility	Frequency
Road Side Ditch	five (5) year
Storm Sewers	five (5) year
Channels/Storm Sewers/Culverts draining	
One hundred (100) acres or less	twenty-five (25) year
Creeks/Channels/Culverts draining	
One hundred (100) acres or more	one hundred (100) year

*All City or District maintained facilities shall be designed for the 100-year storm independent of the amount of acreage served.

B. The Rational Method shall be used for determining the peak flow rate in the sizing of all drainage improvements.

1. Time of Concentration (in minutes) is the time required for peak runoff, from the entire upstream contributing area, to reach the point of interest. Time of concentration can be calculated based upon an analysis of the actual travel time from the most remote point in the drainage area. The travel path should be clearly denoted and a sketch included in the design calculations.

   t_c = D/60V + 10 (minutes)
   D = flow distance (ft)
   V = flow velocity (ft/sec)

   For purposes of calculating t_c, the following velocities are recommended:

   V = 1 ft/sec for overland flow
   V = 1.5 ft/sec for flow across paved surfaces or along gutter flowlines.
   V = 2 ft/sec for flow in a ditch or channel
   V = 3 ft/sec for flow in a storm sewer

2. Rainfall Intensity (inches/hour) shall be calculated using the following formula:

   $$I = \frac{b}{(d + t_c)^e}$$

   b, d, and e values are derived from a single frequency rainfall intensity graph.

   b = the y-intercept of the straight line
   d = a constant used to adjust the relationship to plot as a straight line
   e = the slope of the straight line

Allowable Values for Friendswood are listed below:

t_c <= 60 min			
Rainfall			
Frequency	b	d	e
3-year	51.4	8.1	0.705
5-year	46.6	7.0	0.656
10-year	51.9	6.5	0.647
25-year	61.5	6.4	0.644
50-year	67.9	6.1	0.640
100-year	76.2	6.2	0.641

t_c > 60 min			
Rainfall			
Frequency	b	d	e
3-year	69.9	11.9	0.768
5-year	86.1	19.4	0.775
10-year	110.3	30.9	0.776
25-year	154.0	47.5	0.783
50-year	211.5	67.7	0.798
100-year	318.6	96.0	0.826

3. The Rational Method is a method for calculating the peak flow rate for a storm drain system. The formula for determining the peak flow rate is:
$Q = C_f\ CIA$

Where:

Q = Flow rate (cubic feet per second (cfs))
C_f = Frequency factor, the product of C_f and C should not exceed 1.0
C = Runoff Coefficient
I = Rainfall intensity (inches/hour) for a given storm frequency (Typically 5 year, 25 year, and 100 year).
A = Area (acres)

For the purposes of peak flow calculations, use the following "C_f"

C_f = 1.00, for storm frequencies of 10 years or less
C_f = 1.10, for storm frequencies of 25 years
C_f = 1.25, for storm frequencies of 100 years

For the purposes of peak flow calculations, use the following runoff coefficient "C," which are in no way related to the lot coverage percentage as defined in the Zoning Ordinance.

Land Use Type	Run-off Coefficient
Raw Undeveloped Acres	0.20
Improved Undeveloped Acres (i.e., mowed, filled, re-graded, etc.)	0.30
Parkland	0.40
Residential:	
SFR-Estates (>= 1 acre)	0.45
SFR (< 1 acre)	0.55
Multi-family	0.85
Commercial/Industrial	0.90
Pond (detention and amenity)	1.00

Alternatively, for estate-sized lots [greater than two (2.0) acres], the runoff coefficient "C" in the Rational Method formula can be calculated from the equation:

$C = 0.6Ia + 0.2$

Where:

C = watershed coefficient
Ia = impervious area/total area

If the alternate form is to be submitted, the calculation of the runoff coefficient "C" shall be provided as part of the drainage calculations.

C. Design of storm sewers

1. Design Frequency

a. Areas of New Development

The design storm event for sizing storm sewers for new development areas shall be a five (5) year storm. In any case where new development interferes with the natural sheet flow of the existing adjacent land, the storm system shall accommodate the runoff. Stubbed out streets next to undeveloped areas shall have storm sewer lines continuing to an approved outfall.

b. In-fill Development

1) An existing storm sewer and structures shall be evaluated using a five (5) year storm, assuming no development takes place. The storm sewer and structures shall then be evaluated with the development in place.

a) If the proposed development has a lower or equal impervious cover, no modifications to the existing storm sewer system are required.

b) If the hydraulic gradient of the existing storm drain is below the top of the curb, no improvements to the existing storm sewer system are required.

c. Private Drainage Systems

1) Storm sewers for private drainage systems shall conform to the City of Friendswood Technical Specifications and Standards Details for public drainage systems. Minimum diameter pipe for a private storm sewer system is ten (10) inches.

a) Unless otherwise approved by the City Engineer, all private drainage systems shall be constructed in conformance with the public storm sewer standards.

b) An approved permit shall be obtained from the City before any work shall be done on a private drainage system and shall include plan and profile sheets detailing the scope of the work, with elevations.

c) Open ditch areas may be converted into storm sewer lines with the approval of a Development Permit and Specifications for Residential Storm Sewer Installation Specification Form. Guidelines for the process are defined in Appendix F of this Design Criteria Manual.

d) Private storm sewer connections to public storm sewers shall occur at a manhole, or at the back of an inlet, as approved by the City Engineer.

2. Pipe Velocity and Slope Design

a. All storm drains shall be designed by the application of Manning's Equation and the Continuity Equation.

Manning's Equation:

$V = (1.486/n) R^{2/3} S^{1/2}$

Where

V = velocity (ft/sec)
R = hydraulic radius (area in square feet/wetted perimeter in feet)
S = slope of energy line in feet/feet (same as conduit bottom slopes for uniform flow)
n = coefficient of roughness
n = 0.013 for concrete pipes,
n = 0.024 for CMP (Corrugated Metal Pipe)
n = 0.011 for PVC (Polyvinyl Chloride)
n = 0.010 for HDPE (High Density Polyethylene)

**Note: All public storm sewers in or on public rights-of-way and public drainage easements shall be constructed of RCP (Reinforced Concrete Pipe) unless otherwise approved by the City Engineer. Manning's roughness coefficients for CMP, PVC, and HDPE shall be used for storm sewers on private property only. CMP pipes shall be used for public storm sewers only upon specific approval of the City Engineer and/or the applicable drainage district entity (GCCDD or HCFCD).*

Continuity Equation:

$Q = VA$

Where

Q = discharge (cfs)
V = velocity (ft/sec)
A = wetted cross sectional area of conduit (A^2)

b. Design velocities shall be three (3) feet per second with the pipe flowing full.

c. Maximum velocities shall not exceed seven (7) feet per second without the approval of the City Engineer.

d. Minimum Public Storm Sewer Pipe Slopes:

Pipe Diameter	% Slope
18”*	0.26
24”	0.18
30”	0.14
36”	0.11
42”	0.08
48”	0.07
54”	0.06
60”	0.05
*Used for Inlet leads only.	

e. For pipe sizes not listed above, the minimum slope shall be determined utilizing a design velocity of three (3) feet per second.

3. Pipe Sizes and Placement

a. Public storm sewer lines and inlet leads shall be a minimum of twenty-four (24) inch inside diameter and eighteen (18) inch inside diameter, respectively, or equivalent. Box culverts shall be at least two (2) feet x two (2) feet inside dimension.

b. Larger pipes located upstream shall not flow downstream into smaller pipes unless it is intended for detention requirements.

c. Match crowns of pipe at any size change unless severe depth constraints prohibit such, or engineering calculations show flowlines should be matched.

d. Locate public storm sewers in public street rights-of-way, in parallel and adjoining easements, or in other approved easements. Easements shall be at least twenty (20) feet wide, and the storm sewer shall be centered in the easement.

4. Starting Water Surface and Hydraulic Gradient

a. The hydraulic gradient shall be calculated assuming the top of the outfall pipe as the starting water surface.

b. At drops in pipe flowline, should the upstream pipe be higher than the hydraulic grade line, the hydraulic grade line shall be re-calculated

assuming the starting water surface to be at the top of pipe at that point.

c. For the design storm, the hydraulic gradient shall at all times be below the gutter line elevations at any point along the street.

d. Hydraulic grade lines shall be shown on all profile drawings.

5. Manhole Locations

Manholes are required at the following locations:

a. Size or cross section changes.

b. Inlet lead and conduit intersections.

c. Changes in pipe grade.

d. Street intersections.

e. A maximum spacing of six hundred (600) feet measured along the conduit run.

f. Manholes shall not be placed or located in driveway or sidewalk areas.

g. Adjust manhole frames and covers within the limits of the pavement to meet the proposed final top of slab.

6. Inlets

a. Locate inlets at all low points in gutter.

b. Valley gutters across intersections are not permitted.

c. Inlet spacing is generally a function of gutter slope. For minimum gutter slopes of three-tenths (0.3) percent, the maximum spacing of inlets shall result from a maximum gutter run of three hundred (300) feet from a high point in the pavement to an inlet on a continuously graded street section, for a maximum spacing of six hundred (600) feet between inlets.

d. If gutter slopes are less than three-tenths (0.3) percent, the City Engineer shall determine the inlet spacing. The acceptable minimum gutter grade is two-tenths (0.2) percent.

e. Use only Standard Inlets:

Inlet	Application	Capacity
Type A	Parking Lots/Small Areas	2.5 cfs
Type B-B	Residential	5.0 cfs
Type D	Parking Lots	2.0 cfs
Type E	Roadside ditches	20.0 cfs
Type H-2	Residential / Commercial	5.0 cfs

f. Do not use "Beehive" style grate inlets or other specialty inlets.

g. Do not use grate top inlets in an unlined roadside ditch.

h. Place inlets at the end of curb returns on side streets, when such streets intersect streets of a higher classification, unless special conditions warrant otherwise and are approved by the City Engineer.

i. Storm sewer inlets shall be established in such numbers and in such locations as to effectively drain storm water from paved sections. A graphical plan and calculations of the hydraulic gradient shall be furnished by the design engineer.

D. Consideration of Overland Flow

1. Design Frequency – the design frequency for consideration of overland sheet flow shall consider extreme storm events which exceed the capacity of the underground storm sewer system resulting in ponding and overland sheet flow through the development to the primary drainage outlet.

2. Relationship of Structures to Street – all structures shall be constructed as per the Flood Damage Prevention Ordinance, and shall be higher than the highest level of ponding resulting from the extreme storm event as shown on the latest City adopted flood maps.

3. Calculation of Flow:

a. Streets will be designed so that consecutive high points in the street will provide for a gravity flow of drainage to the ultimate outlet.

b. The maximum depth of ponding at high points will be the top of curb of streets with curbs, or the elevation of the centerline of roads without curbs.

c. The maximum depth of ponding at low points will be nine (9) inches above the gutter elevation of curb of streets with curbs, or three (3) inches above the elevation of the centerline of streets without curbs.

d. Sheet flow between lots can be provided only through a defined drainage easement.

e. A map shall be provided to delineate the flow direction of the extreme event through a proposed development, and how this flow is discharged to the primary drainage outlet.

f. In areas where ponding occurs and no sheet flow path exists, a calculation shall be provided to show that runoff from the one hundred (100) year event can be conveyed and remain in compliance with the other terms of this Section.

4. Overland flow shall enter outfall drainage facilities (channels or detention ponds) through a storm sewer with its last run sized to convey the one hundred (100) year event. Calculations shall be submitted for sizing the structure and determining that adequate inlet capacity exists.

5. Maintain pre-existing natural overland flow of storm water, and provide protection for adjacent properties from redirected storm water flows.

6. For development greater than five (5) acres, show contours of adjacent properties within two hundred (200) feet, and account for natural and existing overland flow or channelized flows. For developments less than five (5) acres, show contours of adjacent properties within fifty (50) feet, and account for natural and existing overland flow or channelized flows. Contour lines shall provide an indication on whether or not adjacent off-site areas drain toward or away from the subject tract.

E. Design of Open Channels

1. Design Frequency

a. Open channels shall be designed according to methods described in the Galveston County Consolidated Drainage District (GCCDD) and Harris County Flood Control District (HCFCD) Criteria Manuals.

b. Design standards for channel construction shall follow the requirements specified in the GCCDD & HCFCD Criteria Manuals.

c. Design standards for the outfalls into channels shall conform to those in the GCCDD & HCFCD Criteria Manuals.

2. Determination of Water Surface Elevations:

a. Water surface elevations shall be calculated using Manning's Equation and the Continuity equation.

b. For the design storm event, the water surface for ditches and channels shall be calculated to remain within the banks and at or below the required freeboard.

3. Design of Culverts

Head losses in culverts shall conform to TxDOT Hydraulics Manual, Chapter 84 – Culverts.

F. Design of Roadside Ditches

1. Design Frequency

a. Roadside ditches are permissible only for single family residential lots having widths larger than, or equal to, one hundred twenty (120) feet.

b. Design storm event for a roadside ditch shall provide one-half (0.5) foot of freeboard below the edge of pavement, or the natural ground at the rights-of-way line, whichever is lower.

c. The design must include an extreme event analysis to indicate that adjoining structures will not be flooded.

2. Velocity Considerations

a. For grass lined sections, the design velocity shall be two (2.0) feet per second during the design storm event. The maximum velocity shall be five (5) feet per second.

b. A grass lined or unimproved roadside ditch shall have side slopes no steeper than three (3) horizontal to one (1) vertical.

c. Minimum grades for roadside ditches shall be two-tenths (0.2) percent.

d. Calculation of velocity shall use a Manning's roughness coefficient of four hundredths (0.04) for earthen sections, and twenty-five-hundredths (0.025) for ditches with paved inverts.

e. Use erosion control methods acceptable to the City when design velocities are calculated to be greater than three (3) feet per second and are approved by the City Engineer.

3. Culverts

a. Culverts shall be placed at all driveway and roadway crossings and other locations where appropriate.

b. Culverts shall be designed assuming inlet control.

c. Roadside culverts shall be sized based on drainage area. Calculations shall provide for each block based on drainage design criteria presented in this manual.

d. Cross open channels with roadside culverts no smaller than eighteen (18) inch diameter or equivalent. The size of culvert used shall not create a head loss of more than two-tenths (0.2) feet greater than the normal water surface profile without the culvert.

e. Use erosion control methods acceptable to the City when design velocities are calculated to be greater than three (3) feet per second and approved by the City Engineer.

f. Sloped End Treatments (S.E.T.’s) are required on all TxDOT Highways.

4. Depth and Size Limitations for Open Ditches

a. Residential streets – the maximum depth shall not exceed two and one-half (2.5) feet below the edge of pavement.

b. Roadside ditch bottoms shall be at least two (2) feet wide.

c. Ditches in adjoining and parallel easements shall have the top of bank not less than two (2) feet from the outside easement line or edge of pavement when applicable.

d. Roadside ditch side slopes shall not exceed three (3) horizontal to one (1) vertical.

e. The design storm event for a roadside ditch shall provide one-half (0.5) foot of freeboard below the edge of pavement, or the natural ground at the rights-of-way line, whichever is lower.

G. Design of Outfalls.

1. Outfall design shall conform to GCCDD and HCFCD standards as applicable.

2. Detention pond and storm sewer outfalls shall be placed one foot above the flowline of the receiving channels, creeks, and detention pond, or two foot above normal water elevation, whichever is greater.

3. Flowlines of storm sewer outfalls shall be located six (6) inches above the flowline of a receiving roadside ditch.

H. Storm Water Detention

1. Application of Detention.

a. As a normal consideration, storm water detention shall be required. The use of on-site detention is required in order to mitigate potential damage to existing structures unless: the current infrastructure has been improved and provides mitigation for the development, the City has developed a plan for a detention facility to serve the overall area, the development is within an existing subdivision served by a detention facility that is within the platted boundaries of said subdivision and that has been previously accepted and approved by the City and the GCCDD, or a development qualifies for the purchase of regional detention under certain circumstances enumerated in 1.04.H.8.

b. Design calculations for sizing the detention basin and related structures shall be performed by the applicable method described in the following sections.

c. All calculations shall be sealed and signed by a Professional Engineer licensed to practice engineering in the State of Texas.

d. All commercial and non-residential new developments, additions, or redevelopments will require a new or revised drainage plan for additional impervious cover. The standard minimum rate of detention referenced in paragraph 2 below will apply to this impervious cover.

e. A parking lot with a curb may be used as part of the detention system, provided that the maximum depth of water over the inlet throat flow line does not exceed nine (9) inches, and the maximum depth in any parking stall does not exceed six (6) inches.

2. Calculation of Detention volume using the Hydrologic Method for Projects of fifty (50) acres or less.

a. Minimum Rate of Detention for Projects of fifty (50) acres or less.

When using any of the methods detailed below for calculating the required amount of detention, the minimum amount of detention provided shall never be less that the following standard minimum rates as follows:

For the purpose of determining the standard minimum rate, all the acreage used in the calculation must include proposed or existing development. Raw/undeveloped acreage may not be included in the calculation to lower the standard minimum rate.

1) Commercial Projects – Defined as projects with ninety (90) percent or more impervious cover or a runoff coefficient of nine-tenths (0.9) or larger – Standard minimum rate of six-tenths (0.6) ac.ft. per acre.

2) Multi-Family Projects – Defined as projects with eighty (80) percent or more impervious cover or a runoff coefficient of eight-tenths (0.8) or larger – Standard minimum detention rate fifty-five-hundredths (0.55) ac.ft. per acre.

3) Residential Projects – Defined as projects with forty (40) percent or more impervious cover or runoff coefficient of

fifty-five-hundredths (0.55) or larger – Standard minimum detention rate of fifty-five hundredths (.55) ac.ft. per acre.

4) Estate Lot Projects – Defined as projects with less than forty (40) percent impervious cover or a runoff coeffieicent less than fifty-five-hundredths (0.55) –Standard minimum detention rate of fifty-five hundredths (.55) ac. ft. per acre.

5) Mixed Use Projects – The Standard minimum rate of detention shall be determined based upon weighted average of the minimum rates set forth above.

6) Single family residential and accessory buildings on existing lots and developments under one (1) acre do not have a minimum detention requirement.

b. Modified Rational Method.

The modified rational method may be used to determine detention storage for all projects less than five (5) acres.

c. Simplified Method

For projects less than five (5) acres, the standard minimum rate may be used in lieu of performing a more complex analysis. This coefficient multiplied by the total acreage will yield the total detention volume required.

d. Optional Detention Storage Methodology for Projects of one fifty (50) acres or less.

The maximum allowable release rate from the detention facility during the one hundred (100) year storm event is the one hundred (100) year peak flow rate from the area under pre-development conditions. The undeveloped peak flow rate shall be determined using the rational method.

The following method will be acceptable for determining storage volume if the simplified method is not utilized.

e. Triangular Hydrograph Method for projects fifty (50) acres or less The volume of storage required may be computed as follows:

$$B = \frac{43560\ V}{0.5\ I}$$

$$S = \frac{0.5\ B\ (I - O)}{43560}$$

Where,
B = Duration of inflow (sec)
V = Total inflow volume in ac-ft (24 hr duration even use SCS Curve Number)
S = Required storage volume (ac-ft)
I = Peak inflow rate (cfs)
O = Peak outflow rate (cfs)

f. Unit Hydrograph Method (Small Watershed Method) may be used for projects with drainage areas between 0 acres and 100 acres a technique developed by Dr. H.R. Malcom may be utilized in determining inflow hydrographs. The maximum inflow rate shall be determined by use of the rational formula. With the peak flow and volume of runoff, the equations presented below may be used to determine the inflow hydrograph for the proposed detention facility.

The maximum allowable outflow rate from the detention facility shall be restricted to the existing flow rate from the undeveloped tract. Outflow control shall be designed for the 5-year, 25-year and 100-year storm frequencies. In cases where the outfall for the detention facility is to be an existing roadside ditch, storm sewer, etc., the allowable outflow rate may need to be restricted to less than the maximum allowable so as to no overload the outfall.

1. $$T_p = \frac{V}{1.39\ Q_p}$$

Where,
T_p = Time to peak in seconds
V = Total volume of runoff for the design storm (ft^3)
Q_p = Peak runoff for the design storm (cfs)

$$V = Dr \cdot A * \left(\frac{43{,}560}{12}\right)$$

Where,
Dr = Runoff Depth (in)

A = Runoff Area (acres)

2. $q_i = \frac{Q_p}{2}\left[1 - cos\left(\frac{\pi\, t_i}{T_p}\right)\right]$ $\quad [t_i \leq 1.25\, T_p]$

*Note: The argument of the cosine function shown above must be expressed in radians.

Where,

t_i = Time of Interest (sec)

q_i= Runoff at Time of Interest (cfs)

3. $q_i = 4.34 Q_p e^{\frac{-1.8 t_i}{T_p}}$ $\quad [t_i > 1.25 T_p]$

*Note: The argument of the cosine function shown above must be expressed in radians.

4. T = $\frac{T_p}{10}$ = Time Interval

3. Detention Storage Methodology for Projects over 50 acres

For drainage areas over 50 acres, a detailed hydraulic analysis utilizing the effective FEMA models will use as a minimum HEC-HMS v. 3.2 and HEC-RAS v. 3.0 (or more current version) for windows. This methodology also applies to properties out of tracts of 50 acres or more. A Drainage Impact Assessment report will be required to detail all design assumptions and parameters.

a. Watershed Modeling Methodology

1. For HEC-HMS watershed analysis, the following parameters shall be used:

Loss Method: Green and Ampt
Transform Method: Clark Unit Hydrograph
Initial Loss: 0.1 Inches
Moisture Deficit: 0.385
Suction: 12.45 inches
Conductivity: 0.024 inches/hour

Percent Impervious Cover

Land Use	Percent Impervious (%)
Water	100
Isolated Transportation	90
High Density	85
Light Industrial	60
Airport	50
Residential Small Lot	40
Residential Large Lot	20
Development Green Acres	15
Residential Rural Lot	5
Undeveloped	0
Unknown	0

Atlas 14 Annual Exceedance Probability Rainfall Data (Inches) - Region III

Duration	3-Year	5-Year	10-Year	25-Year	100-Year
5-min	0.7	0.8	0.9	1.1	1.4
15-min	1.4	1.50	1.8	2.1	2.7
30-min	2.0	2.2	2.5	3.0	3.8
1-hr	2.6	2.9	3.4	4.1	5.2
2-hr	3.3	3.8	4.5	5.6	7.5
3-hr	3.7	4.3	5.2	6.6	9.2
6-hr	4.5	5.2	6.5	8.4	12.2
12-hr	5.3	6.2	7.8	10.2	15.0
24-hr	6.2	7.3	9.2	12.1	17.9

2. Indicate on a map drawn to scale the existing and proposed watershed areas. All major features such as major roads and drainage entries shall be indicated. Node locations shall be provided in the base model with corresponding nodes at identical points in the model for the proposed system.

3. The model shall include the 5-year, 25-year and 100-year pre-development and post development runoff analysis. If a proposed development is to be constructed in phases, the analysis should address any intermediate developed conditions.

4. When time series data or pared data are used in the model, briefly discuss the source of the data in the report or show the calculations. Whenever possible, provide a copy of the calculations, source and model files via file sharing or on an external thumb drive.

5. Time of concentration and storage coefficients shall be calculated as outlined in HCFCD and GCCDD methodology.

6. If a different model than the FEMA effective hydraulic model is utilized, written justification must be provided, and approval granted by the City prior to beginning. At a minimum HEC-HMS v 3.2 shall be used.

b. Water Surface Profile Modeling

1. Water surface profile models shall be created using as a minimum HEC-RAS v 3.1.3 (or more current version) for windows. Alternative approaches to modeling shall be discussed with the City prior to commencing the study.

2. The use of one-dimensional steady flow and unsteady flow approach may be utilized with proper justification.

3. Provide information and data for the base model which must be included in the report. If the base model is different than the FEMA effective model, written justification must be provided, and approval granted before modeling commences. Base models shall be updated using HEC-RAS v 3.1.3 (or more current version).

4. Provide a plan view schematic for the existing and proposed systems. The schematics shall indicate channel designations, node labels and river stations. The river stations and node label so the existing model shall match any identical points on the proposed models whenever possible. Physical reference points shall also be used.

5. All models shall include the 5-year, 25-year and 100-year pre-development and post development runoff analysis. If a proposed development is to be constructed in phases, the analysis should address any intermediate development conditions. Proposed bridge and/or culvert crossing analyses shall include an extreme event.

6. For any steady flow or unsteady flow data used in the model(s), briefly explain how the data was calculated or the source of the data. Whenever available, these separate data files or calculations shall be included on the required external thumb drive and file share transfer with all submittals.

7. All existing bridge or culvert crossing shall be modeled based upon actual on the ground survey data correctly tied to a GCCDD or HCFCD benchmark, datum and year of adjustment unless otherwise authorized.

8. Bridge and/or culvert crossing shall be analyzed using the highest energy answer obtained using the energy and momentum equations.

9. The model should include a reasonable number of cross sections based upon current elevation data to ensure that the actual drainage system is properly represented. The spacing of cross sections may be approximated by using Samuel's equation. The use of numerous interpolated sections between two surveyed cross sections that are too far apart is not an acceptable way of producing additional cross sections.

10. Some portions of channels within the City are tidally influenced. In those reaches, the models shall account for tidal conditions.

11. For HEC-RAS models, the following contraction and expansion Coefficients are required. Any variance from these values must be preapproved by the City.
    Contraction Coefficient: 0.1
    Expansion Coefficient: 0.3

12. Manning's "n" values will follow GCCDD design criteria on the Galveston County side and Harris County criteria on the Harris County side. See the latest versions of the GCCDD Drainage Criteria Manual and the HCFCD Policy, Criteria, and Procedure Manual. Any deviation from these "n" values must be approved by the City before modeling begins.

4. Calculation of Outlet Size:

Outfalls which utilize a pipe restrictor to control outflow shall use the orifice equation.

a. Reducer or Restrictor Pipes shall be sized as follows:

1) Use the following equations to calculate the required outflow orifice:

Area of pipe = $\pi d2/4$

$Q = CA (2 gh)^{1/2}$
$D = Q1/2 / 2.25 h -1/4$

Where
Q = outflow discharge in cfs.
C = 0.8
h = water surface differential (ft)
D = orifice diameter (ft)
A = area of pipe (ft2)
g = gravity (32.2 ft/s2)

New flow into receiving storm sewer cannot exceed undeveloped flow.

2) For head differential in systems outfalling into a roadside ditch or storm sewer, the actual head loss or 1 foot, whichever is greater, shall be used. For all other discharge conditions, use 2 feet, or the difference between one hundred (100) year water surface elevation and the elevation of the twenty-five (25) year storm in the receiving channel, whichever is greater.

3) For detention systems outfalling into a public storm sewer, the restrictor shall be sized based upon the peak five (5) year developed flow.

4) For detention systems outfalling into a public roadside ditch, the restrictor shall be sized based upon the peak five (5) year undeveloped flow.

5) For detention systems outfalling into creeks, channels, or storm sewers sized to carry the twenty-five (25) year or one hundred (100) year storm, the restrictor shall be metered to release the five (5) year, twenty-five (25)year, and one hundred (100) year undeveloped flows.

6) Restrictor shall be either the required diameter or the equivalent cross-sectional area. The orifice diameter “D” shall be a minimum of six (6) inches.

7) Detention ponds less than 1 acre in size shall have a minimum of 4 inches of freeboard. All ponds one (1) acre or larger in size shall have at least one (1) foot of freeboard. Freeboard shall be measured from the maximum one hundred (100) year

water surface elevation and shall not be used in the calculation of storage or mitigation.

5. Detention Pond Structural Requirements:

   a. Side slopes shall not exceed a slope of four (4) horizontal to one (1) vertical.

   b. Maintenance berms will be required in accordance with the Galveston County Consolidated Drainage District Design Criteria Manual.

   c. Ponds with lengths over fifty (50) feet shall have a concrete pilot channel.

   d. Concrete pilot channels shall have a minimum width of four (4) feet and a minimum thickness of four (4) inches with #3 rebar spaced at twelve (12) inches on center each way. The concrete pilot channels shall be constructed of 5-sack cement concrete with a compressive strength of three thousand (3,000) psi at twenty-eight (28) days. Provide a one (1) inch depression per everyone (1) foot of transverse slope, with redwood headers spaced every forty (40) feet.

   e. Single-user ponds may use a GCCDD-approved alternative for concrete pilot channels.

   f. Appropriate covering (grass, slope paving, etc.) shall be established on side slopes and pond bottom, to prevent erosion during periods of maximum water velocity

   g. A concrete gravity spillway, set at the maximum ponding elevation, shall be provided at the detention pond outfall structure.

   h. Wet detention ponds, and ponds with vertical walls, shall provide access for safety and maintenance purposes. Wet detention systems shall have a method in place to minimize stagnation, such as an aeration system.

   i. “Dry” detention ponds shall not be designed with less than two (2) feet of depth.

6. Ownership and Easements:

   a. Private Facilities:

1) Pumped systems shall not be allowed. Only detention facilities which rely on gravity to discharge storm runoff will be allowed by the City and the GCCDD.

2) Responsibility for maintenance of the detention facility must be indicated on the plat.

3) All private properties being served shall have drainage access to the pond.

4) A private maintenance agreement must be provided when multiple tracts are being served.

b. Public Facilities:

1) Facilities will only be accepted for maintenance by the City when such is in the public interest.

2) The City will require a maintenance work area twenty (20) feet wide surrounding the extent of the detention area. Public rights-of-way or permanent access easements may be included as a portion of this twenty (20) foot width.

3) A dedication of easements or reserves must be provided by the plat.

4) Proper dedication of public access to the detention pond must be shown on the plat or by separate instrument. This includes permanent access easements with overlapping public utility easements.

7. Off-Site Detention in the Galveston County Consolidated Drainage District:

a. It is the desire of the City of Friendswood that regional detention be utilized when available. If new development is within the service area of a publicly owned or operated regional storm water detention facility, connection to such regional facility shall be as required by the drainage master plan applicable to such facility.

b. In Galveston County, offsite detention, such as regional or sub-regional detention, may be purchased from the Galveston County Consolidated Drainage District provided:

1) The development drains to the Clear Creek watershed or the tributaries of Clear Creek.

2) All lots or tracts must outfall into a conveyance system with adequate capacity, excluding single family residential construction on lots or tracts containing five (5) acres or less.

3) The proposed improvements do not include the subdivision of land.

4) The developed site does not exceed eight (8) acres for single-family residential lots or tracts, five (5) acres for multi-family residential lots or tracts, and five (5) acres for commercial lots or tracts.

5) Regional detention for site development relating to single-family residential construction on lots or tracts containing five (5) acres or less may be purchased based on square feet of impervious cover by completing the Attachment #4, a copy of which is made a part of this manual. All other site development qualifying for the purchase of regional detention must submit a new or revised drainage plan.

c. Contact the Galveston County Consolidated Drainage District (GCCDD) for the latest regional detention rates.

8. Detention Requirements Summary:

Lot or Tract Type	Acreage	Off-Site Detention Available	Engineered Drainage Plans	Detention Volume Calculation Method	Rates	Attachment #4* Required	GCCDD Board Approval
SFR	0-5	Yes	Not Required	Purchase Regional Detention Based On: New Impervious Coverage Calculation of Detention Volume Unnecessary	Contact GCCDD for fees	Yes	Not Required
	5-8	Yes	Required	Engineer Determines the Detention Volume by an Approved Method	Contact GCCDD for fees	No	Required
	8+	No	Required	Engineer On-Site Detention	NA	No	Required
MFR	0-5	Yes	Required	Engineer Determines the Detention Volume by an Approved Method	Contact GCCDD for fees	No	Required
	5+	No	Required	Engineer On-Site Detention	NA	No	Required
COM	0-5	Yes	Required	Engineer Determines the Detention Volume by an Approved Method	Contact GCCDD for fees	No	Required
	5+	No	Required	Engineer On-Site Detention	NA	No	Required

9. Conveyance:

a. The developer shall provide conveyance to a detention facility without having a detrimental effect on any adjacent properties.

b. If conveyance is directed through properties not directly owned by the developer, an executed contract or recorded deed between the parties agreeing to the said conveyance must be presented to the City and the appropriate drainage district entity.

c. This procedure is approved by both the City and the corresponding drainage district entity (GCCDD or HCFD) during preliminary plan review.

d. Hydrograph timing as a substitute for detention on any project is prohibited.

10. Lowest Floor Elevation:

a. Refer to the City of Friendswood Flood Ordinance (December 2020) Section 34-63 for special lowest floor elevation requirements.

b. The latest FEMA FIRM panel and Flood Insurance Study (FIS) should be referred to for the base flood elevation and the 0.2 percent flood elevation.

1.05 COMPUTER MODELS AND PROGRAMS

A. Current effective models use the HEC-HMS and HEC-RAS computer programs. Guidance for applying these programs is in the HCFCD Hydrology and Hydraulics Guidance Manual and the Galveston County Consolidated Drainage District Criteria Manual. The current effective FEMA model must be used. Any departure from using this model must be submitted in written format and approved by the City prior to submittal.

B. In some cases, HEC-HMS and HEC-RAS cannot accurately model some projects or hydraulic conditions. Alternative models may be used only with consent by the City's Engineering Department. All models selected must be freeware or prepared in a form such that the Engineering Department can open and review the models. The Engineering Department must be notified in writing of the program that will be used with justification early in the design process.

C. All models must be accompanied by a Letter Report or Drainage Impact Assessment describing any assumptions and changes due to the project. All projects larger than 50 acres required a Drainage Impact Assessment.

1.06 SUBMITTALS

A. Drainage Plan Submittals

1. Preliminary Submittals- Submit for Review and Comment:

   One line drawings are required as part of the platting process. One line drawings shall include:

   a. Approximate definition of lots and street patterns.

   b. The approximate drainage areas for each system.

   c. A definition of the proposed drainage system by single line.

   d. The proposed pipe diameters.

   e. Any proposed drainage easements.

   f. Floodplain and floodway boundaries, if any.

2. Final Design – Submit the following for approval:

   a. Copies of any documents which show approval of exceptions to the City Design Criteria.

   b. Design calculations for storm line sizes and grades, and for detention facilities, if any.

   c. Design calculations for the hydraulic grade line of each line or ditch, and for detention facilities, if any.

   d. Contour map and drainage area map of the project.

   e. Plan and profile sheets showing storm sewer or open ditch design (public facilities only).

f. Projects located within a floodplain boundary or within a floodplain management area shall show the floodplain boundary or floodplain area, as appropriate, on the one-line drawing or drainage area map.

g. Soil boring logs.

h. All drainage plans shall have a current FEMA flood zone determination statement.

i. Fill calculations are required for projects located in the FEMA floodway, 100-year floodplain and the 500-year floodplain.

3. Signature State – Submit the following for approval:

a. Review prints.

b. Original drawings.

c. Storm water detention maintenance agreement letters.

B. National Flood Insurance Program (NFIP) Compliance

1. The City of Friendswood is a participant in the National Flood Insurance program's (NFIP's) Community Rating System (CRS). As a CRS community, the City is required to develop and implement various programs intended to reduce flood risk such as identifying drainage problem areas, maintenance of existing drainage systems, construction of drainage projects, outreach to the community, etc. As a result of the community's commitment to reduce the flood risk, the residents of the City are entitled to receive discounted flood insurance premiums based on the City's CRS ranking as evaluated by CRS.

2. All runoff impacts created by development shall be mitigated, so post-project runoff rates and flooding levels are equal to or less than equivalent pre-project conditions.

3. Fill placed in the floodway, 100-year floodplain, or 500-year floodplain as designated on the current Flood Insurance Rate Map, and below the 500-year flood elevation shall be mitigated by the removal of a like amount of compensating cut in the vicinity of the fill, while maintaining hydraulic connectivity to the existing floodplain.

4. Any new development in the floodway will require a No Rise study. All calculations and/or models must be submitted with No Rise study via the City's permitting process.

C. Drainage Report / Drainage Impact Assessment Requirements

Drainage Report/Drainage Impact Analysis must be approved prior to submittal and approval of Construction Plans. The drainage report must include minimum of the following items listed in the drainage report:

1. Executive Summary: To include detention summary table for projects with detention.

2. Introduction: Inclusion of project name and purpose, map and description of project limits, project objectives, assumptions and constraints and any existing prior studies. Any data used must be fully described.

3. Existing Conditions: Include location and topography, land use, FEMA floodplains, right-of-way, pipelines and utilities, survey datum, brief discussion of impact of historical storm events at the project site. Include and Existing Condition Drainage Area Map Exhibit.

4. Hydrology and Hydraulics: Include Design Criteria guidelines used, storm frequencies analyzed, mitigation requirements etc. Include a listing of programs and software used. Include discussion of the hydrologic and hydraulic methodologies used. Include Pre-Project and Post-Project conditions. For projects that will be built in a phased approach include an Interim condition. Include analysis of an extreme event. Exhibits will include Overall Drainage Area Map, Existing Drainage Area Map with 5, 25, 100-year flows and water surface elevations at Major Outfall Nodes; Extreme Condition Map; Floodplain Maps with project boundary.

5. Proposed Drainage Plan. Include a description of the proposed drainage plan, results of the hydrological and hydraulics analyses, channel and/or detention layout, right-of-way requirements, pipeline and utility conflicts, geotechnical requirements, and any environmental issues. Exhibits required include Overall Drainage Area Map, Proposed Drainage Area Map with 5, 25 and 100 year flows and water surface elevations at Major Outfall Nodes, Floodplain Maps with project boundaries shown, Detention Pond layout with detention summary, and Plan and Profile with 5-year, 25-year and 100-year waster surface elevations in case of roadway.

6. Fill Results. Include fill calculations for the floodway, 100-year floodplain and the 500-year floodplain and a discussion of any mitigation. Include a Fill Exhibit showing all areas of cut and fill.

7. Conclusions.
When a detention facility is part of the proposed project, include the following detention summary table:

Project Name				
Detention Basin Area				Acres
Detention Storage Rate				Acres-Feet/Acre
Detention Storage Required				Acre-Feet
Detention Storage Provided				Acre-Feet
Floodplain Fill Mitigation Volume				Acre-Feet
Storm Event	20% (5 Yr)	10% (25-Year)	1% (100-Year)	Pond Maximums
Design Water Surface Elevation (-----Datum, ----- Adjustment)				
Maximum Allowable Outflow 9cfs)				
Maximum Outflow Provided (cfs)				

8. Appendix. Include detailed hydrological and hydraulic calculations. Include models and Geospatial data on an external drive.

1.07 QUALITY ASSURANCE

Prepare calculations and construction drawings under the supervision of a Professional Engineer licensed to practice engineering in the State of Texas and trained in the disciplines required by the drawings. The final construction drawings, all design calculations and any submitted reports shall be sealed, signed, and dated by the Professional Engineer licensed to practice engineering in the State of Texas responsible for the development of the drawings along with their firm's registration information. All hydrologic and hydraulic calculations and/or models used during design must be submitted to the City via electronic transfer and on an external hard drive.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS – Reserved

2.02 DESIGN ANALYSIS

A. All projects shall be tied to National Geodetic Survey (NGS) Datum adjustment which matches the Federal Emergency Management Agency (FEMA) rate maps or the most current NGVD which matches the FEMA rate maps. In the event GPS surveying is used to establish benchmarks, at least two (2) references to benchmarks relating to the FEMA rate maps must be identified. Equations may be used to translate other datum adjustments to the required adjustment.

B. Plan sets shall include a drainage area map which shall contain all storm sewer drainage calculations.

C. All drainage systems for curb-and-gutter pavements shall be underground closed conduits; individual residential lot drainage is exempt. Drainage systems for pavements without curb-and-gutter shall be roadside open ditch sections.

D. Soil boring with logs shall be made along the alignment of all storm sewers having a cross section equal to or greater than seventy-two (72) inches in diameter or equivalent cross section area. Boring should be taken at intervals not to exceed five hundred (500) linear feet, and to a depth not less than three (3) feet below the flow line of the sewer. The required bedding will be determined from the soil boring.

E. Plan sets shall include the five (5) year Hydraulic Grade Line for storm sewers and roadside ditches on the plan and profile sheets.

F. All projects located in the floodway, 100-year floodplain, or 500-year floodplain require fill calculations and Fill Exhibit indicating areas of fill and cut.

SECTION VI

SITE DEVELOPMENT

1.0 GENERAL

A. Should any portion of this Section conflict with the Subdivision Ordinance or the Zoning Ordinance, the more stringent of the latter two (2) shall govern.

B. The City Engineer shall have the final interpretation of any provisions in this Design Criteria Manual.

C. The City Engineer has the right to issue administrative orders or design criteria modifications for just cause related to any provisions or conditions in this Design Criteria Manual.

1.01 CHAPTER INCLUDES

Criteria for the design of site development plans.

1.02 REFERENCES

A. City of Friendswood Zoning Ordinance.

B. City of Friendswood Subdivision Ordinance.

C. City of Friendswood Standard Details and Technical Specifications, latest version. These details can be downloaded from:

www.ci.friendswood.tx.us/350/Publications-Forms

D. Texas Department of Transportation – Traffic Control Plan

E. Architectural Barriers Texas Accessibility Standards (TAS)

1.03 DEFINITIONS

Commission – Planning and Zoning Commission.

1.04 DESIGN REQUIREMENTS

A. Site Development Requirements:

1. General Requirements:

a. Site development plans for all site developments shall be approved by the City Engineer prior to construction.

b. Site developments, not including single family residential, shall include any project that affects public water, wastewater, storm drainage, sidewalks, or paving facilities.

c. All sidewalks in new developments shall be a minimum of five (5) feet from the back of curb, two (2) feet from the edge of the public rights-of-way and shall not be in any utility easements.

d. All site developments shall conform to the requirements of these Standards, the latest version of the International Code Series, as amended, and all applicable rules and regulations of the City of Friendswood.

e. All wastewater, drainage, and paving site development improvements, up to and including the connection to the public system, shall be privately owned, operated, and maintained. All water site development improvements up to but not including the meter and meter vault, shall be privately owned, operated, and maintained

f. Restore the City of Friendswood rights-of-way or easements to existing or better condition than that prior to start of work.

g. Private utilities and service lines shall be placed in an easement on the property being served.

h. Streets that change direction a minimum of ninety (90) degrees will require a different name.

2. Design Review Requirements for Site Development Plans

a. All site development plans for proposed developments shall be submitted to the Community Development Department for approval prior to construction. Site development plans shall show all proposed water, wastewater, paving, parking, drainage, street signage, streetlight locations, flood protection facilities, and sidewalks with approved ADA ramps locations, and a traffic control plan.

b. A traffic impact study shall be required for any development proposal expected to generate traffic volumes that will significantly impact the capacity and/or safety of the street system. All proposed developments generating volumes of five thousand (5,000) trips per day or greater shall abide by this criterion. The trip estimate shall be based on the latest version of the Institute of Transportation Engineers' Trip Generation Manual.

c. The developer should first schedule a Development Review Committee (DRC) meeting with Community Development Department staff. At this meeting, infrastructure issues and the feasibility of developing the site will be discussed.

d. The developer shall prepare a site plan for submittal to be reviewed by staff. The developer shall consult with staff until all significant issues surrounding the proposed site plan and development are resolved, prior to proceeding to the Planning and Zoning Commission.

1) The submittal for the site plan requires five (5) copies of the following:

a) Cover Sheet

b) Site Plan

c) Landscaping Plan

d) Building Elevation Plan

e) Photometric Plan

2) and two (2) copies of:

a) Drainage Plan

b) Utility Plan

c) Grading Plan

d) Storm Water Pollution Prevention Plan

e. The final site plan will be presented to the Planning and Zoning Commission by City Staff for consideration. The Planning and Zoning Commission reviews the final document for completeness and public awareness.

f. The final site plan submittal to be provided to Community Development Department staff at least ten (10) days prior to the next regularly scheduled Planning and Zoning Commission meeting.

g. Once the site plan is approved, the developer may begin the building permitting process. Approval from the appropriate drainage entity is required prior to the issuance of building permits.

h. Three (3) copies of the site development plans shall be submitted to the Building Official for review. The City will typically respond within two (2) to four (4) weeks of the initial submittal.

i. When plan changes are requested, two (2) copies of the revised site development plans shall be submitted to the City for review, which will ultimately result in the reissuance of any applicable permit(s).

3. Building Slab Elevations – Minimum building slab elevations shall conform to the requirements of the City of Friendswood Flood Damage Prevention Ordinance and latest adopted flood zone maps.

4. Water Service – Water service lines and meters shall be sized in accordance with requirements set out in Section III –Waterline Distribution System Design Requirements.

5. Sanitary Sewer Service – Sanitary sewer service leads are normally installed during construction of the public sanitary sewer. When a sanitary sewer service lead is to be installed for a site development, refer to Section II – Wastewater Collection System Design Requirements. All lots, tracts, or reserves shall be connected directly to a public sanitary sewer by a single lead, except as specifically approved by the City Engineer. The City Department of Public Works shall be contacted for all sanitary sewer connections for commercial projects.

6. Site Drainage Requirements – All commercial, industrial, office, recreational, and multi-family tracts shall have an internal drainage system. The internal drainage system shall collect all site runoff and direct it into a private storm sewer system that shall connect to the public

drainage facilities in the area. Refer to Section V – Storm Drainage Design Requirements for more details. Any exceptions require specific approval from the City.

a. The internal site storm sewer shall be connected to a public storm sewer at a manhole or at an inlet adjoining the site. The site drainage outfall shall be connected to the nearest existing drainage system with adequate capacity to serve the drainage area. Where extension of the existing drainage system is required, all costs for extension shall be the responsibility of the developer.

b. All internal facilities shall be designed by a Professional Engineer licensed to practice engineering in the State of Texas, and shall be sized to drain the site in accordance with these standards.

c. Drainage calculations shall be submitted with all site development plans. Additional supporting data may be required by the City.

d. When the site drains directly into a Galveston County or Harris County facility, and/or into a TxDOT or county rights-of-way, the appropriate governmental entity(s) shall approve the site development connection to the public facilities.

7. Driveways

a. It is desirable to minimize the number of non-residential driveways on all streets in order to reduce the number of conflict points and facilitate traffic flow. It is recognized, however, that certain existing tracts may not be able to fully comply with the following standards due to limited frontage or other constraints.

b. When compliance with these criteria is precluded for any reasons, attempts should be made to obtain alternative access where feasible, including joint access driveways, access easements to adjoining properties, or access to intersecting streets.

c. If it can be demonstrated to the City Engineer that sufficient attempts to secure alternative access have been made, and that such access is still not possible, the City Engineer may accept a Traffic Impact Analysis performed by a Professional Engineer licensed to practice engineering in the State of Texas. If approved, the analysis will be used to allow a deviation to the driveway spacing requirements indicated herein.

d. Residential driveways shall be a minimum of twelve (12) feet wide and a maximum of twenty-five (25) feet wide at the rights-of-way line, unless otherwise approved by the City Engineer, and should be placed at least twenty-five (25) feet away from the property line at the intersection of two (2) streets and at least five (5) feet from a property line between two (2) properties.

e. Residential lots must have a minimum of one hundred (100) feet of frontage in order to be eligible for a circular driveway on the lot, and the two (2) driveways shall have at least forty-five (45) feet of separation between them from the inside edges of driveways.

f. Non-residential driveways shall be a minimum of twenty-five (25) feet wide and a maximum of thirty-five (35) feet wide. Non-residential driveways shall be spaced with a minimum of fifty (50) foot separation.

g. Non-residential driveways on major thoroughfares/boulevard streets shall be placed no closer than one hundred (125) feet from the ultimate curb line of the intersecting major thoroughfare or boulevard street. Non-residential driveways on collector/ minor streets are to be placed no closer than seventy-five (75) feet from the ultimate curb line of the intersecting major thoroughfare/boulevard street. Non-residential driveways on major thoroughfares/boulevard streets are to be placed no closer than seventy-five (75) feet from the ultimate curb line of the intersecting collector commercial/minor street.

h. For purposes of determining the separation distance, the back of curb or edge of street shall be used in conjunction with the edge of driveway which is closest and parallel to the street from which the measurement is to be taken.

i. Non-residential tracts with less than one hundred fifty (150) feet of frontage on a public street shall have no more than one (1) driveway. Non-residential tracts between one hundred (150) feet and three hundred twenty (320) feet of frontage on a public street shall have no more than two (2) driveways. Non-residential tracts between three hundred twenty-one (321) feet and six hundred (600) feet of frontage on a public street shall have no more than three (3) driveways. Non-residential tracts with over six hundred (600) feet of frontage on a public street shall have the number of

driveways specially designated and specifically approved by the City.

j. Non-residential driveway connections to the public street shall be approved and inspected by the City, TxDOT, county representative, or appropriate entity.

k. Driveway radii shall not extend beyond the projection of a property line perpendicular to the back of the curb.

l. Driveways shall be installed according to the latest version of the City of Friendswood Standard Details and Technical Specifications.

m. Driveways shall be evaluated with respect to location of existing or proposed signage, landscaping, and structures for adequate sight distance.

n. A note stating, "Access to adjacent property and common driveways may be required" shall be placed on the site plan.

o. Curb returns for driveways shall be, at a minimum:

1) For residential driveways:

a) Five (5) feet on local streets less than twenty-eight (28) feet in width.

b) Ten (10) feet on collector streets, major thoroughfares and boulevards, and local streets greater than twenty-eight (28) feet in width.

2) For non-residential driveways:

a) Twenty-five (25) feet on local streets less that twenty-eight (28) feet in width

b) Thirty-five (35) feet on collector streets, major thoroughfares, boulevards, and local streets greater than twenty-eight (28) feet in width

8. Fire Lanes

   a. Fire lanes shall be required on all multi-family and non-residential tracts if any part of a building is greater than one hundred fifty (150) feet from either a fire lane, private street, or public street rights-of-way.

   b. Fire lanes shall be either twenty (20) feet wide with a twenty-five (25) foot radius or twenty-five (25) feet wide with a twenty (20) foot radius.

   c. Fire lanes shall be constructed using the same pavement structural requirements as a public pavement. Alternate materials may be used with specific approval from the City Engineer.

   d. Fire lanes shall be designed to drain in compliance with the Site Development Requirement.

   e. Fire lane markings shall be provided as specified in the Friendswood Code of Ordinances.

   f. An emergency vehicle turn-around, whether a cul-de-sac of a radius required by the Fire Marshal or a T-head at least one hundred twenty (120) feet in length, shall be required under certain conditions.

9. Controlled Access Gate Requirements

   a. Plans for access control systems shall be submitted to the Fire Marshal’s Office and approved prior to construction.

   b. All access control gates shall have emergency means of operation in the event of power loss.

   c. Access control gates shall provide a clear, passable width of at least twenty (20) feet.

   d. A Knox® key switch shall be provided for all controlled access gates. The key switch shall operate all gates.

   e. A Knox® pad lock shall be provided for all non-motorized gates.

f. The location of the key switch shall be approved by the Fire Marshal's Office.

g. The owner or homeowners' association shall maintain all parts of the access system and keep them in good working order.

h. The Fire Marshal's Office and Police Dispatch shall be notified immediately of any damage to the access system that hinders access including but not limited to, damage to the key box, lock, and gates.

i. Access gates shall be far enough back to provide at least forty (40) feet of stacking space.

10. Storm Water Pollution Prevention Plan

a. A storm water pollution prevention plan shall be provided for all site development projects.

b. Filter fabric fence shall be installed at the perimeter of the site before construction begins.

c. Once construction is complete, the filter fabric fence may be removed; provided a minimum of five (5) feet of hydro-mulch or sod shall be installed at the back of all curbs, or other Best Management Practices, shall be implemented and/or installed.

d. Refer to the Storm Water Ordinance for additional requirements.

11. Parking Lot Guidelines

A parking lot layout is required to ensure that adequate off-street parking is provided with the construction, alteration, or remodeling of any building.

a. Minimum concrete slab thickness shall be five (5) inches with an fc equal to four thousand (4,000) psi. Reinforcement shall be Grade 60, fy = 60,000 psi, #4 deformed reinforcing bars, spaced at sixteen (16) inches center to center, both ways with a minimum lap length of twenty-for (24) inches. Minimum stabilized subgrade thickness shall be eight (8) inches.

b. Hot Mix Asphalt Concrete pavement thickness shall be a minimum of two (2) inches with eight (8) inches of stabilized crushed concrete or limestone and six (6) inches of lime-stabilized subgrade.

c. Off-street parking spaces shall be located on the same lot, tract, parcel, or premises as the use being served, or on other property of the same or less restrictive zoning classification that the owner of the premises being served has a continuing right to use for parking. When the off-street parking spaces are not located on the same lot, tract, parcel, or premises being served, the distance from the center of the parking lot to an entrance to the building, shall not exceed five hundred (500) feet in distance measured along the shortest available pedestrian route with public access.

d. Any existing building that is enlarged, structurally altered, or remodeled by more than fifty (50) percent as it existed shall be accompanied by off-street parking for the entire building. When the enlargement, structural alteration, or remodel is not increased or changed by more than fifty (50) percent, additional off-street parking shall only be required for the increased or changed floor area.

e. Existing parking spaces may not be used to satisfy additional off-street parking requirements unless, the existing spaces exceed the number recommended for the building or use for which the existing spaces are associated.

f. The number of off-street parking spaces required for each building or use shall be determined by reference to the Parking Group Table in Appendix C of this Design Criteria Manual. Where several different property uses will share a joint parking area, the parking should be computed based upon the overall development.

g. The design and dimensions of off-street parking areas shall be in accordance with the following table of minimum dimensions. Minimum stall width shall be nine feet, except for residential and all-day office parking which may utilize stalls eight and one-half (8.5) feet in width, provided that minimum aisle widths are increased by one (1) foot. In addition, the dimensions of up to twenty (20) percent of the total number of off-street parking spaces may be reduced to eight (8) feet in width and sixteen (16) feet in

depth to accommodate compact automobiles (such spaces must be so marked). All dimensions below are in feet:

Angle (degrees)					
	0°	*35°*	*45°*	*60°*	*90°*
Stall, parallel to aisle	23.0	18.0	12.7	10.4	9.0
Stall, perpendicular to aisle	9.0	16.5	19.0	20.0	18.0
Aisle width, one-way	12.0	12.0	12.0	16.0	24.0
Aisle width, one-way	22.0	22.0	22.0	24.0	24.0
Cross aisle, one-way	11.0	11.0	11.0	11.0	11.0
Cross aisle, two-way	22.0	22.0	22.0	22.0	22.0
Refer to Appendix B – Figure 8 of this Design Criteria Manual for Off-street Parking Diagrams					

h. Off-street parking spaces shall be clearly marked. Parking spaces abutting an adjoining property line or street rights-of-way shall be provided with wheel guards or bumper guards located such that no part of a normally parked vehicle will extend beyond the property line. When wheel guards are used, they shall be centered two and one-half (2.5) feet from the property line for ninety (90) degree parking, two and one-third (2.3) feet for sixty (60) degree parking, and two (2.0) feet for forty-five (45) degree and thirty (30) degree parking.

i. The parking layout and design of all off-street parking areas shall be approved by the City Engineer. The City Engineer shall determine that spaces provided are usable, and that the circulation pattern within the area is adequate.

j. The number of accessible parking spaces shall comply with the latest edition of the Architectural Barriers Texas Accessibility Standards (TAS).

k. Accessible parking spaces must be paved and must include:

   a. The international symbol of access painted conspicuously on the surface in a color that contrasts the pavement;
   b. The words “NO PARKING” painted on any access aisle adjacent to the parking space. The words must be painted:
      i. In all capital letters;
      ii. With a letter height of at least one (1) foot, and a stroke width of at least two (2) inches; and

iii. Centered within each access aisle adjacent to the parking space; and

c. A sign identifying the consequences of parking illegally in a paved accessible space. The sign must:
   i. At a minimum state "Violators Subject to Fine and Towing" in a letter height of at least one inch;
   ii. Be mounted on a pole, post, wall, or freestanding board;
   iii. Be no more than eight (8) inches below a sign required by Texas Accessibility Standards, 502.6; and
   iv. Be installed so the bottom edge of the sign is no lower than four (4) feet and no higher than six (6) feet above ground level.

d. A sign that meets the requirements set in Texas Accessibility Standards, 502.6, that includes the required language in subsection (c)(i) satisfies these requirements.

12. Pipelines

All new Pipelines shall be a minimum depth of ten (10) foot in depth to the top of the pipe in all new or existing road rights-of-way.

13. Utility and Cable Installation

a. Utility infrastructure shall be mounted on pads at ground level; if within the rights-of-way, utility infrastructure shall not block sidewalks or visibility at intersections.

b. For future individual utility service, lines which originate in a public road right-of-way and extended to any building or structure shall be installed underground.

c. On side streets with above-ground utility services which intersect a roadway with underground utility lines, the first pole supporting the above ground service shall be placed on such a side street at least one hundred (100) feet from the center of the roadway with the underground utilities.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS

A. Discuss project concepts outlining proposed features and usage with the City.

B. Research existing utility and rights-of-way information.

C. Verify that no restrictions exist that could result in denial of the project concept.

2.02 DESIGN ANALYSIS – Reserved

2.03 DRAWINGS

A. The site development plan shall include layout sheet(s) providing a photometric layout of the site complete with location of proposed lights, information on light heights, and type of light standard proposed.

B. The site development plan shall include an overall drainage layout showing:

1. Total area (in acres) of site to be drained.

2. Area (in acres) drained to each inlet.

3. Contours or an adequate number of spot elevations to indicate area drained to each inlet.

4. Top elevation and flowline elevation at each inlet.

5. Gradient and size on each private storm sewer.

6. Computations to support pipe sizes and grades shown [minimum private storm size shall be ten (10) inches].

7. Design velocity for storm sewers shall be three (3) feet per second.

8. A TxDOT or a county permit shall be required for drainage affecting a state or county owned/maintained facility. Submit permit with site plan.

9. The drawings shall be prepared and sealed by a Professional Engineer licensed to practice engineering in the State of Texas.

10. The size and location of any required detention facility shall be indicated on the plans, along with the size and location of the outfall structure.

C. All site development plans shall be approved by the appropriate drainage entity prior to City approval being granted.

D. The site plan shall show all water and sewer service lines with sizes, grades and alignments; and illustrate any proposed ties into the existing public lines.

E. The site development plan shall show all parking areas.

F. The site development plan shall indicate the types and location of all existing and proposed landscaping. Landscaping shall meet the minimum requirements as set forth in the Zoning Ordinance. If no trees exist, a note to that effect shall be placed on the site development plan. The Qualified Tree List can be found in Appendix D of this Design Criteria manual.

G. The site development plan shall show the location, height, and area of all proposed buildings. All setback lines as required by the Zoning Ordinance shall also be shown with a dimension called out on the site plan between the building and the site boundary.

H. The land use for all adjacent property shall be shown on the site development plan.

I. All parking lot pavements for site development plans shall be engineered to provide for operation by vehicles normally expected to utilize the parking area, and the thickness of paving shall be based upon the soil conditions underlying the parking area. A Professional Engineer licensed to practice engineering in the State of Texas shall certify the design submitted for approval.

J. Sidewalks are required as set out in Section III of the Subdivision Ordinance and Section 70-64 of the Code of Ordinances. Where sidewalks are required, they shall have a minimum width of four (4) feet, except on TxDOT rights-of-way where the minimum width shall be five (5) feet. The design and installation of such sidewalks shall comply with Texas Accessibility Standards Architectural Barriers requirements and the City of Friendswood Standard Details and Technical Specifications. The location of all proposed and existing sidewalks shall be shown on the site development plan.

K. Show location of signs, screening walls or fences [indicate height, material, and appurtenances], and dumpsters (with appropriate screening).

L. If the site is located within the Community Overlay District, a plan note shall be made on the site development plan indicating such; and that the site development will conform to the Zoning Ordinance requirements.

M. No improvements in or to public rights-of-way shall be made without prior approval from the City Engineer. This includes planting trees in public rights-of-way, within residential and non-residential areas, or in any utility or drainage easement. Only Class 2 and Class 3 trees listed in Appendix D of this Design Criteria Manual may be planted in public rights-of way if such planting is approved by the City Engineer. No trees of any class may be planted in utility or drainage easements.

APPENDIX A
Attachments

ATTACHMENTS

1. Lift Station Start-up Log
2. Design Criteria Modification Form
3. GCCDD Form DR-001

City of Friendswood Lift Station Start-Up Log								
Date:	Site:		Pump Number:					
Address:			Pump Designation:					
Name Plate Data								
Pump Data								
Pump Make:			Size:					
Pump Model:			TDH:					
Serial Number:			Impeller Number or Size					
			Flow in GPM:					
Pump Motor Data								
Make (if applicable):			Phase:					
Serial Number (if applicable):			Name Plate Voltages:					
RPM:			Name Plate Full Load Amps:					
Service Factor:			Pump is wired for:					
Start-Up Trial Data								
Insulation Test			Pre-Start Voltage Test					
L1 to GND	L2 to GND	L3 to GND	L1 - L2	L2 - L3	L3 - L1	L1 - GND	L2 - GND	L3 - GND
M	M	M	V	V	V	V	V	V
			Run Voltage Test			Run Amperage Test		
Phase Rotation			L1 - L2	L2 - L3	L3 - L1	L1	L2	L3
ABC	CBA							
Operator:								

CITY OF FRIENDSWOOD
DESIGN CRITERIA MODIFICATION FORM

Modifications to standards identified in the Design Criteria Manual may be permitted by the City of Friendswood's City Engineer. The modification proposal must be submitted by a Professional Engineer licensed by the State of Texas and shall follow generally accepted engineering standards for traffic, sidewalk and other infrastructure as applicable, and such proposal contains the following information and substantiates the findings in Paragraph 4 below. If an appeal to the City of Friendswood City Engineer decision is requested, the Construction Board of Adjustment (hereinafter referred to as "the City") will review that appeal.

This entire form must be completed in its entirety. If form is submitted incomplete, it will be administratively rejected.

PROJECT NAME:

_____

PROJECT ENGINEER:

_____

SUBMITTAL DATE:

_____

SUBDIVISION NAME:

_____

MODIFICATION LOCATION:

_____

_____

_____

_____

1. Set forth the proposed deviation to the technical standard.

SPECIFIC PROPOSED DEVIATION FROM TECHNICAL STANDARD:

_____

_____

_____

_____

2. Set forth the impact such deviation has on speed differential and street capacity, the likelihood of accidents, the long term maintenance and operation effect, the degree of functionality and efficiency, the technological advancements involved, and other relevant matters.

IMPACT OF DEVIATION:

3. Show a comparison of the technical standard to the proposed deviation with respect to overall safety and quality, speed differential, street capacity, existing and projected accidents, long-term maintenance and operation, degree of functionality, degree of efficiency, technological advancements, and other relevant matters.

COMPARISON OF TECHNICAL STANDARD TO PROPOSED DEVIATION:

4. Describe all mitigating improvements that reduce the negative impact of the proposed deviation on overall safety and quality, speed differential, street capacity, accident occurrences, long-term maintenance and operation, degree of functionality, degree of efficiency and demonstrating the degree to which the proposed deviation detrimentally affects the foregoing. Other relevant factors, including technological advances, should be explained by describing how they will affect the proposed development. Mitigating improvements can include but are not limited to, traffic control devices, pavement improvements, added acceleration or deceleration lanes, or reservoirs, and other on-site improvements.

MITIGATING IMPROVEMENTS THAT REDUCE NEGATIVE IMPACT:

SUMMARY & CONCLUSION/RECOMMENDATION FOR MODIFICATION:

_____

_____

_____

_____

_____

List of Supporting Documentation Attached? **Yes____** **No____**

_____
Engineer's Name

_____
Engineering Firm

_____
Address

_____
City, ST, Zip

_____
Telephone

Seal of Professional Engineer

Department of Engineering & Projects Use ONLY

Reviewed By:

_____ _____
Date

Modification Request Approved / Denied By:
Copies of Backup Information/Notes Attached

_____ _____
City Engineer Date

NAME OF APPLICANT: _____

ADDRESS: _____

LEGAL DESCRIPTION: _____

TOTAL ACREAGE: _____

DATE OF PLAT OR RE-PLAT: _____

QUALIFICATIONS FOR PURCHASING REGIONAL DETENTION

PER THE INTERLOCAL AGREEMENT BETWEEN THE CITY OF FRIENDSWOOD AND GCCDD DATED MARCH 7, 2011:

SINGLE FAMILY RESIDENTIAL (SFR) LOTS OF 3.5 ACRES OR LESS QUALIFY
MUST PROVIDE SUPPORTING DOCUMENTATION FOR THE CALCULATION OF IMPERVIOUS COVER

FEE CALCULATIONS BASED ON SQUARE FEET OF IMPERVIOUS COVER:

_____ SF OF IMPERVIOUS COVER X $0.25 = _____

PLEASE MAKE CHECKS PAYABLE TO THE GCCDD

* IMPERVIOUS COVER AREA SHALL BE DEFINED AS SURFACE COVER WHICH DOES NOT ALLOW THE PASSAGE OF STORM WATER INTO THE UNDERLYING SOIL, AND INCLUDES, BUT IS NOT LIMITED TO CONCRETE, ASPHALT, STABALIZED SOIL, TENNIS COURTS, WATER FEATURES, POOLS, SIDEWALKS, CRUSHED CONCRETE, LIMESTONE, AND ROOFING

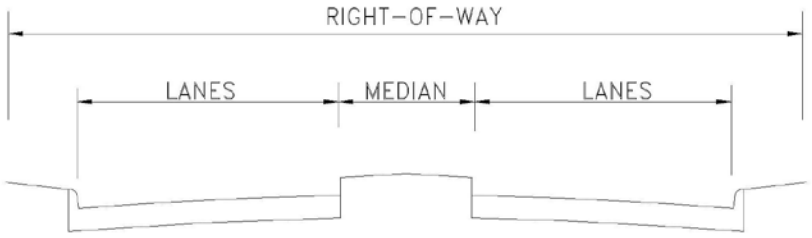
APPENDIX B
Figures

Figure

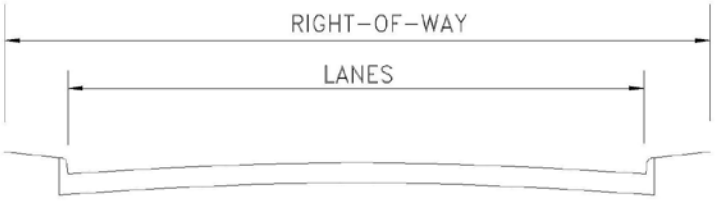
1. Geometric Street Design Standards
2. Divided Roadway Cross Sections – Urban
3. Roadway Tapers For Subdivision Streets
4. Undivided Roadway Cross Sections – Urban
5. Typical Length of Median and Median Opening
6. Median Nose and Left Turn Bay Design
7. Cul-de Sac
8. Driveway spacing and other measurements
9. Off-Street Parking

FIGURE 1

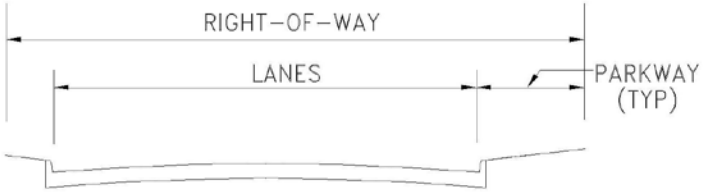
GEOMETRIC STREET DESIGN STANDARDS (MINIMUM STANDARDS)



DIVIDED ROADWAYS
BOULEVARDS – THOROUGHFARES



UNDIVIDED ROADWAYS
COMMERCIAL – COLLECTORS



LOCAL STREET

	DIVIDED		UNDIVIDED		
NUMBER TRAFFIC LANES	6	4	4	2	2
LANE WIDTH (FT)	12	12	11 F-F	40 F-F	27 F-F
R.O.W. WIDTH (FT)	120	100	80	60	50
DESIGN SPEED (MPH)	40 – 55	40 – 50	30 – 40	30 – 40	20 – 30
MAX. GRADE (%)	6	6	8	8	10
STOPPING SIGHT DISTANCE (FT)	325 – 525	325 – 475	200 – 325	200 – 325	125 – 200
HORIZONTAL CURVATURE MIN. RADIUS (FT)	2000	1050	850	850	300
VERTICAL CLEARANCE (FT)	15.5	15.5	15.5	15.5	15.5
LATERAL CLEARANCE (FT)	6	6	6	6	–
MIN. MEDIAN WIDE (FT)	28	28	–	–	–
PARKING PERMITTED	NO	NO	NO	SOME	YES
PARKWAY WIDTH (FT)	10	12	18	10	11.5

FIGURE 2

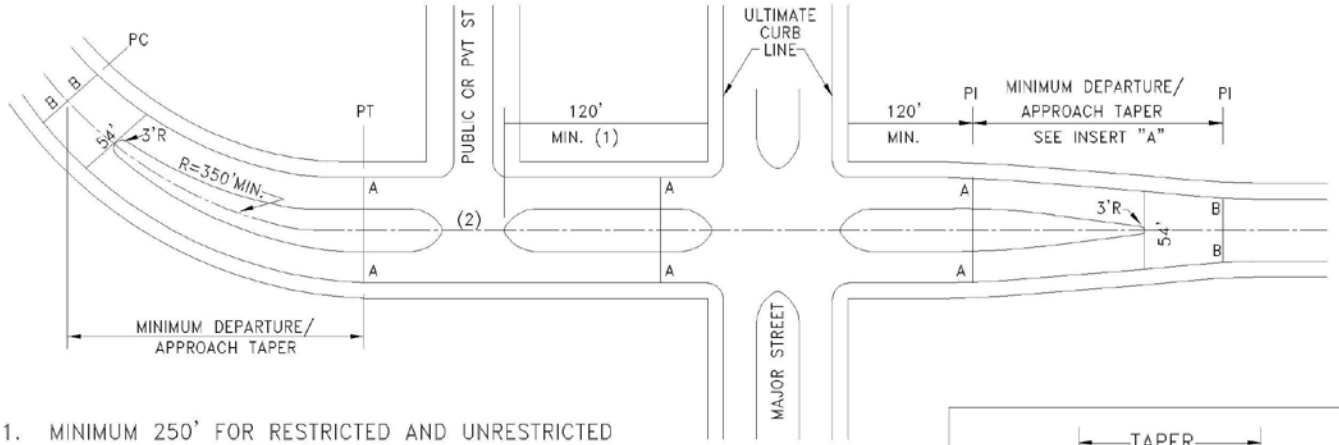
DIVIDED ROADWAY CROSS SECTIONS–URBAN

DIVIDED ROADWAY DIMENSIONS (In Feet)			
R.O.W.	80	100	100
WIDTH	24	24	33
MEDIAN	14	28	14
SIDEWALK	9	12	10

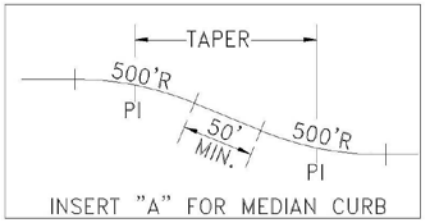
NOTE:
THIS DESIGN REPRESENTS THE PRESENCE OF A TYPICAL CURB AND GUTTER, AND DOES NOT IMPLY OR RECOMMEND A SPECIFIC DRAINAGE DESIGN

FIGURE 3

ROADWAY TAPERS FOR SUBDIVISION STREETS



1. MINIMUM 250' FOR RESTRICTED AND UNRESTRICTED RESERVES AND LOCATIONS WHERE A LEFT TURN LANE MAY BE REQUIRED.
2. MEDIAN OPENING MAY NOT BE ALLOWED IF MEDIAN IS LESS THAN 250' IN LENGTH.



INSERT "A" FOR MEDIAN CURB

NOTE:

a. APPROACH AND DEPARTURE TAPER REQUIREMENT:

$L=\frac{WS^2}{60}$ WHERE L = LENGTH IN FEET
S = SPEED IN M.P.H.
W = LATERAL OFFSET IN FEET

S = 30 M.P.H. MINIMUM DESIGN SPEED FOR SUBDIVISION STREETS

W = A−B

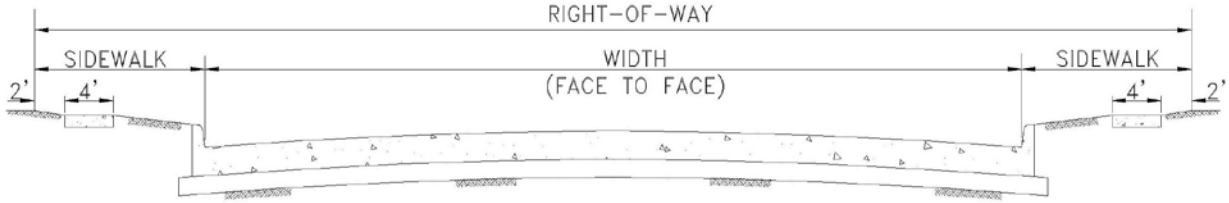
b. 350' MINIMUM CENTERLINE RADIUS FOR HORIZONTAL CURVE WITH APPROACH OR DEPARTURE TAPERS

QUICK REFERENCE GUIDE

ROADWAY CROSS SECTION (FEET)		TAPER $L=\frac{WS^2}{60}$ (FEET)
A+A	B+B	
80	60	150
80	40	300
80	27	400

FIGURE 4

UNDIVIDED ROADWAY CROSS SECTIONS–URBAN



UNDIVIDED ROADWAY DIMENSIONS (In Feet)				
ABUTTING	RESIDENTIAL			ALL OTHER
LAND USE	MFR–GHD	SFR		MINOR/(2) COMM.
R.O.W.	50*(1)	60	60	80
WIDTH	27	27	40	44
SIDEWALK	11.5	16.5	10	18

(1) RIGHT–OF–WAY IN MFR–GHD SHALL MEAN THE DRAINAGE AND UTILITY EASEMENT UTILIZED WHEN PRIVATE STREETS ARE CONSTRUCTED.

(2) MINOR/COMM.– ANY PROPERTY USE OTHER THAN SINGLE FAMILY OR A COLLECTOR OR MINOR THOROUGHFARE

NOTE:
THIS DESIGN REPRESENTS THE PRESENCE OF A TYPICAL CURB AND GUTTER, AND DOES NOT IMPLY OR RECOMMEND A SPECIFIC DRAINAGE DESIGN

FIGURE 5

TYPICAL LENGTH OF MEDIAN AND MEDIAN OPENING

TYPICAL LENGTH OF MEDIAN OPENING "C" = 50' OR D+10', WHICHEVER IS GREATER.

MINIMUM ACCEPTABLE MEDIAN LENGTH FOR TYPE OF STREET				
	PURPOSE OF MEDIAN INTERRUPTION			
IF PLANNED DIVIDED STREET IS:	MAJOR STREET/ THOROUGHFARE (A)	COLLECTOR STREET (A)	LOCAL STREET (A)	PRIVATE STREET OR DRIVEWAY (B)
MAJOR STREET/ THOROUGHFARE	350'	300'	300'	300'
COLLECTOR STREET	300'	250'	250'	250'
LOCAL STREET	250'	250'	250'	200'

FIGURE 6

MEDIAN NOSE AND LEFT TURN BAY DESIGN

MEDIAN DIMENSIONS			
W	R_1	R_2	R_3
≤ 8'	NONE	$\frac{W}{2}$	NA
>8' ≤ 38'	90°	$\frac{W}{5}$	NA
>38'	NONE	NONE	15°

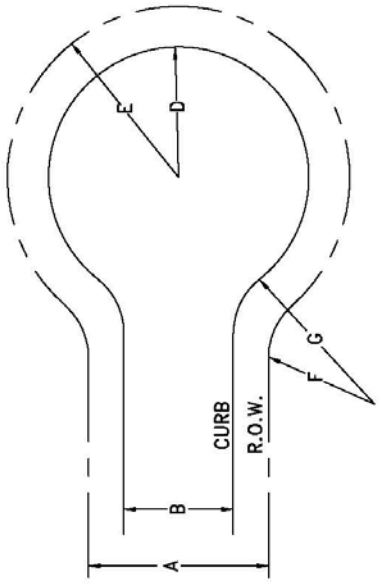
NA - NOT APPLICABLE

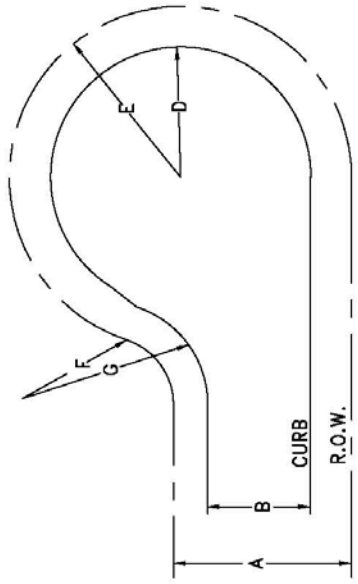
LEFT TURN BAY DIMENSIONS

A = 150' MINIMUM AT INTERSECTION OF TWO MAJOR STREETS.
= 100' MINIMUM AT ALL OTHER INTERSECTIONS.
B = 100' MINIMUM ON STRAIGHT ROADWAY.
B_1 = TAPER LENGTH MAY BE SHORTER IF IT IS ON A HORIZONTAL CURVE TO THE LEFT.
B_2 = TAPER LENGTH MAY BE LONGER IF IT IS ON A HORIZONTAL CURVE TO THE RIGHT.
NOTE: DIMENSIONS MAY BE ADJUSTED AS DETERMINED BY TxDOT.

FIGURE 7

CUL-DE-SAC DESIGN FOR STREET TERMINATION





	ABUTTING LAND USE	
	SINGLE FAMILY *	ALL OTHER
A	ALL WIDTHS	60'
B	ALL WIDTHS	ALL WIDTHS
D	50'	55'
E	60'	65'
F	25'	25'
G	35'	35'

ALL DIMENSIONS MEASURED IN FEET TO FACE OF CURB.

* NOT OPENING ONTO A MAJOR THOROUGHFARE

MAXIMUM CUL-DE-SAC LENGTH SHALL BE 750 FEET.

FIGURE 8

DRIVEWAY SPACING AND OTHER MEASUREMENTS

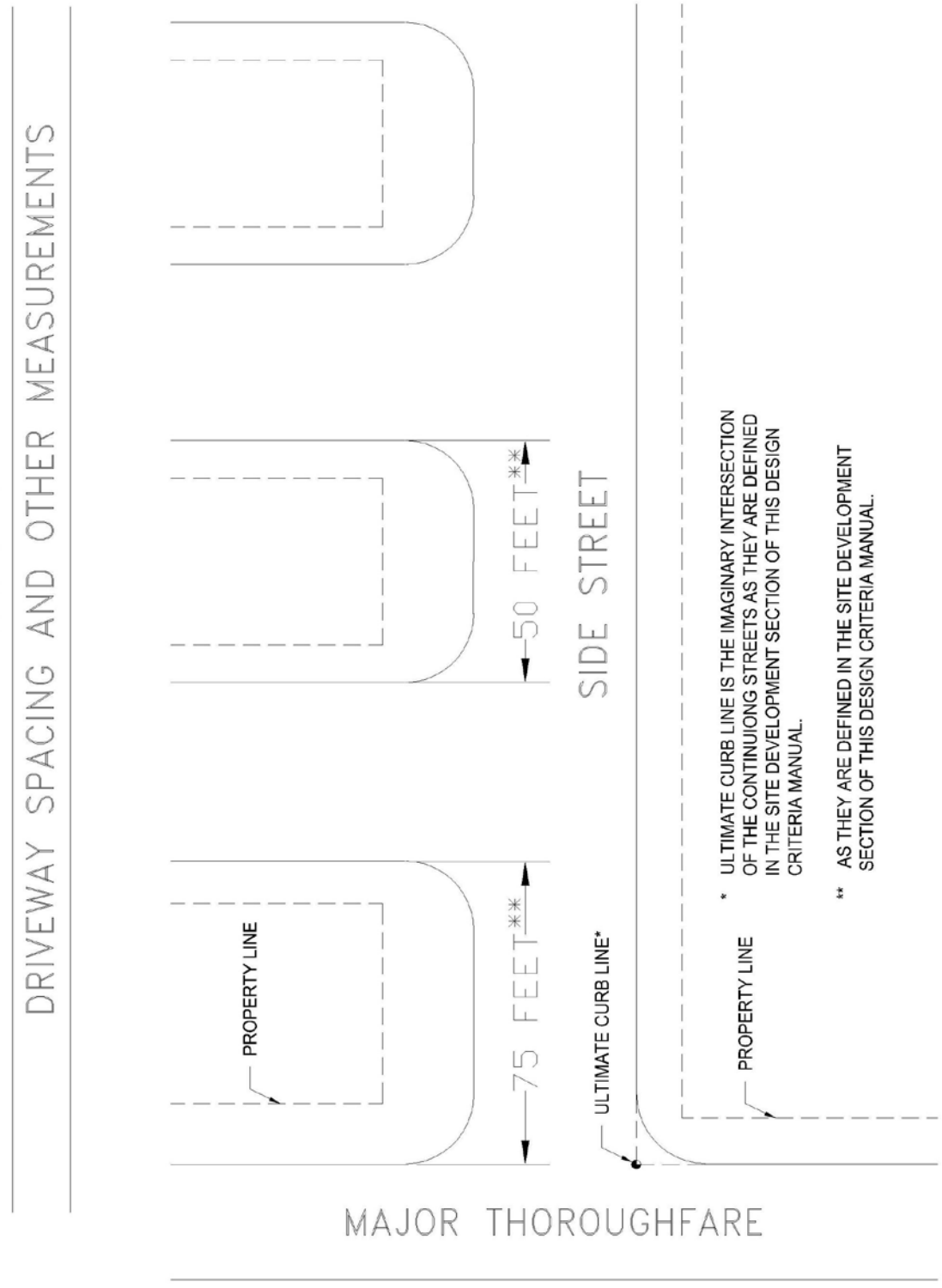
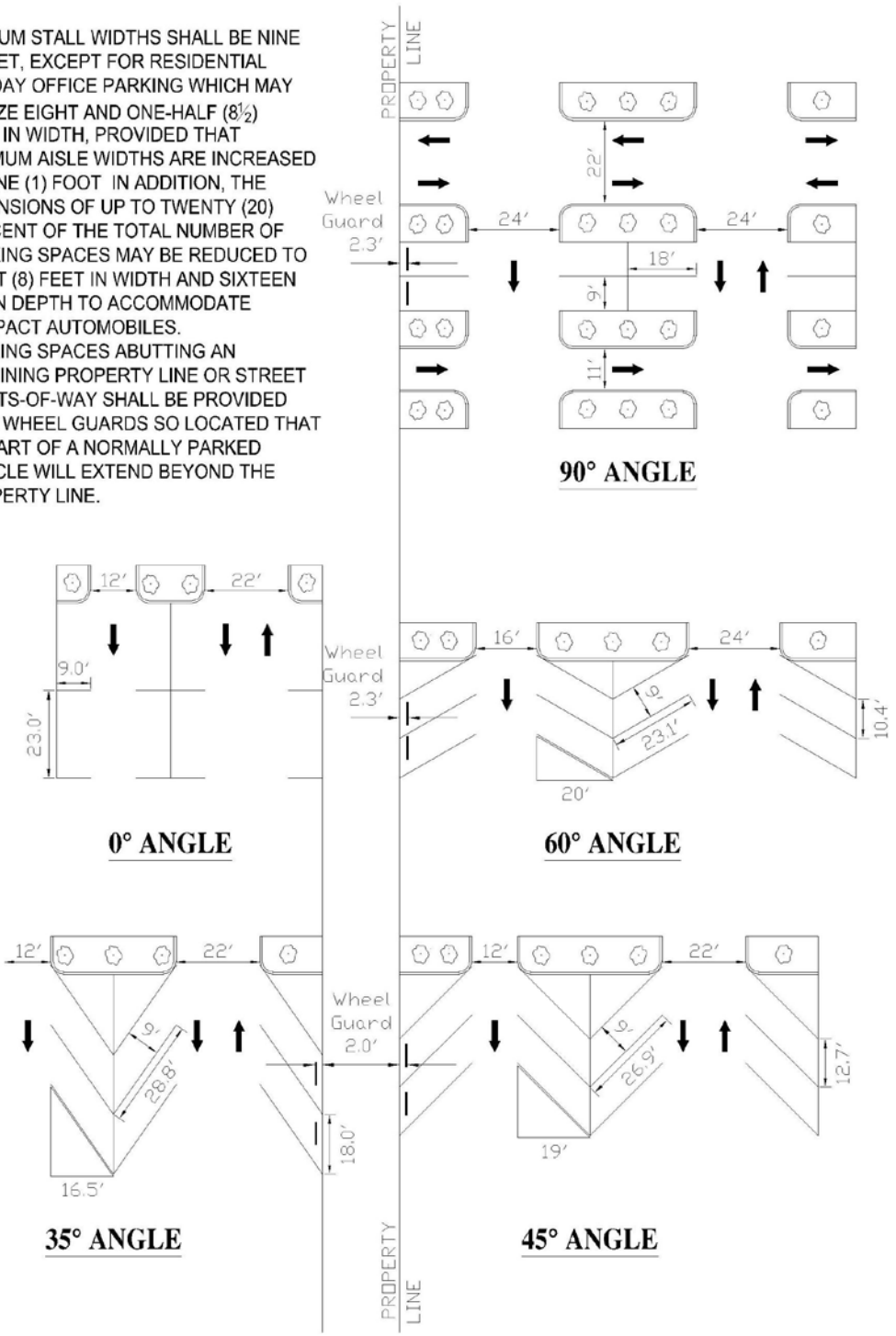


FIGURE 9

OFFSTREET PARKING

NOTES:

1. MINIMUM STALL WIDTHS SHALL BE NINE (9) FEET, EXCEPT FOR RESIDENTIAL ALL-DAY OFFICE PARKING WHICH MAY UTILIZE EIGHT AND ONE-HALF (8½) FEET IN WIDTH, PROVIDED THAT MINIMUM AISLE WIDTHS ARE INCREASED BY ONE (1) FOOT IN ADDITION, THE DIMENSIONS OF UP TO TWENTY (20) PERCENT OF THE TOTAL NUMBER OF PARKING SPACES MAY BE REDUCED TO EIGHT (8) FEET IN WIDTH AND SIXTEEN (16) IN DEPTH TO ACCOMMODATE COMPACT AUTOMOBILES.
2. PARKING SPACES ABUTTING AN ADJOINING PROPERTY LINE OR STREET RIGHTS-OF-WAY SHALL BE PROVIDED WITH WHEEL GUARDS SO LOCATED THAT NO PART OF A NORMALLY PARKED VEHICLE WILL EXTEND BEYOND THE PROPERTY LINE.



APPENDIX C
Parking Group Table

Parking Use Category	Parking Spaces*
Accommodation	
Accommodations:	1.25 spaces per sleeping room or unit, plus the following meeting per banquet space: - less than 10 sq. ft. per sleeping room = none; - 10 to 20 sq. ft. per sleeping room = 30 spaces per 1,000 sq. ft. GFA; - 21 to 50 sq. ft. per sleeping room and over 50 sq. ft. per sleeping room = 20 spaces per 1,000 sq. ft. GFA.
Accommodations with food:	1.25 spaces per sleeping room or unit, plus 10 spaces per 1000 sq. ft. GFA restaurant lounge, plus the following for meeting/banquet space: - less than 10 sq. ft. per sleeping room = none; - 10 to 20 sq. ft. per sleeping room = 30 spaces per 1,000 sq. ft. GFA; - 21 to 50 sq. ft. per sleeping room and over 50 sq. ft. per sleeping room = 20 spaces per 1,000 sq. ft. GFA.
Adult Establishment	1 space for every 4 seats or 1 space for every 50 sq. ft. of customer service area, whichever is greater.
Agricultural, Forestry, Fishing, and Hunting Uses	2 per site plus 1 per 1,000 sq. ft. enclosed floor area.
Amusement and Recreation Industries	
Arcade:	1 space per 200 sq. ft. GFA.
Driving/Archery/Shooting Range:	1 space per 200 sq. ft. GFA of indoor facilities plus 1 space per tee or target.
Fairground, Exhibition, Carnival:	1 space per 500 sq. ft. of outdoor site area plus 1 space per 4 fixed spectator seats.
Fitness and Recreational Sports:	7 spaces per 1,000 sq. ft. GFA.
Golf Course:	1 space per 150 sq. ft. GFA of indoor facilities plus 5 spaces per green.
Miniature Golf :	1 space per 200 sq. ft. GFA of indoor facilities plus 1.5 spaces per hole.
Rodeo, Circus, Auto/Motorcycle Racing:	1 space per 3 spectator seats.
Skateboarding, Water Slide:	1 space per 200 sq. ft. GFA of indoor facilities plus 1 space per 2 persons design capacity of outdoor facilities.
Sports fields, Swimming Pools, Private Parks, and Playgrounds:	1 space per 100 sq. ft. GFA of indoor facilities plus 1 space per 4 persons design capacity of outdoor facilities, including both participants and spectators, as applicable.
Tennis Courts and Other Sports Courts:	2 spaces per court.
Arts, Entertainment, and Recreations	
Arena:	- .33 spaces per seat.
Baseball Stadium:	- .35 spaces per seat.
Football Stadium:	- .31 spaces per seat.

Parking Use Category	Parking Spaces*
Arts, Entertainment, and Recreations (cont.):	
Theater (live performances):	- .40 spaces per seat.
All Other Public Assembly:	- .25 spaces per person in permitted capacity.
Convention Centers, Meeting/Banquet Facilities, not within a hotel or in a hotel, but exceeding 100 sq. ft. per sleeping room:	- up to 25,000 sq. ft. = 30 spaces per 1,000 sq. ft. GFA; plus - 25,000 to 50,000 sq. ft. = 20 spaces per 1,000 sq. ft. GFA; plus - 50,000 and 100,000 sq. ft. = 10 spaces per 1,000 sq. ft. GFA; plus - 100,000 or more sq. ft. = 6 spaces per 1,000 sq. ft. GFA.
Automotive Repair	3 spaces per service bay (service bays not included as parking).
Broadcast and Telecommunication	1 space for each 300 sq. ft. GFA.
Car Wash	2 per wash bay plus 3 stacking spaces per bay.
Civic, Social, and Fraternal Associations:	1 space for each 300 sq. ft. GFA.
Educational Services (based on maximum design capacity)	
Daycare Center or Pre-Elementary:	.3 spaces per person licensed capacity enrollment.
Elementary, Middle Schools:	Higher of .2 spaces per seat in auditorium/gym or .25 spaces per student.
Secondary Schools:	Higher of .3 spaces per seat in auditorium/gym or .3 spaces per student.
College or University:	To be established based on a study of parking needs prepared specifically for the subject institution.
Other Classroom based:	6 spaces per 1,000 sq. ft. GFA;
Other Not Classroom based:	10 spaces per 1,000 sq. ft. GFA.
Finance and Insurance	
General Business Offices:	- up to 25,000 sq. ft. = 3.8 spaces per 1,000 sq. ft. GFA; plus - 25,000 to 100,000 sq. ft. = 3.4 spaces per 1,000 sq. ft. GFA; plus - 100,000 or more sq. ft. = 2.8 spaces per 1,000 sq. ft. GFA.
Consumer Service Offices:	4.6 spaces per 1,000 sq. ft. GFA.
Data Processing, Telemarketing, Operations:	6 spaces per 1,000 sq. ft. GFA.
Food Service	
Restaurant:	10 spaces per 1,000 sq. ft. GFA;
Restaurant bar area:	15 spaces per 1,000 sq. ft. GFA;
Fast Food:	8 spaces per 1,000 sq. ft. GFA;
Take Out and Delivery Only:	3 spaces per 1,000 sq. ft. GFA;
Night Clubs:	15 spaces per 1,000 sq. ft. GFA.
Gas Station	1 space for each side of a gasoline pump unit.
Health Care and Social Assistance	
Medical Offices (not on hospital campus):	4.5 spaces per 1,000 sq. ft. GFA.
Medical Offices (on hospital campus):	4 spaces per 1,000 sq. ft. GFA.

Parking Use Category	Parking Spaces*
Hospitals, Nursing, and Residential Care Facilities	
Hospital/Medical Center:	To be established based on a study of parking needs prepared specifically for the subject institution.
Elderly Housing:	1 space per dwelling unit.
Congregate Care/Assisted Living:	.35 spaces per dwelling unit.
Group, Convalescent, and Nursing Home:	.5 spaces per bed.
Information Services	3 spaces for each 5 employees on largest shift.; or 1 space per 600 sq. ft. GFA.
Cinemas:	- Single screen - 2 to 5 screens - 5 to 10 screens - Over 10 screens
Mining, Utilities, Construction, Manufacturing, Transportation, and Warehousing	3 spaces for each 5 employees on largest shift.; or 1 space per 600 sq. ft. GFA.
Industrial/Manufacturing:	1.85 spaces per 1,000 sq. ft. GFA plus required parking spaces for office, sales, or similar use where those uses exceed 10% GFA.
Mobile Home	2.5 spaces per trailer unit.
Non-Store Retailers	1 space for each 2,000 sq. ft. GFA.
Other Services	1 space for each 250 sq. ft. GFA.
Professional, Scientific, and Technical Services; Management of Companies and Enterprises; Administration/Support Services	
General Business Offices:	- up to 25,000 sq. ft. = 3.8 spaces per 1,000 sq. ft. GFA; plus - 25,000 to 100,000 sq. ft. = 3.4 spaces per 1,000 sq. ft. GFA; plus - 100,000 or more sq. ft. = 2.8 spaces per 1,000 sq. ft. GFA.
Public Administration	1 space for each 300 sq. ft. GFA.
Real Estate, Rental, and Leasing	1 space for each 300 sq. ft. GFA.
Religious Organizations	.4 spaces per seat.
Residential Uses	
Single Family Dwellings	- less than 3,000 sq. ft. = 2 spaces per dwelling unit; - more than 3,000 sq. ft. = 3 spaces per dwelling unit
Multi-Family Dwellings Rental:	- 1 space per dwelling unit for efficiency units; - 1.5 spaces per dwelling unit for 1st bedroom in units with 1 or more bedrooms, plus .25 spaces for each additional bedroom.
Multi-Family Dwellings Owned:	- 1.0 spaces per dwelling unit for efficiency units; - 1.75 spaces per dwelling unit for the 1st bedroom in units with 1 or more bedrooms, plus .25 spaces for each additional bedroom.
Rental in University District	1 space per dwelling unit for efficiency and 1 bedroom units; plus .5 spaces for each additional bedroom.

Parking Use Category	Parking Spaces*
Retail Trade	4 spaces per 1,000 sq. ft. GFA.
Shopping Centers	- 6 spaces per 1,000 sq. ft. GFA up to 200,000 sq. ft.; - 5.5 spaces per 1,000 sq. ft. GFA over 200,000 sq. ft.
Transit and Ground Passenger Transportation; Scenic &Sightseeing	1 space per 100 sq. ft. GFA.
Truck Transportation; Warehousing & Storage	1 space for each 1,000 sq. ft. non-office floor area, plus 1 space for each 300 sq. ft. office area.
Vehicle Dealers	1 space for each 5,000 sq. ft. of lot area.
Wholesale Trade	1 space per 2,000 sq. ft. gross floor storage per sales area.

****Staff may approve a 5% deviation from the recommended parking requirements, unless an alternative plan is approved by the Planning and Zoning Commission.***

APPENDIX D
Qualified Tree List

Common name	Botanical name	Class	N/I	Site	Light	Size	Foilage
Bald Cypress	Taxodium distichum	1	N	2, 3	2	1	D
Bur Oak	Quercus macrocarpa	1	N	2	1	1	D
Cedar Elm	Ulmus crassifolia	1	N	2	1	2	D
Drummond Red Maple	Acer rubrum var. drummondii	1	N	2	1	2	D
Eastern Redbud	Cercis canadensis	1	N	2	2	2	D
Live Oak	Quercus virginiana	1	N	2	1	1	SE
Overcup Oak	Quercus lyrata	1	N	2, 3	1	1	D
Pecan	Carya illinoensis	1	N	2	1	1	D
Possumhaw Holly	Ilex decidua	1	N	2	1, 2	3	D
Shumard Red Oak	Quercus shumardii	1	N	2	1	1	D
Southern Magnolia	Magnolia grandiflora	1	N	2	1	1	E
Swamp Chestnut Oak	Quercus michhauxii	1	N	2, 3	1	1	D
Sweet-Bay Magnolia	Magnolia virginiana	1	N	2	2	2	E
Wax Myrtle	Myrica cerifera	1	N	2, 3	1	3	E
American Elm	Ulmus americana	2	N	2	1	1	D
American Sycamore	Platanus occidentalis	2	N	2	1	1	D
Anacua/Sandpaper Tree	Ehretia anacua	2	N	2	1	2	E
Arrow-wood Viburnum	Viburnum dentatum	2	N	2	2	3	D
Black Hickory	Carya texana	2	N	2	1, 2	2	D
Black Walnut	Juglans nigra	2	N	2	1, 2	1	D
Blackgum	Nyssa sylvatica	2	N	2, 3	1, 2	3	D
Callery Pear/Braford	Pyrus calleryana	2	I	2	1	3	D
Carolina buckthorn	Rhamnus caroliniana	2	N	2	1, 2	3	D
Chalk Maple	Acer leucoderme	2	N	2	2	2	D
Cherry Laurel	Prunus caroliniana	2	N	2	2	2	E
Chinese Elm	Ulmus parvifolia	2	I	2	1	2	D
Chinquapin Oak	Quercus muhlenbergii	2	N	2	1	1	D
Common Crapemyrtle	Lagerstroemia indica	2	I	2	1	3	D
Common Fig	Ficus carica	2	I	2	1	3	D
Common Persimmon	Diospyros virginiana	2	N	2	1	2	D
Eastern Red Cedar	Juniperus virginiana	2	N	2	1, 2	2	E
Eve's Necklace	Sophora affinnis	2	N	1	1	3	D
Green Ash	Fraxinus pennsylvanica	2	N	2, 3	1, 2	1	D
Huisache	Acacia farnesiana	2	N	1	1	3	D
Loblolly Pine	Pinus taeda	2	N	2	1	1	E
Mexican Plum	Prunus mexicana	2	N	1	1	3	D
Nuttail Oak	Quercus nuttallii	2	N	2, 3	1	1	D
Ornamental Holly	Ilex spp.	2	I	2	1, 2	3	E
Paloverde	Parkinsonnia aculeata	2	N	1	1	2	D

Common name	Botanical name	Class	N/I	Site	Light	Size	Foilage
Parsley Hawthorn	Crataegus marshallii	2	N	2	2	3	D
Post Oak	Quercus stellata	2	N	2	2	1	D
Red Bay	Persea borbonia	2	N	2	2	2	E
River Birch	Betula nigra	2	N	2, 3	2	2	D
Rough-leaf Dogwood	Cornus drummondii	2	N	1, 2	3	3	D
Rusty Blackhaw Viburnum	Viburnum rufidulum	2	N	2	2	3	D
Sassafras	Sassafras albidum	2	N	2	2	2	D
Scarlet (Red) Buckeye	Aesculus pavia	2	N	2	2	3	D
Shagbark Hickory	Carya ovata	2	N	2	1	1	D
Slash Pine	Pinus elloittii	2	I	2	1	1	E
Snowbell	Styrax americana	2	N	2	1, 2	3	D
Southern Red Oak	Qurcus falcata var. pagoda	2	N	2	1	1	D
Sweetgum	Liquidambar styraciflua	2	N	2	1	1	D
Texas Mountain-Laurel	Sophora secundiflora	2	N	1	1	3	E
Texas Persimmon	Diospyros virginiana(male)	2	N	1	1	3	D
Texas Pistache	Pistacia texana	2	N	1	1	3	D
Texas Redbud	Cercis canadensis texensis	2	N	1, 2	2	3	D
Water Hickory	Carya aquatica	2	N	2, 3	1	2	D
Water Oak	Quercus nigra	2	N	2, 3	1	1	D
Western Soapberry	Sapindus drummondii	2	N	2	1	2	D
White Ash	Fraxinus americana	2	N	2	1	1	D
White Oak	Quercus alba	2	N	2	1	1	D
Willow Oak	Quercus phellos	2	N	2, 3	1	1	D
Winged Elm	Ulmus alata	2	N	2	1	2	D
Woollybucket Bumelia	Bumelia lanuginosa	2	N	2	2	2	D
Wright Acacia	Acacua wrightii	2	N	1	1	3	D
Yaupon Holly	Ilex vomitoria	2	N	2	1, 2	3	E
American Elderberry	Sambucus canadensis	3	N	2	2	3	D
American Holly	Ilex opaca	3	N	2	2	2	E
American Hornbean	Carpinus caroliniana	3	N	2	2	2	D
Black Locust	Robinia pseudoacacia	3	N	2, 3	1	2	D
Black Willow	Salix nigra	3	N	3	1	2	D
Box-Elder Maple	Acer negundo	3	N	2	2	2	D
Camphor-Tree	Cinnamomum camphora	3	I	2	1	2	E
Catalpa	Catalpa bignonioides	3	N	2	1	2	D
Common Pear	Pyrus communis	3	N	2	1	2	D
Eastern Cottonwood	Populus deltoides (male)	3	N	2	1	1	D
Flowering Crabapple	Malus spp.	3	I	2	1	3	D
Hercules-Club Prickly-Ash	Zanthoxylum clava-herculis	3	N	1	1	3	D
Honey-Locust	Gleditsia triacanthos	3	N	2, 3	1	2	D
Japanese Yew	Podocarpus macrophyllus	3	I	2	1	2	E
Japanese Maple	Acer palmatum	3	I	2	2	3	D
Loquat	Eriobotrya japonica	3	I	2	2	3	E
Mesquite	Prosopis glandulosa	3	N	1	1	2	D

Common name	Botanical name	Class	N/I	Site	Light	Size	Foilage
Mexican Buckeye	Ungnadia speciosa	3	N	1	1	3	D
Red Mulberry	Morus rubra	3	N	2	1	2	D
Sugar Hackberry	Celtis laevigata	3	N	2	1, 2	2	D
Vitex	Vitex agnus-castus	3	I	1	1	3	D
Water Tupelo	Nyssa aquatica	3	N	3	2	1	D
Weeping Willow	Salix babylonica	3	I	3	1	2	D
Arborvitae	Thuja spp.	4	I				
Arizona Ash	Fraxinus velutina	4	I				
Berlandier Ash	Fraxinus berlandieriana	4	I				
Chinaberry	Melia azedarach	4	I				
Chinese Pistache	Pistacia chinensis	4	I	2	1	2	D
Chinese Tallow	Sapium sebiferum	4	I				
Eucalyptus	Eucalyptus spp.	4	1	1, 2	1	3	E
Golden-Raintree	Koelreuteria paniculata	4	I	2	1	2	D
Japanese Black Pine	Pinus thunbergi	4	I	2	1	2	E
Mimosa(Silktree)	Albizia julibrissin	4	I				
Mulberry	Morus alba	4	I	2	1	2	D
Siberian Elm	Ulmus pumila	4	I				
Silver Maple	Acer saccharinum	4	I				
Tulip-Tree	Liriodendron tulipifera	4	I	2	1	1	D

Trees are divided into four classes. Class 1 and 2 trees are considered the most valuable in enhancing the environment and are the most likely to prosper in the Friendswood area. Therefore, only Class 1 and 2 trees shall be approved as new plantings for a) city parks and property, and parking lots and; b) for streets or other public right-of-ways, respectively, unless otherwise approved by the City Engineer on the advice of an Urban Forester. Species that are classified as shade trees will reach a height and size that will conflict with overhead powerlines, permanent structures, or the canopy will exceed the limits of a confined space. Species that are classified as small trees will not provide the protection or aesthetic impact of a large shade tree, yet they are suitable for planting beneath powerlines and are good alternatives for areas of limited space.

Class 1: For the most part this class is for trees that are native, will do relatively well in the Friendswood area, have few diseases or pest problems, are easy to find in local nurseries, and with few exceptions (redbud, possomhaw, and waxmyrtle) are larger in size.

Class 2: This class is for trees that are mostly native, will still do well in the Friendswood area, have little disease or pest problems, sometimes not quite as easy to find in nurseries, are more varied in size, and in many cases are more suitable for wildlife. These trees tend to have larger and messier fruit and/or are thornier than trees in Class 1. Some of these trees are also more prone to some decay at maturity and might not do as well in urbanized areas.

Class 3: This class starts to pick up more introduced species, the trees might or might not do as well in the Friendswood area, require a little more maintenance and care, the natives

might be harder to find in a nursery while the introduced species may be more readily available and in some cases these trees are more prone to decay, disease and pest problems.

Class 4: this class is exclusively introduced species. They may or may not do well in Friendswood. If they do grow well they have the potential to become invasive species and cause problems for local ecosystems and are more prone to decay, disease and pest problems. **NOT RECOMMENDED FOR PLANTINGS.**

Classifications:

N – Native
I – Introduced

Site:

1 – Xerophytic (requires little water)
2 – Mesic (requires moderate water with good drainage)
3 – Aquatic (tolerates poor drainage once established 3 years)

Light:

1 – Full Sun (requires a minimum of 6 hours of direct sunlight)
2 – Partial Sun (requires a minimum of 3 to 6 hours of direct sunlight)
3 – Shade (requires less than 3 hours of direct sunlight)
NOTE: Lower rating number on this scale is the minimum, but can use the next higher rating (i.e. a rating of 2 can also use the rating of 1, a rating of 3, can also use the ratings of 1 and 2)

Size:

1 – 60 feet and greater ultimate height (large shade tree)
2 – 30 to 60 feet in ultimate height (medium tree)
3 – 30 feet and less in ultimate height (small tree)

Foliage:

D – Deciduous (sheds leaves annually) If placed on the south and west walls will reduce indoor temperatures in summer by shading the roof and walls. In winter, these trees allow sunlight through to help heat the building.
E – Evergreen (having green leaves/needles throughout the year) can create a wind break if placed on the northwest side of a building.
SE – Semi evergreen

For example, the code for Live Oak is 1/N/2/1/1, which indicates that the Live Oak is a Class 1 species that is native to Texas, requires moderate water with good drainage, demands or tolerates full sun, and will exceed 60 feet in ultimate height. As a shade tree, the Live Oak will provide protection and has aesthetic impact but the tree is not suitable for planting beneath powerlines or within confined spaces, or in streets or other public rights-of-way.

APPENDIX E
Downtown District Amenities

Streetscape furnishings, as required by City of Friendswood Code of Ordinances, Appendix C – Zoning Ordinance for the Downtown District, are important functional elements and amenities. They should be of high quality, designed for outdoor use, and require minimal maintenance. All provided amenities shall be permanently maintained by the property owner, including paved walkways.

SEATING

Seating should be durable and comfortable. Sharp edges and poorly designed or fabricated furniture should be avoided. Metal is the required material. The seating design should complement other furnishings. All seating should be secured permanently to paved surfaces for safety and to avoid vandalism. The bench below is the preferred model; however, other benches of similar size and features may be approved by the Planning and Zoning Commission.

Manufacturer:	Webcoat Products
Product:	Metal benches
Model:	B5WBCLASSIC
Size:	5’
Color/finish:	Black finish Aluminum frame w/contoured backs

TREE WELLS

Tree wells are an attractive way to protect trees planted in paved areas. Appropriate tree grates and tree wells should be similar to the following:

TREE GRATES

TREE WELLS

Manufacture:	Neenah Foundry Company
Product:	Tree grate
Model:	ASTM A-48, Metropolitan Series

LIGHT POLES

Lighting plays an important part in the character, function, and security of a streetscape. It should be consistent with other streetscape elements and integrate the historic nature of the Downtown District. Light poles shall be the "Bishop's Crook" style. The light pole below is the preferred model; however, other light poles of similar size and features may be approved by the Planning and Zoning Commission.

	Manufacturer:	Hadco
	Product:	Aluminum Pole w/Teardrop Fixture
	Color/finish:	Black powder coat
		Lighting must be metal halide or LED with full cutoff or semi cutoff fixtures that emits 7,000 to 8,000 lumen, or the equivalent thereof, and 5,000 to 6,000K (Kelvin – color temperature).

Lamp height maximum shall be 12'. Lamp height minimum shall be 10'. Lamp shall be positioned towards the rights-of-way to illuminate the public walkway.

Lamp height is the actual lamp height above ground measured at the bottom of the lamp fixture, where the globe or bulb begins.

TRASH RECEPTACLES

Trash receptacles should be easily accessible for pedestrians and trash collection. They must be placed to be unobtrusive yet effective and their design should relate to other site furnishings. Trash receptacles should be firmly attached to paving to avoid vandalism. They should include covered tops and sealed bottoms to keep contents dry and out of sight at all times. Appropriate trash receptacles should be similar to the following:

	Manufacturer:	Victor Stanley, Inc.
	Product:	Trash receptacle
	Model:	Steelsites RB series
	Color/finish:	Black finish TGIC polyester powder coat

PAVERS

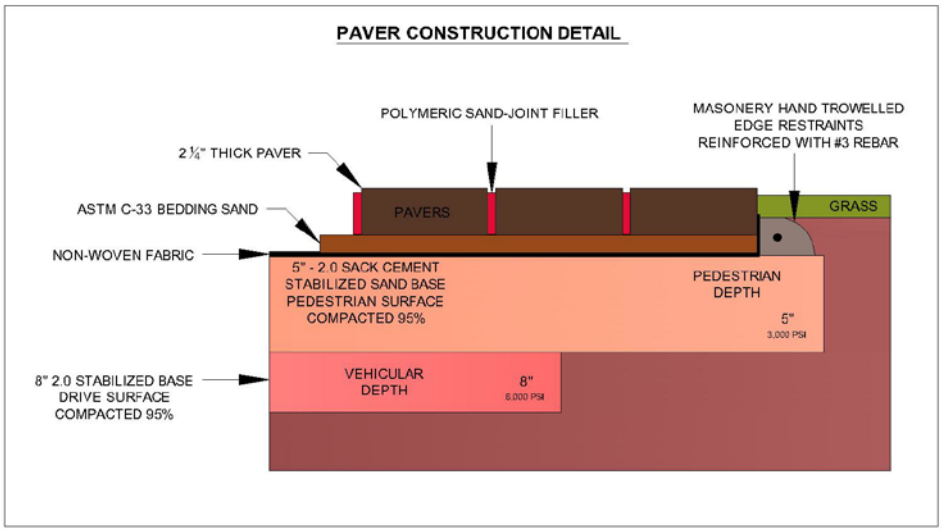
Brick pavers must be used to construct the required brick-paved sidewalk in accordance with the specifications below. The paver color and pattern below is the preferred design; however, other pavers of similar colors and patterns may be approved by the Planning and Zoning Commission.

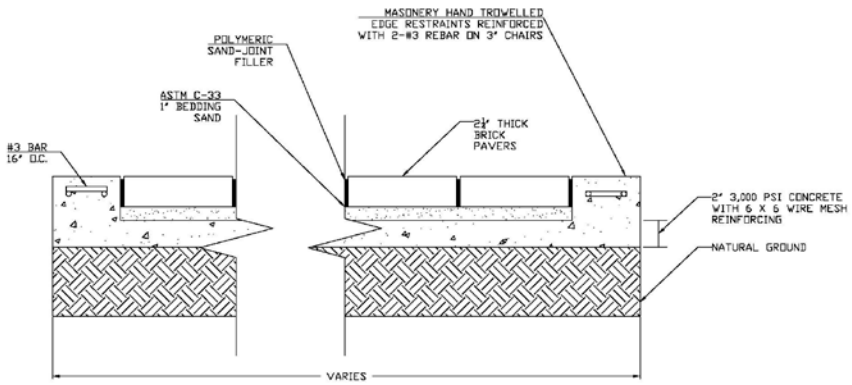
Manufacturer:	Pine Hall Brick Company, Inc.
Product:	Pavers
Model:	Pathway Series, Full Range
Size:	4” W x 8” L x 2 ¼” thick
Color:	Red
Pattern:	Stretcher Bond

Brick pavers must be set on a sand base with a concrete border as stated below and shown on the attached construction detail drawing. No concrete or stamped concrete is allowed for the sidewalk surface.

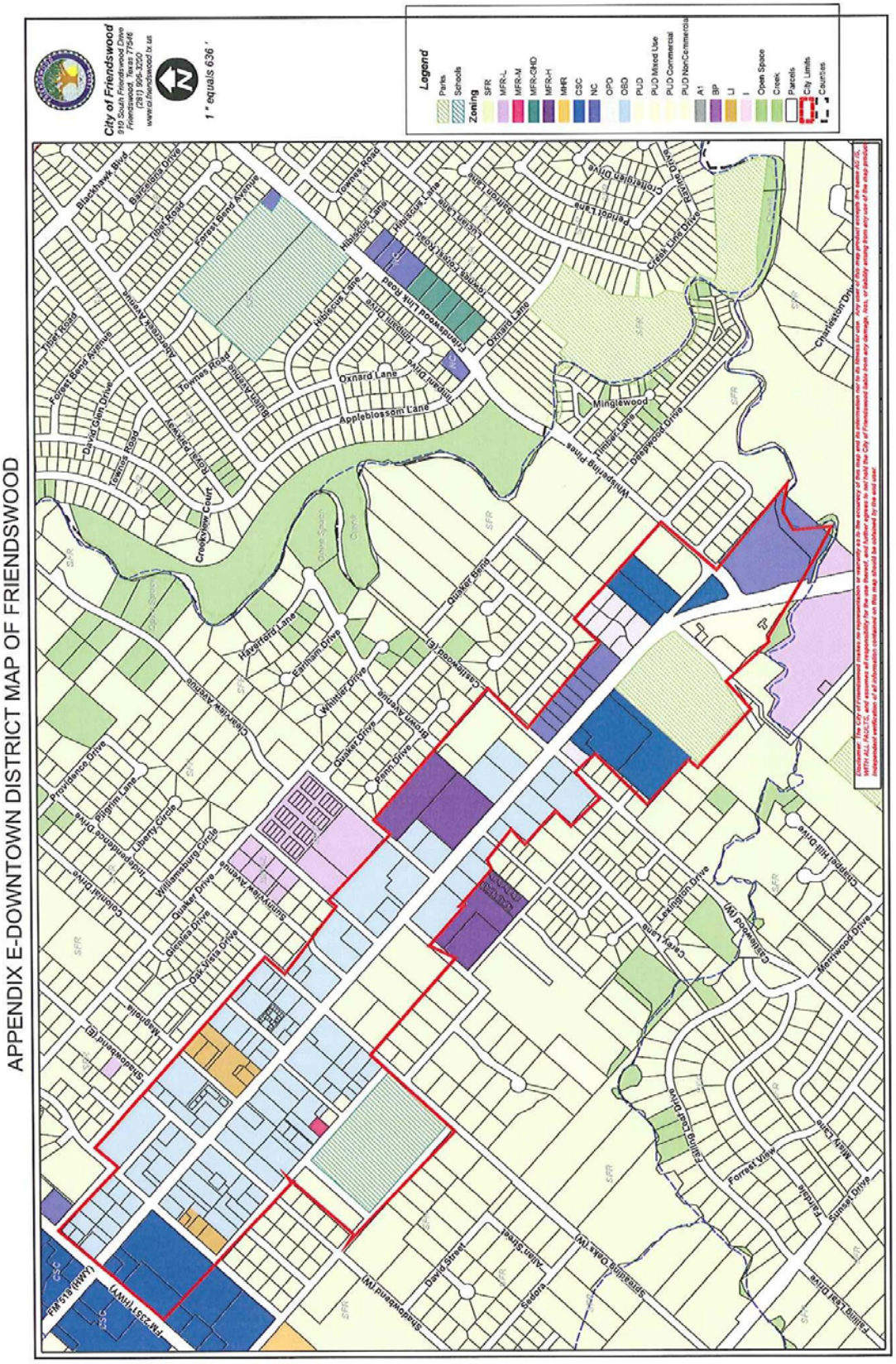
Paver installation specs:
5” of 2.0 sack cement stabilized sand base
Non-woven fabric weed block
1” of ASTM C-33 bedding sand
2 ¼” thick brick unit paver
Polymeric joint sand
Masonry hand troweled edge restraints reinforced with #3 rebar

If the pavers are a part of a drive surface for vehicular traffic, an 8” 2.0 stabilized base drive surface, compacted 95% must be installed below the 5” of 2.0 sack cement stabilized sand base.


PAVER CONSTRUCTION DETAIL
POLYMERIC SAND-JOINT FILLER
MASONERY HAND TROWELLED
EDGE RESTRAINTS
REINFORCED WITH #3 REBAR
2 ¼" THICK PAVER
ASTM C-33 BEDDING SAND
PAVERS
GRASS
NON-WOVEN FABRIC
5" - 2.0 SACK CEMENT
STABILIZED SAND BASE
PEDESTRIAN SURFACE
COMPACTED 95%
PEDESTRIAN
DEPTH
5"
3,000 PSI
8" 2.0 STABILIZED BASE
DRIVE SURFACE
COMPACTED 95%
VEHICULAR
DEPTH
8"
6,000 PSI


MASONRY HAND TROWELLED
EDGE RESTRAINTS REINFORCED
WITH 2-#3 REBAR ON 3" CHAIRS
POLYMERIC
SAND-JOINT
FILLER
ASTM C-33
1" BEDDING
SAND
2¼" THICK
BRICK
PAVERS
#3 BAR
16" O.C.
4" 3,000 PSI CONCRETE
WITH 6 X 6 WIRE MESH
REINFORCING
NATURAL GROUND
VARIES

APPENDIX E-DOWNTOWN DISTRICT MAP OF FRIENDSWOOD



APPENDIX F
Culverts and Driveways Policy

The purpose of this policy is to establish guidelines, procedures, and standard practices regarding installation, maintenance, and repair of culverts and driveways in new and old subdivisions with open ditches.

I. REPLACEMENT OF DRIVEWAY/CULVERTS DUE TO REPAIRS

A. If a failure occurs on an existing paved driveway located within the City rights-of-way due to a defect in the existing public infrastructure (i.e., leaking or broken water or sanitary sewer line, failure in storm sewer, culvert failure, etc.) the City will remove the damaged pavement, repair or replace the damaged infrastructure, and replace the pavement up to the rights-of-way line at no cost to the property owner.

B. If a failure occurs on an existing paved driveway located within the City rights-of-way due to age, wear, or subsidence, and the public infrastructure is found to be in good condition, the property owner shall be responsible for the removal and replacement of the driveway, such replacement being accomplished according to the Ordinances, Design Criteria, Standard Details, and Technical Specifications of the City. In addition, the property owner shall be responsible for any damages that may occur to existing public infrastructure, including the culverts, during the construction process. The property owner shall obtain a building permit from the City for the driveway replacement and shall call in for inspections as needed.

C. If the driveway to be replaced is on an open ditch street, the culverts may be replaced with the same size as existing with no drainage calculations required, unless:

   i. They are smaller than the 18” minimum requirements, or

   ii. The whole drainage ditch is being enclosed (see paragraph III).

D. When new culverts are installed and concrete paving is being replaced, construction joints shall be installed as shown in Detail A.

II. PROPOSED DRIVEWAY CONSTRUCTION/CULVERT INSTALLATION

A. When a property owner chooses to make improvements to an existing driveway, the property owner is responsible for removing and replacing the culverts as well as the existing paving.

B. When a property owner chooses to construct a new driveway, the property owner shall install the proper driveway culverts and new pavement.

C. All work shall be completed in accordance with the City of Friendswood Technical Specifications and Standard Details, latest edition.

D. When new culverts are installed and concrete paving is being installed, construction joints shall be installed as shown in Detail A.

III. PROPOSED CULVERT INSTALLATION FOR THE PURPOSE OF ENCLOSING OPEN DITCHES FRONTING RESIDENTIAL PROPERTY.

A. Development Permit:

i. An approved City of Friendswood Development Permit shall be required prior to installation of residential storm sewer (unless the storm sewer is being installed as part of a new residential building, in which case it shall fall underneath the building permit). Development permits shall only be valid for 1 year.

ii. A plan drawing shall be submitted with the Development Permit Application. The plan shall be drawn to a 1" = 20' scale.

iii. Pipe diameters, pipe flow lines, inlet flow lines, and inlet rim elevations shall be shown on the drawings.

iv. All residential storm sewer projects shall extend from property line to property line.

v. A Traffic Control Plan shall be provided if any of the proposed work involves obstruction of traffic or lane closures of City streets.

vi. All residential storm sewers shall be made of Reinforced Concrete Pipe (RCP) Class III, with a minimum 18" diameter, and shall be designed for the purpose intended.

vii. Alternate sizes and styles may be used as long as they meter the same square inch area of the required pipe size, and is approved by the City Engineer.

B. Installation:

i. Storm sewer inlets shall be located no farther than 15 feet from the property line.

ii. Storm sewer inlets shall be no farther than 30 feet from center to center.

iii. Only Type “A” Inlet (Detail B) or Type “S” Inlet (Detail C) shall be used.

iv. Inlet and junction box size and design shall be approved by the City Engineer.

v. High points shall be located halfway between inlets with mild swales (see Detail D).

vi. Elevations on inlet rims shall be a minimum of 3 inches lower that the surrounding high points (see Detail D).

vii. All storm sewer projects are subject to inspections by City of Friendswood personnel before they are covered up. Such inspections may require changes or corrections to all or part of the culvert installations during any phase of the work. All inspections shall be called into the Building Division at (281) 996-3201 a minimum of 24 hours prior to inspections.

viii. Contractor shall have a means to determine flows on site (i.e., laser level, level, etc.).

ix. All storm sewers shall receive a final inspection and approval by City of Friendswood personnel upon completion. Any deficiencies noted shall be completed within 30 days of such notice.

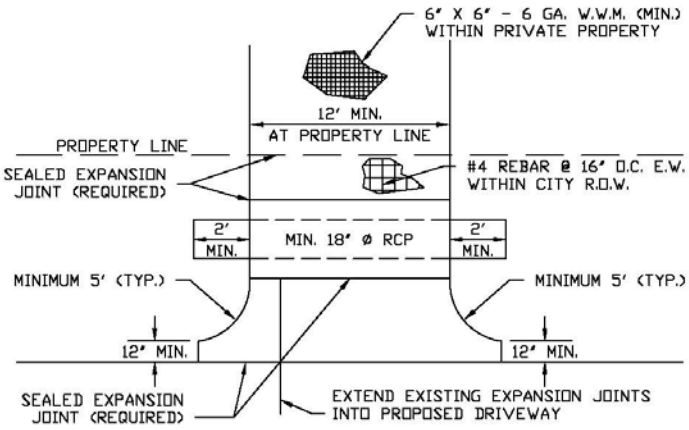
x. The City of Friendswood reserves the right to adjust or remove all or part of the storm sewer at any time for any reason.

xi. All work shall be completed in accordance with the latest revisions of this Design Criteria Manual, City of Friendswood Technical Specifications, and City of Friendswood Standard Detail; which can be found online at:

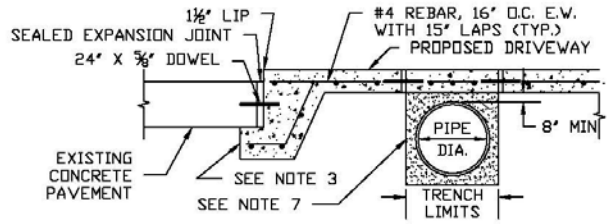
www.ci.friendswood.tx.us/350/Publications-Forms

IV. ACKNOWLEDGEMENT

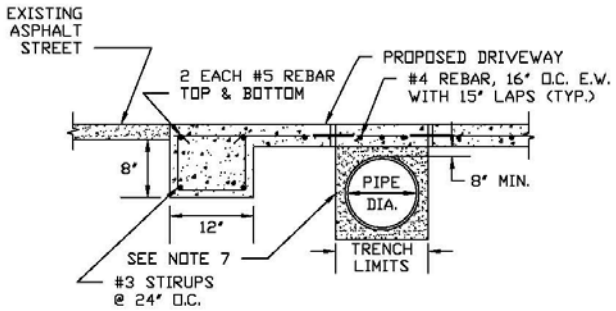
By signing the permit application, the applicant acknowledges they have received and fully understand the requirements pertaining to the installation of residential storm sewers.



PLAN – ALL STREETS



PROFILE – CONCRETE STREETS



PROFILE – ASPHALT STREETS

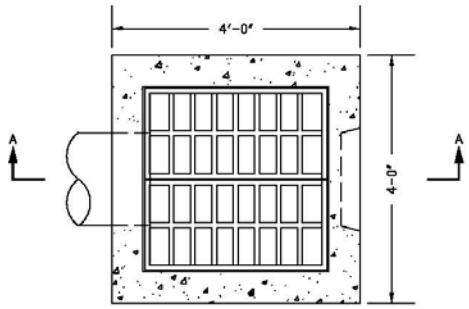
NOTES:

1. EXPANSION JOINT ON CONCRETE STREETS SHALL BE NOMINAL REDWOOD OR ASPHALTIC EXPANSION JOINT MATERIAL WITH 1' PULL-OF STRIP TO BE FILLED WITH APPROVED JOINT SEALANT.
2. 1½' LIP (CONCRETE STREETS ONLY) SHALL NOT BE REQUIRED ON STREETS WITH 4' X 12' MOUNTABLE CURB.
3. CONCRETE PAVEMENT HEADERS SHALL BE BUILT IN ACCORDANCE WITH CITY OF FRIENDSWOOD PAVING DETAILS.
4. CONNECTION TO EXISTING ASPHALT STREETS SHALL BE MADE BY BLOCKING NEW CONCRETE WITH EDGE OF PAVEMENT. A 8' DEEP BY 12' WIDE BEAM SHALL BE PLACED ALONG THE EDGE OF THE ASPHALT PAVEMENT. NO EXPANSION JOINT MATERIAL REQUIRED BETWEEN EXISTING ASPHALT STREET AND NEW CONCRETE DRIVEWAY.
5. DAMAGE TO EXISTING STREETS, WHETHER ASPHALT OR CONCRETE, SHALL BE REPAIRED AT CONTRACTORS EXPENSE.
6. ALL CONCRETE SHALL BE CLASS 'A', 3,000 PSI AT TWENTY-EIGHT DAYS.
7. USE MATERIAL AND DIMENSION AS SPECIFIED IN STORM SEWER DETAILS FOR TRENCH WIDTHS AND BACKFILL.
8. NO MORE THAN ONE (1) DRIVEWAY ON LOTS WITH LESS THAN 120' OF FRONTAGE.
9. 24' X ⅝' DOWELS SHALL BE EMBEDDED A MINIMUM OF 12' INTO EXISTING CONCRETE ROADWAY. DOWELS TO BE INSTALLED AT 12' O.C.

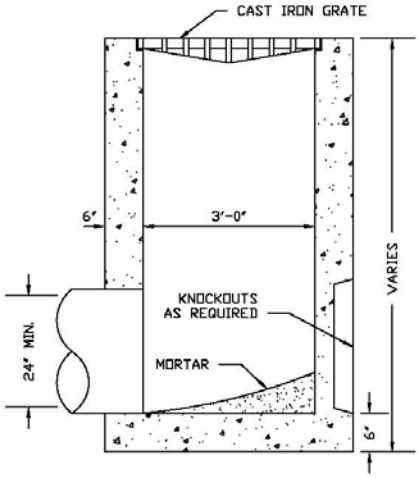
RESIDENTIAL CONCRETE DRIVEWAY
(OPEN DITCH STREETS)

DEPARTMENT OF PUBLIC WORKS

DRAWN: 12/09	SCALE: N.T.S.	DRAWING: B.S. #11



PLAN



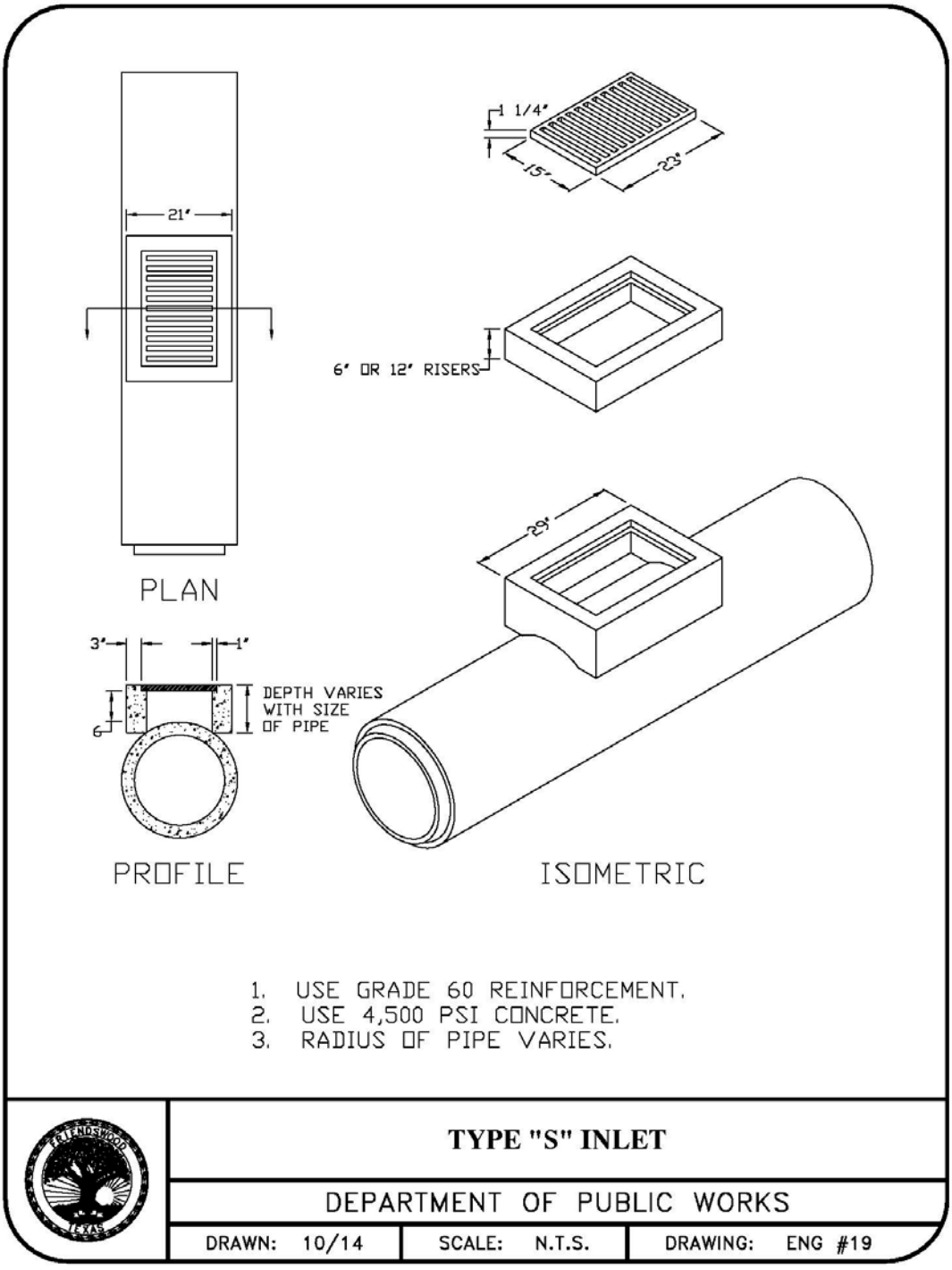
SECTION A–A

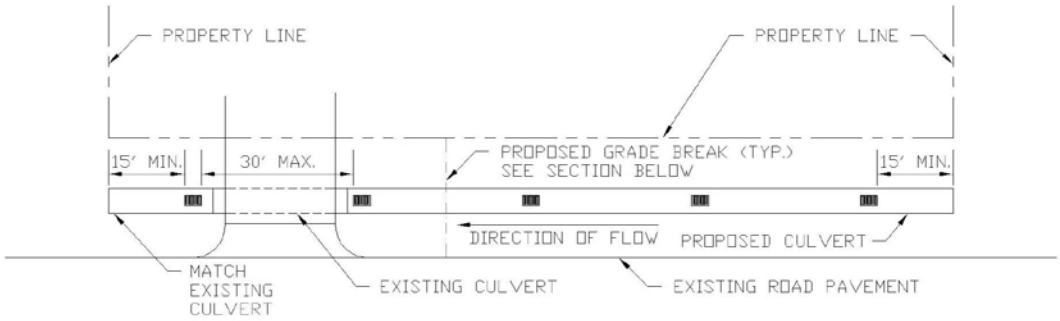
TYPE "A" INLET

NOTES:

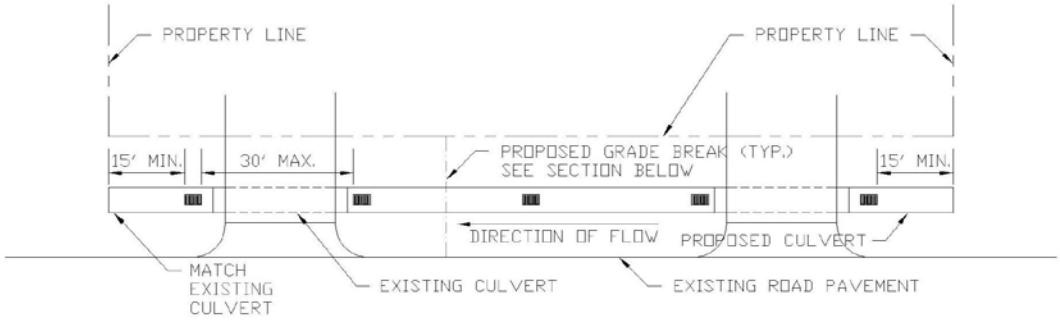
1. USE #4 REBAR IN 12" O.C.E.W.
2. CONCRETE SHALL BE CLASS "A" WITH A TWENTY-EIGHT DAY COMPRESSIVE STRENGTH OF 4,000 PSI.
3. GRATES SHALL BE CAST IRON.

TYPE "A" INLET		
DEPARTMENT OF PUBLIC WORKS		
DRAWN: 08/10	SCALE: N.T.S.	DRAWING: B.S. #14

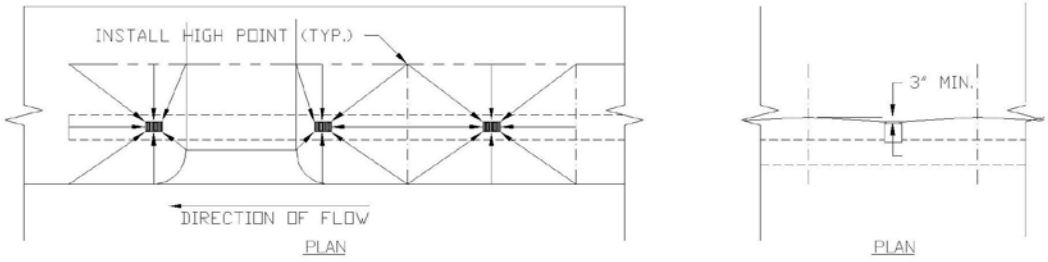

1 1/4"
15"
23"
21"
6" OR 12" RISERS
PLAN
3"
1"
6"
DEPTH VARIES
WITH SIZE
OF PIPE
29"
PROFILE
ISOMETRIC
1. USE GRADE 60 REINFORCEMENT.
2. USE 4,500 PSI CONCRETE.
3. RADIUS OF PIPE VARIES.
TYPE "S" INLET
DEPARTMENT OF PUBLIC WORKS
DRAWN: 10/14
SCALE: N.T.S.
DRAWING: ENG #19



PLAN VIEW FOR SINGLE DRIVEWAY



PLAN VIEW FOR DOUBLE DRIVEWAY



DRAINAGE GRADING

REQUIREMENTS FOR FILLING IN ROADSIDE DITCHES IN RESIDENTIAL AREAS

DEPARTMENT OF PUBLIC WORKS

DRAWN: 10/16	SCALE: N.T.S.	DRAWING: ENG #21

APPENDIX G
Traffic Control Sign Policy

TABLE OF CONTENTS

ATTACHMENTS:

PURPOSE

This policy establishes consistent procedures for addressing traffic-related concerns that may occasionally arise along roadways within or nearby residential areas in the city. Traffic concerns specifically addressed in this policy include the following:

- No Parking/Parking Zone Requests
- Cut Through Traffic Mitigation Requests
- Pedestrian Treatment Requests
- School Zone Safety Requests
- Speed Control Requests
- Intersection Control Requests (Multi-way Stops, Traffic Signals, and Roundabouts)
- "Children at Play" Sign Requests
- Other Advisory or Advanced Warning Sign Requests
- Other Public Safety and Traffic Issue Requests

Other traffic concerns not specifically addressed in this policy may be presented to staff for review by any citizen, Homeowners Association (HOA) business, or group. The Engineering staff will work with those parties to review their situation and formulate an appropriate response as necessary.

In accordance with the City of Friendswood Code of Ordinances Chapter 82 – Traffic and Vehicles and further stated in Ordinance 300, the Traffic Engineer or their designee, will be responsible for all traffic investigations in the City of Friendswood.

SCOPE

The City of Friendswood is committed to improving the quality of life within its City. When a request is made to review a traffic concern, the City's direct efforts are to work and coordinate with the requesting party in understanding and addressing concerns in a defined area. The Engineering Department (hereafter called "Engineering") will inform the affected residents of any significant changes. This policy is applicable only to non-state routes.

The adoption of this policy is not intended and should not be construed to affect or waive the City's immunity from damages under the Texas Tort Claims Act (CPRC Chapter 101) or any other law or ordinance. This policy does not require the City to install, remove, or modify any traffic control device, sign, signal, or warning device if the City has, in the absence of this policy, the discretion under State law to install, remove, or modify the traffic control device, sign, signal, or warning device. All investigations for traffic concerns and signage shall be investigated and warranted in compliance as outlined in the Texas Manual on Uniform Traffic Control Devices (TMUTCD), latest edition.

TERMS

City Traffic Director – The Duties of the City Traffic Director will be encompassed by the City Engineer. The City Manager will retain the final approval/disapproval authority over all decisions of the City Traffic Director.

Engineering Judgment – The evaluation of available pertinent information, and application of appropriate principles, provisions, and practices as contained in the TMUTCD (see below) and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. Engineering judgment shall be exercised by an engineer, licensed to practice engineering in the State of Texas, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. Documentation of engineering judgement is not required.

HOA – Homeowners Association approved, recognized, and incorporated by law.

Ordinance 300 – The City of Friendswood Ordinance 300 grants the power to the City Traffic Director the authority to determine installation and proper timing and maintenance of traffic control devices, to conduct engineering analyses of traffic accidents to devise remedial measures, to conduct engineering investigations of traffic conditions, to plan the operation of traffic on the streets and highways of the City of Friendswood, and to cooperate with other officials in the development of ways and means to improve traffic conditions, and to carry out the additional powers and duties imposed by the ordinances of this City.

ROW – Right(s)-of-way, the area between property lines given the legal right by usage or grant, for traffic or pedestrian travel.

TMUTCD – Texas Manual on Uniform Traffic Control Devices. The TMUTCD is the authoritative manual on installation, implementation, and maintenance of all types of traffic control devices, both permanent and temporary, for the State of Texas.

Traffic Committee – The Traffic Committee is composed of employees of the City of Friendswood representing the Police Department, the Fire Marshal's Office, the Public Works Department and Engineering Department.

Traffic Study – A traffic study is the procedures and other investigations as described in the TMUTCD to determine if a warrant is necessary for a traffic concern.

Warrant – a warrant describes the threshold condition based upon average or normal conditions that, if found to be satisfied as part of an engineering study, shall result in analysis of other traffic conditions or factors to determine whether a traffic control device or improvement is justified. Warrants are not a substitute for engineering judgement. The fact that a warrant for a particular traffic control devices is met is not conclusive justification for the installation of the device.

PROCEDURES

1. Residents, homeowners associations, or similar type groups may make a written request to Engineering requesting that a traffic concern be addressed. Traffic concerns may be submitted directly to Engineering via a fillable form at www.ci.friendswood.tx.us/350/Publications-Forms under Traffic.

2. The requesting party's issue will be entered in the Engineering Traffic database to search for similar requests in the subject area.

3. Staff will communicate with the requesting party to fully understand their request and thoroughly define the area of concern.

4. Engineering will identify the area of concern and define the area affected.

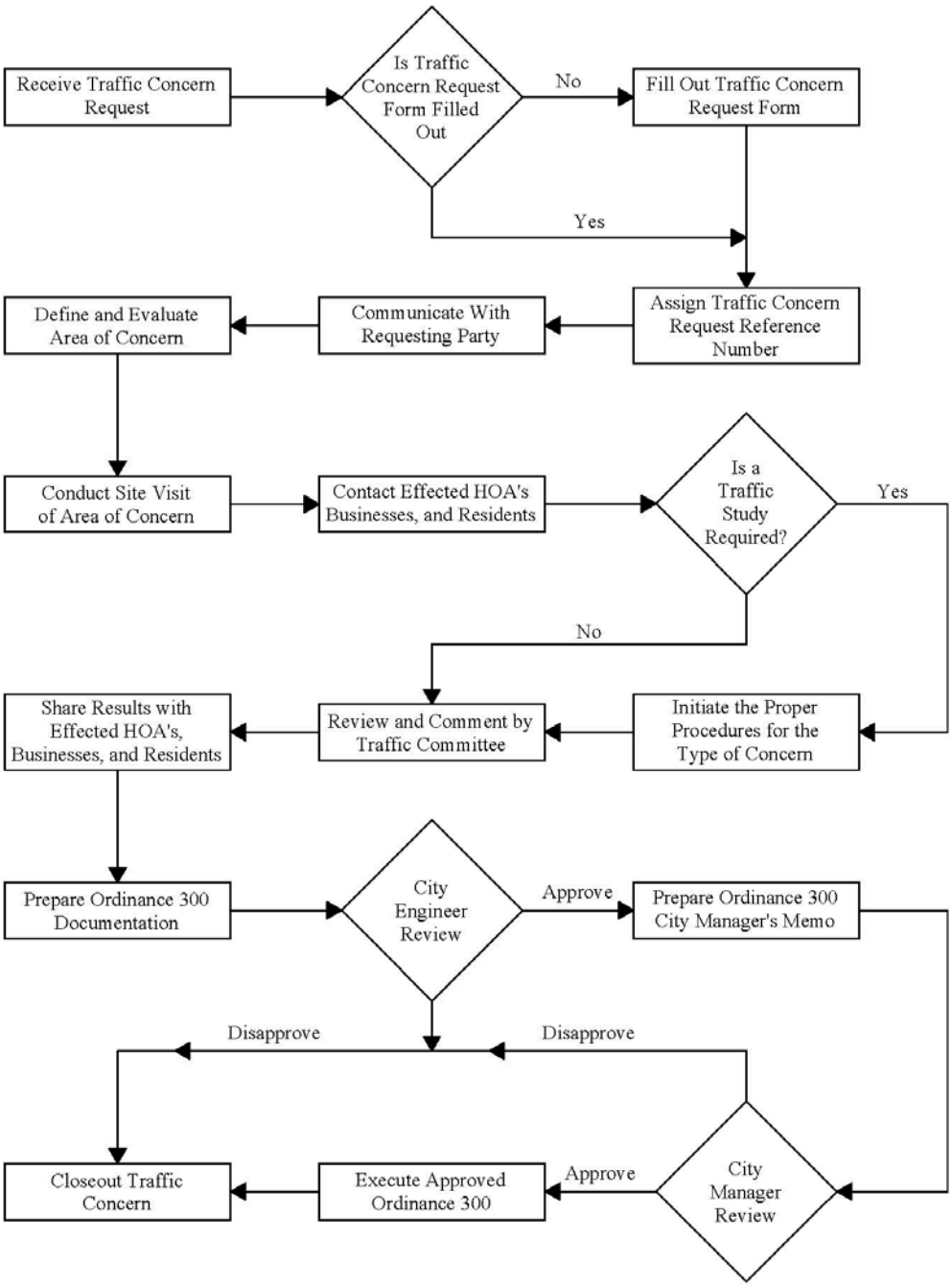
5. Engineering staff will evaluate the request, collect data if necessary to confirm the magnitude of the problem, and determine if further study is necessary.

6. If the Engineering staff determines that further study is necessary, procedures to address the specific traffic issue will be implemented. These procedures are detailed in the following portion of this policy, "Specific Traffic Concerns."

7. Should changes be warranted, Engineering shall attempt to convey the proposed changes with the impacted residents before any improvements are implemented.

A flow chart that graphically illustrates the above listed procedures is illustrated on the following page.

Traffic Concern Request Flow Chart



SPECIFIC TRAFFIC CONCERNS

Specific types of traffic requests in the City of Friendswood are addressed in this section of the policy.

No Parking/Parking Zone Implementation Requests

As with all requests to review traffic concerns in the City of Friendswood, requests for "No Parking"/"Parking" zone implementation will be addressed with the same measures outlined in the *Procedures* section of this policy.

- Engineering and the originator of the request will define a study area for property owners that may be impacted by a proposed "No Parking"/"Parking" zone.
- An engineering study will determine if a "No Parking"/"Parking" zone is appropriate for the requested area for twenty-four (24) hours per day or for specific days and/or time periods.
- In order to implement a "No Parking"/"Parking" zone, 100% of the property owners that are projected to be affected adjacent to their property must agree in writing to the "No Parking"/"Parking" zone implementation. The requestor will be required to obtain signatures from the owners.
- If deemed appropriate by an engineering study and agreed to by the property owners that will be affected adjacent to their property, "No Parking"/"Parking" signs will be posted by the entire street, block, or logical termination point as determined by Engineering. Other advisory or advanced warning signs will be placed as dictated by sound common engineering practices or the Texas Manual on Uniform Traffic Control devices, latest edition.
- All "No-Parking"/"Parking" zone applications shall be thoroughly reviewed by Engineering after a period of two (2) full years from the date of implementation. The "No-Parking"/"Parking" zone shall remain in effect unless a compelling safety reason is discovered.

As with all requests to review traffic concerns in the City of Friendswood, should the implementation of a "No Parking"/"Parking" zone in the study area be warranted, Traffic Engineering and Operations shall attempt to convey the proposed changes with the impacted residents before any modifications or improvements are implemented.

Additional information concerning no parking/parking zones is included in the **Attachment A** under the title *No Parking and Parking Zones.*

No Parking/"Parking" Zone Removal Requests

As with all requests to review traffic concerns in the City of Friendswood, requests for "No Parking"/"Parking" zone removal will be addressed with the same measures outlined in the *Procedures* section of this policy.

- An engineering study will determine if the removal of a "No Parking"/"Parking" zone is appropriate for the requested area. If appropriate, "No Parking"/"Parking" signs will be removed by the entire street, block, or logical termination point as determined by Engineering and the requesting party. Other advisory or advanced warning signs will be placed, or removed, as dictated by sound common engineering practice or the Texas Manual on Uniform Traffic Control devices, latest edition.

As with all requests to review traffic concerns in the City of Friendswood, should the removal of a "No Parking"/"Parking" zone in the study area be warranted, Engineering shall attempt to convey the proposed changes with the impacted residents before any modifications or improvements are implemented.

Additional information concerning no parking/parking zones is included in the **Attachment A** under the title *No Parking and Parking Zones.*

Commercial Truck Cut-Through Traffic Mitigation Requests:

As with all requests to review traffic concerns in the City of Friendswood, requests for commercial truck cut-through traffic mitigation control will be addressed with the same measures outlined in the *Procedures* section of this policy.

- An engineering study will determine the measures that are appropriate to address the specific commercial truck cut-through traffic mitigation concerns that may exist for the given the study area. In order to be considered a candidate for measures to reduce commercial truck cut-through traffic, a roadway must be a local roadway or a minor collector roadway with residential characteristics with a peak hour volume of over 375 vehicles in one direction with over 40% cut-through vehicles.
- To implement a plan which limits commercial truck cut-through traffic, 100% of the affected property owners must sign a petition as implemented through these policy guidelines.

As with all requests to review traffic concerns in the City of Friendswood, should changes to the study area to control commercial truck cut-through traffic in the study area be warranted, Engineering shall attempt to convey the proposed changes with the impacted residents before any modifications or improvements are implemented.

Additional information concerning commercial truck cut-through traffic is included in the **Attachment B** under the title *Commercial Truck Cut-Through Traffic Mitigation.*

Pedestrian Facility Requests:

As with all other requests to review traffic issues in the City of Friendswood, requests for pedestrian improvements will be addressed with the same measures outlined in the *Procedures* section of this policy.

- Engineering will study the requested location and perform a crosswalk analysis which includes volume of pedestrian traffic, proximity of the subject location to schools, parks, swimming pools, retail centers, hike and bike facilities, vehicular traffic volume, etc.
- The placement of a crosswalk at an uncontrolled intersection or in the middle of a block shall be considered only in rare cases. In general, the placement of a crosswalk at an uncontrolled intersection may create a false sense of security for pedestrians that could increase the likelihood of a vehicle-pedestrian incident.

As with all other requests to review traffic issues in the City of Friendswood, should pedestrian improvements be warranted, Engineering shall attempt to convey the proposed changes with the impacted residents before any modifications or improvements are implemented.

Additional information concerning pedestrian facilities is included in the **Attachment C** under the titles *Pedestrian Safety, Pedestrian Signals,* and *Installation of Marked Crosswalks.*

School Zone Safety Requests.

As with all other requests to review traffic issues in the City of Friendswood, requests for school zone safety will be addressed with the same measures outlined in the *Procedures* section of this policy. School zone safety requests encompass a broad range of requests in the vicinity of a school. Common requests in the City of Friendswood are addressed specifically below. Other requests will be addressed on a case per case basis.

- The traffic policy is not intended to replace or alter the existing provisions and ordinances established by the City of Friendswood.
- Reduced speed school zones are areas in which the speed limit is reduced for certain periods of the day that may be requested by individual citizens, communities, or schools. A traffic engineering study will determine if a reduced speed school zone is warranted based on the proximity of the roadway to the school, the type of school (elementary, junior high, senior high, etc.), vehicular volumes, pedestrian volumes, vehicular speeds, availability of sidewalks, alternative routes between the school residential areas served by the school, and other factors.
- Requests for a crosswalk in the vicinity of a school will be treated with the same procedures as outlined in the "Pedestrian Facility Requests" section of this policy. Proximity to schools and type of vehicular control are major factors in the consideration of crosswalks.
- Parking restrictions in the vicinity of a school will be treated with the same procedures as outlined in the "No Parking Zone Implementation" section of this policy. Proximity of schools is a major factor in the consideration of parking restrictions.
- No right-turn on red at signalized intersections in a school zone is a means to reduce the likelihood of conflicts between right-turn vehicles and school aged children in crosswalks. If appropriate, a traffic engineering study will determine the need for no right-turn on red restrictions based on vehicular volumes, pedestrian volumes, traffic signal timing, and other factors.
- The Texas Manual of Uniform Traffic Control Devices (latest edition) does not require the installation of flashing beacons to alert motorists to school zones. The City of Friendswood will consider the installation of school flashing beacons on arterial and collector roadways, but not on local streets.

As with all other requests to review traffic issues in the City of Friendswood, should changes to the conditions within a school zone be warranted, Engineering shall attempt to convey the proposed changes with the impacted residents before any modifications or improvements are implemented.

Additional information concerning school zone safety is included in the **Attachment D** under the titles *School Zones* and *School Traffic Safety*

Speed Control Requests.

As with all other requests to review traffic issues in the City of Friendswood, requests for speed control will be addressed with the same measures outlined in the *Procedures* section of this policy.

- Engineering will maintain a database of locations at which excessive vehicular speeds have been reported that will be shared with the Police Department for enforcement purposes.
- The Texas Manual of Uniform Traffic Control Devices (latest edition) states that a speed limit should be posted within 5 mph of the 85th percentile speed of the free-flowing traffic. Engineering Judgement is the overriding determination for all speed limit postings.
- The following alternatives are available to address speed control requests.

    - The Neighborhood Speed Watch Program is a public awareness program through which concerned citizens can take an active role in making neighborhood streets safer by observing and recording traffic speeds in their neighborhood. Additional information and application forms to participate in the Neighborhood Speed Watch Program may be obtained from Traffic Engineering and Operations, the Appendix of this policy, or downloaded at www.ci.friendswood.tx.us.
    - A speed feedback sign may be installed to alert motorists to their actual speed and the posted speed limit on a roadway. Additional information concerning the speed feedback sign is included in the Appendix of this policy.
    - A speed study may be conducted at the site. The speed study will determine the 85th percentile speed and consider other issues in the site vicinity including pedestrian traffic volume, roadway curvature, the frequency of traffic accidents, sight distance restrictions, and other issues specific to the study site. The speed study may determine that the posted speed limit at the study site is too low/high and may recommend that the posted speed be adjusted to within 5 mph of the 85th percentile speed.

As with all other requests to review traffic issues in the City of Friendswood, should changes to the speed control in the study area be warranted, Engineering shall attempt to convey the proposed changes with the impacted residents before any modifications or improvements are implemented.

Additional information concerning speed control is included in the **Attachment E** under the title *Speed Limits.*

Intersection Control Requests (Multi-way Stops, Traffic Signals, and Roundabouts):

As with all other requests to review traffic issues in the City of Friendswood, requests for intersection control will be addressed with the same measures outlined in the *Procedures* section of this policy.

- Multi-way stop signs or traffic signals shall not be installed within the corporate City limits of the City of Friendswood unless approved by an authorized warrant analysis and by the City Traffic Director.
- Multi-way stops and traffic signals are warranted based on vehicular traffic volumes, pedestrian traffic volumes, vehicular speeds, traffic accident data, and other traffic data in accordance with guidelines defined in the Texas Manual of Uniform Traffic Control Devices (TMUTCD).
- According to the TMUTCD, "regulatory and warning signs should be used conservatively because these signs, if used to excess, tend to lose their effectiveness." If confirmed by a traffic engineering study, existing multi-way stop locations that are not warranted will be removed by the City of Friendswood.
- According to the TMUTCD, stop signs or traffic signals shall not be installed for the purpose of controlling the speed of a roadway as they have been shown to become a hazard at times when installed without warrant.
- Implementation of multi-way stop signs, traffic signal, and roundabouts will be in accordance with necessary budget considerations.

As with all other requests to review traffic issues in the City of Friendswood, should changes to the intersection control in the study area be warranted, Engineering shall attempt to convey the proposed changes with the impacted residents before any modifications or improvements are implemented.

Additional information concerning intersection control is included in the **Attachment F** under the titles *Stop Signs, Signal Installation,* and *Roundabouts.*

“Children at Play” and “Deaf Child Area” Sign Requests:

“Children at Play” and “Deaf Child Area” signs are not recognized by the State of Texas or by the Federal Highway Administration as official traffic control devices. These signs may create a false sense of security for parents of children and typically do not achieve the desired safety benefits.

The city does not recommend installing “Children at Play” signs within its boundaries. Existing “Children at Play” signs will be removed by the city that have previously been placed without proper authorization and are not in compliance with this sign policy.

“Deaf Child Area” signs may only be installed in school zones if deaf children attend the school. If installed, these signs will be removed when the deaf child no longer attends the school.

Additional information concerning children at play signs and deaf child area signs is included in the **Attachment G** under the title *Children at Play Signs.*

Other Advisory or Advanced Warning Sign Requests:

As with all other requests to review traffic issues in the City of Friendswood, requests for advisory or advanced warning signs will be addressed with the same measures outlined in the *Procedures* section of this policy.

- Traffic Engineering and Operations will study the requested location and perform an advisory/advanced warning sign analysis which includes volume of pedestrian traffic, proximity of the subject location to schools, parks, swimming pools, retail centers, hike and bike facilities, vehicular traffic volume, etc.
- The requesting party will be informed that it is City policy to only install advisory or advanced warning signs that are in accordance with the Texas Manual on Uniform Traffic Control devices, latest edition.

Other Public Safety and Traffic Issue Requests:

Other requests to review traffic issues in the City of Friendswood will be addressed with the same measures outlined in the *Procedures* section of this policy.

Engineering shall attempt to convey the proposed changes with the impacted residents before any modifications or improvements are implemented.

ATTACHMENT A
No Parking and Parking Zones

Parking Zones:

Commercial Zones are designated for commercial vehicles to load and unload merchandise for up to 20 minutes. Yellow zones are usually found in commercial areas for the use of adjacent commercial areas.

Green Zones are used for limited term parking, usually 20 minutes as indicated on a sign. In any limited parking you can receive a citation if you exceed the maximum limit by 1 minute or more. To avoid a citation, you must vacate the parking space within the time limit specified and let other members of the public use these high demand spaces.

Red Zones indicate no parking at any time and are reserved for fire and emergency vehicles. Any other vehicle parked or encroaching on or in the red zone is considered a violation of the parking restriction and may receive a ticket and/or be towed.

Blue Zones are reserved parking spaces for vehicles used by disabled persons and displaying the appropriate disabled parking placard or license plate.

Where is it illegal to park?

- No Parking Zones marked by No Parking, No Stopping, or No Standing signs.
- In front of a private or public driveway.
- In front of or within 15 feet of a Fire Hydrant.
- Within marked or unmarked crosswalks. An unmarked crosswalk is considered to be an extension of sidewalk boundary lines across a street or driveway.
- On sidewalks.
- In public rights-of-way for the purpose of advertising or selling without proper authorization.
- In handicapped parking spaces without a legally obtained handicap placard or license plate.
- Where a vehicle will obstruct or block a handicapped parking space.
- Within 30’ on the approach to a flashing signal, stop sign, yield sign, or traffic control signal located at the side of the roadway.
- Within 3’ of a handicap access ramp.
- In stripped loading zones next to handicapped parking spaces.
- Straddling the markings or lines designating a parking stall.
- Along the curb return within 10’ of an intersection.
- Within marked hatched no parking areas.
- Within 15’ of the entrance to a fire or ambulance station.
- Within 500’ of fire trucks or emergency equipment when these are stopped answering a fire alarm or emergency call.
- Other areas as designated in the Texas State Transportation Code section 545.302 which restricts parking even if no signs are posted.

Parking areas for persons with disabilities

Parking areas for persons with disabilities, also known as handicapped parking spaces are established for the exclusive use of vehicles transporting persons with disabilities. Any vehicle parked in a marked handicapped space or tow away zone parking space that does not display a placard or license plate with the international symbol of access can be given a ticket, towed, and impounded. Handicap spaces can be established on public or private property if the property owner and the City Engineer determine the need for such space/spaces.



A citizen with a valid handicap placard or license plate is allowed to park in a regular metered space without paying provided there are no other restrictions by signage. For example: *No Parking 7 – 9 AM or 4 – 6 PM.* However no one can park at meters in commercial loading/unloading zones unless they possess and have visibly displayed in the vehicle a commercial loading/unloading parking permit.

How close to the curb must I park?

All vehicles parking parallel to the curb must park within 18 inches. All vehicles parking at an angle must have 1 front tire within 6 inches of the curb. All parallel parking must have passenger side to curb, unless parked on a one-way street.

What is the maximum length of time I can park my vehicle on the street without moving it?

- Passenger vehicles cannot be parked on public streets for more than 48 hours.
- Trailer/Semi-Trailer cannot be parked on a public street for more than 2 hours.

ATTACHMENT B
Commercial Truck Cut-Through

Truck cut-through traffic trying to avoid congestion on major streets is a growing concern to city residents. Local and residential streets were not typically designed to carry high volume or heavy loaded through traffic. This unnecessary through traffic generates noise, air pollution, and creates other issues, including safety, for residents. Some trucks also try to park on narrow residential streets, which also causes concerns for the residents and emergency vehicles.

Residents concerned with high volumes of truck traffic traveling through, or parking in, their neighborhood have several remedies available. The City will evaluate the specific problems of your street and implement the most effective solution if the conditions warrant action.

Definitions of "Commercial Vehicle" and "Commercial Truck"

A commercial vehicle can be defined as any vehicle that is used and maintained for commercial purposes. A commercial truck is a commercial vehicle with more than 2 axles.

Cut-Through Traffic

Cut-through traffic can be defined as commercial vehicles passing through a neighborhood without at least 1 trip end (origin or destination) in that neighborhood. Cut-through traffic causes unwanted noise, dust, pollution, and safety issues for residents. Cut-traffic can be passenger vehicles, commercial vehicles, and/or commercial trucks. A cut-through commercial vehicle or truck is one that passes through a street/neighborhood without a scheduled stop in that neighborhood.

In additions to pollution and safety issues, cut-through commercial traffic cause pavement deterioration of the neighborhood roads since most neighborhood roads are not designed for heavy commercial traffic.

Cut-through traffic is also defined as motorized vehicles cutting through a parking lot and/or business to avoid heavy traffic or traffic control devices such as Stop/Yield Signs or traffic signals.

Possible Solutions

If your neighborhood has a high volume of cut-through traffic, you can request a traffic study by filling out the Traffic Concern form at www.ci.friendswood.tx.us/350/Publications-Forms. Upon receiving a completed request form, the Engineering will make an initial determination of the need for a study as in outlined in the procedures of this policy. Counteractive measures such as signage and enforcement, or traffic calming measures may be instituted.

Parking in Residential Neighborhoods

Residential neighborhoods, which are in close proximity to busy commercial areas with limited parking facilities or near a truck parking facility/compound, may find unwanted vehicles parked in the neighborhood. Commercial Vehicles cannot be parked on a public street overnight and trailer/semi-trailer cannot be parked on a public street for more than 2 hours.

ATTACHMENT C
Pedestrian Facilities

I. PEDESTRIAN SAFETY

The need for Pedestrian Safety:

Whether for school, work, or recreation, most of us walk every day. However, some people have to walk as their primary means of transportation or choose to walk to improve their health. Whatever our reasons may be for walking, pedestrians have a legitimate right to walk without feeling unsafe or uncomfortable. Since most of our roads were designed for vehicular traffic, we need to improve walkability in our communities and make them safer for walking.

Typical Issues with Pedestrian Safety

The first step in improving pedestrian safety involves identifying the problem. Residents can help identify the pedestrian safety concerns in their neighborhoods. The following lists some of the typical problems associated with pedestrian safety and can be used as a guide in identifying problems in a neighborhood.

Poor or Inadequate Walking Facilities

- Existing sidewalks and trails are insufficient and do not connect to schools, parks, churches, etc. Dirt paths or desire lines show that more sidewalks or paths are needed.
- Existing sidewalks are not wide enough for people to walk comfortably or pass each other.
- Sidewalk surfaces are uneven, broken, or covered with debris.
- Sidewalks and paths are blocked by barriers such as vehicles, trash cans, vegetation, utility poles, mail boxes, benches, or other obstructions.
- There is not enough space between the sidewalk and the roadway to make pedestrians feel comfortable.
- The intersections are wide and crossing distances are long. Turning radii at the intersections allow cars to turn at higher speeds.
- Bicyclists riding on the sidewalk (possibly because they do not feel safe in the street) cause conflicts with people walking.

Unsafe Driver Behaviors or Traffic Characteristics

- Drivers do not stop or yield to pedestrians crossing the roadway.
- Drivers drive too fast through neighborhoods, around schools, or near other places where people are walking.
- Drivers take short cuts through neighborhoods to avoid traffic on major roads.
- Red light or stop sign runners endanger pedestrians and bicyclists.
- Drivers pass other vehicles stopped at crosswalks for pedestrians or pass stopped school

buses.
- Drivers are more distracted than ever by cell phones, electronic media, passengers, and other activities.

Unsafe Pedestrian Behaviors

- Pedestrians do not look both ways before crossing the street.
- Pedestrians attempt to cross the street when traffic is approaching.
- Pedestrians cross against pedestrian signals.
- Pedestrians crossing midblock where there are no crosswalks.
- Pedestrians, like drivers, can be distracted by cell phones and other electronic devices.

Typical Solutions

Once the problem or problems have been identified, the next step is developing an appropriate solution. Pedestrian transportation improvements or potential solutions for pedestrian safety are described in terms of the "Four E's":

1. **Engineering** – Physical changes to infrastructure (i.e., sidewalks, traffic signals, signs, etc.) that affect the operation and movement of traffic and pedestrians.

2. **Education** – Includes strategies that aim to educate pedestrians, drivers, or other groups in order to motivate a change in behavior.

3. **Enforcement** – Community-based or law-agency-based measures to enforce laws and regulations related to pedestrians.

4. **Encouragement** – Efforts to promote walking and increase the level of walking in a community.

II. Pedestrian Crosswalks

Crosswalks

A crosswalk is typically defined as a designated portion of the roadway that pedestrians use to cross the street. A crosswalk may be marked or unmarked. There is no legal difference between marked and unmarked crosswalks at controlled intersections (those with stop signs or traffic signals). However, marked crosswalks at mid-block locations provide a designated and legal crossing zone for pedestrians.

1. *Unmarked Crosswalks* – most every intersection is considered to represent a crosswalk, even if it is not marked as such. An unmarked crosswalk is basically the extension of a sidewalk that extends across intersecting roads.

2. *Marked Crosswalks* – are those crosswalks marked with pavement markings,

usually 12' wide white pavement markings on 6' centers, either plain, perpendicular crosshatched, or 45 degree crosshatched.

3. *Enhancements* – are traffic control devices or signals that enhance and aids the safe movement of pedestrian traffic in the roadways.


Benefits of Marked Crosswalks

Marked crosswalks guide pedestrians to a proper crossing location and alert motorists of a pedestrian crossing point. However, at uncontrolled locations, marked crosswalks may create a false sense of security for pedestrians resulting in a greater number of pedestrian crashes (if additional safety treatments are not provided).

City Policy on Marked Crosswalks

The City's current policy is to install marked crosswalks at controlled intersections where there is a demonstrated need. Crosswalks are also marked at established school crossings. At other locations, an engineering study must be conducted to ensure that marked crosswalks are installed only where there is significant pedestrian activity and/or based on engineering judgment. The need for, and potential use of, a proposed crossing varies with each location, each should be considered individually, and with an effort to maintain consistency in the decision making process. Approval of marked intersection on state highways, or an intersection of a state highway and city road, within the City Limits shall be coordinated with TxDOT.

Categories of Marked Crosswalks

Marked crosswalk locations fit into 1 of 3 categories:

1. Marked crosswalks are **Standard** on signalized approaches at intersections.

2. Marked crosswalks alone (without other enhancements or treatments) are **Permitted** on roadways with posted or 85th percentile speeds less than or equal to 35 mph, if recommended as part of an engineering study and approved by the City Engineer.

3. Marked crosswalks with enhancements or active devices are installed on roadways with posted or 85^{th} percentile speeds greater than 35 mph, if recommended as part of an engineering study and approved by the City Engineer. Such enhancements might include traffic calming features (i.e. median refuge

islands, curb extensions, narrowed travel lanes, traffic diverters, chicanes), illumination, or enhanced devices (i.e. advance signage), or active devices (i.e. pedestrian-activated signals).

III. Pedestrian Signals

Why do some traffic signals have push button and signal indications for pedestrians and others do not?

Pedestrian signals are primarily installed for 2 reasons:

1. A high volume of pedestrian traffic present; or

2. The green time given for vehicles in a particular direction is not sufficient for pedestrians to cross the roadway in that direction.

When signal indications for vehicles are easy to see and provide plenty of green time for pedestrians to cross safely, push buttons and pedestrian signal indications are often not needed. Push buttons are sometimes provided at intersections where the signal timing is typically controlled by the volume of vehicular traffic. If traffic volumes are low at these intersections, pedestrians will not have enough time to cross the street without push buttons. If pedestrian crossing times were factored into every signal cycle, many intersections would become inefficient and delay vehicles more than necessary. The use of pedestrian push button allows extra time to be provided only when a pedestrian is present.

What do pedestrian signals mean, and why isn't there enough time to cross the street during the walk indication on a pedestrian signal?

The City has in use the pedestrian signals that indicate illuminated symbols of a walking person and an upraised hand, along with a countdown timer of how many seconds of time until the pedestrian signal indicates "Do Not Cross". The signals are timed for an average walking distance of 4 feet per second.

- The steadily illuminated upraised hand indication means that a person should not enter the roadway in the direction of the signal.

- The walk symbol (the white colored walking person) means that a pedestrian may start crossing the road toward the signal.

- The flashing orange upraised hand means you can continue to cross, but there is not adequate time to begin crossing. The purpose of the flashing indication is to keep pedestrians from entering and intersection too late and to let pedestrians already in an intersection know that their time to finish crossing is becoming shorter, which is now indicated by the countdown timer.

Will pushing the pedestrian walk button several times make the signal change faster?

No, the walk button will send a message to the controller requesting a walk indication be granted to the requested direction in the next ***available*** signal cycle. Continuously pressing the pedestrian button does not send additional messages to the controller since the controller has already acknowledged the pressing of the walk button with the first push.

Why do vehicles keep turning even when the pedestrian signal indicates that pedestrians have the right to cross?

Pedestrian signals assign the right-of-way for pedestrians to cross the street. However, since right turns on red are allowed, some drivers may make right turns without yielding to pedestrians or do not see the pedestrian signals. This is why it is important to always be cautious when crossing busy intersections. The following suggestions are offered in the interest of safety:

- Always cross intersections defensively.
- When crossing the street, regardless of the availability of signals, cross as quickly as possible. Minimize your time in the roadway.
- Always watch for turning vehicles. You have the legal right to be there, but that does not protect you from the carelessness of some motorists.
- Whether marked or unmarked, or signalized ***ALWAYS*** look both ways before crossing the roadway.

ATTACHMENT D
School Traffic Safety

School Traffic Safety Statistics

On average, each year 23 school-age children die in school related traffic accidents in the United States. Out of these, 6 are occupants of school transportation and 17 are pedestrians. Based on these statistics, the City would like to stress the importance of pedestrian safety around schools and school buses. However, pedestrian safety is not solely dependent upon the pedestrians themselves but is very much dependent upon the driving practices of motorists near and around schools and school buses.

I. AROUND SCHOOLS

Pedestrian Safety Tips for Children

Most people, and especially young children, cannot judge the speed, distance, and size of oncoming vehicles. Parents should walk the route to school (or other destinations) with children and point out safe and unsafe practices. This includes locations where children may go to catch a bus.

- At a traffic signal, the green light or walk signal (the white walking person) means that children should stop at the curb or edge of the road, look both ways for oncoming traffic, and then if it is safe, cross the street. Having the walk indication or green light does not guarantee that cars will stop. Pedestrians must always look for oncoming and turning traffic even when they have the right of way.
- Before crossing the street, children may want to wait for a “fresh green light.” This means that they wait for the next new walk indication if the “don’t walk” indication (upright orange hand) is flashing and the countdown timer is nearing zero. Doing this gives them the most time to cross.
- If children are in the middle of the street and the “don’t walk” indication begins flashing, they should not stop or return to the curb or edge, but continue on to walk at their maximum comfortable pace until they reach the other side. They should not run as they might fall.
- And Remember;

    - Children crossing the street should be accompanied by an adult whenever possible.
    - Avoid crossing streets at mid-block, especially when parked vehicles may obstruct vision. Use stops signs, traffic signals, and crossing guards when available.
    - Children should not follow others or run to others when the call until a safe crossing is available.

Vehicle Safety Around Schools

Parents and other adults can do much to improve traffic safety around schools by driving cautiously, teaching children safe practices, and limiting vehicle trips. Drivers should obey all traffic laws and apply the following practices:

- Carpooling can reduce the number of vehicles near the school, especially during inclement weather.
- Avoid parking on the opposite side of the street from the school. When it is necessary, instruct children on how to safely reach the vehicle.
- Make sure that children are careful when opening vehicle doors and that they enter and exit on the curbside of the vehicle. Children should not be allowed to cross in the middle of the block to reach the vehicle.
- Drivers should not double park or block traffic. Waiting or parking in red zones is also not allowed.
- Do not block buses or use areas designated for buses only. If an emergency vehicle requires access, the area should be cleared.
- Never leave a vehicle unattended in a loading zone.
- Do not park in a crosswalk or pass a stopped vehicle allowing pedestrians to cross.
- Do not violate the law by using the excuse "I will just be here a minute" when picking up or dropping off children. Violations still present a danger and cause congestion during the time of day when it is most important to provide safety for children and avoid congestion.
- Learn the traffic patterns at and near a school to avoid being a disruption.
- Pay attention to children getting in and out of vehicles. Children sometimes forget to use the curb side door and exit suddenly.

Crossing Guards

The City is responsible for the assignment and designation of crossing guards for the schools within the City Limits. Crossing Guards are employees under the Police Department and have the force of law for traffic movements in school zones. Children and motorists should follow their directions when directing traffic and helping children crossing the street.

II. AROUND SCHOOL BUSES

School Bus Safety – Children

When waiting for, riding, and exiting the school bus, children should follow these rules:

Getting on the School Bus

- When waiting for the school bus, stay away from traffic and avoid roughhousing or other behavior that can lead to carelessness. Do not stray into streets, alleys, or private property.

- Line up away from the street or road as the school bus approaches.
- Wait until the bus has stopped and the door opens before stepping into the roadway.
- Use the handrail when stepping onto the bus.

Behavior on the Bus

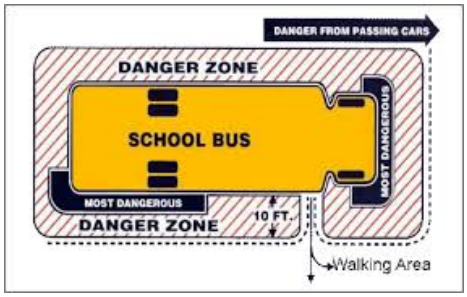
- When on the bus, find a seat and sit down. Loud talking or other noise can distract the bus driver and is not allowed.
- Never put head, arms, or hands out of the window, nor throw anything out of the window.
- Keep aisles clear. Books and bags are tripping hazards and can block the way in an emergency.
- Before you reach your stop, get ready to leave by getting your books and belongings together.
- At your stop, wait for the bus to come to a complete stop before getting up from your seat. Then, walk to the front door and exit using the hand rail.

Getting off the School Bus

- If you have to cross the street in front of the bus, walk at least 10 feet ahead of the bus along the side of the road, until you can turn around and see the bus driver.
- Make sure the bus driver can see you.
- Wait for a signal from the bus driver before beginning to cross.
- When the bus driver signals, walk across the road, keep an eye out for sudden traffic changes.
- Stay away from the bus's rear wheels at all times.

School Bus Safety – Parents

- If possible, accompany children to school bus stop and help them get in and out.
- Teach children to follow common sense practices and **ALWAYS STAY OUT OF THE DANGER ZONE OF THE BUS.**



School Bus Safety - Motorists

- When backing out of a driveway or leaving a garage, always watch out for children walking or bicycling to school.

- When driving in neighborhoods with school zones, watch out for young people who may be thinking about getting to school, but may not be thinking about getting there safely.
- Slow Down! Watch for children walking in the street, especially if there are no sidewalks in the neighborhood.
- Slow down! Watch for children playing in and congregating near bus stops.
- Be Alert! Children arriving late for the bus may dart into the street without looking for traffic.
- Learn to obey the school bus laws. Learn the "flashing signal light system" that school bus drivers use to alert motorists of pending actions:

    - ***Yellow Flashing Lights*** indicates that the bus is preparing to stop to load or unload children. Motorists should slow down and prepare to stop their vehicles. It also means that the motorist should NOT speed up to pass the bus before the red flashing lights are on.
    - ***Red Flashing Lights*** and extended stop arms and stop signs indicate that the bus has stopped, and that children are getting on or off. Motorists must adhere to the driving law below and only proceed when the red lights stop flashing and the extended stop sign and bar is withdrawn, and the bus begins moving before they can start driving again.

        - Two Lane roadways, with traffic in both directions, both traffic lanes shall stop.
        - Multi-lane roadways with or without center turn lanes, traffic shall stop in both directions.
        - Roadways divided by raised medians, the traffic traveling in the same directions as the bus shall stop. The traffic in oncoming direction on the other side of the median shall slow and proceed with caution, but it is also suggested that motorist stop for the ultimate safety.

School Zone Signs and Operations

School zones may be installed on streets that border school property line and where students cross a roadway. The signs can be static or include flashers. The flashers are usually installed on roadways with more than 5,000 vehicles per day. The signs conform to the standards and specifications in the Texas Manual on Uniform Traffic Control Devices.

School zone times shall be established and installed according to the following general guidelines:

- **Morning Times** – 45 minutes before start to 15 minutes after the start of school.
- **Midday** – beginning to end of lunch period.
- **Afternoon Times** – 15 minutes before dismissal to 30 minutes after dismissal of school.

These times may be adjusted at each school based on individual campus requirements.

Parking Regulations

In order to promote safe and efficient traffic circulation around a school, it may be necessary to regulate, restrict, or prohibit parking, stopping, or standing adjacent to the school grounds or at an established school crossing. The Engineering Department will determine if the street needs parking restrictions.

Crosswalk Location and Installation

Crosswalks are located to enhance the utilization of sidewalks, to serve school routes and to define the appropriate crossing area in the street at high pedestrian volume intersections. When reviewing an area for installation of a crosswalk, the proximity to a school is one factor. Other factors include: volume of vehicular and pedestrian traffic, average vehicular speed, visibility available to motorist and pedestrians, type of traffic controls present, width of street to be crossed, and location of adjacent crosswalks.

ATTACHMENT E
Speed Limits

Authority

Speed limits are set by statute by the Texas Transportation Code § 545.352. The statute specifies the following speed limits:

- Streets in Urban Districts – 30 mph
- Alley in Urban Districts – 15 mph
- State or Federal numbered highways outside of Urban Districts – 70 mph. Any other highway outside of the Urban District – 60 mph.

These are known as "prima facie" limits and do not require signs for enforcement. For example, in the absence of any other speed limits sign, the speed limit is 30 mph in residential districts within the City Limits. The City Council may alter the maximum or prima facie speed limits based on an engineering and traffic study on any street or portion thereof within the City. The altered speed limits are posted regulatory speed limit signs (signs with black text on white background) and are considered prima facie (or legal) for enforcement.

Speed Zoning

When an engineering study determines that statutory speed limits are not appropriate for the existing road and traffic conditions, altered speed limits are established using speed zoning. The types of speed zones are:

- ***Regulatory Speed Zones*** impose a restriction on a particular roadway and indicators of the speed limitations imposed by physical and traffic conditions of the roadway. Regulatory speed limits are posted using regulatory speed limit signs which has black lettering on white background as shown in the Texas Manual on Uniform Traffic Control Devices for Streets and Highways (TMUTCD).
- ***Construction Speed Zones*** may be regulatory or advisory speed zones through a construction project depending on the importance of speed control in the construction zone. Construction advisory signs are typically black lettering on an orange background.
- ***School Speed Zones*** are established in accordance with city policy on School Zone Installation and Removal and in accordance with State Law. Maximum speed reduction allowed is 15 mph under the posted speed limit.
- ***Advisory or Warning Speeds*** are desirable speeds for curves, intersections, or other locations where design standards or physical conditions of the roadway restrict safe operating speeds to value less that the maximum legal speeds or posted regulatory speed limit. Advisory speed signs supplement other warning signs (such as for a curve) and have a black message on a yellow background.

What is the Law?

All drivers are required to obey the posted speed limits. These limits are designed to provide for the orderly flow of traffic under normal driving conditions. During periods of heavy traffic, inclement weather, low visibility, or other poor driving conditions, speed must be adjusted so that accidents will be avoided. In the absence of posted speed limits, prima facie speed limits are in effect. Any speed in excess of the legal speed limit on that roadway will be considered prima facie (or "on the face of it") evidence that the speed is unreasonable, non-prudent, and unlawful.

How are Speed Limits Established?

Regulatory speed zones are established in accordance with the procedures described in the TxDOT manual "Procedures for Establishing Speed Zones". Posted speed limits are set by the 85th percentile method, which represents the speed of the majority of drivers will be traveling at or below. Speed checks are conducted to determine the 85th percentile speed. The observed free-flowing speed for vehicles is tallied and the 85th percentile speed is calculated using collected data. To ensure a true reflection of normal traffic situation, speed checks are made on average weekdays during off-peak hours, under favorable weather conditions.

The speed limit is normally set at the nearest value to the 85th percentile speed ending in 5 or 0. The posted speed limit may be adjusted downwards of the 85th percentile speed based on the following factors:

- Roadway pavement width of 20 feet or less.
- Curves and hills.
- Hidden driveways and other developments.
- High number of driveways.
- Crash history.
- School crossings and characteristics of sites that generate traffic.
- Lack of striped, improved shoulders.

Once a speed limit is determined, the speed zone is added to the Ordinance 300 identifying the limits and speed of the speed limit zone. After approval by the City Manager, or their designee, the sign shop is instructed to install the necessary signs at the locations approved and shown in the Ordinance 300 memo.

Speed Limit Misconceptions

Studies have shown that there is no significant change in speeds following the posting of a revised speed limit. This is true whether the speed limit is increased or decreased. Safety is also not improved by establishing unreasonably low speeds limits. Some misconceptions about speed limits include:

- Reducing the speed limit will not slow the speed of traffic;
- Reducing speed limits will necessarily decrease the number of crashes and increase safety;
- Having a posted speed limit is not necessarily safer than an unposted speed limit; and
- Drivers always go 5 to 10 mph over the posted speed limit.

Why Do We Need Speed Limits?

Speed limits which are realistic and reasonable:

- Encourage compliance from a majority of the drivers;
- Give a clear reminder of reasonable and prudent speeds;
- Provide an effective enforcement tool to the police; and
- Encourage drivers to travel at the speed where the risk of crash involvement is the lowest.

Studies have shown crash rates are lowest at around the 85th percentile speed. Drivers traveling significantly faster OR slower than this speed are at greater risk for being in a crash. It is not high speeds alone that relate to crash risk; it is variation of speed within the traffic stream. In fact, on a per mile driven basis, high speed roadways, like interstates, have a lower speed-related fatality rate than low speed roadways because large variations in speed within the traffic stream create more conflicts and passing maneuvers (and opportunities for driver error and collisions).

However, unrealistic speed limits:

- Discourage voluntary compliance;
- Create perception of “speed traps;”
- Cause public antagonism toward the police;
- Create a bad image for a community in the eyes of non-residents; and
- May increase the potential for crashes.

ATTACHMENT F
Intersection Controls

I. STOP SIGNS

Stop Signs

A STOP sign is a sign used to direct motorists to stop at the spot where the STOP sign is located. STOP signs are a method for controlling traffic at intersections where the normal application of the right-of-way rule is insufficient to ensure safety and provide reasonable compliance with the law. These signs are found on the right side of the roadway (and in some cases in the median to increase visibility). When more than two directions are controlled by STOP signs, then a supplemental ALL WAY plaque shall be used to inform motorists of the type of traffic control that exists at the intersection. If a STOP sign is in its correct location and it cannot be seen very well due to hills or curves, a STOP AHEAD warning sign may be used in advance on the approach to the STOP sign.

Installation Policy

STOP sign installations will be addressed according to the City of Friendswood Sign Policy, current edition. STOP signs at an intersection are installed only upon the approval of the City Engineer and reflected in the Ordinance 300, after a careful investigation has been made of existing conditions. The investigation is conducted using the guidelines for installing STOP signs provided in the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

Should STOP Signs Be Used to Control Speeding in Neighborhoods?

This is a question that is frequently asked or requested from citizens concerned about speeding in their neighborhood. Although the City does share the concerns of the citizens about speeding and safety in residential neighborhoods, the installation of STOP signs is not the appropriate way to solve the problem of speeding. STOP signs are traffic control devices intended for assigning rights-of-way, not controlling speed. Traffic calming devices (as stated in the City's Traffic Calming Policy) and police enforcement have been found to be much more effective in controlling speeding.

STOP signs result in speed reduction only near the sign, and drivers tend to speed up between STOP sign controlled intersections to make up for perceived lost time. According to National Engineering Transportation Study, when required to stop by cross street traffic, 5% to 20% of all drivers come to a complete stop, 40% to 60% will come to a rolling stop below 5 mph, and 20% to 40% will pass through at higher speeds.

Often, unjustified STOP signs are ignored by motorists, which can be more dangerous than speeding. Therefore, it is the City's policy not to install STOP signs to control speeding.

Adverse Impacts of Unjustified STOP Signs:

- Unjustified STOP signs cause motorists frustration when they are forced to stop for no

apparent reason. Unwarranted STOP signs result in disrespect for all signs and reduce the effectiveness of STOP signs at other intersections where they are essential for safety.

- Vehicle emissions account for much pollution in the air. These emissions increase when vehicles are accelerated and decelerated. It is important to minimize unnecessary stops since steady speeds increase fuel economy and reduce vehicle emissions. Unwarranted STOP signs increase the number of unnecessary stops and reduce the efficiency of our transportation system which results in increased air pollution.

II. YIELD SIGNS

Yield Signs

At intersections where a full stop is not necessary at all times, consideration should be first given to less restrictive measures such as a YIELD. A YIELD sign is used to assign rights-of-ways on certain approaches to an intersection. Vehicle controlled by a YIELD sign need to slow down to a speed that is reasonable for the existing conditions or stop when necessary to avoid interfering with conflicting traffic.

Installation Policy

YIELD sign installations will be addressed according to the City of Friendswood Sign Policy, current edition. YIELD signs at an intersection are installed only upon the approval of the City Engineer and reflected in the Ordinance 300, after a careful investigation has been made of existing conditions. The investigation is conducted using the guidelines for installing YIELD signs provided in the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

III. TRAFFIC SIGNAL INSTALLATION

Purpose

When warranted, properly designed, located, and operated, traffic control signals can provide orderly movement of vehicular and pedestrian traffic, can reduce the frequency and severity of certain types of crashes, and can increase the traffic handling capacity of the intersection. These benefits have perpetuated a common belief that traffic signals provide the solution to all traffic problems at intersections.

However, when unwarranted and improperly designed, traffic signals cause excessive delays, driver frustration, disobedience, overuse of less adequate routes, and increased collisions. This is why the City of Friendswood looks at every intersection being considered for signalization very carefully to determine that a signal is indeed needed.

Signal installation requests, like all other requests for signage, starts with a traffic concern report to the Engineering Department at www.ci.friendswood.tx.us/350/Publications-Forms. There will be an initial review and determination as stated in the procedures in the City of Friendswood's Sign Policy. As is true with all warrant justifications, the same is true of Traffic Signals having

to meet the analysis and standards in the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

Construction, Operation, and Maintenance

Once the signal is approved for placement, plans are created for construction. Depending on the conditions at the intersection, it may require up to two years to recommend design, and construct a traffic signal. Once constructed, the traffic signal is maintained by either Texas Department of Transportation (TxDOT) for signals on highways and Farm-To-Market Roads, Harris County in Harris County or the City in Galveston County. If a traffic signal is malfunctioning, please notify the Police Department.

ATTACHMENT G
Children At Play Signs

We Have a Lot of Small Children in Our Neighborhood; can we get a "Children at Play" sign?

The City of Friendswood often receives a lot of requests to install signs warning drivers of the possible presence of "Children at Play." However, these signs may give a false sense of security and have been proven to be ineffective. In residential areas within the City, drivers should expect children to be present. Studies have shown that signs attempting to warn motorists of normal conditions do not achieve the desired safety benefits.

The City of Friendswood does not want to endorse that children can or should be allowed to play safely on or near streets. These signs are not warranted or part of the Texas Manual on Uniform Traffic Devices (TMUTCD). Current Children at Play signs exist in the city in residential areas, but will not be replaced if faded, stolen, or destroyed. However, the City does have in place a process wherein the HOA can petition for these types of signs to be put in their neighborhood in the rights-of-way. These will still need to follow the typical procedures for all other signage with the addition of the following:

- The HOA will have to submit minutes that this was approved at a general HOA meeting with advanced notification relayed to residents of the proposal to install these signs.
- There will need to be a plan establishing the locations of the signs to be installed.
- If approved by the HOA and the Traffic Committee, the HOA would have to purchase the signs, sign bases, and poles and bring them to the Engineering Department. The City will install the signs at the agreed upon locations that have been approved.
- The signs would have to be added to the insurance policy of the HOA.
- As stated previously, stolen, damaged, or faded sings will not be replaced by the City.

ATTACHMENT H
Speed Bumps, Humps, and Lumps

Speed Bumps, Humps, and Lumps are traffic calming devices that use vertical deflection to slow vehicular traffic in order to improve safety conditions. Although their uses are effective in keeping vehicle speeds down, engineering studies have shown that drivers will increase their speed in between vertical speed traffic calming devices to make up for perceived lost time due to slowing down to negotiate the vertical device.

Speed Bumps

Speed Bumps are an abrupt raised area in the pavement surface, effective at controlling speeds on low volume private driveways and parking lots and have the following characteristics:

- Typically they are 3 to 6 inches in height with a travel lane width of 6 to 12 inches.
- Cause significant driver discomfort at typical residential speeds.
- Cause vehicles to slow at 5 mph or less at the bump.
- Considered an increased liability risk on public roads.
- Truck, Emergency Response, cargo, and bus passengers more likely to be affected.
- Maintenance headache.

Speed Humps

Speed Humps are a gradual raised area in the pavement surface and are typically for use in residential and low speed roadways, and have the following characteristics:

- They are typically 3 ½ inches in height with a travel length of 4 to 6 feet.
- Create a gentle rocking motion slowing most vehicles down to 15 to 20 mph, and 25 to 30 mph when properly spaced.
- They are typically painted to identify vertical change in the roadway.
- Need to be properly designed, marked, and signed according to standards in the TMUTCD.
- Effective at controlling speeds without creating accidents or imposing unreasonable or unacceptable safety risks.
- Either permanent bituminous ones or portable ones can be installed; there are pros and cons to each type.
- Can be utilized as a raised crosswalk as well.

Speed Lumps

Speed Lumps are relatively new and have the effect of slowing vehicles down as does a speed hump, but the main problem is that speed humps still cause ALL traffic to slow down. Speed lumps are a hybrid combination of speed bumps and humps. Speed lumps are in a nominal size and placed with a gap between them. This gap is spaced (normally 2 feet) so that emergency

vehicles, such as fire trucks and ambulances, which have a wider wheel base width, can easily transverse the gaps where normal vehicles cannot. Added to the safety issue is that the edges near the gaps are either parabolic or flat.

APPENDIX H
Streetlight Policy

I. SUMMARY:

The goal of this policy is to provide for effective procedures for review, approval, and installation of streetlighting throughout the City of Friendswood. This Policy will enforce requirements specifically targeting areas where existing lighting conditions are deemed to be insufficient for public safety and areas of new residential, commercial, and industrial development.

II. GENERAL:

Streetlight installation is intended as the basis for fixed lighting on all roadways. Careful considerations shall be taken in the making streets and roadways safe during hours of darkness. Certain criteria as shown in the Warranting section of this policy shall be a part of the evaluation process for the need of street lights. Streetlights are to be installed on City owned streets to illuminate the roadway. They are not to be installed on private streets, parking lots, or for security lighting. A street segment shall be in the City Limits in order to be eligible for street lights. All street lights are installed, owned, and maintained by Texas New Mexico Power Company (in Galveston County) or CenterPoint Energy (in Harris County). Once a street light is installed, the City shall pay the monthly operating and maintenance cost of the streetlight.

III. WARRANTING:

The Warranting Process that is used is based on the Transportation Association of Canada (TAC) Guide for Roadway Lighting (27) which was based on the Roadway Lighting Handbook published by the U.S. Department of Transportation. This Streetlight Warrant system is a conditional based and not observed based system. Factors that are taken into consideration are divided into four sections; 1) Geometric, 2) Operational, 3) Environmental, and 4) Collision. Each individual factor is rated from 1 to 5 in accordance with the parameters listed in the warranting worksheet. Each individual factor is weighted as a percentage of the whole, and on a point system of 0 to 100, the warranting condition must achieve a minimum of 60 points to warrant the installation of a streetlight, yet the City Engineer is the final authority of approval for a streetlight.

a. GEOMETRIC SECTION:

There are eight factors that are considered under the Geometric Section of the Streetlight Warrant Process:

- Total number of lanes including center turn lanes.

- Width of the lanes.
- Number of median openings per mile.
- Number of driveways and entrances per mile.
- Horizontal curve radius.
- Vertical grade.
- Sight distance.
- Parking.

b. OPERATIONAL SECTION:

There are five factors that are considered under the Operational Section of the Streetlight Warrant Process:

- Signalized intersections.
- Left turn lanes.
- Median width.
- Posted speed.
- Pedestrian activity.

c. ENVIRONMENTAL SECTION:

There are five factors that are considered under the Environmental Section of the Streetlight Warrant Process:

- Percentage of development adjacent to roadway.
- Area classification
- Distance from development to roadway.
- Ambient lighting.
- Raised median curb.

d. COLLISON SECTION:

There is only one factor in the Collision Section of the Streetlight Warrant Process. This is a Night-to-Day ration of accidents occurring on the street that is being reviewed.

Lighting is warranted where a total point-score of 60 or more is achieved. Lighting of equal scores may be prioritized by also using the different sections in the Warrant Worksheet.

IV. NEW SUBDIVISION INSTALLATION

As per the approved Streetlight Policy for New Development approved by Friendswood City Council Action, the following shall apply:

a. All subdivision plats shall include a provision for streetlighting using concrete poles.

b. Streetlights shall be provided at all corners and intersections and, in addition, at two hundred fifty (250) foot intervals along residential streets. Additional lights may be required at the option of the City Engineer.

c. Each streetlight shall be at least one hundred (100) watts on local and collector streets and two hundred fifty (250) on major thoroughfares.

d. All necessary easements for streetlighting shall be shown on the final plat prior to final approval by the City of Friendswood and the Planning and Zoning Commission.

e. The City shall authorize the installation of public streetlights after acceptance of the subdivision by the City for the contractor's one-year maintenance period.

V. PRIVATE SUBDIVION INSTALLATION

a. The Developer/Owner my install a private streetlight system in accordance with the standards outlined above, except that ornamental poles other than concrete may be used. Wood poles shall not be used in any new streetlighting system.

b. The Developer/Owner shall be required to provide for the installation of this private streetlight system and also provide for its perpetual operation and maintenance,

c. The Final Plat shall indicate that streetlighting is private and this shall also be labeled on all construction plans.

VI. EXSISTING SUBDIVISION INSTALLATION

The City's franchise utilities Texas-New Mexico Power (in Galveston County) and CenterPoint Energy (in Harris County) have established programs for installing streetlights in the City. The City will evaluate all requests for streetlights within the guidelines of this policy and the warranting system.

a. STREETLIGHT POLE TYPES

In all cases, any pole to be installed shall match any existing poles already installed inside the subdivision.

- Wooden Poles – lights shall only be installed on existing wooden utility poles served by overhead distribution. The light shall be installed on the existing wooden pole. An additional wooden pole may be installed to

serve a specific need. Other than state previously, no wooden shall be used in areas where the power is distributed underground.

- Concrete Poles – shall be installed on other areas such as commercial/industrial/collector roads within the City Limits.

- Metal Poles – shall be used on all thoroughfare roads inside the City Limits.

- The exception to the above mentioned poles would be the streetlights required in the downtown district by the Design Criteria Manual.

b. STREETLIGHT SPACING AND PATTERN

- All intersections shall have a minimum of one (1) streetlight.

- Undivided roadways less than sixty (60) foot width from back of curb to back of curb shall stagger the streetlighting along both sides of the roadway.

- Undivided roadways greater than sixty (60) foot width from back of curb to back of curb shall pair the streetlighting along both sides of the roadway.

- Divided roadways shall be pair the streetlighting along both sides of the roadway or as an option approved by the City Engineer, substitute one (1) streetlight in the middle of the median/dividing device in lieu of two (2) along both inside lanes of the divided roadway.

- Spacing in rural areas that have large acreage lots may be extended to five hundred (500) foot spacing and staggered along both sides of the roadway.

c. STREETLIGHT COST

The cost of installing new or additional streetlighting would be absorbed by the City of Friendswood, however in the event that there is not available power on the roadway (either overhead or underground), the City would partner with the Homeowners Association or other responsible entity.

- In either case, the City would need to have a letter from the HOA or other entity approving the installation and location of the new streetlight.

- The HOA or other entity approving the installation would be required, if power is not available in the Right-Of-Way of the roadway, to purchase, provide, have surveyed, and recorded all necessary easements for the installation of said pole.

VII. STREETLIGHT REQUEST PROCEDURE

a. Applicant completes a request form (Exhibit "A") and submits to the Engineering Department at www.ci.friendswood.tx.us/350/Publications-Forms.

b. Engineering informs approving authority of the request, and steps needed to complete the process.

c. Engineering gathers information for Warranting Worksheet.

d. Engineering draws Exhibits and forwards information to the City Engineer for review.

e. After City Engineer approves, Engineering requests that City Manager approve the installation of the streetlight and gives authorization to the appropriate franchise utility to install.

f. The appropriate franchise utility reviews the streetlight request and conducts the installation (if approved) of the proposed streetlight within a designated time period.

g. Engineering distributes confirmation letter to the applicant and approving authority giving an approximate date of installation.

VIII. LIGHTING PROBLEMS

All streetlights, poles, and wiring remain the property of the franchise utility. If the streetlight is not working properly, or are damaged please contact the appropriate franchise utility.

a. Galveston County would be Texas New Mexico Power at (281) 996-0453.

b. Harris County would be CenterPoint Energy at (713) 307-2222.

Please give the franchise utility the pole number (approximately six (6) feet above ground) facing the roadway. If one is not visible, get the address or distance from the nearest intersection.

If tree limbs are blocking the light, please call the Public Works Department at (281) 996-3380.