

City of Pearland, Texas



Engineering Design Criteria Manual

October 2020

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CITY OF PEARLAND

**CHAPTER 1
GENERAL REQUIREMENTS**

ENGINEERING DESIGN CRITERIA MANUAL
October 2020

CHAPTER 1 GENERAL REQUIREMENTS

1.1 GENERAL

- 1.1.1 The EDCM describes the general requirements for the preparation of construction plans and the supporting documents required for approval by the City. Additional specific design requirements may be required by the City.
- 1.1.2 Construction plans for public improvements within Pearland city limits shall be approved by the City. Construction plans for public improvements within the City extraterritorial jurisdiction (ETJ) shall be reviewed and approved by Brazoria County Engineering Department, respective Municipal Utility Districts, Brazoria Drainage District No. 4, and City.
- 1.1.3 Construction plans for private improvements that connect to or have an impact on public infrastructure shall be reviewed in accordance with the Site Development chapter of EDCM and the Unified Development Code (UDC).
- 1.1.4 All projects required to conform to the EDCM shall also comply with applicable City ordinances.
- 1.1.5 All construction plans and supporting documentation shall conform to the requirements of the EDCM and applicable regulations of all Federal, State, County, and entities having jurisdiction. It shall be the responsibility of the project engineer to use the EDCM to produce a design product conforming to acceptable engineering practices.
- 1.1.6 Any reference by this manual to any law, regulation, rule, publication, or any other source shall refer to the most recently adopted, promulgated, or otherwise effective version applicable as such may be amended from time to time.
- 1.1.7 The Engineering Department shall review and maintain the EDCM and approve or disapprove recommended changes to the EDCM. Approved changes to the EDCM shall be summarized and updated as determined by the City Engineer, but not less than once every two years.
- 1.1.8 The Engineering Department shall develop and maintain Standard Construction Details which shall be maintained and updated periodically by the Engineering Department.

- 1.1.9 Engineering Department shall develop and maintain an Approved Product List. This Approved Product List shall be maintained and updated periodically by the Engineering Department.

1.2 REFERENCES

- 1.2.1 All projects that are required to conform to these Standards shall also be in compliance with all applicable City ordinances. All construction plans and supporting documentation shall conform to the requirements of these Standards and all applicable regulations of all Federal, State, County, and Local entities having jurisdiction. Relevant related laws and regulations included but are not limited to the following:

- A. City of Pearland Ordinances

- B. State of Texas

1. Texas Accessibility Standards (TAS), pursuant and subject to the Texas Government Code, Chapter 469, and the Texas Administrative Code, Title 16, Chapter 68
2. Rules and Regulations published by the Texas Commission on Environmental Quality (TCEQ):
 - i. Rules and Regulations for Public Water Systems, Texas Administrative Code, Title 30, Chapter 290, Subchapter D
 - ii. Design Criteria for Domestic Wastewater Systems, Texas Administrative Code, Title 30, Chapter 217
 - iii. TCEQ storm water pollution prevention protection standards
3. State of Texas Engineering Practice Act, Texas Occupations Code, Chapter 1001 Professional Land Surveying Practices Act, Texas Occupations Code, Chapter 1071
4. Texas Manual on Uniform Traffic Control Devices.

- C. National

1. Americans with Disabilities Act, 42 U.S.C. § 12101 et seq and regulations, 28 CFR Part 36.
2. American Association of Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets
3. Institute of Transportation Engineers, Traffic Engineering Handbook
4. Highway Capacity Manual, National Research Council, Transportation Research Board

1.3 DEFINITIONS

For the purposes of this manual, the following words and phrases shall have the meanings respectively ascribed to them by this section.

Approved Products List – List of approved products that can be utilized for construction in the city. This list may be updated periodically.

City Code – The code of Ordinances of the City of Pearland, Texas.

City Engineer - The City Engineer or his designee.

Collector Streets - Street routes that have short travel distances and collect traffic from intra-city streets and funnel it into major thoroughfares or other collector streets.

Commercial Driveway Approach - The portion of a driveway within the public right-of-way that provides access to property on which an office, retail commercial center, or a building having more than three dwelling units is located or any driveway approach which accesses property that is primarily used for a non-residential purpose.

County –The applicable political subdivision of the State of Texas in which a subject tract is located. Pearland city limits and its extraterritorial jurisdiction covers portion of Fort Bend County, Harris County and Brazoria County.

Design Analysis - Narratives and calculations necessary to support design of a project.

Drawings - Plan, profile, detail, and other graphic sheets to be used in a construction contract, which define character and scope of the project.

Driveway - Entrance to and exit from premises where it is possible to park completely off the street, and which is not open for vehicular traffic except by permission of the owner of such private property.

Driveway Approach - A way or place including paving and curb returns between the street travel lanes and private property that provides vehicular access between the roadway and said private property.

Dwelling Unit - A building or portion thereof designed exclusively for residential occupancy.

Engineering Department – Department develops, implements, and manages city infrastructure for capital projects and residential and commercial development and ensures that city infrastructure is designed and constructed per city standards.

Highway, Street, or Roadway - A general term denoting a public or private way for the purpose of vehicular travel.

Infrastructure - Any facility or structure proposed to be constructed, reconstructed, repaired, or regraded wholly or partially within right-of-way public easements or connecting to right-of-way, including, but not limited to, streets, driveways, sidewalks, curbs, gutters, culverts, open ditches, storm drains, and irrigation facilities owned or maintained by a public entity.

Intersection - The area embraced within the prolongation or connection of the lateral curb lines, or, if none, then the lateral boundary lines of two or more roadways, including public street, private street, commercial driveway, residential driveway, driveway approach, alley or combination thereof which join one another at, or approximately at, right angles, or the area within which vehicles traveling upon different roadways joining at any other angle may come into conflict.

Major Thoroughfare - Highways, streets and roadways devoted to moving large volumes of traffic over long distances. Major thoroughfares shall be set forth in the Major Thoroughfare Plan adopted by City Council and may be amended, periodically.

Professional Engineer - An engineer currently licensed by and in good standing with the Texas Board of Professional Engineers.

Professional Land Surveyor - A surveyor currently registered with and in good standing with the State of Texas Board of Professional Land Surveying.

Project Engineer Representative – A representative of the design engineer who possesses the knowledge, skills and abilities to carry out inspection duties to insure compliance with the approved plans and specifications.

Private Projects or Private Improvements - All projects involving construction, reconstruction, modification or maintenance of privately-owned/maintained facilities including, but not limited to, buildings, parking lots, utility systems, private shared access drives and any facility supporting functions within private property boundaries.

Public Works Projects, Public Improvements or Public Projects – All projects involving construction, reconstruction, modification or maintenance of public infrastructure, including, but not limited to, streets, drainage facilities, water and wastewater systems, construction in public rights-of-way or easements. Any project that will be accepted for permanent maintenance by a public agency or political subdivision of the State of Texas. Any project subject to review and approval by the terms of Section 1.01 of this chapter.

Residential Developments - Residential developments shall mean all areas identified as residential under the City of Pearland Zoning Ordinance or otherwise zoned or devoted primarily to residential use.

Residential Driveway Approach - The portion of a driveway within the public right-of-way that provides access to property on which a single-family residence, duplex, or multi-family building containing three or fewer dwelling units is located.

Residential Streets - Street routes that provide access to local property owners and which connect property to major thoroughfares or collector street networks.

Residential Structure - A single-family home, apartment house, townhouse, condominium or any other type of dwelling unit.

Review Authorities - The authorized representatives of City departments, divisions, or sections responsible for reviewing and approving calculations and drawings for privately funded projects and for design and construction contracts with the City.

Right-of-way - Property that is publicly owned or upon which a governmental entity has an express or implied property interest (e.g. fee title, easement, etc.) held for a public purpose. Examples of such public purpose include by way of example and not limitation, highways, streets, sidewalks, drainage facilities, sewerage and water facilities.

Sidewalk – The section of pavement between the curb lines of a roadway and the adjacent property lines or located within an easement intended for the use of pedestrians.

Specifications - City of Pearland Standard Specifications plus project-specific narrative descriptions of procedures, requirements, and materials for a particular project.

Standard Construction Details – This is a separate document that contains the City construction details and may be updated periodically.

Standards – The requirements of this design manual.

Traffic Impact Analysis – A study performed by engineers with expertise in traffic engineering principles and practice which reviews development of a specific property and how it integrates into the existing and proposed City of Pearland street network. The analysis utilizes data and conclusions developed in previous studies and identifies improvements needed to mitigate the impact of traffic generated by a development on the street network system.

Variance – A onetime formal exception to a particular rule or rules granted for extenuating circumstances, approved by City Engineer.

1.4 PRELIMINARY RESEARCH

- 1.4.1 Personnel from Public Works Department and Engineering Department shall be available for preliminary meetings to discuss a proposed project with the project engineer and/or developer. The preliminary meetings are available when no need for predevelopment meetings exists, or to clarify discussions from a prior predevelopment meeting. This preliminary meeting between the City and the engineer/developer shall be scheduled with the Engineering Department staff before submittal of any documents for review. Predevelopment meetings shall be scheduled through the Community Development Department.
- 1.4.2 Research of existing utility and right-of-way information with City, County, State, and other public and private utility agencies shall be completed and documented prior to submittal of plans to the City. The City will make the available information to the requester upon receipt of Public Information Request (PIR) through City Secretary office.

1.5 FEES

- 1.5.1 Prior to initiating construction on a project, all applicable fees shall be paid to the City.

1.6 DESIGN REVIEW REQUIREMENTS

- 1.6.1 Electronic copies of construction plans and supporting documentation shall be submitted to the City via City of Pearland Community Web Portal Engineering Department for review. Plans will be reviewed by the appropriate departments using City's eTRAKiT system. The eTRAKiT system will update the engineer/applicant about the status of approval which may include pending, comments, approved etc. The City utilizes Manage IT Program Management System for Capital Improvement Project during design and construction Phase. If the project is a City Capital Improvement Project, all correspondence shall be directed to the City Engineer.
- 1.6.2 Depending on the trip estimates for the proposed development by the design engineer, a Traffic Impact Analysis may be required to determine necessary traffic mitigation measures to maintain the required level of service as dictated by City regulations and requirements. Refer to Chapter 7 for further requirements.
- 1.6.3 Final Drainage plans within the jurisdiction of Brazoria Drainage District No.4 or Harris County Flood Control District must be approved and signed prior to submitting to City for approval.

- 1.6.4 The engineer must adequately address comments and provide written response. Revised construction plan along with written responses shall be submitted to the City via eTRAKiT system. For CIP, ManageIT shall be used for the submission of revised documents.
- 1.6.5 Following final City approval, an electronic copy of the plans will be stamped by the City Engineer for approval.
- 1.6.6 If a project has begun the review process but becomes inactive for a period of 12 months from the date of the last correspondence, the project will be considered stopped. Projects re-activated after 12 months of inactivity will be treated as new submittals, subject to all current requirements and changes in codes or ordinances.
- 1.6.7 The project must be platted and recorded prior to final acceptance.
- 1.6.8 As warranted by scope and type of design, plans shall be submitted for review and approval by Texas Commission on Environmental Quality (TCEQ).
- 1.6.9 As warranted by scope and type of design, plans shall be in compliance with Texas Accessibility Standards (TAS) and American with Disabilities Act (ADA) regulations and criteria.
- 1.6.10 The design engineer should be responsible for making sure that appropriate permit approval are received prior to the construction. Such permit may include; permit from US Army Corps, FEMA, TxDOT, etc.

1.7 QUALITY ASSURANCE

- 1.7.1 Surveying and platting shall be accomplished under direction of a Professional Land Surveyor. Recording documents shall be sealed, signed, and dated by a Professional Land Surveyor. Survey shall be completed within 12 months of the plan submittal.
- 1.7.2 Engineering calculations shall be prepared by or under the direct supervision of a Professional Engineer trained and licensed in disciplines required by the project scope and sealed by the Professional Engineer. Final engineering design drawings shall be sealed, signed, and dated by the Professional Engineer responsible for development of the drawings.
- 1.7.3 Final architectural design drawings shall be sealed, signed, and dated by the licensed Architect responsible for development of the drawings.

- 1.7.4 Final landscape architecture design drawings shall be sealed, signed, and dated by the licensed Landscape Architect responsible for development of the drawings.
- 1.7.5 Final irrigation design drawings shall be sealed, signed and dated by either a Texas Professional Engineer, a licensed irrigator or a licensed Landscape Architect.

1.8 CONSTRUCTION PROCEDURE REQUIREMENTS

- 1.8.1 Construction shall not begin until construction plans are approved by the City Engineer, a preliminary plat is approved, and all permits, bonds and licenses have been obtained.
- 1.8.2 Coordinate with the Engineering Department forty-eight hours (48) in advance to set up the pre-construction meeting for the project. Department staff overseeing the construction process shall attend the pre-construction meeting, which shall be held at the Engineering Department or at the project site.
- 1.8.3 Notify the Engineering Department at least three (3) business days prior to beginning construction and at least twenty-four (24) hours prior to the placement of concrete on the project and prior to all required inspections or tests. Inspections shall be conducted by the Engineering Department staff or its designee. All Saturday construction shall be scheduled with the Engineering Department at least forty-eight (48) hours in advance. There will be no construction or inspections made on Sundays unless in case of emergency. Request for Sunday or holiday construction or inspections shall be made in writing and submitted to the Engineering Department for approval not later than 72 hours prior to the intent. All Saturday, Sunday or holiday inspections will be on a fee basis paid directly to the City prior to final approval of the project. A schedule of fees is on file in the Engineering Department.
- 1.8.4 Notify the Engineering Department office at least three (3) business days prior to final inspection. The Engineering Department staff and representatives of all entities having jurisdiction shall be present during all final inspections (i.e., Public Works, Municipal Utility District, TCEQ, TxDOT, etc.).
- 1.8.5 For acceptance of the project, the project engineer shall provide to the City an electronic file copy (PDF format min. 400 dpi resolution), an AutoCAD file (.dwg) or compatible .dxf file, and a GIS compatible file (see Chapter 2, and Chapter 11 for more electronic file options and requirements). Project engineer shall provide to the Engineering Department the other project completion deliverables such as Maintenance Bond, Affidavit of

Bills Paid, Engineer's Letter of Completion, applicable test results, etc. (See Appendix A- Final Checklist for subdivision acceptance). All documents other than the Maintenance Bond shall be in an electronic format. Engineer of Record has thirty (30) days to submit "Final Acceptance" paper work to the Engineering Department.

- 1.8.6 Record Drawings (mark-ups) submitted by contractor to the project engineer for the preparation of official Record Drawings shall include verification (as applicable) of all manhole and junction box locations, line sizes and lengths, elevations and inverts, lift station facility changes, fire hydrants and valve locations, driveways, service lines locations and sizes, changes to roadway profile and geometrics, etc. Project engineer shall modify plans accordingly and submit revised electronic plans as Record Drawings for approval.
- 1.8.7 All delivery tickets for all materials (e.g., concrete, cement stabilized sand) shall be maintained by the Engineer of Record and upon written request be made available for review by the Engineering Department. These delivery tickets shall be maintained for a maximum of one year from the completion of the project.
- 1.8.8 Changes to approved plans shall be approved by the City Engineer prior to construction. Any required changes during construction due to field conditions or errors shall be discussed with the Engineering Department for approval/coordination prior to making the change.
- 1.8.9 Engineering Department shall be on the distribution list for all construction test results and reports.
- 1.8.10 Competent, full-time resident inspection by the Project Engineer's representative shall be provided at all critical points of construction and as deemed necessary by the City. Critical points of construction include, but are not limited to, operations involving inspection of bedding and pipe prior to backfilling, placing and compaction of backfill, placement of structural concrete and paving, sidewalk placement and all on-site testing activities.
- 1.8.11 A certified testing laboratory shall be on site to perform applicable tests required so that construction practices and materials conform to plan and specification requirements.
- 1.8.12 All disturbed areas must be properly re-vegetated (minimum 70% established grass cover on unpaved area) prior to demobilization and acceptance of project.

1.9 APPROVAL AND ACCEPTANCE OF PUBLIC IMPROVEMENT PROJECTS

- 1.9.1 Public Improvement projects shall subject to final approval by the City Engineer prior to placing the facilities in service.
- 1.9.2 The Project Engineer shall also issue a certificate, at the completion of the work, acknowledging that the project was constructed in accordance with the City approved plans, specifications and special provisions.
- 1.9.3 All items listed in “Appendix A – Final Check List for Subdivision Acceptance” shall be met prior to final approval by the Engineering Department.
- 1.9.4 Final approval of a project shall be documented in writing by the City Engineer.
- 1.9.5 Public Improvement projects within the City shall be subject to a minimum two (2) year maintenance bond. An inspection prior to the end of the maintenance period shall be conducted by the Engineering Department and all other entities having jurisdiction. All facilities shall be operational and in good working condition prior to final acceptance of a project in order to obtain a refund of the maintenance bond.
- 1.9.6 The Engineer or Developer is required to comply with the Storm Water Pollution Protection Plan (SWPPP) developed for the development and for the implementation and maintenance of the Best Management Practices (BMP). Once the project is complete and the final BMPs are installed, the Engineer or Developer shall maintain the BMPs until revegetation is established to prevent sediment transport and erosion. The Engineer or Developer is responsible for the removal of BMPs once the revegetation is established. These BMPs shall be removed within 30-days once the revegetation has been reestablished. This will be reviewed during the two-year maintenance period as described in Section 1.9.4.

1.10 APPROVALS AND VARIANCES

- 1.10.1 Approvals required in the EDCM shall be the responsibility of the Owner. Failure to obtain appropriate approvals may be grounds for suspension of construction until appropriate approvals are granted. Items failing to conform to the EDCM shall be submitted for a variance request.
- 1.10.2 Variances from these Standards are authorized only if approved in writing by the Engineering Department. Variances must be submitted at the time of the original construction plan submittal. Persons seeking a variance from these Standards shall submit to the Engineering Department a written

variance request application on a form (Appendix B) provided by the City with the applicable fee. Variance request applications should be submitted with pertinent information such as construction plans or a right-of-way use permit. Incomplete variance request applications will not be processed until the applicant adequately addresses all outstanding items. It is the applicant's sole responsibility to adequately support all requested variances. The City's standard variance request application form is included at the end of this chapter.

- 1.10.3 Construction work related to any specific approval item not approved in writing shall not begin until the City Engineer has granted written approval. Any work proceeding without specific approval shall be subject to removal and replacement in accordance with the EDCM.
- 1.10.4 Materials and manufactured items used in construction of public improvements shall conform to the City's Standard Specifications. Water, wastewater and drainage system appurtenances shall subject to the approved items as listed in the Approved Products List and City of Pearland Standard Construction Details available from the Engineering Department and City website. Items not appearing on the approved list shall not be used for construction of public works facilities in the City of Pearland.
- 1.10.5 All projects required to conform to the EDCM shall also comply with applicable City Ordinances. Projects shall be reviewed for compliance with the Zoning, Subdivision, Floodplain Management, Signage, Traffic, Water, Sewer, Stormwater Management, and any other applicable Ordinances.

Appendix A
Final Checklist for Subdivision Acceptance

FINAL CHECK LIST FOR SUBDIVISION ACCEPTANCE

Name of Subdivision: _____

Name of Developer: _____

Name of Contractor: _____

ITEMS

1. Field Compliance
 - (A) Bench Marks, Brass Caps to be set with following information:
 1. Elevation
 2. Date of Adjustment
 3. Surveyor's number
 - (B) Location and elevation to be furnished to City _____
2. Construction Plans:
Developer's Engineer has furnished City with complete set of scanned recorded drawings and GIS files (See Chatter 2 and Chapter 11) for the subdivision on CD (PDF file format, 400 DPI minimum) _____
3. Water Distribution Construction Checklist submitted by the Developer's engineer. _____
4. Statement from County Tax Collector as to ownership and status of State, County, School District and City taxes. _____
5. Two Year Maintenance Bond (original) in amount of 50% of construction costs. _____
6. Contractor's affidavit of all bills paid. _____
7. Cost for two (2) years operating cost for the total number of Lights installed. _____
8. All street signs as required within the subdivision. _____
9. Engineers certification letter. _____

- 10. Total linear feet of storm sewer pipe. _____
- 11. Total linear feet of gravity sanitary sewer pipe. _____
- 12. Total linear feet of sanitary sewer force main pipe _____
- 13. Total linear feet of concrete streets. _____
- 14. Total number of manholes _____
- 15. Total number of valves _____
- 16. Total linear feet of water lines. _____

4" water line _____

6" water line _____

8" water line _____

12" water line _____

- 17. Deposit for building thoroughfare (if any). _____
- 18. Perimeter Sidewalks (6' or 4') _____
- 19. Lift Station
 - a. Dimensions of wet well
 - b. Number, manufacturer, and type of pumps
 - c. Size of pump, flow and Hp of pumps

Submitted by:

Engineer of Record

Date

Reviewed by:

Construction Inspector

Date

Approved by:

City Engineer

Date

Appendix B
Variance Form



City of Pearland
Engineering
2559 Hillhouse Rd TEMP
Pearland, Texas 77584
Tel: 281.652.1637
pearlandtx.gov

Engineering Design Criteria Manual (EDCM) VARIATION PROCEDURE

Variation to any technical standard in the infrastructure standards may be permitted by the City if a proposal is submitted by a registered professional engineer following 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 four (4) below:

PROJECT NAME:

PROJECT ENGINEER:

SUBMITTAL DATE:

RECORDED SUBDIVISION NAME:

This entire form must be submitted complete. If form is submitted incomplete, it will be administratively rejected.

VARIANCE LOCATION:

A proposal must contain the following information and substantiate the findings in paragraph four (4) below:

1. SPECIFIC PROPOSED DEVIATION FROM TECHNICAL STANDARD:

2. IMPACT OF DEVIATION: Set forth the relative factors such as 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.

3. COMPARISON OF TECHNICAL STANDARD TO PROPOSED DEVIATION: Show the proposed deviation with respect to relative factors such as overall safety and quality, traffic 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.

4. MITIGATING IMPROVEMENTS THAT REDUCE NEGATIVE IMPACT: Describe for example: overall safety and construction quality, traffic 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 deviation. 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.

SUMMARY & CONCLUSION/RECOMMENDATION FOR VARIANCE:

Supporting Documentation Attached. Yes ____ **No** ____

Signature and Seal of Professional Engineer:



ENGINEERING DEPARTMENT USE ONLY

Reviewed By:

Engineering Department Reviewer Date

Variance Request Approved / Denied By:
Copies of Backup Information/Notes Attached

City Engineer Date

CITY OF PEARLAND

**CHAPTER 2
CONSTRUCTION PLAN REQUIREMENTS**

**ENGINEERING DESIGN CRITERIA MANUAL
October 2020**

CHAPTER 2 CONSTRUCTION PLAN REQUIREMENTS

2.1 GENERAL

- 2.1.1 This chapter includes the graphic requirements for engineering drawings submitted for review and permitting to the City of Pearland.
- 2.1.2 The City Engineer shall approve construction plans for public improvements within the City of Pearland city limits or City's extraterritorial jurisdiction.
- 2.1.3 Construction plans for private improvements, within public rights-of-ways and public easements that connect to or affect the public infrastructure shall be approved by the City of Pearland and subjected to the requirements of this manual and review and approval using the process defined in this manual.

2.2 REQUIRED PLAN SHEETS

- 2.2.1 Cover Sheet
- 2.2.2 Approved Plat (latest version of the approved plat shall be included in the Record Drawings)
- 2.2.3 Construction Notes and Legend
- 2.2.4 Topographical Survey Map
- 2.2.5 Overall plan Layouts for proposed improvements
- 2.2.6 Permanent Street Signage Plan
- 2.2.7 Drainage Area Map and Calculations
- 2.2.8 Lot Grading Plan showing Existing and Proposed Spot Elevations
- 2.2.9 Plan and Profiles
- 2.2.10 Detention Pond Plan, Profiles, Cross sections, and Details, as Applicable
- 2.2.11 Traffic Control Plans and Details, as Applicable
- 2.2.12 Pavement Marking and Signage, as Applicable
- 2.2.13 Specific Construction Details
- 2.2.14 Storm Water Pollution Prevention Plan and Details
- 2.2.15 Standard City of Pearland Construction Details

2.3 DESIGN REQUIREMENTS

- 2.3.1 The seal, date, and signature of the engineer responsible for preparation of the plans shall be required on each sheet in compliance with the rules and regulations of the Texas Board of Professional Engineers (TBPE). The engineer may use TBPE-accepted electronic seal, date, and signature. The Chapter 2 Section 2.11.3 is applicable for small residential infill lots.

- 2.3.2 Signature Block: Construction plans for public improvements shall contain a Signature Block for approval for the City Engineer. Signature Blocks shall include the statement, "Approval void if progress has not been made toward completion of project within one year of date of signature."
- 2.3.3 Use the City Survey Control Monuments for vertical and horizontal control. A benchmark location, elevation and description shall be required on each sheet along with floodplain information for the project. Date of datum adjustment for the benchmark shall be noted in plans.
- 2.3.4 Each sheet in the plans on which elevations are marked shall include the vertical datum and adjustment, consistent with the effective FIRM, along with the site benchmark used for vertical control; except that, if the plan elevations are not on the same vertical datum as the base flood elevations shown on the effective FIRM, each sheet in the plans on which elevations are marked shall also show tabulated vertical datum differences.
- 2.3.5 Label each plan sheet as to street right-of-way widths, pavement widths and thickness, type of roadway materials, curbs, intersection radii, curve data, stationing, existing utilities type and location, etc. Please check Chapter 11 for graphical requirement of the construction plan.
- 2.3.6 Stationing shall run from left to right except for short streets or lines originating from major intersection where the full length can be shown on one sheet.
- 2.3.7 A north arrow shall be required on all appropriate sheets and shall be oriented either upward or to the right. This requirement may be waived under the following conditions: a storm or sanitary sewer flow is from west to east or from south to north and a primary outfall ditch which flows from west to east or from south to north.
- 2.3.8 Show all lot lines, property lines, rights-of-way lines, easement lines; and provide the grading elevation at each corner of lot.
- 2.3.9 A cover sheet that includes the engineering firm's registration number shall be required for all projects and clearly identify any proposed variances unless approved by the City Engineer. All plan sheets shall be listed by sheet number on the cover sheet. A vicinity map shall always be included to show the project location and a City of Pearland signature block shall be provided.
- 2.3.10 If a roadway exists where plans are being prepared to improve or construct new pavement or to construct a utility, this roadway shall be labeled with its existing width, type of surfacing, and base thickness if available. Pavement thickness can be ascertained by coring. When complete the core

hole shall be filled full depth with concrete immediately after completion to protect pavement prior to construction.

- 2.3.11 Plans shall be prepared using permanent ink, photographic or other approved process on paper, and plans shall be submitted electronically.
- 2.3.12 Plans shall not place match lines in intersections.
- 2.3.13 Service areas outside of project boundary shall be delineated on the aerial map.
- 2.3.14 All utility lines four inches (4") in diameter or larger within the right-of-way or construction easement should be shown in the profile view. All utility lines, regardless of size shall be shown in the plan view.
- 2.3.15 Plans shall depict flow line elevations and direction of flow of all existing ditches and culverts.
- 2.3.16 Plan shall indicate natural ground profiles along the centerline and each right-of-way or easement line. One right-of-way profile is sufficient when there is a difference of less than 0.5 feet.
- 2.3.17 Resolve all known conflicts of proposed utilities with existing utilities.
- 2.3.18 Plans shall be standard twenty-two inch by thirty-four inch (22"x34") and all half-size plans shall be to exact half scale. All plans shall be submitted electronically (minimum 400 DPI to scale)
- 2.3.19 Details of special structures not covered by approved standard drawings, such as stream and gully crossing, special manholes, etc., shall be drawn to scale with the horizontal and vertical scales equal to each other.
- 2.3.20 Plans shall be drawn to accurate scale, showing proposed pavement typical cross-sections and details, lines and grades, and all existing topography within the street rights-of way; and at intersections, the cross street for designing adequate street crossings.
- 2.3.21 Grades shall be labeled for the top of curb except at railroad crossings. Centerline grades are acceptable only for paving without curbs and gutters.
- 2.3.22 Curb return elevations and grades for turnouts shall show in the profile.
- 2.3.23 Gutter elevations are required for vertical curves where a railroad track is being crossed.

- 2.3.24 The surface elevation at the property line of all existing driveways shall be shown in the profile.
- 2.3.25 Station all esplanade noses affected by proposed construction, both existing and proposed.
- 2.3.26 Station all points of curvature, points of tangency, and points of intersection in the plan view. Station all radius returns and grade change points of intersection in the profile with their respective elevations.
- 2.3.27 The standard scales permitted for plans and profiles of paving and utility plans are as follow:
- A. Major thoroughfares or special intersections/situations:
1" = 2' Vertical; 1" = 20' Horizontal
 - B. Minor Streets:
1" = 5' Vertical; 1" = 50' Horizontal or
1" = 4' Vertical; 1" = 40' Horizontal or
1" = 2' Vertical; 1" = 20' Horizontal
 - C. The scales described above represent the minimum allowable. Larger scales may be required to show details of construction.
 - D. A scale bar is required on all appropriate sheets.
 - E. Deviations to these scales may only be allowed with the prior approval of the Engineering Department.
- 2.3.28 In addition to the plan and profile sheets described herein, each set of construction drawings shall contain paving and utility key drawings indexing specific plan and profile sheets. Overall layouts may be drawn at a scale of one inch equals one hundred feet (1" = 100') or one inch equals two hundred feet (1" = 200').
- 2.3.29 Standard City details, where applicable, shall be included.
- 2.3.30 Construction plans shall include a legend describing standard symbols that may not be reflected in the plans.
- 2.3.31 All property ownership and easement information shall be shown in the construction plans. Fort Bend County, Harris County and/or Brazoria County recording information, whichever is applicable, shall be shown in the construction plans.

- 2.3.32 When ownership, easement, and right-of-way recording information is not shown on the plat included in the plans, this information shall be shown on Construction plan sheets.
- 2.3.33 The City shall be provided with a pdf (minimum 400 DPI) of final plans and eventually Record Plans on an electronic format. Additionally, City shall be provided with the electronic files of construction plans in one of the following formats, as appropriate: Geodatabases (personal geodatabase, file geodatabase, ArcSDE geodatabase), Shape files (.SHP), DXF (AutoCAD, current version), DWG (AutoCAD, current version), DGN (5.x to 8 Microstation), LizardTech MrSID and MrSID Gen 3 (.SID) Aerial photos – for raster data (images).
- 2.3.34 Coordinate points for project controls or various project points as deemed necessary by the engineer shall be based on Texas State Plane Coordinate South Central Zone (4204), NAD 83 for horizontal georeferencing and NAVD88, 2001 Adjustment, GEOID 18 for vertical georeferencing.
- 2.3.35 Construction plan review submittals shall include a signed and sealed copy of the relevant Geotechnical Report.
- 2.3.36 Construction plan review submittals shall include a signed and sealed copy of the traffic analysis report as warranted and determined to be necessary at the discretion of the City Engineer.
- 2.3.37 Construction plan review submittals shall include a signed and sealed copy of drainage analysis report to provide background data and information needed to support design calculations.
- 2.3.38 Construction plan review submittals shall include a signed and sealed copy of the water and wastewater design analysis report to provide background data and information needed to support the design.

2.4 EASEMENTS

- 2.4.1 Provide all existing easements, recording information and any proposed easements shall be shown in the construction plans in accordance with Section 2.
- 2.4.2 Storm sewer, sanitary sewer, and water line easements shall be dedicated for the specific intended use.
- 2.4.3 Public utility easement requirements for a sixteen-foot (16') easement are as outlined in the "Typical Utility Location in 10-Foot Wide and 16-Foot Wide Easement Back-to-Back Lots and 14-foot Perimeter Lots" drawing prepared by the Utility Coordinating Committee for Metropolitan Area,

Effective June 1, 1971. The public utility easement width for dry distribution lines shall be ten feet (10'). Perimeter easement may be eight feet (8') by eight feet (8'), provided that the easement is dedicated by separate instrument or special notes on the plat.

2.4.4 Water line easements – the following minimum width easements are required when facilities are not located within public street rights-of-way or water line easements (as required in Chapter 3):

- A. Fire hydrants located outside of public rights-of-way or water line easements shall be located in a ten-foot by ten-foot (10'x10') exclusive, easement. Fire hydrants shall not be located within any other type of easements.
- B. Water meter easements shall be exclusive and shall be located adjacent to a public right-of-way or water line easement.
- C. Two-inch (2") and smaller meters serving non-residential and multi-family developments shall be set in five-foot by five-foot (5'x5') exclusive water meter easements.
- D. Three-inch (3") and larger meters shall be set in a minimum of ten-foot by twenty-foot (10'x20') exclusive, water meter easements.
- E. Subject to approval by the City Engineer, water mains may be located in easements not adjacent to public street rights-of-way and shall be centered in a twenty-foot (20') wide exclusive easement restricted to water only. No fencing or other restrictions limiting access to the full width of the easement or reserve will be allowed.
- F. For new construction, any watermain, except at a fire hydrant, located less than five feet (5') from the road right-of-way line and within the right-of-way shall have a water line easement adjoining the right-of-way. Water line easements adjoining a right-of-way for watermains shall have a minimum width of five feet (5').

2.4.5 Sanitary Sewer Easements

- A. Sanitary Sewers shall be designed and located to conform to regulations of the Texas Commission on Environmental Quality. Sanitary sewer easements shall be dedicated for the specific intended use. Easements for a specific facility shall be exclusive and shall not overlap other easements, except to cross the other easements. The following minimum width easements shall be required.
 - a. The minimum width of all exclusive sanitary sewer easements shall be equal to the depth of the sewer from finished grade plus

two (2) pipe diameters but no less than twenty feet (20') minimum.

- b. Sewer lines shall be located in the center of the easement. The minimum width of a sanitary easement shall be twenty feet (20') when split along a lot line, and twenty feet (20') wide for easements located within a single lot.
- c. Exclusive sanitary sewer easement adjoining a public right-of-way shall be minimum five feet (5').
- d. Sanitary sewers to a maximum depth of ten feet (10'), measured from finished grade, shall be placed within the right-of-way at least five feet (5') from inside the right-of-way. Sanitary sewers shall be placed along a uniform alignment within the right-of-way and shall include a five foot (5') easement outside of right-of-way.
- e. Where required, additional easement shall be provided adjoining the right-of-way to provide required clearances. An exclusive sanitary sewer easement adjoining a public right-of-way shall be five feet (5') wide provided the sewer is at least five feet (5') from the edge of the easement and the sewer is no deeper than ten feet (10'). Sewers at greater depth than ten feet (10') shall be centered within an exclusive easement parallel and adjoining the right-of-way
- f. Easements for force mains of all sizes shall comply with the requirements of sanitary sewers.
- g. A combined storm and sanitary sewer easement shall have minimum widths as required in Section 2.4.6 for storm sewer easements. Additionally, the sanitary sewer main, trunk or force main shall be located such that the centerline of the pipe shall be at least five feet (5') from the easement line, as defined in Section 2.4.6.
- h. If sanitary sewers or force mains are installed in easements separated from public rights-of-way by other private or utility company easements, the sanitary sewer easement shall be extended along or across the private utility company easement to provide access for maintenance of the sewer or force main.

2.4.6 Storm Sewer Easements - the following minimum easement widths shall be required:

- A. The minimum width shall be twenty feet (20') with the storm sewer centered in an exclusive easement, unless otherwise approved by the City Engineer.
- B. For storm sewers greater than ten feet (10') and less than fifteen feet (15') in depth, the minimum width of an exclusive easement shall be twenty-five feet (25').
- C. For storm sewer greater than fifteen feet (15') in depth, the minimum width of an exclusive easement shall be determined by the City Engineer.
- D. For all easements specified in Section 2.4, a minimum distance of five feet (5') shall be maintained from the easement line to the outside edge of the storm sewer.
- E. When approvals are granted for a special use or combination easement located along side lot or back lot, the minimum width shall be twenty-five feet (25'). The easement width shall meet or exceed all other easement requirements.
- F. For specially approved storm sewers located in an exclusive easement adjacent to public rights-of-way, the minimum easement width shall be ten feet (10'). The easement width shall meet or exceed all other easement requirements.

2.5 UTILITY LOCATIONS

- 2.5.1 All utilities shall be underground with the exception of electric primary lines. The electric primary lines, defined as feeders or three phase lines, shall be located around the subdivision perimeter whenever possible.
- 2.5.2 Water Main Location
 - A. All water mains shall be located within a public right-of-way or within dedicated water main easements in accordance with this Chapter and Chapter 3.
 - B. Water mains shall not be located in combination easements without the approval of the City Engineer.
- 2.5.3 Sanitary Sewer Location
 - A. Sanitary sewers shall be located within a public right-of-way or an easement adjoining the right-of-way. Sanitary sewers shall be located within the public street right-of-way in accordance with Chapter 4. Sanitary sewers may be located in exclusive or combination easements provided the easement widths comply with Chapter 2, above.

- B. Sanitary sewers shall not be located in side lot easements without the approval of the City Engineer.
- C. Sanitary sewers shall be located within the right-of-way between the property line and the back of curb on the opposite side of the right-of-way from the water main.

2.5.4 Storm Sewers

- A. Storm sewer shall be located in the public street right-of-way in accordance with this Chapter and Chapter 5.
- B. All storm sewer lines shall be located within public rights-of-way or approved easements. Placement of a storm sewer in side lot and back lot easements is discouraged. Approval from the City Engineer for the use of side lot or back lot easements for storm sewers shall be obtained prior to plan preparation.

2.6 PRIVATE FACILITY LOCATIONS (Not Including Landscaping)

- 2.6.1 Installation of private facilities, including utilities, in public road rights-of-way and their adjoining easements shall be subject to the approval of the City Engineer.
- 2.6.2 Private facilities shall not conflict with other facilities in the right-of-way and shall not be located in exclusive easements as required in the EDCM. All structures proposed to be located within the public right-of-way may not interfere with existing or proposed facilities and shall be subject to the approval of the City Engineer.
- 2.6.2 All facilities in the right-of-way shall be located at least two feet (2') behind the curb and all underground facilities in the right-of-way shall be located at least two and one-half feet (2.5') below the top of curb on a public street.
- 2.6.3 Private facilities shall be constructed in accordance with construction plans approved by the City Engineer.
- 2.6.4 Landscaping within the public right-of-way or adjoining easements shall not impact public utilities or traffic visibility.

2.7 CROSSINGS

- 2.7.1 Highway Crossings - All State and County Roads
 - A. State maintained Highway and Farm to Market Road crossings shall be constructed in accordance with the requirements of Texas Department of Transportation.

- B. A water main, sanitary sewer, or force main shall be encased in a steel pipe casing extending from right-of-way to right-of-way.
- C. County road crossing shall be constructed in accordance with the County's requirements.
- D. Where additional right-of-way has been acquired or will be required for future widening, the casing, where required, shall be carried to within ten feet (10') of each future right-of-way line.

2.7.2 Street Crossings

- A. All 6" and above water main, sewer forcemain, and sprinkler line crossings under streets identified as collectors and thoroughfares shall be encased. For all water mains, steel casing shall be used, and for fire sprinkler lines PVC pipe, SDR 26 shall be used.
- B. Conduits and gravity sewer lines not carrying liquid under pressure may be bored and jacked into place without an encasement pipe.
- C. Crossings under existing City Streets shall be constructed by boring and jacking. PVC pipe shall be jacked into place using equipment designed for that purpose. Water may be used to facilitate the boring and jacking operations. Jetting the pipe main into the place shall not be permitted. When conditions exist that warrant open cut across an existing street, approval by the Engineering Department shall be required.
- D. All open cut installations under existing or proposed streets need to be approved by the City Engineer and shall be backfilled as shown in the City of Pearland Standard Construction Details.
- E. All street crossings shall be constructed in accordance with construction plans approved by the Engineering Department. All street crossings shall be inspected by the Engineering Department and meet the requirements of the EDCM.

2.7.3 Railroad and Pipeline Crossings

- A. For railroad crossings, the carrier pipe shall be encased in steel pipe casing extending from right-of-way to right-of-way.
- B. All construction within the railroad or pipeline right-of-way shall conform to minimum requirements set out in an agreement with the owner of the right-of-way and/or easement.

- C. Copies of the permits and/or agreements from the railroad or pipeline shall be provided with the Major Construction Improvement permit application to the Engineering Department

2.7.4 Ditch and Stream Crossings

- A. Aerial crossing attached to the bridge structure is the City's preferred method.
- B. Where existing or proposed bridges have sufficient space and structural capacity for installing water mains or conduits (twelve inches (12") or smaller) under the bridge, but above the top of the bent cap elevation, such installation may be permitted upon approval of the construction plans. In all cases, the water main or conduit shall be above the bottom chord of the bridge and eighteen inches (18") above the 100-year water surface elevation. All conduits attached to a bridge shall be constructed using steel pipe and shall extend a minimum of ten feet (10') beyond the bridge bent or to the right-of-way line, whichever is greater. All conduit attached to a bridge shall be maintained by the owner of the conduit or be subject to removal.
- C. Separate, free-standing crossings across drainage ways are not allowed. Project engineer shall obtain prior approval from the Engineering Department prior to design when such installations are necessary.
- D. All stream or ditch crossings shall be constructed of steel piped from right-of-way to right-of-way.

2.8 TRENCH SAFETY

- 2.8.1 All construction within the City of Pearland and its extraterritorial jurisdiction shall conform to federal and state requirements. Trench safety is required for all excavations greater than five feet (5') in depth. The contractor shall prepare or obtain the appropriate safety systems, including current OSHA standards for trench safety. Design of trench safety systems, sealed by a licensed professional engineer, shall be submitted to the Engineer of Record by the contractor prior to the execution of work.

2.9 STREET LIGHTING

- 2.9.1 Installation of street lighting shall be mandatory along all public streets in the City. In addition, the installation of street lighting is strongly encouraged along existing or repaved streets. Street lighting plans shall be coordinated with the Engineering Department. For areas in the Extraterritorial Jurisdiction (ETJ) of the City of Pearland, street lighting shall be required and reviewed by the Engineering Department in accordance with these Standards.

- 2.9.2 The location of street lights shall be designed to maintain approximately 200' spacing and shall be subject to approval by the Engineering Department.
- 2.9.3 Subject to City approval private lighting systems may supplement or replace all or a portion of the public street lighting provided the light system is equivalent to the lighting standard contained herein. A perpetual entity, such as an incorporated homeowners association and/or an approved private entity, shall notify the Engineering Department of its agreement to pay for the operation and maintenance of a private lighting system prior to installation of the system.
- 2.9.4 Street lights shall be designed in accordance with the design and luminance requirements established by AASHTO in the most recent edition of the Roadway Lighting Design Guide. All public rights-of-way street lighting systems shall include only light fixtures CenterPoint Energy makes available to the City.

2.10 SURVEY

- 2.10.1 The survey performed in the City shall use the Primary or Secondary Survey control monuments established by the City in 2020. The professional surveyors are instructed to identify and use the closest survey control monuments using the City's GIS webpage.
- 2.10.2 The City's monuments (Bench Mark) are established using Texas State Plane Coordinate, Texas South Central Zone (4204), NAD83 and NAVD 1988, 2001 adjustment, GEOID 18.
- 2.10.3 It is the professional surveyor's responsibility to calculate the vertical datum differences between the project datum and the datum as shown on the effective FEMA FIRM and present a table with vertical datum difference.
- 2.10.4 A tertiary bench mark shall be set in each subdivision section or at a spacing of one mile, whichever is greater. The benchmark shall have an elevation based on the North American Vertical Datum of 1988, 2001 adjustment.
- 2.10.5 The benchmark elevation and location shall be certified by a registered public surveyor as a Texas Society of Professional Surveyors (TSPS) Standard and Specifications for Category 8, TSPS Third Order Vertical Control Survey. Accuracy of elevations for benchmarks shall conform to the Texas Society of Professional Surveyors Category 8, Third Order.
- 2.10.6 Bench marks shall be constructed of a brass disc set in concrete as approved by the City Engineer. The concrete footing for the bench mark shall be

eight inches (8") in diameter and three feet (3') deep, and concrete shall be reinforced with two number four (2-#4) rebars.

- 2.10.7 Construction plans shall clearly identify the location of the bench mark and shall include a complete description, coordinates and elevation, with adjustment date, of the bench mark.

2.11 RESIDENTIAL LOTS AND IMPROVEMENTS

- 2.11.1 All residential lots shall drain to a public right-of-way directly adjoining the lot. Drainage from a residential lot to a public right-of-way at the rear or side of a lot may be permitted if the drainage system has been properly designed to accept the flow. Drainage from a residential lot to an adjoining greenbelt or golf course shall require a public easement and an agreement that the easement will be maintained by a homeowner's association or other approved entity. Drainage to a private easement shall require prior approval by the City Engineer and shall be noted on the recorded subdivision plat. Drainage to a Brazoria County drainage easement shall be subject to approval by Brazoria Drainage District No. 4.
- 2.11.2 A lot grading plan showing proposed minimum slab elevations shall be included in the construction plans.
- 2.11.3 A Construction plan (site plan, grading plan, drainage plan etc) for a residential in-fill lot (<15,000 sf), located outside of regulatory floodplain can be prepared by the property owner/designer/architect. This provision is not applicable to the construction within the regulatory floodplain and must be signed and sealed by a PE and should include Pre-Construction and Post-Construction elevation certificate.
- 2.11.4 See Chapter 5 Storm Sewer Design for design requirements.

2.12 FLOODPLAIN MANAGEMENT

- 2.12.1 All development shall conform with the City's Flood Damage Prevention Ordinance.
- 2.12.2 Amendments to the published flood maps, map revisions and all requests for changes to the base flood elevation within Pearland city limits shall be submitted to the City Engineer for approval. Technical data required by the Federal Emergency Management Agency and justification for the proposed change must be included with all requests. All requests for changes to the base flood elevation within the City of Pearland Extraterritorial Jurisdiction (ETJ) shall be submitted to the City of Pearland Floodplain Administrator for comments. Modifications to the floodplain or floodway shall require a FEMA approved Conditional Letter of Map Revision (CLOMR) prior to construction plan approval. Upon completion of construction modifications

to floodway or floodplain shall require a FEMA approved Letter of Map Revision (LOMR).

- 2.12.3 All data submitted shall be prepared under the supervision of a registered professional engineer and/or a registered public surveyor and shall comply with all requirements of the Federal Emergency Management Agency.
- 2.12.4 All development within regulatory floodplain must apply for a City permit. Construction within the floodplain is prohibited until a permit is approved by the City's Floodplain Administrator.
- 2.12.5 Per City Ordinance 532 (most current version), Building lowest floor elevation shall be 12 inches above the highest the crown of street along the property frontage for a property outside of FEMA mapped floodplain or 12 inches above 100-year floodplain for a property located within FEMA mapped floodplain.
- 2.12.6 Per City Ordinance 532 (most current version), All the machinery or equipment (AC unit, Generator, etc.) servicing the building shall be elevated at least 12 inches above the base flood elevation.
- 2.12.7 Building floor elevation for critical facilities as defined in the City's Flood Hazard Ordinance shall be 18 inches above the 100-year base flood elevation.
- 2.12.8 Pre-Construction and Post Construction Elevation Certificate (EC) signed by a Professional Engineer, Professional Surveyor, or an Architect is required for all new and substantial improvement structures within FEMA mapped 100-year floodplain.

2.13 STORMWATER MANAGEMENT PLAN

- 2.13.1 All development projects irrespective of size must develop Stormwater Pollution Prevention Plan and comply with the City's latest Illicit Discharge and Stormwater Ordinance 1570 (most current version). See Chapter 8 - Stormwater Management for more detail.

CITY OF PEARLAND

**CHAPTER 3
WATER SYSTEM DESIGN CRITERIA**

ENGINEERING DESIGN CRITERIA MANUAL
October 2020

CHAPTER 3 WATER SYSTEM DESIGN CRITERIA

3.1 GENERAL

- 3.1.1 Criteria for the design of water service and water distribution lines are herein established. All water lines constructed within the City or the City's Extraterritorial Jurisdiction (ETJ) shall follow these criteria and be in agreement with the City Water Master Plan.
- 3.1.2 Design, construction and sizing of all water mains and appurtenances shall meet or exceed the requirements of the Texas Commission of Environmental Quality (TCEQ) as per 30 TAC 290, Texas Board of Insurance (TBI), and City Water Master Plan/model.
- 3.1.3 The public water system shall not extend beyond the individual water meter. All waterline construction in City rights-of-way or easements up to and including construction to the water meter shall conform to these standards.
- 3.1.4 Design and construction shall conform to the City construction details and construction specifications.
- 3.1.5 The "City of Pearland" for the purposes of these criteria shall consist of all land within the city limits, and land located within the City's ETJ.
- 3.1.6 The final decision approving authority for the City with respect to the water system design criteria shall be with the City Engineer and Public Works Department.
- 3.1.7 Transmission mains are defined as 20-inch and above.
- 3.1.8 Distribution mains are defined as 18-inch and smaller.
- 3.1.9 Construction and sizing of all water mains and appurtenances shall meet or exceed the requirements of the Texas Commission on Environmental Quality, the Texas Department of Health, and the City Water Master Plan.
- 3.1.10 All proposed water distribution systems and interconnects between separate systems and/or utility districts, shall be approved by the City Engineer and Public Works Department and, if required, by the Pearland Fire Marshal.

3.2 DESIGN REQUIREMENTS

- 3.2.1 Obtain approval from the City Engineer for exceptions or deviations from these requirements. Exceptions or deviations may be given on a project-by-project basis through the variance process identified in Chapter 2.
- 3.2.2 Public water distribution systems shall be designed to handle the necessary water flow based upon complete development. The necessary water flow shall include applicable residential and non-residential uses and fire protection flows.
- 3.2.3 The water system shall be designed to deliver peak-hour demand flows. The fire flow shall be available above the peak hour demand of the system and for a duration and at the residual pressure as specified by the Fire Marshal.
- 3.2.4 One (1) copy in Adobe Acrobat (.pdf) format of the system hydraulic calculations, sealed by a Texas Registered Professional Engineer, shall be submitted with all water distribution system plans. These calculations shall show how the water flow rates were computed, design assumptions and that fire flow requirements are met. If the proposed water distribution system is connecting to an existing system, verification of the flow rates and pressure in the existing system, both before and after inclusion of the new system, shall be provided by the design engineer and approved by the City Engineer.
- 3.2.5 Layout of the overall water system and of all water mains within the city limits and extraterritorial jurisdiction shall be approved by the City Engineer. The overall water system shall be designed to maintain adequate pressure throughout the system. In all cases, specific water pressure and flow analysis and study shall be required. The layout of the water mains should provide maximum circulation of water to prevent future problems of odor, taste, or color due to stagnant water.
- 3.2.6 Provide adequate circulation and place valves and fire hydrants, so that flushing of all mains will be simplified.
- 3.2.7 Dead-ends shall be avoided where possible. All dead-ends shall be isolated with a line valve, be as short as possible, and be equipped with a fire hydrant at the end of the main as required in this Chapter.
- 3.2.8 Water Distribution System Materials
 - A. All materials used in the construction of public water distribution systems shall be in conformance with American Water Works Association (AWWA) and National Sanitation Foundation (NSF) International guidelines.
 - B. Poly Vinyl Chloride (PVC) Pressure Pipe, two-inch (2") through twelve-inch (12"), shall conform to the requirements of

ANSI/AWWA C900, current revision, Class 150 DR 18. Pipe shall be designed and constructed in conformance with the minimum requirements of the "Manual of Water Supply Practices", AWWA Manual No. M23. PVC pipe with the use of ductile iron fittings is the preferred material for water line construction. The use of ductile iron pipe is allowed as necessary.

- C. Bedding and backfill shall conform to the City Standard Construction Details.
- D. Other pipe materials may be used for construction of water mains, when specifically approved by the City Engineer.
- E. Construction of water mains shall be in accordance with approved construction plans and the City Standard Construction Details.

3.2.9 Lines:

- A. Locate water lines within street rights-of-way, or appropriate utility easements and as determined by the Water Master Plan/model and City Engineer:
 - a. Six-inch interconnected/looped mains shall be a maximum of 1500 feet long, shall be supported on both ends by an 8-inch main or larger and shall have no more than two (2) intermediate fire hydrants. Dead end six-inch (6") mains shall not be more than six hundred feet (600') in length and shall terminate at a fire hydrant.
 - b. Except when 6-inch diameter lines are permitted under the above criteria, all water lines shall have a minimum diameter of 8-inches for lengths above 1500 feet, or when three (3) or more intermediate fire hydrants are required or as determined by the design model.
 - c. 10-inch diameter water line is not permitted.
 - d. Pipe with a min. 12-inch diameter and larger mains shall be required at locations established by the City Engineer and/or as determined by the design model.
 - e. Dead-end lines:
 - i. Dead-end lines shall not be allowed in subdivisions with 25 or more connections unless a looped or interconnecting water main system is not nearby. A non-looped system within such subdivision requires prior approval from the Engineering Department.
 - ii. The design of all water distribution systems shall include the opportunity for future looping or interconnect of any approved or proposed dead-end line.
 - iii. Non-residential dead-end lines within public right-of-way:
 - 1. On permanent dead-end lines not serving residential cul-de-sacs, the line shall be 6 or 8 inches in diameter and shall not exceed

more than 600 feet in length from the closest interconnection main line and shall terminate with a valve, reducer and fire hydrant. Line shall be restrained. Thrust blocking is not allowed. Line size shall be determined by the water model.

2. In temporary dead-end situations or if the possibility for future extension of the water line exists do not reduce pipe sizes successively. Carry 8-inch diameter pipe to the last appurtenance or the plug. Place the last service as near as possible to the end and install a valve, reducer and fire hydrant at the end of the line. The maximum length of such a line shall be 600 feet and the line shall be restrained. Thrust blocking is not allowed.
3. In unavoidable permanent dead-end situations, reduce the sizes of pipe successively. The last segment of line shall be 8 inches in diameter and shall not exceed more than 600 feet in length from the closest interconnection main line and shall terminate with a valve, reducer and fire hydrant. Thrust blocking is not allowed.

- f. Water line placement in side lot easements shall not be allowed except by specific approval from the City Engineer for looping purposes. Where water line placement is allowed, they shall be required to be lined in a continuous steel casing pipe. When such casing is required by the City, extend the casing uninterrupted from building line to building line. No horizontal or vertical deflections are allowed. Construct encased water line of restrained joint PVC pipe to prevent lateral movement. Provide and install casing spacers and end seals. This item shall only apply to publicly maintained lines.

B. Testing of Installed Water Lines

- a. A hydrostatic ex-filtration test shall be performed on all water lines in accordance with the requirements of TCEQ and AWWA C600-10 (ductile iron pipe) or C605-13 (PVC pipe), current editions, prior to being placed in service.
- b. New water lines shall be thoroughly disinfected in accordance with AWWA Standard C651 and TCEQ requirements and then flushed and sampled prior to being placed in service.

- c. All newly installed water lines shall have to pass bacteriological testing before being accepted for maintenance by the City.
 - d. Copies of all test results shall be given to the City.
- C. Backfill shall be in accordance with City Standard Details. All backfill within public right-of-ways and public easements shall be compacted to a minimum of ninety-five percent (95%) of Standard Proctor Density (ASTM D2922-78 and ASTM D3017-78), without additional moisture control, cured and tested in accordance with ASTM C31.
- D. All waterline located underneath and within thirty-six (36") of any paving shall be bedded in bedding sand and cement stabilized sand in accordance with the Standard Construction Details. The cement stabilized sand shall be in accordance with the following requirements.
 - a. The cement shall be Portland Cement, Type I, ASTM C150.
 - b. The sand shall be clean, durable sand, with less than 0.5 percent clay lumps, ASTM C142; with less than 0.5 percent lightweight pieces, ASTM C123; with organic impurities, ASTM C40, not showing a color darker than standard color and a plasticity index of less than six (6) when tested in accordance with ASTM D423 and ASTM D424.
 - c. Compact to ninety-five percent (95%) Standard Proctor Density (ASTM D2922-78 and ASTM D3017-78) in maximum loose lifts of eight inches (8") thick. Actual testing shall be required as deemed necessary by the City of Pearland.
 - d. The cement-sand mixture shall consist of at least 1.5 sacks of cement per ton of sand. The cement-sand mixture shall have a minimum unconfined compressive strength of one hundred pounds per square inch (100 psi) in forty-eight (48) hours, when compacted to a minimum of ninety-five percent (95%) of Standard Proctor Density (ASTM D2922-78 and ASTM D3017-78), without additional moisture control, cured and tested in accordance with ASTM C31.
- E. Water lines outside of paving shall be bedded in accordance with the Standard Construction Details.
- F. Bedding shall be compacted to ninety-five percent (95%) Standard Proctor Density six-inches (6") over pipe prior to backfilling the trench. In water bearing sand, washed shell or other approved granular material will be required with geo-textile fabric wrap as shown in the Standard Construction Details. When water bearing sands are encountered, the City shall be notified immediately.

- G. Within 90-days of the end of the two-year warranty period the developer/contractor shall conduct a scouring of the line through “pigging” the lines. This will be coordinated with the City Engineer and Public Works Department for this work. Costs to conduct this cleaning shall be borne by the developer/contractor.

3.2.10 Location

- A. Boulevard streets: If approved, public water lines may be located within the esplanade. Water lines shall be located as near the centerline as possible to avoid conflict with future pavement widening.
- B. Locations within an easement: Water line easements shall be in conformance with Chapter 2. The City Engineer may require a wider easement if the line is to be buried more than 8 feet deep from natural ground surface at any point in the easement. Obtain approval from the City for lines to be located in smaller or multi-use easements.
- C. When a water line is placed parallel to but not crossing any other proposed or existing utility line, other than a sanitary sewer, the water line shall have a minimum of 1-foot horizontal clearance from the outside wall of the existing utility to the outside wall of the proposed waterline and vice versa. Any proposed deviation from these criteria must first be approved by the Engineering Department.
- D. A minimum distance of 5 feet shall be maintained from the right-of-way or easement line to the outside edge of the water line.

3.2.11 Depth of Cover (See Table 3.1)

- A. Provide the minimum depths of cover shown in Table 3.1 from the top of natural ground behind the curb for curb-and-gutter streets, or from the lowest elevation of the nearby ditch bottom for roadside ditch street sections whichever is applicable unless a variation is granted by the Engineering Department.
- B. Whenever possible, changes in grade or alignment to clear utilities or underground features should be accomplished by deflecting pipe joints. The maximum designed deflection shall be $\frac{1}{2}$ of the manufacturer’s allowable deflection. The vertical realignment shall be restrained in each direction per restraint requirements and be constructed with mechanical joint fittings and restraints. Any bell joints located in the vertical realignment shall also be restrained.

- C. If a depth greater than 8 feet is proposed, all joints of PVC pipe shall be mechanically restrained. All fittings shall be restrained. Where conflicts are encountered with utilities or other underground facilities, the depth of cover may be reduced to 2 feet from top of curb.

**Table 3.1
DEPTH OF COVER FOR WATER LINES**

SIZE OF LINE	DEPTH OF COVER*	
	TOP-OF-CURB	OPEN-DITCH
8-INCH & 6-INCH	4 FEET	5 FEET below ultimate flowline
12-INCH & LARGER	5 FEET	5 FEET below ultimate flowline

**When crossing easements whose owning or governing agency has stricter depth of cover criteria than that shown in Table 3.1, the stricter of the two shall apply. Where other agencies have review authority or jurisdiction and have different depth of cover requirements, the stricter of the two shall apply.*

3.2.12 Appurtenances

- A. Do not place appurtenances in pavement when the appurtenance would be covered in whole or in part by pavement. When approved by the City, gate valves may be placed in sidewalks or paved roadways provided that the top of the valve box is flush with the finished pavement.
- B. All water system valves shall conform with AWWA standards and shall include:
 - a. Cast iron valve boxes are required on all valves.
 - b. All valves shall be sized to equal the size of the water main.
- C. Valves
 - a. Spacing – set at maximum distances along the water line as follows:
 - i. Distribution – 1000 feet
 - ii. Transmission – 2000 feet
 - iii. The total number of valves at any water line intersection shall equal the total number of lines leading out from the intersection point.
 - iv. Refer to standard specifications for tapping sleeve & valve.

b. Location

- i. Valves must be located at street intersections along the street right-of-way lines projected across the water line where possible. Tapping sleeve and valves are excluded from this requirement.
- ii. Isolate fire hydrants and flushing valves from the service main with a valve located on the fire hydrant or flushing valve lead at the main line connection. This valve should not be located in the slope or flowline of roadside ditches.
- iii. Intermediate valves, not located on the projection of the right-of-way line, shall be located on the water line 5 feet from a fire hydrant but shall not be set in a driveway.
- iv. Locate valves a minimum of 10 feet horizontally away (either direction) from any sanitary sewer crossing.
- v. Valves located near reducers shall be located on the larger diameter pipe.
- vi. All water mains shall be valved within the street right-of-way.
- vii. Valves shall not be placed under or within 2 feet of ultimate pavement, when it is known that the street will be widened in the future, without prior approval of the Engineering Department.

c. Valve Type

- i. All valves shall be resilient seated Gate Valve, AWWA C509, counterclockwise opening with mechanical joints (MJ) or flange by MJ connections. Valves shall have a complete epoxy coating on all iron parts in the valve interior and exterior to eliminate corrosion.
- ii. Butterfly valves are not allowed in the distribution system.
- iii. Valves shall be approved by the City and shall be listed on the Approved Products List.

D. Fire Hydrants

- a. Fire hydrants shall have three-way nozzle arrangement, five and one-quarter-inch (5-1/4") compression type main valve, mechanical joint boot, and conform to the requirements of AWWA C502. The pumper nozzle shall be equipped with a five-inch (5") Storz locking connection that is factory

installed. Hydrants shall be factory painted. Field painting of the hydrants after installation is not allowed other than touch-up. Approved fire hydrants shall be listed on the Approved Products List.

- b. The body of the fire hydrant shall be factory painted Safety Blue (Code No 225A120) two part Polyurethane Enamel. All paints shall conform to the City of Pearland Fire Hydrant Color Code. Fire hydrants shall be color coded on the fire hydrant bonnet and caps based upon mainline size. The paint utilized shall be a two part Polyurethane Enamel or approved equal and installed in accordance with the manufacturer's instructions. The color code shall be as follows:

Color	Water Main Diameter (in.)	Polyurethane Enamel
White	6"	Glossy White Code No 225A100
Orange	8"	Safety Orange Code No 225A122
Green	12"	John Deere Green Code No 225A133
Yellow	16" to 20"	John Deere Yellow Code No 225A138
Red	22" and larger	Safety Red Code No 225A123

- c. All fire hydrants shall be installed so that the steamer connection will face the fire lane or street or as directed by the Fire Marshall.
- d. A Blue Stimsonite, Fire-Lite reflector model 88-SSA (or approved equal) shall be placed 12 inches (12") from the centerline of the street, offset towards the fire hydrant. At intersections, reflectors shall be placed on both roadways opposite fire hydrant.
- e. Spacing
 - i. Single family residential development – 500 foot maximum spacing or as designated by the Fire Marshal.
 - ii. All other development – no less than 300 foot spacing.
- f. Location in or along street right-of-way
 - i. Locate fire hydrants primarily at or near street intersections.
 - ii. Locate fire hydrants at the end of a curb radius of a street intersection, 3 feet behind back of curb or

- projected future curb in a curb & gutter road construction application.
- iii. On cul-de-sacs, place fire hydrant in straight section to avoid conflict with placement of the sidewalk.
 - iv. On streets with roadside ditches, set the fire hydrants within 5 feet of rights-of-way lines. Fire hydrant lead valves should not be located in the slopes or flow lines of ditches.
 - v. Set fire hydrants not located at intersections or block corners at mid-lot or on lot lines, as extended to pavement, when located between right-of-way intersections. These locations may be adjusted 5 feet either way to avoid driveways or obstructions. In either case, do not locate fire hydrants closer than 5 feet from driveways.
 - vi. Provide fire protection on both sides of Major and Minor Thoroughfare and Collector roads with median dividers. Fire hydrant shall have an average spacing of 300' and be arranged in an alternating basis.
 - vii. Fire hydrants are not allowed in esplanades of streets.
 - viii. On all Texas Department Transportation (TxDOT) rights-of-way, set the fire hydrants and flushing valve set-backs from the edge of right-of-way shall adhere to TxDOT criteria.
- g. Location of fire hydrants or flushing valves outside street rights-of-way and in public easements:
- i. City review and approval is required for all submitted locations of fire hydrants and flushing valves in all developments within the City of Pearland and its ETJ.
 - ii. Locate fire hydrant and flushing valves in protected, easily accessible areas behind curb lines.
 - iii. For fire hydrants or flushing valves that are located adjacent to water lines constructed in 10 foot wide water line easements, the fire hydrant or flushing valve shall be centered in a minimum 15 foot by 15 foot separate easement.
 - iv. For non-residential developments in the City of Pearland, provide isolation valves at each end of fire loops requiring on-site fire hydrants.
- h. Fire hydrant leads shall be designed to have a minimum 4 foot bury where possible. Bends may be used on the fire hydrant branch to maintain a 4 foot bury or a 3 foot back of curb set-back.

- i. Do not install fire hydrants within 10 feet vertically or horizontally of sanitary sewers and force mains.
- j. The fire hydrant supply line from the public water main to the fire hydrant shall be constructed of Ductile Iron Pipe. PVC is not allowed.
- k. The depth of bury for all fire hydrants shall be established such that the manufacturer bury line on the fire hydrant is installed at the ground line at each location or at the finished ground after pavement construction.
- l. Fire hydrants shall not be installed within nine feet (9') of a sanitary sewer system under any conditions.
- m. Fire hydrants that are to be designated as private shall have a factory coated body color of red. The caps and bonnet shall be coated as per this Chapter. These fire hydrants will be owned and maintained by the property owner/entity. The valve for the fire hydrant line shall be located at the public water main.

E. Fittings

- a. Fittings shall be Ductile-Iron Compact Fittings Three-Inch (3") to Twelve-Inch (12"), AWWA C153/A21.53.84, conforming to the minimum requirements of "Gray-Iron and Ductile-Iron Fittings, Twelve-Inch (12") through Forty-Eight-Inch (48")", for Water and Other Liquids", AWWA C153 (ANSI 21.10), current revision. Fittings shall be furnished with epoxy or cement mortar lined, AWWA C104 (ANSI A21.4).
- b. All fittings shall be identified and described on the construction plans.
- c. Fittings are not permitted in fire hydrant leads, except as specifically approved by the City Engineer,
- d. Water main fittings shall be mechanical joint.
- e. All water main pipe joints shall be push-on joints. Only flanged joints shall be used for above ground waterline installations or at above ground valve locations.
- f. Polyethylene tube encasement shall conform with 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.
- g. All underground bolts and nuts shall be 316 stainless steel.

F. Ductile Iron Pipe

- a. Use of ductile iron pipe shall be with prior approval of the City Engineer and Public Works Department.

3.2.13 Water Meter Service

- A. All water meters 2 inches and smaller shall be installed by the City of Pearland on custom home residential properties. All water meters in subdivision developments shall be installed by City personnel.
- B. Vaulted water meter installation shall be undertaken by private contractors with prior approval from the Engineering Department.
- C. Commercial water meters shall be the same size as the water service line.
- D. Stub outs for future water service are not allowed except where part of a preapproved master plan, site plan development plan or tract development plan.
- E. Minimum size water service line and fittings shall be 5/8-inch meter with $\frac{3}{4}$ inch stop at the meter for any single connection for residential homes. The Chief Building Official and Inspection Services should be consulted to ensure the proper sized meter is selected for any proposed service.
- F. Water service leads from the water main to the water meter shall be placed at a minimum 4 foot below final paving elevations.
- G. Meter boxes shall be located just within the public right-of-way. Location of meters in the ditch of open ditch streets shall be avoided. Meter boxes shall be installed no more than 2 inches above final natural ground.
- H. Back-flow prevention devices shall be installed in line on the private water meter service line on all commercial developments, irrigation metered service, and shall be installed in all applications where the City of Pearland's Plumbing Code and its latest revision requires.
 - a. Fireline services utilizing pumps, fire department connects, (FDC) shall have a Reduced Pressure Principal Detector Check Value Assembly.
 - b. All commercial and irrigation service lines tapped off the public water main shall have an above ground reduced backflow prevention assembly located behind the water meter.

- c. Vacuum Breaker styles will be used for irrigation systems.
- d. The City of Pearland Backflow Division will review and provide approval of the backflow prevention device to be used for the appropriate usage. Depending on the size of the backflow device it may require a vault or be located above ground in a lockable vault.

3.2.14 Water Line Crossings within the City of Pearland

A. Public and private utility crossings other than sanitary sewer: Where a water line crosses another utility other than a sanitary sewer, a minimum of 1 foot of clearance must be maintained between the outside wall of the water line and the outside wall of the utility.

B. Stream or ditch crossings

a. Elevated crossings

- i. Water lines shall be welded steel pipe and shall extend a minimum of 15 feet beyond the last bend or to the right of way line, whichever is greater.
- ii. Elevated crossings are preferred to underground crossings.
- iii. Use a separate elevated supporting structure for 12 inch and larger water lines. Locate structures a minimum of 10 feet from any existing or proposed structures.
 - 1. Adequate structural capacity shall have been calculated and provided for including considerations for pipe deflection and all applicable loading.
 - 2. Clearance for maintenance purposes above bent cap elevation shall be provided where elevated water lines are to be run under bridges.
- iv. When approved by the Engineering Department, bridge attachments for elevated water line crossings may be made instead of separately supported crossings. Designer to provide support documents that bridge was designed for such load or provide analysis signed and sealed by a professional engineer that bridge can support such load.
- v. Design elevated crossings with the elevation of the bottom of the water line 2 feet above the 100-year floodplain elevation

- vi. Create a high point in the elevated stream or ditch crossing and provide an air release valve at that highest point of the water line.
- vii. Provide sufficient span length to accommodate the cross section of future widening of the stream or ditch to ultimate cross section.
- viii. Base the columns' support designs on soil capacity, spacing, loading, and all pertinent structural requirements.
- ix. Spacing of supports shall consider effect of support on channel hydraulics and be subject to city approval.
- x. Provide pedestrian pipe guards on elevated crossings.

b. Underground Crossings

- (1) Provide a minimum 5 foot clearance from the top of the pipeline to the ultimate flow line of the ditch.
- (2) Provide sufficient length to exceed the ultimate future development of the stream or ditch.
- (3) Water lines shall be C-900 PVC, HDPE, Fusible PVC or ductile iron pipe (if approved by the Engineering Department) and shall extend a minimum of 15 feet beyond the last bend or to the right of way line, whichever is greater. Carrier pipe may be required.
- (4) Where other agencies have review authority or jurisdiction and have different underground crossing requirements, the stricter of the two shall apply.

C. State Highway and County Road Crossings

- a. Extend carrier pipe from right-of-way to right-of-way.
- b. The approval of the design by the appropriate governmental agency shall be demonstrated to the City Engineer before plans will be approved.
- c. Where additional right-of-way has been acquired for future widening, the casing shall extend 5 feet beyond each right-of-way line.

D. Railroad Crossings

- a. For mainline and spur line railroad crossings, the water line shall meet the requirements of the governing agency and such requirements shall be followed from 5 feet beyond each right-of-way line and across the right-of-way itself. Any

deviation shall be approved by the railroad companies. The approval of the design by the appropriate governing agency shall be obtained and submitted to the City Engineer before plans will be approved.

- b. Where there is no railroad but a railroad owned easement or right-of-way, as a minimum extend a steel casing from right-of-way to right-of-way line.
- c. The approval of the design concept by the railroad involved shall be obtained and submitted to the City Engineer before plans will be approved.

E. Additional Requirements

- a. Isolate water lines from casing with spacers and supports.
- b. The carrier pipeline shall extend a minimum of 1-foot beyond the end of the casing to allow flanged joints to be constructed if necessary.

F. Oil and Gas Pipeline Crossings

Use PVC pipe when crossing a non-service transmission pipeline regardless of depth. Designer is required to meet with the City Engineer to discuss possible encasement for the PVC water main. All non-service transmission pipeline crossings must have the approval of the company whose lines are being crossed. Maintain a minimum 2 foot vertical separation between the pipeline and the water line.

3.2.15 Auger Construction: Use the following general criteria for establishing auger, bore and jack, or microtunneling sections when site conditions require their use:

- A. Improved streets – Use auger or microtunneling construction to cross a street regardless of surface. Auger or microtunneling length shall be computed as roadway width at the proposed bore location plus a minimum of 10 feet to either side of roadway.
- B. Driveways – Use auger or microtunneling construction to cross improved driveways. Bore and jack, auger or microtunneling length shall be a minimum of the driveway's width.

3.2.16 Circulation and Flushing for Water Quality: The layout of the water distribution system shall provide for maximum circulation of water.

- A. Provide a source of fresh water at each end or at multiple points of a subdivision or development. Provide ways to create circulation and place valves and fire hydrants to allow simple flushing of lines.

3.2.17 New Water Lines Constructed Near Sanitary Sewers and Force Mains and Manholes

- A. Water mains shall be designed and located to conform to regulations of the Texas Commission on Environmental Quality.
- B. For water mains crossing an existing or proposed sanitary sewer or force main, the following clearances shall be provided for protection from contamination. The minimum clearances will be approved only when justified and field conditions so dictate. The latest edition of "Rules and Regulations for Public Water Systems", of the Texas Commission on Environmental Quality, shall be followed for minimum criteria and instructions for water line crossings

3.3 QUALITY ASSURANCE

- 3.3.1 Prepare calculations and drawings prepared under the supervision of a Texas Professional Engineer trained and licensed under the disciplines required by the nature of the drawings. The final design drawings, must be sealed, signed and dated by the Professional Engineer responsible for development of the drawings.
- 3.3.2 For Elevated Stream and Ditch Crossings: Prepare design calculations for support columns and column spacing.

3.4 ADDITIONAL STANDARDS

- 3.4.1 All existing developed areas shall be restored to original condition after construction.
- 3.4.2 Proper barricading and signage, conforming to the Texas Manual of Uniform Traffic Control Devices' latest edition, shall be required on all projects. Adequate signage for vehicular and pedestrian traffic shall be installed. A traffic control plan shall be submitted to the City of Pearland and approved by the City Engineer for all streets open to travel by the public.
- 3.4.3 A continuous trace wire, such as a solid 14-gauge copper wire with blue shielding or approved equal, shall be affixed to the top of the new water main prior to bury. Trace wire shall be connected to all water meter angle stops, fire hydrants, and valve box risers. Wire splices shall be completed using approved, mechanical splice kits. Soldered connections are not permitted. A continuity test shall be completed prior to acceptance.

- 3.4.4 As an option to trace wire the use of locator “ball markers” that are color coded for the water main can be used. Spacing to be at the manufacturer’s recommendation. This option will require City Engineer and Public Works Department Approval.

3.5 EXTRA TERRITORIAL JURISDICTION

The criteria herein described in this chapter shall be applicable to all water main and appurtenance construction and all devices thereunto related within the City of Pearland and required for projects located within the ETJ. For those projects located in the ETJ, the City of Pearland will review public improvement construction drawings for conformance with the City’s Standards.

CITY OF PEARLAND

**CHAPTER 4
SANITARY SEWER DESIGN CRITERIA**

**ENGINEERING DESIGN CRITERIA MANUAL
October 2020**

CHAPTER 4 SANITARY SEWER DESIGN REQUIREMENTS

4.1 GENERAL

- 4.1.1 This chapter addresses the design of the sanitary sewer systems to be located within the public right-of-way or a dedicated public easement and the extra-territorial jurisdiction of the City of Pearland. Sanitary sewers located on private property, that are not in a dedicated public easement, shall not be considered part of the publicly maintained sanitary sewer system.
- 4.1.2 Construction plans for private improvements, within public right-of-ways and public easements that connect to or affect the public infrastructure shall be approved by the City of Pearland subject to the requirements of this manual and are subject to review and approval using the process defined in this manual.
- 4.1.3 Construction and sizing of all sanitary sewer mains and appurtenances shall meet or exceed the requirements of the Texas Commission on Environmental Quality and the Texas Department of Health.
- 4.1.4 Sanitary sewer service shall be extended to all building sites prior to development. Septic systems are not allowed, except as specifically approved by the City Engineer.
- 4.1.5 The public sanitary sewer system shall be defined as all sewers, including stacks and service leads that are located in public easements or street rights-of-way, and that are installed in accordance with these Standards. The public sanitary sewer system shall not extend beyond the service connection. All public construction shall conform to the requirements of this manual. All private construction beyond the service connection shall conform to the requirements of the City of Pearland adopted Plumbing Code.
- 4.1.6 On a case-by-case basis the City of Pearland reserves the right to allow deviations from these design criteria where necessary. See Chapter 1 for procedures to apply for variances to these design criteria. These design criteria are not intended to cover repairs to pre-existing facilities especially when such repair work is performed by City of Pearland personnel/forces. These criteria are not intended to cover existing sanitary sewer facilities located in alleys or other areas that do not conform to these criteria.

4.2 DEFINITIONS

- 4.2.1 Public Sanitary Sewer - All sewers that are maintained by the City of Pearland and located in public easements or street rights-of-way, pre-

existing sanitary sewer lines that are serving the public at the time of the adoption of these regulations, and new sanitary sewers that are installed in accordance with these standards.

- 4.2.2 Sanitary Sewer Main – A sewer which receives the flow from one or more lateral sewers.
- 4.2.3 Lateral Sewer – A sewer running laterally down a street, alley or easement which receives flow from abutting property.
- 4.2.4 Service Lead – A sewer which branches off of a public sewer and extends to the limits of the public right-of-way. It shall be construed as having reference to a public sewer branching off from a main or lateral sewer to serve one or more houses, single family lots, or other types of small land tracts situated in the same block, but not directly adjacent to the main or lateral sewer. A service lead shall never exceed 100 feet in perpendicular length from the intersecting sewer main or lateral. If the sewer is designed to serve more than two houses, or the equivalent of two single family residences along a street, a lateral sewer as defined above shall be constructed.
- 4.2.5 Septic Systems - Septic systems are not allowed in the city limits, except as specifically approved by the City Engineer

4.3 DESIGN REQUIREMENTS

- 4.3.1 Drawings to be Furnished
 - A. Before any Public Sanitary Sewer is constructed and before the City will approve any proposed sanitary sewer for construction, plan-and-profile sheets of the proposed sanitary sewer shall be prepared and submitted to the City Engineer for approval.
 - B. Drawings shall include at a minimum layout sheets, plan-and-profile sheets, and details sheets for special items.
 - C. Sanitary sewers shall conform to the City's Wastewater Master Plan/model for orderly expansion of the system.
 - D. Sanitary sewer systems shall be designed to handle the necessary flow based upon complete development. The necessary flow shall include applicable residential and non-residential average daily flows and shall include a minimum peak design flow of 4 times the average daily flows. Sanitary sewer systems within the City of Pearland's jurisdiction shall allow for orderly expansion of the system and shall conform to the Wastewater Master Plan for the City of Pearland.

- E. The average day flow for the design of sanitary sewers shall be based on a minimum set by the Texas Commission on Environmental Quality in gallons per day per single-family connection for residential areas. Commercial, industrial, and office areas shall be designed for an average day flow that can be anticipated from contributing area.
- F. One copy of the system hydraulic calculations, sealed by a Texas Registered Professional Engineer, shall be provided electronically (PDF format) with all sanitary sewer system plans. These calculations shall show how the sanitary flow rates were computed; design assumptions and that Texas Commission on Environmental Quality requirements are met. If the proposed sanitary sewer system is connecting to an existing system, verification of the availability of capacity in the existing system, after inclusion of the new system, shall be provided by the design engineer and approved by the City.
- G. All gravity sewers shall be designed to accommodate the peak flow from the contributing service area. The peak flow will be computed using the appropriate peaking factor, F, multiplied by the average day flow for the contributing area. For nonresidential areas, the peak flow should include consideration of flow characteristics from the anticipated development. The minimum allowable values for the design peak factor are:
- a. In all cases, the design peaking factor, F, shall meet or exceed the values as follows
 - 1) An equivalent population less than 5,000 persons:

$$F = 4$$
 - 2) An equivalent population greater than or equal to 5,000 persons:

$$F = (14 / (3.316 + P^{0.5})) + 1.5$$

$$P = \text{equivalent population in thousands}$$
 - b. Sewers larger than eighteen-inch (18") may be sized using a peaking factor of less than four (4) with approval of the City Engineer.
- H. Additional consideration of peak flow shall be given for design of pumping stations. The impact of pumping stations on the upstream and downstream sanitary sewer system shall be evaluated. The peak flow for design of a pumping station shall be based on the actual flow into the station. A reduced peak flow, based on the peaking factor presented above, may be used for design of larger pumping stations provided a detailed hydraulic analysis is performed on the sanitary sewer system. Specific approval by the City Engineer shall be required prior to use of a reduced peak flow for the design of a pumping station and related sanitary sewer system.

- I. The minimum size allowable public sewer shall be eight-inch (8"). Public sanitary sewers are not allowed in back lot/rear yard easements.
- J. The minimum size residential sanitary sewer service lead shall be four-inch (4") and shall serve only one residential lot. A single six-inch (6") sanitary sewer service lead shall not serve more than two (2) residential services.
- K. Commercial sewer service leads shall be six-inch (6") pipe or larger and shall not serve more than one (1) commercial connection.
- L. A cleanout shall be placed at the property line.
- M. All elevations shall be shown to the nearest one-hundredth of a foot (0.01').
- N. All stationing shall be based on centerline of street right-of-way stations. In utility easements where both sanitary sewer and storm sewer piping are constructed and laid in parallel trenches, stationing shall be based on centerline of storm sewer piping.
- O. All mains to be installed under an existing roadway shall be installed by bore unless otherwise approved by the City Engineer.

4.3.2 Details to be Shown on Drawings:

- A. The construction drawings shall show at a minimum the exact location of the proposed sanitary sewer in the right-of-way, alley, or dedicated easement with respect to the edge of the particular right-of-way, survey base line, any nearby utilities, 100-year floodplain elevation within the project area, major landscaping (existing and future), and other structures (above ground and below ground) within the construction site.
- B. No trees or landscaping with invasive root structures shall be placed in the sanitary sewer easements

4.3.3 Sanitary Sewer Mains and Lateral Sewers Layout and Placement

- A. All sanitary sewer systems shall be designed in conformance with the requirements of the Texas Commission on Environmental Quality and other applicable standards.
- B. Sanitary sewers shall be identified by number, letter, or other identification as shown on the sanitary sewer layout sheet and manholes shall be identified by letter or number.

- C. Sanitary sewers in curved easements, easements defined by property lines, and combined easements containing other public utilities must be shown in both plan and profile views.
- D. The profile shall show other underground and surface utilities and facilities, both in parallel and at crossings; the size, grade, and type of pipe of the proposed line, the elevations of the proposed line to the hundredths of a foot at manholes, changes of grade and clean outs where allowed; and the proposed finished grade over the sewer with elevations. Where proposed fill or cut is contemplated, the proposed new natural ground line should be shown as a separate line from the pre-existing natural ground line. Bedding and backfill shall comply with City of Pearland standard specifications and standard details.
- E. The construction drawings shall show the existing natural ground line at either the right-of-way or edge of easement, in addition to centerline of the pipe, when the proposed sanitary sewer is to be placed:
 - a. Between the existing pavement and the right-of-way line.
- F. Between existing pavement and an existing or proposed easement. When a sanitary sewer is located under existing pavement, then the finished elevations of the pavement shall be shown on the construction drawings.
- G. Sanitary sewers shall be laid in a straight alignment, manhole-to-manhole. No curvilinear bends are allowed.
- H. All connections to the public sewer system shall be approved by the City Engineer prior to construction. A representative of the utility system shall inspect actual connections to the public sewer system.

4.3.4 Plan and Profile Required for Sewer Mains

- A. Sanitary sewer overall layout sheets for single family residential subdivisions should use a standard engineering scale large enough to show the entire project on one and no more than two standard 22"x34" sheets. In all cases, the following information must be shown on the layout:
 - a. All easements containing or buffering sanitary sewers. These corresponding recordation information including but not limited to the corresponding file number for the easement.

- b. Sanitary sewer sizes are shown at points of size change and between all manholes.
 - c. All manhole locations.
 - d. The sanitary sewer alignment shall accurately reflect in the plan and profile sheets the location of the sanitary sewer as shown on the detailed plan view. Alignment shall be stationed with 100-ft. stations.
 - e. Service leads that cross street pavement or serve adjacent property shall be shown on the overall layout.
 - f. The number, size, and layout of the lots depicted on both the overall sanitary 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.
 - g. The direction of flow for existing and proposed sanitary sewers shall be shown on the overall sanitary sewer layout sheet.
 - h. The location of the proposed sanitary sewer within either the public right-of-way or a dedicated easement.
 - i. The overall sanitary sewer layout sheet shall show the area, in acres or in number of lots plus any acreage outside the project area, which the proposed sewer is designed to serve. Include a vicinity map which references the project or lots to nearby major thoroughfares.
- B. Commercial sanitary sewer layouts shall follow the same overall layout sheet format.
- C. Horizontal and vertical scales for the detailed plan-and-profile views shall be confined to standard engineering scales.
- D. The plan view shall show, at a minimum, all of the following information for the project area:
- a. Topographical features.
 - b. Stationing for the proposed sewers.
 - c. All existing utilities including gas, power, telephone, fiber optic, cable etc.
 - d. Any significant landscaping or other structures which might impact construction or construction-related activities.
 - e. The width and type of existing and/or proposed easements.
 - f. Proposed service leads.
 - g. The limits of any proposed bore and jack, microtunnel, or auger operations.
 - h. Locations where pressure pipe is to be installed for water line crossings.
 - i. The proposed sanitary sewer with pipe diameter, length, material type, and grade clearly labeled.

- E. The profile view shall show, at a minimum, all of the following information for the project area:
- a. Underground and surface utilities/facilities which are either parallel to the proposed sanitary sewer or cross the proposed sanitary sewer within the construction site.
 - b. The proposed sanitary sewer's diameter, grade, length, and material type for each section between manholes. This shall be labeled on every applicable page and identified as "proposed."
 - c. The flowline elevation and centerline station for every sanitary sewer at every manhole.
 - d. The top of rim elevation of affected existing and proposed manholes.
 - e. The flowline elevation and centerline station at each sheet break.
 - f. The type of pipe bedding and backfill shall comply with City of Pearland standard specifications and standard details.
 - g. The finished grade for proposed and existing pavement. Where cut and fill are proposed, the proposed new natural ground line should be shown as a separate line from the existing natural ground line.
 - h. The existing natural ground line at the centerline of the sanitary sewer when a sewer is to be placed between the edge of pavement and the public right-of-way. In the cases where roadside ditches exist, the centerline elevations of the roadside ditch shall be shown.
 - i. The existing ground line at the centerline of the proposed sanitary sewer where a sanitary sewer is to be placed within an existing easement. Show any proposed cut and fill as described above.
 - j. The limits of any proposed bore and jack, microtunnel, or auger operations.
 - k. Locations and limits of where pressure pipe is to be installed for water line crossings.
 - l. The location of special backfill and any proposed stacks shall be identified by stations indicated on the design plans.
 - m. Avoid vertical breaks in profiles. Use alternate scale for all profile sheets if all of proposed sanitary sewer cannot be shown on any one profile section for the station run indicated in plan view for that sheet.
- F. All construction drawings for new sanitary sewers shall show the proposed location, by stations and offsets, of all service leads, and service connection risers.

4.3.5 Service Lead Construction for Residential and Commercial Developments

- A. Space the location of service leads so as to limit the number of service lead taps to the lateral sewer or sewer main. Service leads shall be spaced at every other property line between two adjoining residential lots unless there is an odd number of lots. The City reserves the right to direct the engineer to relocate any proposed service lead upon reviewing any submitted plans. A single 6-inch service lead located at the property line between two adjoining residential lots would serve two single-family residences with a wye placed at the end of the service lead with a cleanout at the property line. The wyes shall be located in the right-of-way at the private property line.
 - a. Near side double sewer service leads shall not exceed 5 feet in length, shall terminate at the property line whereupon a wye, with a cleanout, and shall be located within the public right-of-way or dedicated easement.
 - b. In cases where the sanitary trunk main is farther than 5 feet from edge of the right-of-way, a single 6-inch service shall be run from the sewer main to the edge of the right-of-way whereupon a wye, with a cleanout, shall be placed at the end of service lead, if 2 lots or parcels are to be served. This shall apply to residential sanitary service leads and not to commercial service taps.
- B. Any far side service lead of more than 100 feet perpendicular to the street right-of-way shall, at the City's discretion, be treated as a lateral sewer.
- C. Service leads for single-family developments shall connect to the main line.
- D. Commercial or industrial service leads shall discharge directly into a proposed or existing sanitary sewer manhole. Any variance from this requirement shall have prior approval from the City Engineer.
 - a. Service leads shall be provided to serve each lot or parcel within a proposed residential, commercial or industrial development. The detail for a typical near-side and far-side service leads shall be included with the construction drawings.
 - b. Service leads shall be a minimum of 6 inches in diameter where two lots or parcels are served. If the perpendicular length of a service lead exceeds 100 feet, the minimum diameter shall be 6 inches and a manhole shall be utilized for connection to the public sewer. The use of 8 inch leads may, at the discretion of

- the City, be reviewed upon submittal of the construction drawings as a lateral sewer line.
- c. In such cases where a service lead is proposed to run diagonally across the street, prior approval from the City Engineer must be obtained.
 - d. Service leads with a diameter of 6 inches shall utilize full body fittings be they extruded or factory-fabricated for connection to a proposed public sewer or an approved saddle-type connector for connection to an existing public sewer.
 - e. For residential and commercial developments connection shall be full-body tee.
 - f. The service lead shall be placed so as to minimize the use of bends as site conditions permit.
 - g. For existing residential lots (which are not served in accordance with these guidelines) that need a service lead, if the distance to the nearest existing sanitary sewer is less than 60 feet and is not the long side of the sewer main, the service lead may be a 4 inch-line if only one lot or parcel is to be served. Commercial and industrial lots and parcels shall have a minimum 6 inch line under the same conditions.
 - h. The location where the service lead or its wye meets the property line shall be shown on the plans and as-builts, and marked in the field as shown on the standard details. There shall be a riser placed where the service lead meets the property line so that the service lead stub-out can be recovered at the time that the connection to the service lead is made.
 - i. All service leads shall be installed at the time of the construction of the sanitary sewer in new residential subdivisions.

4.3.6 General Requirements

- A. A licensed plumber shall be responsible for connecting private residential sanitary sewer service to the public sanitary sewer system, to wyes and/or tees or to lateral sewers as indicated on the plans. Said licensed plumber shall be responsible for a properly installed and watertight private residential service connection.
- B. Commercial service connections to the public sanitary sewer with more than 5,000 gallons per day flow, shall be made at manholes. Service connection at a concrete manhole should have a rubber boot that is cast into manhole or service connection should be cored. If cored, opening must be secured with “Linkseal”, grouted and manhole coating shall be repaired.
- C. All materials used in the construction of sanitary sewer systems shall be in conformance with the City of Pearland Approved Products List and

the requirements of the Texas Commission on Environmental Quality. Sewers shall be designed to meet or exceed the pipe manufacturer's recommendations for depth.

- D. Solvent welded sanitary sewer joints are not an acceptable joining method for PVC piping materials. Use of rubber gasketed bell and spigot sanitary sewer joints shall be mandatory.
- E. Sanitary sewers fifteen inches (15") or less in diameter and installed at depths of sixteen feet (16') or less to invert shall be constructed conforming to ASTM specification D 3034 SDR-26 (115psi) color shall be green and shall meet ASTM specifications D 3212 for pipe joined with rubber gaskets conforming to ASTM F477. Bell (female) ends of pipe shall be installed on upstream side with spigot (male) ends oriented downstream.
- F. All sanitary sewers greater than eighteen inches (18") in diameter and less than twenty-seven inches (27") in diameter and installed at depths of eighteen feet (18') or less to invert shall be constructed conforming to ASTM specification F 679 SDR-26 (115psi) color shall be green and shall meet ASTM specifications D 3212 for pipe joined with rubber gaskets conforming to ASTM F477. Bell (female) ends of pipe shall be installed on upstream side with spigot (male) ends oriented downstream.
- G. All force mains 6" to 12" shall be AWWA specification C900, Class 150 DR 18, color shall be green and shall be ASTM specifications D 3139 for pipe joined with rubber gaskets conforming to ASTM F 477. Force mains greater than twelve inches (12") shall be AWWA specification C 905, Class 235, DR 18, color shall be green and shall meet ASTM specifications D 3139 for pipe joined with rubber gaskets conforming to ASTM F 477 or Ductile Iron Pipe shall conform to the requirements of "Ductile-Iron Pipe, Centrifugally Cast in Metal Molds for Sand-Lined Molds, for Water and Other Liquids", AWWA C151, (ANSI A21.51), current revision. Pipe shall be lined with Protecto 401 ceramic epoxy lining or approved equal. Pipe thickness shall be the minimum specified in C151. Bell (female) ends of pipe shall be installed on upstream side with spigot (male) ends oriented downstream. All ductile iron fittings shall be Ductile-Iron Compact Fittings AWWA C153/A21.53.84 mechanical joint and restrained with Ebba "Meg-a-lugs" or approved equal. The fittings shall be lined with Protecto 401 ceramic epoxy lining or approved equal. A two-inch (2") wide green marker tape with the words "Sanitary Sewer Forcemain" shall be installed twelve inches (12") above the top of pipe during installation.
- H. All constructed sanitary sewer lines shall be air tested for leaks and a mandrel pulled for structural defects. All sanitary sewer testing shall

comply with or exceed the procedures and qualifications listed in Texas Administrative Code, Chapter 217, Section 217.57. All sanitary manholes shall pass a vacuum testing per Chapter 217, Section 217.58. Upon successful completion of air testing and prior to placing the sanitary sewer lines in operation, all constructed sanitary sewer lines shall be flushed and cleaned prior to video. Every joint shall be videoed 360 degrees. A copy of video on DVD shall be submitted to the City Engineer. Lines and joints shall be corrected if warranted from video inspection. For procedures and requirements for the video inspection, refer to City's Standard Specifications.

- I. All public sanitary sewers and service leads shall have bedding and backfill that shall comply with or exceed City of Pearland Standard Details. Those sanitary sewers that are bore and jacked, microtunneled, augured, or encased in a steel pipe may require special bedding and backfill.
- J. Backfill shall be in accordance with City of Pearland Standard Details. All backfill within public right-of-ways and public easements shall be compacted to a minimum of ninety-five percent (95%) of Standard Proctor Density (ASTM D2922-78 and ASTM D3017-78), without additional moisture control, cured and tested in accordance with ASTM C31.
- K. All sanitary sewer lines located underneath and within eighteen inches (18") of any paving shall be bedded in cement stabilized sand to within 18" of the lime stabilized road material and in accordance with the Standard Construction Details. The cement stabilized sand shall be in accordance with the following requirements.
 - 1. The cement shall be Portland Cement, Type I, ASTM C150.
 - 2. The sand shall be clean, durable sand, with less than 0.5 percent clay lumps, ASTM C142; with less than 0.5 percent lightweight pieces, ASTM C123; with organic impurities, ASTM C40, not showing a color darker than standard color and a plasticity index of less than six (6) when tested in accordance with ASTM D423 and ASTM D424.
 - 3. Compact to ninety-five percent (95%) Standard Proctor Density (ASTM D2922-78 and ASTM D3017-78) in maximum loose lifts of eight inches (8") thick. Actual testing shall be required as deemed necessary by the City of Pearland.
 - 4. The cement-sand mixture shall consist of at least 1.5 sacks of cement per ton of sand. The cement-sand mixture shall have a minimum unconfined compressive strength of one hundred pounds per square inch (100 psi) in forty-eight (48)

hours, when compacted to a minimum of ninety-five percent (95%) of Standard Proctor Density (ASTM D2922-78 and ASTM D3017-78), without additional moisture control, cured and tested in accordance with ASTM C31.

- L. Sanitary sewers outside of paving shall be bedded in accordance with the Standard Construction Details and the cement stabilized sand utilized shall meet the same requirements.
- M. Sanitary sewer bedding shall be cement stabilized sand or approved granular material. Bedding shall be compacted to ninety-five percent (95%) Standard Proctor Density six-inches (6") over pipe prior to backfilling the trench. In water bearing sand, washed shell or other approved granular material will be required with geo-textile fabric wrap as shown in the Standard Construction Details. When water bearing sands are encountered, the City of Pearland shall be notified immediately.
- N. Public sanitary sewers and force mains shall be located in either the public right-of-way or dedicated easements. Side lot and back lot easements should be avoided. Side lot and back lot easements may be granted special approval from the City Engineer only when a sanitary sewer located in the street right-of-way is impossible from an economic and engineering standpoint.
 - a. Lateral Location of Sewer in Right-of-Way/Easement
 - 1) The location of the sanitary sewer within a dedicated easement shall be along the centerline of the proposed dedicated easement or as close to the centerline as can be designed. In those instances where the dedicated easement is adjacent to the public right-of-way, the lateral location of the sanitary sewer shall be at the discretion of the Design Engineer with approval from the City Engineer and in compliance with Chapter 2.
- O. The final determination as to that portion of a street, alley, or dedicated easement to be occupied by a proposed sanitary sewer rests with the City Engineer. The City Engineer will take into consideration existing, planned and proposed facilities such as manholes, pavement, pipes/conduits, along with existing trees and shrubs, historical features, wetlands or other unique surface conditions when arriving at a decision.
- P. The drawings of the sanitary sewer shall show the location of any existing pipe or duct that might interfere with the construction of the sanitary sewer and call to the attention of the City Engineer any known

obstacles that might be encountered in constructing the sanitary sewer in any location under consideration. The Professional Engineer of Record shall determine the existence of pipes, ducts, obstacles and other utilities (i.e. gas, telephone, electric, fiber optic, cable, etc.) from a visual survey on the ground plus research of the public records and private records when available.

- Q. Sanitary sewers within the City of Pearland's jurisdiction shall be designed and installed at such a size and depth as to allow for orderly expansion of the system, so as to avoid duplication in the future.
- R. Sanitary sewers shall be designed and located to conform to regulations of the Texas Commission on Environmental Quality. For water mains crossing an existing or proposed sanitary sewer or force main, the following clearances shall be provided for protection from contamination. The minimum clearances will be approved only when justified and field conditions so dictate. The latest edition of "Rules and Regulations for Public Water Systems", of the Texas Commission on Environmental Quality, shall be followed for minimum criteria and instructions for water line crossings.
- S. Sanitary sewers shall be separated from storm sewer lines by a minimum of 4 feet of horizontal clearance as measured from outside wall to outside wall and the storm sewer line shall be above the sanitary line where possible, unless prior approval from the City Engineer is granted.
- T. Sanitary sewers shall be maintained minimum 12 inches of horizontal clearance from culverts, unless prior approval from the City Engineer is granted.
- U. For sanitary sewers crossing utilities other than water or storm sewer (i.e. cable, gas, fiber optic, power, etc.), a minimum of 12 inches of horizontal and vertical clearance shall be maintained as measured from outside wall to outside wall, where possible.

4.3.7 Line Size

- A. The minimum pipe diameter for a public sanitary sewer main shall be 8 inches.
- B. Service leads 6 inches in diameter shall not serve more than the equivalent of 2 single family lots or other equivalent types of small land tracts.
- C. Service leads for single family residential lots shall have a minimum grade of 1% for a 4-inch line and 0.70% for a 6-inch line.

- D. The average daily flow for the design of sanitary sewers shall be based on minimum 320 gallons per equivalent single-family connection and a peaking factor of 4 (minimum). Designer to determine the total equivalent connections based on the residential, commercial, or industrial development being proposed. Submit documents on proposed connections, flows and sizes to the office of City Engineer for review and approval.
- E. For commercial service leads, the required size of the line shall be established from the plumbing drawings. Commercial, industrial, and office areas shall be designed for an average daily flow that can be anticipated from the contributing area.
- F. Commercial sewer service leads shall be 6 inch pipe or larger. A single 6 inch commercial service connection shall not serve more than one commercial lot or parcel. Four inch service leads for commercial developments shall not be allowed.
- G. Sewer mains shall end at a manhole.
- H. The City Engineer shall have final review and approval authority as to the size and depths required for sanitary sewer mains and lateral sewers.

4.3.8 Line Depth

- A. The sanitary sewer should be laid with the top of the pipe a minimum of 3 feet below the surface of the natural ground or finished grade.
- B. Sanitary sewers laid in street rights-of-way with a curb and gutter section shall have a minimum cover of 3 feet from the top of the pipe to the flowline elevation of the gutter in the street at all locations. The Professional Engineer of Record shall account for any anticipated future sanitary sewer extension whereas the future sanitary sewer extension shall have a minimum 3 feet of cover from the top of the pipe to the flowline of the gutter of the street. The Professional Engineer of Record shall adjust the depth of the proposed pipe accordingly. The City Engineer reserves the right to require greater depth where the need is perceived.
- C. Sanitary sewers laid in street rights-of-way with crowned roads and roadside ditches shall have a minimum depth of 6 feet from the crown of the road to the top of the pipe and an absolute minimum cover of 3 feet below the flowline of a roadside ditch. The City Engineer shall have final determination on any deviation from these criteria.

4.3.9 Line Grades

A. The following table lists the minimum grade for 6-inch to 36-inch diameter public sanitary sewers. The minimum velocity for a sanitary sewer flowing full shall be 2.3 feet per second (fps). The maximum recommended grade shall be calculated by the Professional Engineer of Record for a maximum velocity of 4.5 fps based on a Manning equation for full flow with the Manning's "n" equal to 0.013. The use of different pipe materials will not alter the use of $n=0.013$ for the purposes of design.

Table 4.1
MINIMUM GRADES FOR SANITARY SEWERS*

PIPE SIZE	MINIMUM GRADE (PERCENT)
4	1.0
6	0.65
8	0.44
10	0.33
12	0.26
15	0.19
18	0.15
21	0.13
24	0.11
30	0.074
36	0.059

*Minimum grades shall be utilized for on-site service

B. For sanitary sewers larger than 36 inches (36") in diameter, the Professional Engineer of Record shall determine the appropriate grade utilizing the Manning Formula, $n=0.013$, and a full pipe maximum velocity of 4.5 fps and minimum velocity of 3.0 fps.

4.3.10 Gravity sanitary sewer mains shall be laid in straight alignment with uniform grade between manholes. Grade and alignment changes without the use of manholes shall not be allowed.

4.3.11 Unequal size sewers shall be designed so that the inverts of the pipes are matched at manholes. The upstream sewer may be designed so that the flow line of the upstream is higher than the flow line of the downstream sewer. When the flow line of the upstream sewer is raised more than twenty-four inches (24") above the flow line of the downstream sewer, a drop manhole connection is required, except as specifically approved by the City Engineer.

4.3.12 Sanitary sewer service leads shall be laid at a minimum seventy hundredths of a percent (0.70%) slope.

4.3.13 Manholes

- A. Type: Manholes shall be precast concrete manholes in accordance with Standard Details and Specifications. No brick manholes shall be allowed. All manholes shall be coated. Refer to Standard Specifications for types of coatings. Standard manhole shall have 5' inside diameter. Larger diameter manholes may be required due to sewer main size, numbers, or configuration at the manhole. It shall be the responsibility of the Professional Engineer of Record to ensure that proper diameter manholes is specified. All precast manholes shall conform to the latest ASTM requirements. Public manhole covers shall be 32" diameter or larger and have the words "Sanitary Sewer" and the City of Pearland logo cast into the cover per Standard Detail. Hinged manholes shall be used in ditch lines and floodplain areas. All manholes shall be installed with stainless steel manhole inserts with 1/8 inch vents and strap handles.
- B. Location: Manholes shall be placed at changes in alignment, changes in grade, changes in size of sanitary sewers, at the intersection of sanitary sewers, junction points, and either at street, alley, or easement intersections. Clean-outs will not be permitted on public lines.
- a. The maximum distance between manholes shall be determined from Table 4.2 for 8 inch to 36 inch pipe diameters. Spacing for manholes on sewer mains with diameters larger than 36 inches shall be recommended on an individual basis by the Professional Engineer of Record subject to City of Pearland approval.

Table 4.2
MAXIMUM DISTANCE BETWEEN
SANITARY SEWER MANHOLES

PIPE DIAMETER IN INCHES	MANHOLE MAXIMUM SPACING IN FEET
8-15	400
18-36	400
>36	Per Designer of Record, subject to the City Engineer Approval

- b. Place manholes at the dead-end of sewer mains and lateral sewers.
- c. Manhole covers shall be cast iron, minimum 32" diameter and traffic bearing type ring and cover.
- d. Private manholes shall have a manhole cover indicating a private sanitary system and shall not have the City design.
- e. Criteria for Manhole Junctionures
 - (1) Connections between public sanitary sewers and the manhole shall adhere to the following criteria.

- (a) The elevation of the flowline of the discharging sanitary sewer shall match the elevation of the flowline of the receiving sanitary sewer for both equal and unequal pipe diameters.
- (b) Drop manholes in accordance with Standard Details are allowed. A drop connection or drop manhole is required when the difference in elevation between the effluent flowline and the influent flowline is greater than 36 inches; or where a service line is proposed to tie onto a sanitary sewer trunk main of 18 inches in diameter or larger.

4.3.14 Manholes should be located as to minimize or eliminate the inflow of stormwater into the sanitary sewer. The top of manhole rim shall be set a minimum of 3 inches above the surrounding finished grade when the manhole is not in a paved roadway. Sealed manholes are required on all newly constructed manholes within the 100-year flood plain. Vented manholes are required a minimum of every 800 feet when not located in the 100-year floodplain. Unless approved by the City Engineer, the elevation of the top of rim of a sanitary sewer manhole shall be at or above the 100-year base flood elevation for the area it is being built in. All manhole rims that are 3 feet and greater above grade shall use Revolution Assembly Rim and Cover. All manholes in ditches shall have water tight hinged ring and cover.

4.3.15 No cast-in-place manhole are allowed.

4.3.16 Steps in manholes shall not be allowed.

4.3.17 All manhole adjustments shall be made with precast concrete rings when an additional precast vertical section is too large. No brick shall be used for manhole adjustments.

4.3.18 All manholes shall be tested and witnessed by the City inspector and by the construction contractor and results provided to the City Engineer before being accepted by the City for maintenance. The City reserves the right to require retesting of manholes, if there is reason to question the results. All manhole testing shall comply with or exceed the procedures and qualifications listed in Texas Administrative Code, Chapter 217, Section 217.58.

4.3.19 Manholes shall have a traffic bearing frame and cover Manholes shall have a design strength of 4500 psi and in compliance with ASTM C478 reinforcement.

- 4.3.20 Sewers laid in easements shall have a manhole at each side of a street crossing.
- 4.3.21 Manholes should be located to eliminate the inflow of storm water into the sanitary sewer. The top of manhole rim elevation shall be shown on the plans for all sanitary manholes. Manholes shall not be located within street pavement. Manholes shall have inflow protection inserts, minimum thickness of one-eighth inch (1/8"), made of stainless steel as approved in the standard details and approved product list. Insert shall include a lift strap and vent hole with vent disk. Where gasketed manhole covers are required for more than three (3) manholes in sequence, an alternate means of venting shall be provided at less than one thousand five hundred feet (1500') intervals.
- 4.3.22 Manholes shall be constructed in accordance with the City of Pearland Construction Details. The diameter of a manhole constructed over the center of a sewer shall vary with the size of the sewer. For eight-inch (8") through twenty-seven-inch (27") shall be five-foot (5') minimum diameter; thirty-inch (30") and thirty-six-inch (36") shall be six-foot (6') minimum diameter. Manholes deeper than twelve feet (12') shall be a minimum of five-foot (5') diameter or six-foot (6') diameter pending on pipe size. If a drop structure is required the manhole shall be a minimum of five-foot (5') in diameter.
- 4.3.23 A drop manhole is required for pipes that have a change in elevation greater than twenty-four inches (24"). The manhole will be a minimum five foot (5') diameter. The use of an interior drop is required. Drop structure will be provided by Reliner "inside drop bowl" or approved equal and attached with stainless steel hardware.
- 4.3.24 All manhole adjustments shall be made with three inch (3") precast concrete rings. A maximum of five (5) adjustment rings are permitted.
- 4.3.25 All new manholes shall have an interior surface coated with calcium aluminate coating or an approved epoxy coating a minimum of 125 mils thick. If the project requires a rehabilitation of an existing manhole the use of approved calcium aluminate coatings will be required. Bituminous coatings are not allowed. Approved coatings are listed in the Approved Products List. Epoxy coatings shall be tested with a Holiday tester. Testing shall be in accordance with latest edition of NACE "Standard Recommended Practice Discontinuity Testing of Protective Coatings". All holidays shall be marked and repaired and retested. All joints shall be grouted smooth prior to installation of the interior coating. Should the manhole be pre-coated at the place of manufacturing the joint shall be grouted smooth and the grouted area shall be coated in accordance with this

section. Warranty on interior coatings shall be 10-year and include all labor and materials to address warranty issues.

- 4.3.26 Fiberglass manholes are not allowed as part of public sanitary sewer systems. All manholes within public right-of-ways and public easements shall be pre-cast manholes.
- 4.3.27 Where unequal size pipes enter a manhole, inverts of pipes are required to be at the same elevation, unless due to an elevation drop connection.
- 4.3.28 Service connections entering a manhole twenty-four inches (24") or more above the flow line of the manhole shall include an internal drop pipe with fittings. The drop shall consist of a "Reliner" internal drop bowl system, or approved equal, installed adjoining and anchored to the wall of the manhole, with all stainless steel hardware and fasteners. The cored opening for the pipe shall be secured with "Linkseal", grouted and the manhole coating shall be repaired per the coating manufacturer's recommendations
- 4.3.29 Provide adequate markings on site and accurate as-built locations, so that the service connections stub-out can be recovered at the time that the connection to the service is made.
- 4.3.30 Lift Stations

- A. Lift station design and construction drawings as well as design requirements and pertinent data shall be designed in accordance with TCEQ Design Criteria Chapter 217, Sections 217.59 thru 217.63 and sealed by a Professional Engineer registered in the State of Texas and submitted with the construction drawings for review by the City Engineer. Lift Stations shall only be considered only when a gravity system cannot be achieved from both an engineering and an economic standpoint. Lift stations shall only be considered with prior approval from the City Engineer or where the lift station is designed to be temporary in nature. A preliminary design meeting with the City Engineer is required. Design engineer to provide a master development plan for the service area of the proposed lift station.

- a. The lift station site shall be conveyed in fee to a utility district, the City of Pearland, or other acceptable public entity. The site may be part of a larger site that includes a public wastewater treatment facility or other facility. The site shall have a minimum size of 50 feet by 50 feet. Site access shall be provided by a 15-foot (15') wide public right-of-way with an approved, all-weather access road a minimum of 12 feet (12') in width. Wet well structures shall be a minimum of 12 feet from outside walls of structure to the site boundary fencing. Fencing

shall be in conformance with the City of Pearland Zoning Ordinance.

- b. Use drainage swales, sidewalls and driveways, culverts, storm sewers, or a combination thereof for internal site drainage. Site drainage may sheet flow to a public right-of-way. Storm sewer systems, if provided shall be sized in accordance with applicable design guidelines.
- c. The top of the wet well and all electrical controls shall be located 24-inches above the 500-year floodplain or 3 feet above the top of curb (outside of floodplain), whichever is greater, and the design engineer shall take into consideration wave action, which may exceed this elevation. Entry to the site must be accessible during a 25-year flood.
- d. The lift station shall be classified under one of three categories;
1) Regional Lift Station; 2) Semi-Regional Lift Station or 3) Local Lift Station.
 - i. Regional Lift Station is one that receives flow from multiple sources (Semi-Regional Lift Station and gravity collection) and pumps to the wastewater treatment plant. Regional Lift Stations require an automatic transfer switch, permeant generator and odor control system.
 - ii. Semi-Regional Lift Station is one that receives flow from multiple sources (Local Lift Station and gravity collection) and pumps to a Regional Lift Station. Semi-Regional Lift Stations require an automatic transfer switch, permeant generator and odor control system.
 - iii. Local Lift Station is one that receives flow from gravity collection system and pumps a Semi-Regional Lift Station. Local Lift Stations require a manual transfer switch and generator connections
- e. All gravity sanitary sewers discharging to the wet well shall be located where the invert elevation is at or above the liquid level of the highest pump's "ON" setting to achieve the firm pumping capacity. Gate valves and check valves shall not be located in the wet well, but may be located in a valve vault or on a concrete slab. Piping shall be spaced to maintain the pump manufacturer's minimum clearances between pumps.

- f. Size the diameter of the wet well, hatches, and hatch spacing to accommodate the selected pumping equipment. Consideration should be given to the dimensions of the ultimate pump in a multi-phased lift station to ensure adequate clearances. Provide a minimum of eighteen inches (18”) of clearance from the inside wet well wall to all flanges to enable removal of all bolts. Pre-cast concrete wet wells may be used in any diameter provided calculations demonstrate that wet well thickness and material weight will resist imposed up- lift pressure. Provide hatch safety nets with aluminum sliding rails or Flygt Safe-hatch access cover.
- g. The wet well volume shall be based on the minimum cycle time of the largest pump planned for the lift station plus additional depth to prevent motor overheating and vortexing. Wet well working volume should be sized to allow for the recommended pump cycle for each pump. The cycle time shall not be less than those listed below:

CYCLE TIME

Motor Size (Horsepower)	Cycle Time (Minutes)
< 50	6
50-100	10
>100	15

- h. The "OFF" elevation of the submersible pumps shall be deep enough to prevent vortexing and motor overheating. The design engineer shall verify with all pump manufacturers on the List of Acceptable Manufacturers that each pump is capable of operating continuously at the "OFF" elevation shown on the plans.
- i. The wet well floors shall have a minimum of 10 percent slope to the pump intakes and have a smooth finish. There shall be no wet well projections, which will allow deposition of solids under normal operating conditions. The inlet structure shall be designed to minimize turbulence.
- j. The wet well shall have a vent sized such that the maximum velocity of air through the vent is 600 feet per minute at the firm pumping capacity. Vents shall have a stainless steel insect screen that is easily replaceable and will prevent the entrance of rainwater. Vent pipes shall be corrosion-resistant.
- k. Access shall be provided to underground valve vaults.

Stairways shall have corrosion-resistant, non-slip steps and conform to OSHA regulations with respect to rise and run. Where ladders are utilized in lieu of stairways, ladders shall conform to OSHA requirements.

- l. Floor drains from valve vaults to wet wells shall be designed to prevent gas and raw sewer water from entering the valve vault. Such designs shall include "P" traps and floating ball type backwater valves.
- m. All walls shall be a minimum of 18 inches from the outermost edge of all flanges to enable removal of all bolts. Pipes shall have a minimum spacing greater than that required by the pump manufacturer for minimum pump spacing. Swing check valves shall be positioned such that the shafts may be removed without removing the valve body.
- n. Design shall follow the latest version of ACI 350 with the exception that the minimum concrete cover over steel reinforcing shall be at least four inches (4") where in contact with raw sanitary sewer. Wet wells shall be designed to resist the effects of buoyancy assuming full saturation of the surrounding soils to the finished grade or the 100-year floodplain, whichever is greater. Surface friction shall not be included in the design unless a friction factor is provided in a geotechnical report signed and sealed by a licensed professional engineer. A safety factor of 1.1 shall be used for buoyancy resistance. Wet well walls shall be designed to withstand lateral earth pressures and static water levels at finished grade as outlined in ACI 350. At a minimum, 3,500 psi concrete shall be used. Class III or IV RCP may be used in lieu of cast in place concrete if structural calculations are provided showing that sufficient strength exists to resist construction and final loadings. Top slabs shall be designed for a uniform loading of 100 pounds per square foot and a point load equal to the weight of the largest pump planned for the lift station at any location.
- o. Hatches shall be constructed entirely of aluminum or stainless steel and designed for a minimum of 150-pound-per-square-foot load. The underside of the hatch shall have the following stenciled in red paint: "Warning! Confined Space Entry." Where individual hatches are incorporated into the top slab, the separation distance from inside face to inside face shall be a minimum of 12 inches.

- p. Where riser pipes pass through the top slab, offsets or two 45-degree bends shall be used to provide clearance between the outside diameter of the pipe and the inside face of the hatches. The amount of clearance will be determined by the diameter of the slab reinforcing and the maximum aggregate diameter.
- q. Use of vault-type OR above-ground valves and piping is permitted. Valves shall be mounted in a concrete vault, or on an above-ground concrete foundation. Isolation and check valves shall not be located in the wet well.
- r. Pumps shall be of a non-clog design, capable of passing a 3-inch diameter or greater incompressible sphere, and shall have suction and discharge openings a minimum of 4 inches in diameter. Pump seals shall be silicon carbide or tungsten carbide.
- s. Pumps shall be sized to operate at optimum efficiency. Minimum acceptable efficiency at the operating point shall be sixty percent (60%), unless specifically approved by the City Engineer. Leak detection sensors shall be provided in the motor housing of submersible pumps. Pumps shall be securely supported, per manufacturer recommendations, so as to prevent movement or vibration during operation. Rail-type pump support systems shall be provided for submersible pump installations. That allows pump removal and installation without requiring dewatering of or entry into the wet well. Rails, lifting chains, and hardware shall be constructed of Series 300 stainless steel.
- t. Electric motors shall be sized so as to operate at maximum design load without use of the service factor. Electric motors shall be 120-volt single-phase, 240-volt or 480-volt 3-phase. Motor service factor shall be a minimum of 1.15. Thermal protection shall be provided in the motor housing. Electric motors (excluding submersible units) shall be equipped with space heaters.
- u. The following electrical power sources shall be considered for serving lift stations:
 - 1. For stations where total pump motor sizes do not exceed 30 hp, and where any individual pump motor size does not exceed 20 hp, 120/240-volt, three-phase service is recommended.

2. For stations where individual pump motor sizes do not exceed 5 hp and motor ratings are available as single-phase, and where three-phase service is not available, 120/240 volt, single-phase service may be used.
 3. For stations requiring pump motors that are available in only three-phase ratings and where three phase electrical service is not available (or not economically feasible), 120/240-volt, single-phase service with a three-phase inverter unit is acceptable as a last resort but is not recommended. Inverters are available for up to 100-hp motor sizes.
 4. For stations where total pump motor sizes exceed 30 hp and where individual motor sizes exceed 20 hp, 480/277-volt, three-phase service is recommended.
 5. Where owner has an existing portable generator with only 480/277-volt, three-phase output, it may be more advantageous to utilize 480-volt, three-phase power for the smaller stations.
 6. Emergency power connections shall require a manual transfer switch and generator connector.
- v. Controls and equipment shall be selected from the City of Pearland Approved Products List. The pump controller shall be a solid state, programmable pump controller with pump alternator, submersible level transducer, back-up floats, alarm contacts, and power supply. The use of a Variable Frequency Drive is acceptable. Lightning and surge protection shall be installed on the Main Power Bus, single- or three-phase, as applicable.
- w. The following controls and indicators shall be provided.
1. Pump HOA Selector Switch (for each pump)
 2. Alarm Reset Switch
 3. Seal-Fail and Over-Temp Reset Switch (for each pump protection module supplied by pump manufacturer)
 4. Phase-Fail Light
 5. Pump Run Light (for each pump)
 6. Control Power Light On
 7. Pump Seal-Fail Light (for each pump protection module - supplied by pump manufacturer)
 8. Pump Over-Temp Light (for each pump protection

- module - supplied by pump-manufacturer)
 - 9. High Level Alarm Indicator
 - 10. Alarm Rotating Beacon Light
 - 11. Pump Run Elapse Time Meter (for each pump)
- x. The following motor protection devices shall be provided.
 - 1. Motor Circuit Protectors (MCP's) or circuit breakers
 - 2. Motor Overload Current Trip Devices or C.T.'s with Relays (for each motor)
 - 3. Motor Over-Temp and Seal Fail Relays (for each motor - furnished by pump motor manufacturers)
 - 4. Phase Fail Relay
- y. Level Controls
 - 1. Primary: Solid state submersible pressure transducer, rated for wastewater application
 - 2. Back-up: PVC ball type float with mercury switch - high and low level
- z. Operation: As level rises, the submersible level transducer detects the pressure change and sends a 4-20 MA signal that is proportional to wet well level to the pump controller.
 - 1. Each pump is brought on as level rises, and when wet well level falls back to a preset level, all pumps stop.
 - 2. Pump alternator in the controller alternates lead/lag pump selection at end of each pumping cycle.
 - 3. If pumps fail to draw down wet well, high-level alarm signal is initiated at the pump controller and controller automatically switches to standby floats for activation of pump controls.
 - 4. In the event of fail signal from transducer, controller automatically switches to floats.
- aa. Alarm Signals
 - 1. Alarms activate local indicator lights and send signals to an approved autodialer.
- bb. Pump Cable Terminal Boxes
 - 1. NEMA 4X stainless steel boxes mounted near pump access hatch for termination of pump power and control cables and for termination of transducer and float cables.
 - 2. All hub-type conduit entries.

- cc. Control Panel Enclosure
 - 1. NEMA 4X stainless steel enclosure on factory stainless steel stands with inside swing door, back plate, quick release latches, and hooking clasp.
 - 2. All hub-type conduit entries.
- dd. Emergency operations shall be considered. Provide fittings and a blind flange that will be readily accessible for emergency bypass pumping. Provide external hook up for an emergency generator
- ee. Force mains shall be a minimum of 4 inches in diameter, unless used in conjunction with grinder pumps. Pump stations with two pumps shall have force main velocities of a minimum of 3 fps with one pump in operation. For pump stations with three or more pumps, the force main velocity shall not be less than 2 fps with the smallest pump only in operation. Force main velocities shall not exceed 6 fps without the engineer performing an analysis for possible high and low negative surge pressures in the event of sudden pump failure.
- ff. Isolation valves shall be provided on the discharge side of pumps for submersible pumps and suction and discharge side of pumps for dry pit lift stations, positioned such that the pump and/or check valve can be isolated for removal. Plug valves shall be used. Check valves shall be swing type with an external lever and shall be installed in a horizontal position. Use of butterfly valves, tilting disc check valves, or other valves utilizing a tilting disc in the pipe flow is not permitted.
- gg. Surge relief valves, air release, and/or combination air and vacuum valves shall be provided, as required.
- hh. Lift station piping shall have flanged, grooved (Victaulic) or flexible connections to allow for removal of pipe and check valves without interruption of the lift station operation.
- ii. Lift stations shall be designed to discharge the peak design flow at the system head required and to operate efficiently during any initial, interim, or ultimate design phase.
- jj. Firm pumping capacity shall be provided, and is defined as total station, maximum pumping capacity, with the largest pumping unit out of service.

- kk. Pump selection shall be based on the analysis of the system head and pump capacity curves for the determination of pumping capacities. System losses shall be calculated in accordance with the Hydraulic Institute standards. The selected C coefficient value for use in the calculation of friction head losses per the Hazen-Williams Formula shall be based on the selected pipe material for new and aged (20-year) conditions.
- ll. Force main velocities shall be included on the system curve.
- mm. Chemical feed odor control for force mains shall be provided at the lift station if travel time, cycle time or other conditions create the odor problems.
- nn. Design considerations shall include corrosion control and protection of concrete and metallic surfaces located within the wet well/valve vault or within the immediate vicinity from the effect of hydrogen sulfide (H₂S) gas in the wastewater. The effects of H₂S gas should be minimized by reducing the production or release of H₂S gas from the wastewater discharging to or being contained in the lift station. Design and control methods shall include:
 - 1. Protecting the exposed concrete and steel surfaces with an epoxy lining. Refer to Approved Products List for list of materials. All exposed piping shall be protected with a 100% solids novolac epoxy or approved equal.
 - 2. The use of Series 300 stainless steel for equipment, piping, devices, etc., exposed to corrosive gases.
 - 3. Providing odor control equipment for wet well atmospheric vents.
 - 4. Design wet wells that lack interior corners, projections, or areas that can result in the accumulation of solids. Design interior surfaces with smooth finishes that facilitate cleaning.
 - 5. Provide wash-down water at site when possible.
- oo. Corrosion protection shall be provided by coating interior concrete surface of the wet well, structural steel, piping and hangers, air systems, electrical, mechanical and other components subject to a corrosive environment. All metal components subject to a corrosive environment shall be stainless steel or aluminum unless otherwise approved by the City Engineer and Department of Public Works. Surfaces to

be protected include:

1. Interior of wet well: The interior of the wet well shall be coated with an approved epoxy coating. Refer to Approved Products List for list of materials.
2. Piping located within wet well: All exposed piping shall be protected with a 100% solids novolac epoxy or approved equal.
3. Guide rails, lifting chains, hardware, and miscellaneous metal shapes located within wet well shall be constructed/manufactured of Series 300 stainless steel.

pp. Lift station construction plans shall include drawings that provide the following information:

1. Site layout
2. Plan and profile of pump station and associated site piping
3. Profile view of pump operational and control levels and settings
4. Hydraulic system curve
5. Electrical wiring and control system schematics
6. Structural details

4.3.31 Design Analysis

- A. Calculations of design flows for the overall development project shall be approved by the City Engineer. Peak flow calculations shall include potential inflow infiltration.
- B. All collection system lift stations shall utilize submersible pumps. A minimum two (2) pumps shall be required for all lift stations. Capacity of the pumps shall be such that maximum wet weather flow can be handled with largest pump out of service.
- C. A minimum peaking factor of 4 is required for pump sizing.
- D. Pumps shall be sized to operate at optimum efficiency. Minimum acceptable efficiency at the operating point shall be 60%.
- E. Electrical equipment and electrical connections in wet well must meet National Fire Prevention Association 70 National Electric Code explosion prevention requirements, unless continuous ventilation is provided.
- F. Emergency operations should be considered. Provide fittings and a blind flange that will be readily accessible for emergency bypass pump.

- G. A geotechnical boring to a minimum depth 15' below bottom of wet well and a foundation design recommendation is required.

4.4 QUALITY ASSURANCE

- 4.4.1 Prepare calculations and construction drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the drawing. The final construction drawings must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings. If more than one Professional Engineer was responsible for the development of the design/construction drawings, then the appropriate Professional Engineer should seal the drawings he/she is responsible for.

4.5 ADDITIONAL STANDARDS

- 4.5.1 If a lot or parcel is within 200 feet of an existing sanitary sewer then the site shall extend the sewer main through the property and tie-on. Such building shall comply with Chapter 30 Article 3 Section 30-78 of the City of Pearland Code of Ordinances.
- 4.5.2 Construction Features - In conjunction with the design, the engineer shall determine the extent of, and fully detailed on the plans, all special construction features required to complete the project in a safe, convenient, and economic manner.
- 4.5.3 Bore and Jack - Bore and jack sections shall be specifically approved by the Department of Public Works and clearly shown on plans by location and footage. Refer to the City of Pearland Standard Details. The following criteria are generally used as a basis for setting bore and jack sections.
 - A. Public Streets - All existing public streets are to be bored and jacked regardless of surface. Bore and jack length shall be computed as roadway width at proposed bore plus five feet (5') to either side.
 - B. Driveways - Whenever it is cost effective, concrete driveways in good condition shall be bored and jacked. Bore and jack length shall be computed as driveway width at bore plus one foot (1') to either side. Where driveways cross culvert pipe sections along open ditch streets and the proposed wastewater main is in close proximity and parallel to the culvert pipe, the length of bore shall be the same as the length of culvert pipe.
 - C. Sidewalks - When the wastewater line crosses under a sidewalk four feet (4') or more in width and in good condition, the sidewalk shall either be bored and jacked or the sidewalk shall be removed and replaced to

the City of Pearland criteria, whichever is 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. Trees - When saving trees and shrubs in a previously developed area is a consideration, all trees six inches (6") and larger in diameter within ten feet (10') of the centerline of the water main must be noted on the plans. The water main shall be bored and jacked within the drip line of any tree larger than six inches (6") in diameter.
- E. Bore Pits - Bore pits shall be at least three feet (3') from back of curb and five feet (5') from back of curb on a major thoroughfare. Bore pits in highway, county road, or railroad right-of-way shall conform to these requirements and to the requirements of the crossing permit and/or use agreement. All bore pits shall be shored in accordance with OSHA requirements. Bore pits and/or receiving pits to be located in street or driveway paving, shall be shown on plans.

- 4.5.4 Open Cuts – Open cuts require specific approval of the City Engineer. Where open cuts are allowed in street paving, plans shall call for steel plate covers to be installed and maintained over the cut during periods when contractor is not actively engaged in work at the site. Streets that are open cut shall be "saw cut" prior to pavement removal. Saw cut shall be full depth.
- 4.5.5 All existing developed areas shall be restored to original condition after construction
- 4.5.6 Proper barricading and signage, conforming to the Texas Manual of Uniform Traffic Control Devices' latest edition, shall be required on all projects. Adequate signage for vehicular and pedestrian traffic shall be installed. A traffic control plan shall be submitted to the City Pearland and approved by the City Engineer for all streets open to travel by the public.

CITY OF PEARLAND

CHAPTER 5 STORMWATER DESIGN CRITERIA

Note:
Chapter 5 has been amended
in August 2021. Please see
amended section for EDCM
chapter 5

**ENGINEERING DESIGN CRITERIA MANUAL
October 2020**

CHAPTER 5 STORMWATER DESIGN CRITERIA

5.1 GENERAL

This chapter includes criteria for the design of storm drainage improvements for the City of Pearland, Texas. These Storm Drainage Design Requirements shall be effective within the City of Pearland and in the subdivisions located within its extraterritorial jurisdiction. All drainage work proposed for design within these limits are to adhere to these criteria explicitly. Any questions regarding their use or function should be addressed to the City Engineer.

5.1.1 Background

Over the years, a number of methods have been used in Brazoria County and adjacent counties for discharge determination in the design and analysis of flood control facilities. The methods included various forms of the Rational Method, U.S. Soils Conservation Service (SCS) synthetic unit hydrograph analysis using existing stream gaging records and computer programs developed by the U.S. Army Corps of Engineers, and U.S. Geological Survey generalized regression equations developed for the area.

In the mid-1960's, the Harris County Flood Control District (HCFCD) and the City of Houston commissioned a detailed hydrologic study of Harris County which resulted in the development of the Site Runoff Curve (discharge versus drainage area relationships) and unit hydrograph methodologies used for the design of flood control and drainage facilities.

In June of 2001, Tropical Storm Allison came ashore on the Upper Texas Coast and produced record rainfall amounts and pervasive flooding in Harris and surrounding counties, including the Clear Creek Watershed. In October of 2001, through a joint effort between FEMA and HCFCD, Harris County began the Tropical Storm Allison Recovery Project (TSARP). Flood Insurance Studies including for Clear Creek Watershed were finalized in June 2007.

In September 2018, National Oceanic and Atmospheric Administration (NOAA) released Atlas 14, a rainfall study which predicts the frequency of rainfall for an area. Based on Atlas 14, the depth of rainfall for various events such as 3-year, 10-year, and 100-year differ from what has been used for the analysis and design of drainage systems. For example; 24 hours rainfall depth for 100-year storm event changed from 13.5 inches to 17.9 inches. It is up to the Floodplain administrator's sound engineering judgment to call for the requirement case by case basis to reduce or prevent probable flooding of the area.

Special care must be taken to make sure that the correct models and methodologies are used for projects that require FEMA approval. In any case, for projects

requiring FEMA approval, design engineers should use the current effective model of the study stream. For modification requirements to FEMA floodplain and/or floodway, refer to Chapter 2.

In the case that FEMA approval is not required for the project, design engineers should use the methodology presented in this manual to design drainage facilities in the City of Pearland.

5.1.2 Previous Design Requirements

The criteria of this Manual supersedes the previous document of the same name dated December 2018. All items listed herein are intended to supersede those documents, so all designs of drainage facilities within the City of Pearland, including all subdivisions within its extraterritorial jurisdiction, shall be based on the criteria of this Manual from this time forward, until such time as it may be revised or replaced.

5.2 DRAINAGE POLICY

5.2.1 Design Requirements

The drainage criteria administered by the City of Pearland for newly designed areas provides protection of habitable areas from flooding by large storm events. This is accomplished with the application of various drainage enhancements such as storm sewers, roadside ditches, open channels, detention and overland (sheet) runoff. The combined system is intended to prevent flooding of houses by extreme events up to the level of a 100-year storm.

Recognizing that each site has unique differences that can enhance proper drainage, the intent of these criteria is to specify minimum requirements that can be modified, provided the objective for drainage standards is maintained and such modifications are made with the approval from the office of the City Engineer.

5.2.2 Street Drainage

Street ponding of short duration is anticipated and designed to contribute to the overall drainage capability of the system. Storm sewers and roadside ditch conduits are designed as a balance of convenience and economics. These conduits are designed to convey less intense, more frequent rainfalls with the intent of allowing for traffic movement during these events. When rainfall events exceed the capacity of the storm sewer system, the additional runoff is intended to be stored or conveyed overland in a manner that reduces the threat of flooding habitable structures.

5.2.3 Floodplain Management

- A. The City of Pearland 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 area, maintenance of existing drainage system, construction of drainage project, 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 premium based on the City's CRS ranking as evaluated by CRS.
- B. 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. Stormwater detention requirements are presented in Section 5.8.
- C. All fill placed in the 100-year floodplain, as designated on the Flood Insurance Rate Map shall be mitigated. Any fill placed between the 100-year and any proposed grade up to the 500-year water surface elevation shall be mitigated by the removal of a like amount (i.e. 1 cubic yard fill to 1 cubic yard removal) of compensating cut in the vicinity of the fill, while maintaining hydraulic connectivity to the existing floodplain. No fill mitigation required for the fill placed above 500-year floodplain.
- D. See Chapter 2, Section 2.12 Floodplain Management for additional details and requirements.

5.2.4 Relationship to the Permitting and Platting Process

Approval of storm drainage is part of the review process for planning and platting of a new development. The review of storm drainage is conducted by the Engineering Department.

5.2.5 Final Drainage Plan and Plat

A detailed drainage plan for each proposed development shall be prepared by a Registered Professional Engineer and shall be presented to the City Engineer for review and approval. The plan shall consist of the detailed design drawings for all drainage improvements and structures, rainfall runoff and impact data and notes as applicable on the Final Drainage Plan as specified in Sections 5.5 through 5.9.

The following items, at a minimum, shall be shown on a plan for a development:

1. Name, address, and phone number of the engineer that prepared the plans.
2. Scale of drawing with a minimum scale of 1" = 100'.

3. Benchmark and reference benchmark with year of adjustment.
4. Location or vicinity map drawn to a scale.
5. Date on all submittals with date of all revisions, including month, day, and year.
6. Contour lines at 0.5-foot intervals or greater with a minimum of 2 contours covering the entire development and extending beyond the development boundaries at least 100 feet on all sides for developments over 5 acres and 50 feet for developments under 5 acres.
7. Lot grading plan, which provides for the passage of sheet flow from adjacent property. The lot grading plan shall include the proposed elevation of each corner of the lot.
8. A 100-year sheet flow analysis that provides direct access to the detention facility or main outfall.
9. Drainage area divides for project area, with peak runoff rates for each inlet, structure, or drainage area.
10. Locations of pipelines, drainage structures, buildings, or other physical features on the property and adjacent rights-of-way.
11. True locations of existing creeks, bayous, streams, gullies, and ditches, as determined by actual ground survey current within one year of approval of the Preliminary Plan. Show stream alignment 200 feet upstream and 200 feet downstream of development.
12. Cross sections of detention facility, ditches, property lines, and earthworks.
13. Details of all ditches, which are to convey rainfall runoff from a subdivision and/or through a subdivision to the appropriate drainage artery and location of that drainage artery.
14. Drainage easements and dedicated right-of-way along all creeks, bayous, streams, gullies, and ditches.
15. Bridges which span any creek, bayou, stream, gully, or ditch and maintenance responsibility and/or ownership of such structures.
16. Culvert type and size shall be shown. No culvert shall be less than 18" in diameter, without special permission by the City Engineer.

17. Copy of TxDOT permit approval (driveway, drainage connection, utility crossing), if applicable.
18. Copies of letters of approval from entities holding easements or rights-of-way to be crossed.
19. An erosion control plan acceptable to both the City and the TCEQ must be presented with all plans. Copies of all submittals to the TCEQ shall be delivered to the City.
20. Signatory requirement is applicable as noted on Chapter 2, Section 2.3.
21. Refer to Chapter 2-section 2.11.3 and this Chapter for engineering grading and drainage plans requirement for the small residential infill lots.

5.3 REFERENCES

All projects that are required to conform to these standards shall also be in compliance with all applicable city ordinances current versions. Relevant related laws and regulations included but are not limited to the following.

1. Brazoria Drainage District No. 4, “Rules, Regulations, & Guidelines”, November 5, 1997 (BDD4 Regulations), amended April 2013.
2. Harris County Flood Control District, “Hydrology & Hydraulics Guidance Manual”, December 2009 (HCFCD Criteria).
3. Applicable Portions of the City of Houston Design Manual, Chapter 9, “Storm Sewer Design Requirements”, July 2019.
4. Ordinances of the City of Pearland (as currently amended).
5. U.S. Army Corps of Engineers. HEC-RAS River Analysis System User’s Manual Version 4.1, The Hydrologic Engineering Center, Davis, California, January 2010.
6. U.S. Weather Bureau. “Rainfall Frequency Atlas for the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years,” Technical Paper No. 40, January 1963.
7. U.S. Army Corps of Engineers. Civil Works Bulletin 52-8.
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9. Chow, V. T., Open-Channel Hydraulics, McGraw-Hill, 1959.

10. Ramser, C. E., Flow of Water in Drainage Channels, U.S. Department of Agriculture, Technical Bulletin No. 129, November 1929.
11. Engineer Handbook, Hydraulics, Section 5, U. S. Department of Agriculture, Soil Conservation Service, 1955.
12. Barnes, Harry H., 1967, Roughness Characteristics of Natural Channels, U. S. Geological Survey Water Supply Paper, 1849.
13. King, H. W. and E. F. Brater, Handbook of Hydraulics, 6th Edition, McGraw-Hill, 1976.
14. Research Studies on Stilling Basins, Energy Dissipators, and Associated Appurtenances, Bureau of Reclamation, Hydraulic Laboratory Report No. Hyd-399, June 1, 1955.
15. Texas State Department of Highways and Public Transportation standard specifications for Construction of Highways, Streets, and Bridges latest edition.
16. ASTM A796 Structural Design of Corrugated Steel Pipe, Pipe Arches, and Arches for Storm and Sanitary Sewers.
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19. Federal Emergency Management Agency. National Flood Insurance Program and Related Regulations, Index 44 CFR, October 1, 2002.
20. Hare, G. "Effects of Urban Development on Storm Runoff Rates," U. S. Army Corps of Engineers, Galveston District, September 1970.
21. Malcolm, H. R. A Study of Detention in Urban Stormwater Management, Report No. 156, Water Resource Research Institute, University of North Carolina, Raleigh, North Carolina, July 1980.
22. Texas Water Development Board. "Study of Some Effects of Urbanization on Storm Runoff from a Small Watershed," Report 23, August 1966.
23. Hydraulic Design of Stilling Basins and Energy Dissipators, Engineering Monograph No. 25, U. S. Department of the Interior, Bureau of Reclamation, 1964.

24. Viessman, Jr., Warren; John W. Knapp; Gary L. Lewis and Terence Harbaugh, Introduction to Hydrology, Harper & Row, 1977.
25. Coenco, Inc. Master Drainage Plan, April 11, 1980, Revised 1988.
26. Rust Lichliter/Jameson. Flood Protection Plan for Brazoria Drainage District No. 4, Brazoria County, Texas, November 5, 1997.
27. U.S. Geological Survey, Water Resources Investigations Report 98-4044, Depth-Duration Frequency of Precipitation for Texas, Austin, Texas 1998.
28. U.S. Geological Survey & Texas Department of Transportation, Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas, June 2004.
29. USACE EM 1110-2-1417.
30. McCuen, Richard H., Prentice Hall, *Hydrologic Analysis and Design*, 1989.
31. City of Pearland Plat Amendment Ordinance No. 421.
32. City of Pearland Flood Damage Prevention Ordinance No. 532-6.
33. City of Pearland Flood Mitigation Exempt Ordinance No. 817-1.
34. City of Pearland City Right-of-Way Management Ordinance No. 669-3.
35. City of Pearland Amending Chapter 27 for Sidewalk City Ordinance No. 741-5.
36. City of Pearland Maintenance of Stormwater Storage Facilities Ordinance No 1059.
37. City of Pearland Discharge Ordinance No 1570.
38. Landuse and Urban Development Ordinance 509.

5.4 DEFINITIONS

- Backslope Drain:*** A drain or swale that collects overland peak discharge from channel overbanks and other areas not draining into the storm sewer collection system. These may be to prevent unplanned runoff from entering a detention system, or from entering a drainage ditch. They are also used to prevent overland discharge from eroding the sides of a ditch or pond.
- Benchmark:*** A point of known exact elevation, set and used by Surveyors to start from to obtain elevations on other points of unknown

elevation. The known elevation is usually based on “mean sea level” and is referenced to a “Year of Adjustment”.

- BDD4:*** Brazoria Drainage District No. 4.
- cfs:*** Cubic Feet Per Second.
- City Engineer:*** An Engineer licensed in the State of Texas who is responsible for reviewing drainage plans or plats under the authority of and in the employment of the City of Pearland.
- CMP:*** Corrugated Metal Pipe.
- Coefficient of Roughness:*** A number used to measure and compare the roughness of pipe interior or open channel sides and bottom.
- Commercial:*** Development of real estate for any purpose other than “residential” as defined herein.
- Conduit:*** Any open or closed device for conveying flowing water.
- Construction:*** The building of a planned or designed project.
- Continuity Equation:*** $Q = VA$
- Where, Q = discharge (cfs or cms)
V = velocity (ft/sec or m/sec)
A = cross sectional area of conduit in square feet or square meters.
- Contour Line:*** A line on a map, chart or plan that follows a continuous line of a certain known elevation.
- Culvert:*** One or more pipes that carry the flow of water from one point in a ditch or channel to another point in a ditch or channel.
- Design Storm Event:*** The rainfall intensity and/or depth upon which the drainage facility will be sized.
- Detention Control Structure:*** The outlet pipe or weir, and high-level spillway that limits the discharge from a detention facility.
- Detention Facility:*** A reservoir, dam, pond or other area where storm water collects and is held temporarily. The collected storm water is released at a calculated rate through a control structure.

<i>Developer:</i>	A person or entity that develops land.
<i>Development:</i>	A tract of land that has been improved or subdivided, exclusive of land being used and continuing to be used for agricultural purposes. Improvement of land includes grading, paving, building structures, or otherwise changing the runoff characteristics of the land.
<i>Development Engineer:</i>	An Engineer licensed in the State of Texas who is performing work for a Developer.
<i>Disturbed Area</i>	An area of the land or tract that changes the drainage characteristics. This include any changes in land grading, paving, building structures, or otherwise changing the runoff characteristics of the land.
<i>Drainage Area Map:</i>	Area map of watershed which is subdivided to show each area served by each storm drainage subsystem.
<i>Drainage Arteries:</i>	Natural or man-made ditches or channels that intercept and carry stormwater on to a larger major creek, bayou or stream.
<i>Drainage Plan:</i>	An engineering representation of the peak discharge of rainfall runoff on or onto a particular area, and off of that same area. It may also include systems that will be used to detain or control runoff and provide flood control for a development, subdivision, or structure.
<i>Drainage System:</i>	A series of swales, storm sewers, ditches and creeks which function to collect and convey stormwater runoff in a watershed.
<i>Easement:</i>	An area designed and dedicated for a specific use but remains the property of the owner out of which it is a part. The uses may be for drainage, maintenance, access, future widening of channel or ditch, or other specific uses.
<i>FEMA:</i>	The Federal Emergency Management Agency, which administers the National Flood Insurance Program.
<i>FIRM:</i>	Flood Insurance Rate Maps published by a Federal Emergency Management Agency.
<i>Flood Plain Administrator:</i>	Person identified by the governing municipality or County as responsible for administering the National Flood

Insurance Program for the City or County in accordance with guidelines established by FEMA.

<i>HCFC</i>	Harris County Flood Control District.
<i>HDPE</i>	High Density Polyethylene.
<i>HEC-HMS</i>	“Hydrologic Modeling System” computer program written by the U.S. Army Corps of Engineers.
<i>HEC-RAS</i>	“River Analysis System” computer program written by U.S. Army Corps of Engineers.
<i>Hydraulic Analysis</i>	The study and/or definition of the movement of stormwater through a drainage system.
<i>Hydraulic Grade Line</i>	A line representing the pressure head available at any given point within the drainage system.
<i>Hydrologic Analysis</i>	The study and/or definition of the properties, distribution and circulation of stormwater runoff over land or in the soil.
<i>Hydromulching</i>	A process that prevents or helps to prevent erosion of the soil. When sprayed on an exposed slope, it seals the surface and seeds it with vegetation.
<i>ICPR</i>	Interconnected Channel and Pond Routing computer program by Streamline Technologies, Inc. Computes unsteady gradually varied flow.
<i>Impact</i>	The effect of a proposed development on the hydrology or hydraulics of a subarea or watershed as defined by an increase or decrease in peak discharges or water surface elevations.
<i>Impact Data</i>	Data required to support the Developer’s Engineer to show the effect the proposed development will have on the rainfall runoff rates, rainfall concentration times and the surface level of the affected creek, stream, gully, or ditch into which proposed development runoff drains.
<i>Impervious Cover</i>	A land surface cover which does not allow the passage of stormwater into the underlying soil. Used in hydrologic analysis to calculate the amount of stormwater runoff from an area.

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.

Manning's Equation:

$$V = (K/n) R^{2/3} S_f^{1/2}$$

Where K = 1.49 for English units,
1.00 for metric units
V = velocity (ft/sec or m/sec)
R = hydraulic radius (ft or m)
(area/wetted perimeter)
S_f = friction slope (headloss/length)
n = 0.013 for concrete pipes,
0.011 for HDPE pipes,
0.028 for CMP
0.035-0.05 for earthen channels

Metering Device:

A device or structure containing pipe, V-notch weir, slots and other configurations designed to measure or regulate the outflow.

Mitigate:

To lessen or eliminate the impact of a proposed development on the hydrology or hydraulics of a subarea or watershed.

NAVD:

North American Vertical Datum or Mean Sea Level, pertaining to base elevations.

Outfall Structures:

A structure made to contain the outfall pipe or peak discharge, with necessary weir, concrete slope paving, interlocking concrete block, or other methods to control velocity and prevent erosion, and may contain the metering device.

Outflow:

The final peak discharge from the development system into another or existing drainage system.

Overflow:

The peak discharge that will not pass through the design pipe or structure and must go over a weir or some other relief structure.

Peak Discharge:

The maximum rate of stormwater runoff from a tract of land or in a ditch or channel, as determined from the maximum point in cubic feet per second of the calculated hydrograph for the study area.

<i>Plat:</i>	A formal drawing of property lines and spaces that may, or may not, be recorded.
<i>Rainfall Data:</i>	Data pertaining to the amount of rainfall in a certain area and occurring over a certain specified period of time.
<i>Rainfall Frequency:</i>	<p>The probability of a rainfall event of defined characteristics occurring in any given year. Information on rainfall frequency is published by the National Weather Service. For the purpose of storm drainage design, the following frequencies are applicable:</p> <p><u>3-year frequency</u> - a rainfall intensity having a 33% probability of being equaled or exceeded in any given year.</p> <p><u>5-year frequency</u> - a rainfall intensity having a 20% probability of being equaled or exceeded in any given year.</p> <p><u>10-year frequency</u> - a rainfall intensity having a 10% probability of being equaled or exceeded in any given year.</p> <p><u>25-year frequency</u> - a rainfall intensity having a 4% probability of being equaled or exceeded in any given year.</p> <p><u>50-year frequency</u> - a rainfall intensity having a 2% probability of being equaled or exceeded in any given year.</p> <p><u>100-year frequency</u> - a rainfall intensity having a 1% probability of being equaled or exceeded in any given year.</p> <p><u>500-year frequency</u> - a rainfall intensity having a 0.2% probability of being equaled or exceeded in any given year.</p>
<i>Rational Formula:</i>	A method for calculating the peak runoff for a storm drainage system.
<i>Redevelopment:</i>	A change in land use that alters the impervious cover from one type of development to either the same type or another type and takes advantage of the existing infrastructure in place as a drainage outlet.
<i>RCP:</i>	Reinforced Concrete Pipe.
<i>Regional Detention Facility:</i>	A detention facility that collects and holds stormwater from more than one development or from one of the major creeks or tributaries in the City of Pearland.

<i>Residential:</i>	Of or pertaining to single family detached dwelling(s) not including multi-family townhomes, condominium, duplexes, or apartments.
<i>Right-of-Way:</i>	A strip of land that is set aside and reserved for certain purposes including drainage and maintenance, and possibly future widening of a drainage channel.
<i>Runoff:</i>	That part of rainfall on property that does not soak in or evaporate, and ultimately reaches drainage arteries.
<i>Runoff Coefficient:</i>	A comparative measure of different soils, slopes and growths, and improvements, for their capability of allowing the peak discharge of water to move along and over them.
<i>Sheet Flow:</i>	Overland storm runoff that is not conveyed in a defined conduit and is typically in excess of the capacity of the conduit.
<i>Site:</i>	A space of ground occupied or to be occupied by a building or development.
<i>Spillway:</i>	The part of the outfall structure that allows and controls the “overflow” that does not go through the outfall structure.
<i>Subdivide:</i>	To divide a tract of land into two or more smaller tracts or building lots.
<i>Subdivision:</i>	A tract of land which has been separated from surrounding tracts and has been divided into two or more lots.
<i>Swale:</i>	A very shallow ditch that usually has very long sloping sides, in some cases not much more than a small depression that allows water to peak discharge in a somewhat controlled manner.
<i>TSARP:</i>	Tropical Storm Allison Recovery Project. Federally funded flood study managed by Harris County Flood Control District begun in October of 2001.
<i>U.S.G.S. SIR 2004-5041:</i>	2004 U.S.G.S Publication regarding rainfall depth-duration frequency relationships for Texas.
<i>Variance:</i>	A one-time formal exception to a particular rule or rules granted for extenuating circumstances, approved by City

Engineer. Engineering Variance as mentioned in EDCM Chapter 1 is applicable.

Watershed:

A region or area bounded peripherally by a ridge of higher elevation and draining ultimately to a particular watercourse or body of water.

5.5 STORM SEWER AND ROAD-SIDE DITCH DESIGN REQUIREMENTS

Storm sewer structures shall be per City of Pearland Standard Details. The City of Pearland also adopts the hardware requirements of the TxDOT Specifications and Standard Drawings as necessary. Manhole covers shall include the City of Pearland designation as shown in Standard Details.

Furthermore, all outfall pipes, ditches, and structures that enter District Channels shall also be designed in accordance with BDD4 Regulations or HCFCF Criteria. In such instances wherein a conflict of these criteria arises, the most stringent requirements of these shall be utilized for the design.

To distinguish the adequacy of road-side ditches to be designed by the following requirements of this section, it is important to note that these ditches DO NOT include channels which receive runoff flows from any other outfall drainage sources other than direct overland runoff flows. Design of channels that do receive outfall system drainage can be found in Section 5.7 of this Manual.

5.5.1 Determination of Runoff

The stormwater runoff (peak discharge) shall be determined for each inlet, pipe, roadside ditch, channel, bridge, culvert, outfall, or other designated design point by using the following standards applicable to the above requirements.

A. Application of Runoff Calculation Models

a. Acceptable Methodology for Areas Less Than 200 Acres

For areas up to 200 acres served by storm sewer or roadside ditch, peak discharges will be based on the Rational Method. If the modeling is associated with establishing a flood-prone area for purposes of a FEMA submittal, the models to be used must be acceptable to that agency.

b. Acceptable Methodology for Areas Greater Than 200 Acres

Rainfall runoff modeling will be applied to areas greater than 200 acres in size. Again, if the modeling is associated with establishing a flood-prone area for purposes of a FEMA submittal, the models to be used must be acceptable to that agency.

B. Rainfall Durations for Hydrologic Modeling

For design using the HEC-HMS model, the 24-hour design storm isohyetograph will be used for rainfall data for drainage areas greater than 200 acres.

C. Application of the Rational Method

Use of the Rational Method for calculating the peak runoff for a storm drainage system involves applying the following formula to runoff:

$$Q = CIA$$

where: Q = peak discharge (cfs)

C = runoff coefficient

A = area (acres)

I = rainfall intensity (inches per hour)

a. Calculation of Runoff Coefficient

The runoff coefficient "C" values in the Rational formula will vary based on the land use. Land use types and "C" values which can be used are as follows:

<u>Land Use Type</u>	<u>Runoff Coefficient</u>
Paved Areas/Roofs*	1.00
Compacted gravel, limestone	0.80
Residential Districts	
Lots more than ½ acre	0.40
Lots 1/4 - ½ acre	0.50
Lots 8,000 sf. – 1/4 acre	0.55
Lots 5,000 sf. – 8,000 sf.	0.60
Lots less than 5,000 sf.	0.70
Multi-Family areas	
Less than 20 DU/AC	0.75
20 DU/AC or Greater	0.85
Business Districts	0.95
Industrial Districts	0.95
Railroad Yard Areas	0.30
Parks/Open Areas	0.30
Rice Fields/Pastures	0.20
Lakes/Detention Ponds**	1.00
Dry Detention Ponds	0.85

*Includes concrete and asphalt

**Includes wet detention facilities. Area will be computed from top of slope.

Composite “C” values for mixed-use drainage areas are allowed for use in the Rational Formula. These values are to be obtained by calculating a weighted average of all the different “C” values of the sub-areas contributing to each mixed-use drainage area. Any calculations of these Composite “C” values are to be provided as part of the drainage calculations.

$$C = \frac{(C_1A_1 + C_2A_2 + C_3A_3 + \dots C_nA_n)}{(A_1 + A_2 + A_3 + \dots A_n)}$$

The calculations and an exhibit of land use types for used for composite “C” values shall be included with the drainage calculations and provided in plans.

b. Determination of Time of Concentration

The following method shall be used for determining the time of concentration:

$$T_c = D / (60 * V) + T_i$$

where: T_c = Time of concentration (minutes)

T_i = Initial time (minutes)

Use 10 minutes for developed flows

Use 15 minutes for undeveloped flows

D = Travel distance on flow path (feet)

V = Velocity (ft/sec)

The time of concentration shall be calculated for all inlets and pipe junctions in a proposed storm drainage system or other points of runoff entry to the system. Time of concentration shall be based upon the actual travel time from most remote point in the drainage area to the point of runoff. The design engineer shall provide a sketch of the travel path with the computations.

The following minimum and maximum velocities shall be used when calculating the time of concentration:

SURFACE TYPE	UNDEVELOPED FLOWS MIN V (fps)	DEVELOPED FLOWS MIN V (fps)
Storm sewer	3.00	3.00
Ditch / channel	2.00	2.50
Paved area	1.50	1.50
Bare ground	0.50	1.00
Grass	0.35	0.50
Vegetation	0.25	0.35

For storm sewers, time of concentration for other analysis points shall be the highest time of concentration of the previous upstream contributing area(s) plus time of flow in the pipe. For drainage areas of one acre or less the time of concentration need not be calculated and a storm duration of 10 minutes for mostly impervious area or 15 minutes for mostly pervious area may be used as the basis of design.

Note: Sheet flow usually becomes shallow concentrated flow after around 100 feet.

c. Rainfall Intensity

The time of concentration of the runoff will be used to determine the rainfall intensity component of the Rational Method Formula. The rainfall intensity shall be computed as follows:

$$I = b / (T_c + d)^e$$

where: I = Rainfall intensity (in/hr)

T_c = Time of Concentration (min)

b, d, e = Coefficient per table below

	100-YEAR	50-YEAR	25-YEAR	10-YEAR	5-YEAR	3-YEAR
T _c ≤ 60 min						
b	90.8	107.0	98.5	107.9	92.9	90.6
d	16.5	21.1	24.0	23.6	19.7	19.5
e	0.685	0.734	0.729	0.781	0.788	0.803
T _c > 60 min						
b	84.0	86.5	89.2	96.6	70.1	71.0
d	11.0	10.0	10.4	17.2	7.7	8.4
e	0.679	0.709	0.736	0.770	0.752	0.774

d. Sample Calculation Forms

Appendix A has a sample calculation form for storm sewer systems.

5.5.2 Design of Storm Sewers

A. Design Frequency

a. Newly Developed Areas

The design storm event for sizing storm sewers will be 3-year rainfall. The storm sewer should be designed so that the design hydraulic grade line shall be at or below the curb gutter grade for a curb and gutter section, and six inches below the shoulder of a roadside ditch section. For major thoroughfares and secondary thoroughfares, the design storm event will be 5-year rainfall.

b. Redevelopment or In-fill Development

The existing storm drainage system will be evaluated using 3-year rainfall, assuming no development takes place. The same system will then be evaluated with the development in place. Modifications to the existing drainage system are to be considered based on the following:

1. If the proposed redevelopment has a lower or equal runoff potential, no modifications to the existing storm drainage system are required.
2. If the hydraulic gradient of the affected existing storm drainage system is below the curb gutter grade (or six inches below the shoulder of a roadside ditch section), no improvements to the existing storm drain are required.
3. If the hydraulic gradient is above the gutter grade (or the edge of shoulder of a roadside ditch section), the drainage system must be analyzed for the impact of the 100-year storm event. If the 100-year event is at or one foot below the floor levels of adjacent existing habitable structures and exceeds the top of curb (or the roadway centerline elevation in a roadside ditch section) by twelve inches or less, no improvements to the existing system are required.

If none of these conditions are met by the proposed development changes, improvements to the existing system will be required.

In all cases of development (development which increases the runoff potential of the site), mitigation in the form of onsite or offsite detention must be in compliance with section 5.8 of this chapter.

c. City of Pearland Projects (Capital Improvement Programs)

Proposed City of Pearland Capital Improvements Program may indicate that a larger diameter storm sewer is planned in the area for drainage improvements. The City Engineer will provide information on planned capital improvements and should be consulted as to its impact on new development.

d. Private Drainage Systems

Drainage facilities draining private areas shall be designed in conformance with appropriate design standards. The City of Pearland will not approve nor accept for maintenance a drainage system on private property unless it drains public water and is located in a drainage easement. The connection of any storm sewer, inlet, ditch, or culvert to a public drainage facility will be reviewed and approved by the City of Pearland. Stormwater shall not be discharged or flow over any public sidewalk or adjoining property except to existing creeks, ditches, streets, or storm sewers in public right of way or easements. Drainage to an existing Texas Department of Transportation (TxDOT) ditch, road, or storm sewer, must be approved or documented with a permit, letter or note of no objections to the plan by TxDOT. Similarly, drainage to an existing BDD4 or HCFCD ditch/creek must be approved or documented with a permit, letter or note of no objections to the plan by BDD4 or HCFCD respectively.

B. Velocity Considerations

- a. Minimum velocities should not be less than 3 feet per second with the pipe flowing full, under the design conditions.
- b. Maximum velocities should not exceed 8 feet per second without use of energy dissipation before release to natural or cultivated grass channels.

C. Pipe Sizes and Placement

- a. Use storm sewer and inlet leads with at least 18-inch inside diameter or equivalent cross section. Box culverts shall be minimum of 2' x 2'. Closed conduits (circular, elliptical, or box) shall be selected based on hydraulic principals and economy of size and shape. For inlets and leads carrying 5 cfs or more, 24-inch inside diameter is the minimum.
- b. Larger pipes upstream should not flow into smaller pipes downstream unless construction constraints prohibit the use of a larger pipe downstream, the improvements are outfalling into an existing system, or the upstream system is intended for use in detention.
- c. Match crowns of pipe at any size change unless depth constraints or other conditions justify matching flowlines.
- d. Locate storm sewers in public street rights-of-way or in approved easements of adequate width as shown in standard details. Back lot and side lot easements are discouraged and must be approved by the City Engineer.

- e. Follow the alignment of the right-of-way or easement when designing cast in place concrete storm sewers.
- f. A straight line shall be used for inlet leads and storm sewers.
- g. Minimum vertical clearance between the exterior of any storm pipe or other appurtenances (manhole, inlet etc) shall be at least 18 inches from exterior of the existing or proposed utilities.
- h. Cast-in-place concrete storm sewers are not allowed within the public right-of-way.

D. Starting Water Surface and Hydraulic Gradient

a. Tailwater elevation selections for Hydraulic Gradient Line (HGL) analysis:

- (1) If the receiving channel for the storm system being analyzed is less than 2,000 feet from the project limits, then the starting tailwater shall be determined from outfall at the receiving channel according to criteria noted below:
 - For the 3-year design rainfall event with non-submerged outfall to the receiving channel, the starting tailwater shall be the top of pipe.
 - For the 100-year extreme rainfall event and outfall to the receiving channel, the starting tailwater shall be the 10-year water surface elevation (WSE) or 2-feet below the top of bank, whichever is higher.
- (2) If the receiving channel for the storm system being analyzed is greater than 2,000-feet from the project limits, then the starting tailwater may be determined from an outfall point, or truncation, downstream of the project interconnect point, as noted below:
 - For the 3-yr design rainfall event the starting HGL, shall be the top of pipe 2,000-feet downstream of the project interconnect point assuming pipes are connected at soffit. If pipes are connected at flow line, the top of the larger receiving pipe must be used. If a starting tailwater other than the top of pipe is chosen, the consultant shall analyze the storm system from outfall at the receiving channel upstream to the point of interconnect to demonstrate the alternate starting HGL value.
 - For the 100-year extreme rainfall event the starting HGL shall be 2-feet above the top of pipe 2,000-feet downstream of the project interconnect point. If a starting tailwater other than 2-ft above the top of pipe is chosen, the consultant shall analyze the storm system from

outfall at the receiving channel upstream to the point of interconnect to demonstrate the alternate starting HGL value.

- The design engineer can also use a stage/time variable tailwater developed from effective HEC-RAS and HEC-HMS model for extreme event analysis.

(3) For the hydraulic impact analysis, a variable tailwater at the downstream end of the model may be used. A variable tailwater condition is recommended for use for detention analyses.

- b. At drops in pipe invert, where the top of the upstream pipe be higher than the HGL, then the HGL shall be recalculated assuming the starting water surface to be at the top of pipe at that point.
- c. For the Design Rainfall Event, the hydraulic gradient shall at all times be below the gutter line for all newly developed areas.
- d. For the 100-year design storm, the maximum depth of ponding allowed will be 9-inches above top of curb for minor collector and local streets, and 3-inches above top of inside curb for major and secondary thoroughfare roads which is also known as one lane passable criteria.

E. Manhole Locations

- a. Use manholes for precast conduits at the following locations:
 - (1) Size or cross section changes.
 - (2) Inlet lead and conduit intersections.
 - (3) Changes in pipe grade.
 - (4) Street intersections.
 - (5) A maximum spacing of 600 feet measured along the conduit run.
 - (6) Manholes and inlets shall not be located in driveway areas.

F. Inlets

- a. Locate inlets at all low points in gutter.
- b. Valley gutters across intersections are not permitted without approval from the City Engineer.
- c. Inlet spacing is a function of gutter slope, contributing drainage area, and ponding width and height. For minimum gutter slopes, the maximum spacing of inlets shall result in a gutter run of 350 feet from high point in pavement, with a maximum total of 700 feet of pavement draining towards any one inlet.

- d. Use the following standard inlets as detailed in standard details:

Inlet Type	Application	Capacity
Type A	Parking Lots/Small Areas	2.5 cfs
Type B-B	Residential/Commercial	5.0 cfs
Type C	Residential/Commercial	5.0 cfs
Type C1	Residential/Commercial	10.0 cfs
Type C2	Residential/Commercial	15.0 cfs
Type D	Parking Lots	2.0 cfs
Type E	Roadside Ditches	20.0 cfs

- e. Do not use “Beehive” grate inlets or other “specialty” inlets without approval from City Engineer.
- f. Do not use grate top inlets in unlined roadside ditches.
- g. Place inlets at the end of proposed pavement, if drainage will enter or leave pavement.
- h. Do not locate inlets adjacent to esplanade openings.
- i. Place inlets on side streets intersecting major streets, unless special conditions warrant otherwise.
- j. For lots 65’ in width or greater, place inlets at mid lot.

G. Outfalls

Storm sewer and open street ditch outfalls to BDD4 or HCFC Ditches shall be per BDD4 or HCFC D criteria, as approved by the respective District and City Engineer.

5.5.3 Consideration of Overland Flow

All storm drainage designs will take into consideration the overland flow of runoff to account for the possibility of system inundation, obstruction, failure, or events that exceed the design storm. A representation of the overland flow scheme must be submitted with the system design.

A. Design Frequency

The design frequency for consideration of overland sheet flow will focus on 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 outlet or detention basin. Unless otherwise

accepted by the City Engineer, the default storm event for this type of analysis is the 100-year storm.

B. Relationship of Structures to Street

Relationship of structures to street shall comply with EDCM chapter 2.

C. Calculation of Flow

- a. Streets will be designed so that consecutive high points in the street will provide for a gravity flow of sheet flow drainage to the ultimate outlet.
- b. Sheet flow between lots will be provided only through a defined drainage easement, through a separate instrument, or on the plat.
- c. A map shall be provided to delineate extreme event flow direction through a proposed development and how this flow is discharged to the primary drainage outlet or detention basin.
- d. In areas where ponding occurs and no sheet flow path exists, then a calculation showing that runoff from the 100-year event can be conveyed (or stored) and remain in compliance with the other terms of this paragraph must be provided.
- e. Selective reaches of the proposed storm sewer may need to be increased in size to adjust the elevation of the 100-year HGL to not exceed the desired HGL with respect to roadway top of curb.
- f. Analysis using the Stormwater Management Model (XP-SWMM) will be acceptable to the City.

5.5.4 Design of Roadside Ditches

Open ditch subdivisions and asphalt streets are prohibited unless in an area conforming with “RE” zoning as specified in the City’s Land Use and Urban Development Ordinance or unless a variance has been granted by the City. In either of these exceptions, the following shall apply to the design of roadside ditches.

A. Design Frequency

- a. The design storm event for the roadside ditches shall be 3-year rainfall.
- b. The 3-year storm design capacity water surface elevations for a roadside ditch shall be no higher than six inches below the edge of shoulder or the natural ground at the right-of-way line, whichever is lower.

The design must include an extreme event analysis to indicate that habitable structures will not be flooded.

B. Velocity Considerations

- a. For grass lined sections, the maximum design velocity shall be 3.0 feet per second during the design event.
- b. A grass lined or unimproved roadside ditch shall have side slopes no steeper than three horizontal to one vertical (3:1).
- c. Minimum grades for roadside ditches shall be 0.1 foot per 100 feet (0.1%) unless approved by the City Engineer.
- d. Calculation of velocity will use a Manning's roughness coefficient of 0.035 for improved earthen sections and 0.025 for ditches with paved inverts.
- e. Use erosion control methods acceptable to the City of Pearland when design velocities are expected to be greater than 3 feet per second.

C. Culverts

- a. Culverts will be placed at all driveway and roadway crossings and other locations where appropriate.
- b. Culverts may not be extended across property frontage to cover the roadside ditch except for driveways.
- c. Culverts will be designed assuming either inlet control or outlet control, whichever the situation dictates.
- d. Roadside culverts are to be sized based on drainage area. Calculations are to be provided for each block based on drainage calculations. Headlosses in culverts shall conform to TxDOT Hydraulics Manual.
- e. Cross culvert for open channels with roadside shall be no smaller than 18 inches inside diameter or equivalent. The size of culvert used shall not create a headloss of more than 0.20 feet greater than the normal water surface profile without the culvert.
- f. Stormwater discharging from a ditch into a storm sewer system must be received by use of an appropriate structure (i.e., stubs with ring grates or type "E" inlet manholes).

D. Depth and Size Limitations for Roadside Ditches

The use of roadside ditch drainage systems is stipulated by other City development codes. When the use of open ditch drainage systems is approved, the following shall apply to the design of roadside ditches:

- a. Roadside ditches shall drain streets and adjacent land areas.
- b. Residential Streets - The maximum depth of proposed roadside ditches will not exceed 4 feet from centerline of pavement.
- c. Commercial and Thoroughfare Areas - The maximum depth of proposed roadside ditches will not exceed 4 feet from edge of roadway.
- d. Roadside ditch bottoms should be at least 2 feet wide, unless design analysis will support a narrower width.
- e. Roadside ditch side slopes shall be set at a ratio of 3:1 or flatter.
- f. Ditches in adjoining and parallel easements shall have the top of bank not less than 2 ft from the outside easement line.
- g. The minimum street right-of-way for open ditch drainage in residential developments shall be 70 feet in width. Rights-of-way shall be wider for deep ditches. The minimum open-ditch section roadway shall be 24 feet pavement with 6 feet shoulders on each side.

5.5.5 Design of Outfall Pipes

Outfall design shall conform to BDD4 rules or HCFCD Criteria, as appropriate, and as approved by the City Engineer and the Drainage District. Section 5.6 of this Manual generally incorporates BDD4 and HCFCD's rules and/or criteria and shall apply to all channel and detention designs subject to their requirements.

Pipe discharges of stormwater into earthen channels shall not exceed 5 feet per second. Use erosion control methods acceptable to the City of Pearland, BDD4 or HCFCD when design velocities are expected to be greater than 3 feet per second.

5.5.6 Stormwater Mitigation Detention Alternatives

Detention basin design shall conform to City of Pearland criteria, BDD4 rules, or HCFCD criteria on a case-by-case basis as approved by the office of the City Engineer. The City of Pearland detention design criteria appear in Section 5.8 of this Manual.

5.6 HYDROLOGIC ANALYSIS OVERVIEW

The selection of an appropriate hydrologic methodology for all projects shall be carried out in accordance with Figure 5.6-1. The design engineer should contact the appropriate reviewing agencies prior to preparing the analysis to obtain approval of the selected methodology.

HEC-HMS was created at the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC). Please note that a rainfall runoff analysis using HEC-HMS should only be used in cases where it is required for FEMA submittals or where a reviewing agency has determined that the design engineer must investigate the downstream impacts of the proposed project. In any case, for projects requiring FEMA approval, design engineers should use the most current effective model of the study stream.

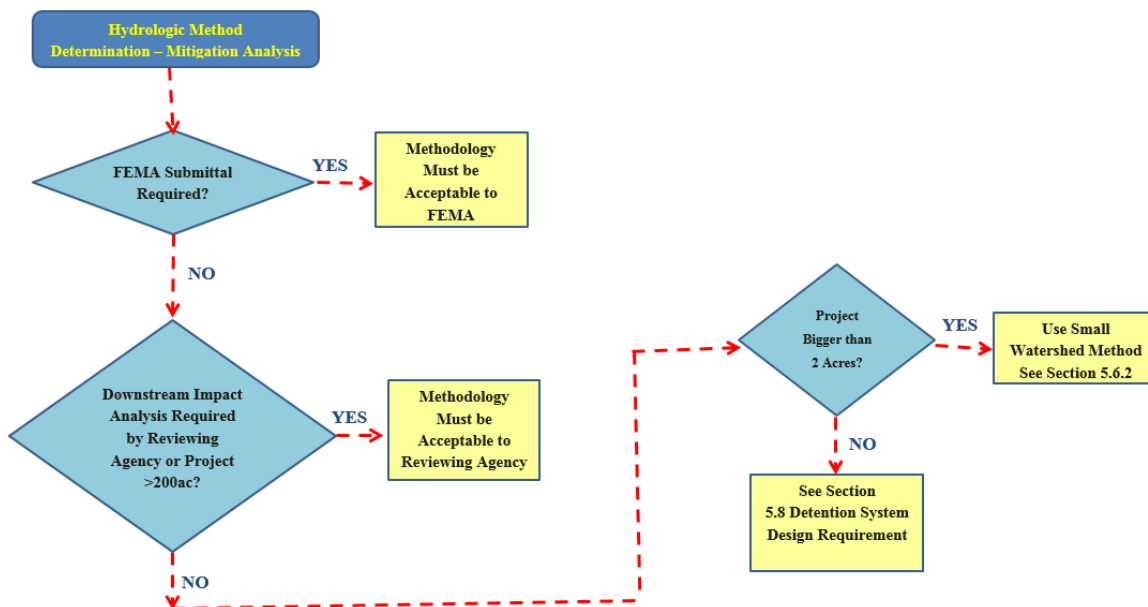


Figure 5.6-1 Hydrologic Method Determination – Mitigation Analysis

5.6.1 Peak Discharge Determination

For areas draining less than 200 acres, the natural, existing and proposed discharge rates can be determined by the Engineer using the Rational Method Formula, $Q = CIA$, where C is the runoff coefficient, I is the rainfall intensity in inches per hour, and A is the drainage area in acres. See Section 5.5.1.C of this manual for the application of this method.

5.6.2 Hydrograph Development for Small Watershed (Small Watershed Method)

The small watershed method referred to is the one developed by H.R. Malcolm and is described below.

A. Introduction

A technique for hydrograph development which is useful in the design of detention facilities serving relatively small watersheds has been presented by H.R. Malcolm. The methodology utilizes a pattern hydrograph which peaks at the design flow rate and which contains a runoff volume consistent with the design rainfall. The pattern hydrograph is a two-part function approximation to the dimensionless hydrograph proposed by the Bureau of Reclamation and the Soil Conservation Service.

B. Equations

The Small Watershed Hydrograph Method consists of the following equations:

$$T_p = \frac{V}{1.39Q_p} \quad (1)$$

$$q_i = \frac{Q_p}{2} \left[1 - \cos \left(\frac{\pi t_i}{T_p} \right) \right] \quad \text{for } t_i \leq 1.25T_p \quad (2)$$

$$q_i = 4.34Q_p e^{-1.30t_i/T_p} \quad \text{for } t_i > 1.25T_p \quad (3)$$

* Calculator must be in radian mode.

where T_p is the time (in seconds) to Q_p , Q_p is the peak design flow rate (in cubic feet per second) for the subject drainage area, V is the total volume of runoff (in cubic feet) for the design storm, and t_i and q_i are the respective time (s) and flow rates (cfs) which determine the shape of the inflow hydrograph. All variables must be in consistent units.

C. Applications

The peak flow rate, Q_p , is obtained from the Rational Method Formula. The total volume of runoff (V) is the same as the rainfall excess. Table 5.6-1 below gives typical values for the rainfall excess based on percent impervious cover. The actual values may be interpolated from the table. See Table 5.6-3 for determination of percent impervious cover.

**Table 5.6-1. Typical Rainfall Excess Values
To Be Used with Small Watershed Method**

	100-Year	10-Year	3-Year
Impervious Cover	Rainfall Excess (in)	Rainfall Excess (in)	Rainfall Excess (in)
90%	13.2	7.5	4.5
80%	13.0	7.2	4.3
70%	12.7	7.0	4.1
60%	12.4	6.8	3.9
50%	12.2	6.5	3.7
45%	12.0	6.4	3.6
40%	11.9	6.3	3.5
35%	11.8	6.2	3.4
30%	11.6	6.1	3.3
20%	11.4	5.8	3.1
10%	11.1	5.6	2.9
0%	10.8	5.4	2.7

The Small Watershed Hydrograph Method should only be used where an impact analysis is not required for the total drainage system including the detention facility and outfall channel as indicated in Figure 5.6-1. The Small Watershed Hydrograph Method cannot be used in conjunction with the HEC-HMS models of watersheds studied in the Flood Insurance Study. The time to peak of the Small Watershed Hydrograph Method is computed strictly to match volumes and has no relationship to the storm durations and rainfall distributions used in the Flood Insurance Study.

5.6.3 Watershed Modeling

In October of 2001, through a joint effort between FEMA and HCFCD, Harris County began the Tropical Storm Allison Recovery Project (TSARP). TSARP models for Clear Creek simulated the existing conditions in Clear Creek Watershed when released in June 2007. The effective models for Clear Creek watershed can be downloaded from the HCFCD Model and Map Management (M3) System in HCFCD website at www.m3models.org. Design engineers should always use the current effective model when FEMA approval is required.

In the case that FEMA approval is not required for the project, design engineers should use the methodology presented in this Chapter to design drainage facilities in the City of Pearland.

A. Rainfall Frequency and Duration

The storm event used to establish regulatory flood plain and floodway limits in the Flood Insurance Study is the 100-year, 24-hour event. For planning purposes and establishing flood insurance rate zones the 10-, 50-, and 500-

year events analysis also required. For projects requiring FEMA submittals, the rainfall depths in the most current effective model should be used. For all other projects requiring a rainfall runoff analysis, the depths should be based on Table 5.6-2, which includes the maximum values for each depth, duration and frequency from the TSARP, TP40 and Hydro 35 information.

Point rainfall amounts for various durations and frequencies for use in the City are given in Table 5.6-2.

Table 5.6-2. Point Rainfall Depth (Inches) Duration-Frequency Values¹

Duration	Depth (in)				
	100-Year	25-Year	10-Year	5-Year	3-Year
5 min.	1.20	1.00	0.90	0.80	0.70
30 min.	3.00	2.4	2.10	1.90	1.60
1 hr.	4.3	3.4	2.90	2.50	2.20
2 hr.	5.7	4.4	3.70	3.10	2.60
3 hr.	6.8	5.1	4.20	3.50	2.80
6 hr.	9.10	6.6	5.30	4.40	3.30
12 hr.	11.10	8.00	6.40	5.30	4.00
24 hr.	13.50	9.80	7.80	6.40	4.80

¹Harris County Hydrologic Region 3 Rainfall (inches)

B. Rainfall Depth-Area Relationship and Temporal Distribution

The version of HEC-HMS that was available at the time of the TSARP does not have an option for depth-area indices for watersheds larger than 10 square miles. Therefore, it was decided to use point rainfall depths to specify the hypothetical rain events used in the hydrologic analyses. For projects requiring FEMA approval, the rainfall input of the most current effective model should be used. For projects not requiring FEMA submittals, point rainfall depths should be used.

The version of HEC-HMS that was available at the time of the TSARP allows the user to shift the peak of the storm from 50% of the storm duration to 25%, 33%, 67%, or 75% of the storm duration. For projects requiring FEMA approval, the rainfall input of the current effective model should be used.

C. Loss Rates

Rainfall excess and runoff volume are dependent on factors such as rainfall volume, rainfall intensity, antecedent soil moisture, impervious cover,

¹ Source: TP-40, Hydro-35 and U.S.G.S.

depression storage, interception, infiltration, and evaporation. The extent of impervious cover and depression storage is actually a measure of development and is discussed in the next section. The other factors are dependent on soil type, land use, vegetative cover, topography, time of year, temperature, etc.

For projects requiring FEMA approval, the loss input in the most current effective model should be used. For all other projects requiring a rainfall runoff analysis, the Green-Ampt loss function available in HEC-HMS shall be used. A detailed description of the Green-Ampt loss function can be found in USACE EM 1110-2-1417. The following parameters should be used to compute the Green-Ampt losses:

Initial Loss	=	0.1 inches
Volume Moisture Deficit	=	0.385
Wetting Front Suction	=	12.45 inches
Hydraulic Conductivity	=	0.024 in/hr

Additional development in the watershed is analyzed by increasing the value of the impervious cover parameter in the runoff model. Table 5.6-3 gives appropriate values of percent impervious based on land use types:

Table 5.6-3. Percent Impervious Cover For Land Use Types

Land Use	% Impervious
High Density	85%
Dry Detention Ponds	85%
Undeveloped	0%
Developed Green Areas	15%
Residential Small Lot (<1/4 acre or schools)	40%
Residential Large Lot (≥1/4 acre or older neighborhoods with limited roadside ditch capacity)	20%
Residential Rural Lot (≥5 acre ranch or farm)	5%
Isolated Transportation	90%
Water	100%
Light Industrial	60%
Airport	50%

5.6.4 Unit Hydrograph Methodology

The model for the Clear Creek Watershed flood insurance study is based on the Clark unit hydrograph. In cases where FEMA submittals are required, the design engineer should use the Clark unit hydrograph method. In other cases, where a downstream impact analysis is required, consult the appropriate reviewing agencies on the applicability of the Clark unit hydrograph. In some cases, other unit hydrograph methods may be applicable.

The watershed parameters for the Clark unit hydrograph may be developed using the Harris County methodology. Design engineers should refer to the current effective model available on HCFCD Model and Map Management (M3) System Website (<http://www.m3models.org/>) and the most recent version of the HCFCD hydrology manual.

5.6.5 Flood Hydrograph Routing

Flood routing is used to simulate the runoff hydrograph movement through a channel or reservoir system. Flood routing techniques vary greatly between hydrologic computer models and caution should be used in selecting a routing method, which adequately represents the channel storage conditions present in areas with extremely flat slopes, such as within the City of Pearland.

The HEC-HMS program employs several flood routing methods for characterizing the transfer of the runoff hydrograph through the drainage system of a watershed. The models developed for the Flood Insurance Study for the Clear Creek watershed use the Modified Puls Method of routing. This flood routing method is based on the continuity equation and a relationship between flow and storage or stage. The routing is modeled on an independent-reach basis from upstream to downstream. A detailed discussion of the Modified Puls Method can be found in the user's manual for HEC-HMS.

A. Storage –Routing Computations Using HEC-RAS

All of the Flood Insurance Study data submitted for the Clear Creek Watershed have utilized the HEC-RAS computer program to generate the storage-discharge relationship required for HEC-HMS to utilize the Modified Puls flood routing. Listed below is a suggested procedure by which the HEC-RAS program can best be formatted to provide the most effective input and output data necessary for hydrologic studies.

- a. Determine which routing reaches of the subject channel will need to be evaluated. Routing reaches that are defined in the Flood Insurance Study usually represent an area between outfalls of two significant drainage areas.

- b. Review all the available data for the routing reaches of the subject stream.
- c. Run HEC-HMS for the 100-year storm event using preliminary channel routing data or alternate methods (i.e. Muskingum or Lag).
- d. Use the effective model to determine the 100-year flows for the stream in question. Multiply the preliminary 100-year peak discharges determined above by 0.20, 0.40, 0.60, 0.80, 1.00, 1.20, and 1.50 to obtain a series of seven discharges for each storage routing reach.
- e. The discharges that have been developed are then input to the HEC-RAS program. The discharges should be held constant throughout the subject routing reach. Outflows through a routing reach should not vary.
- f. Obtain storage outflow data calculated using HEC-RAS utilizing the most upstream and downstream cross section of the reach.
- g. Determine the average flood wave travel time along the reach. To calculate the average wave travel time, divide reach travel time by a flood wave velocity factor of 1.5.
- h. Determine the number of subreaches to be used in the HEC-HMS computations. Determine this number by dividing the average flood wave travel time along the reach by the HEC-HMS computational time step for each of the flows entered in the HEC-RAS model.
- i. Run the HEC-HMS model.
- j. Cycle (or balance) the HEC-HMS and HEC-RAS until the 1% exceedance probability (100-year) flows at the downstream end of the routing reach match within 5%.

The HEC-RAS model used in the storage-outflow analysis should be reviewed to ensure that the analysis is correctly determining the total storage volume. Make sure that the ineffective flow areas are modeled appropriately.

5.7 HYDRAULIC CHANNEL DESIGN CRITERIA

5.7.1 Introduction

The hydraulic design of a channel or structure is of primary importance to ensure that flooding and erosion problems are not aggravated or created. This section summarizes methodologies, procedures, and criteria which should be used in the hydraulic analysis of the most common design problems in City of Pearland and

Brazoria County, Texas. In some instances, methodologies and parameters not discussed in this section may be required. When an approach not presented herein is required, it should be reviewed early on with the office of the City Engineer.

A. Design Frequencies

All the City of Pearland open channels will be designed to contain the runoff from the 100-year frequency storm within the right-of-way, except where channel improvements are necessary to offset increased flows from a proposed development. In those cases, the 100-year flood profile under existing conditions of development should not be increased.

In areas served by closed systems, stormwater runoff should be removed during the 100-year frequency storm without flooding of structures. This is accomplished through the design of the street system, the storm sewer system, and other drainage/detention systems.

B. Required Analysis

In designing a facility for flood control purposes, a hydraulic analysis must be conducted which includes all the factors significantly affecting the water-surface profile or the hydraulic grade line of the proposed facility. For open channels, the primary factors are losses due to friction, constrictions, bridges, culverts, confluences, transitions, and bends. The design of channels or conduits should generally minimize the energy losses caused by these factors which impede or disrupt the flow. Factors affecting the hydraulic grade line in closed conduits are entrance losses, friction losses, exit losses, and bend losses.

C. Acceptable Methodologies

Several methods exist which can be used to compute water-surface profiles in open channels. The methodology selected depends on the complexity of the hydraulic design and the level of accuracy desired. Peak discharges and discharge hydrographs developed using one of the methodologies described in Section 5.6 must be incorporated into the existing effective HEC-RAS model in order to determine the impact of any proposed development flood control facility on the entire channel system.

For the design of proposed channel with flow confined to uniform cross-sections, either a hand calculated normal depth or direct step computation is sufficient. Manning's equation should be used for computing normal depth. For designing a non-uniform proposed channel with flow in the overbanks, the use of HEC-RAS is recommended. Any proposed channel improvements to an existing collector ditch or creek within the jurisdiction

of the City must be modeled using HEC-RAS and incorporated into the model used in the Flood Protection Plan.

Bridges, culverts, and expansion and contraction losses are taken into account in the HEC-RAS computer program. If these losses are significant and the normal depth or direct step method is employed, the losses must be included in the backwater calculations. Design criteria for bridges, culverts, transitions, bends and drop structures are presented in the remainder of this section.

5.7.2 Open Channel Design

A. Location and Alignment

The first step in designing or improving an open channel drainage system is to specify its location and alignment. Good engineering judgment must be incorporated to insure the proposed channel location provides maximum service to an area while minimizing construction and maintenance costs. General factors and the City of Pearland criteria which should be taken into account in locating improved channels are as follows:

- a. Follow existing channels, ditches, swales, or other low areas in undeveloped watersheds. This will minimize the cost of the channel itself and the underground storm sewer system and will allow for overland flow to follow its natural drainage pattern.
- b. For safety reasons, channels and roads must not be located adjacent to one another. Should such a conflict appear unavoidable, the design must be approved by the office of the City Engineer.
- c. The angle at which two channels intersect must be 90 degrees or less (angle measured between channel centerlines on upstream side on point of intersection).
- d. The minimum radius of curvature for unlined channel bends is three times the ultimate channel top width, and the maximum bend angle for both lined and unlined sections is 90 degrees. Bend losses and erosion protection must be included in the hydraulic analysis of severe curves.

B. Existing Cross Sections

For determining existing flood profiles, both the channel section and overbank areas must be used in the hydraulic calculations. Channel sections must be based on a recent field survey. In some cases, the City of Pearland may have recent channel improvements information which can be utilized. Plans of previous channel improvements should only be used for very

preliminary analysis. Overbank areas are best defined by field surveys, but this is not always practical or economically justified. Elevations in the flood plain beyond the limits of the channel can be obtained from the best topographic information available for the study reach.

When designing a channel improvement, the channel sections used should extend beyond the City of Pearland right-of-way a reasonable distance. The purpose of including elevations beyond the right-of-way is to avoid a design which creates ponding adjacent to the right-of-way a reasonable distance and depends on the adjacent terrain, but in no case shall it be less than 20 feet.

C. Typical Design Sections

Typical channel sections have been established which should be used in designing improved channels. Minimum dimensions are based on experience of constructing and maintaining channels.

For some applications, other cross section configurations may be necessary. A proposed cross section different from the typical sections presented should be reviewed with the office of the City Engineer for approval before proceeding with design or analysis.

a. Earthen Channels

The following are minimum requirements to be used in the design of all earthen channels:

1. Maximum earthen side slopes should be 4 (horizontal) to 1 (vertical). Slopes flatter than 4:1 may be necessary in some areas due to local soil conditions. For channels and detention reservoirs 6 feet deep or greater, side slopes selection shall be supported by geotechnical investigations and calculations.
2. Minimum bottom width is ten (10) feet unless approved by the office of the City Engineer or BDD4.
3. A minimum maintenance berm is required on either side of the channel of between 10 and 30 feet depending on channel size as depicted in Table 5.7-1A and 5.7-1B.

These criteria and regulations shall be applicable for all channels that will be accepted for maintenance by BDD4 or HCFCD. Small channels on private property, not draining public water, that do not conform to these criteria shall remain the responsibility of the owner. These private

small channels within the City of Pearland and road-side ditches along City streets shall be designed in accordance with Section 5.5.

Table 5.7-1A. Key To Easement Requirements

Channel Depth [feet]	Channel Bottom Width [feet]							
	6	8	10	12	15	20	30	40
4	A	A	B	B	B	B	C	C
6	A	A	B	B	B	B	C	C
8	B	B	B	C	C	C	C	C
10	C	C	C	C	C	C	C	C
12	C	C	C	D	D	D	D	D
14	D	D	D	D	D	D	D	D
16	D	D	D	D	D	D	D	D
18	D	D	D	D	D	D	D	D

TABLE 5.7-1B. Ultimate Maintenance Requirement for Channels

Key Value	Total Berm Width [feet]	Berm Width Each Side [feet]	Berm Width Uneven [feet]	
			Side 1	Side 2
A	30	15	20	10
B	40	20	25	15
C	50	25	30	20
D	60	30	30	30

Larger maintenance berms may be required due to the future needs of an ultimate channel. Right-of-way requirements for all main outfall channels are included in the Brazoria Drainage District No 4 (BDD4) Flood Protection Plan.

1. Backslope drains or interceptor structures are necessary at a minimum of 1,000 feet intervals to prevent sheet flow over the ditch slopes.
2. Channel slopes must be re-vegetated immediately after construction to minimize bank erosion.
3. Flow from roadside ditches must be conveyed to the channel through a roadside ditch interceptor and pipe.

b. Concrete-Lined Trapezoidal Channels

In instances where flow velocities are excessive, channel confluences create a significant erosion potential, or right-of-way is limited, fully or partially concrete lined channels may be necessary. The degree of structural analysis required varies significantly depending on the intended purpose and the steepness of the slope on which paving is being placed. Slope paving steeper than 3:1 shall be designed based on

a geotechnical analysis that addresses slope stability and groundwater pressure behind the paving.

The following are minimum requirements for partially or fully concrete lined trapezoidal channels:

1. All slope paving should include a minimum 24-inch toe wall (9 inches thick) at the top and sides and a 48-inch toe wall (9 inches thick) across or along the channel bottom for clay soils.
2. Fully lined cross-sections should have a minimum bottom width of eight (8) feet.
3. Concrete slope protection placed on 3:1 slopes should have a minimum thickness of 4 inches and be reinforced with #3 bars on 18-inch centers both ways.
4. Concrete slope protection placed on 2:1 slopes should have a minimum thickness of 5 inches and be reinforced with #3 bars on 15-inch centers both ways.
5. Concrete slope protection placed on 1.5:1 slopes should have a minimum thickness of 6 inches and be reinforced with #4 bars on 18-inch centers both ways. Poured in place concrete side slopes should not be steeper than 1.5:1.
6. In instances where the channel is fully lined, no backslope drainage structures are required. Partially, lined channels will require backslope drainage structures.
7. Weep holes may be required to relieve hydrostatic head behind lined channel sections. Check with the geotechnical investigation report.
8. Where construction is to take place under conditions of mud and/or standing water, a seal slab of Class C concrete should be placed in channel bottom prior to placement of concrete slope paving.
9. For bottom widths of twenty (20) feet and greater, transverse grade beams shall be installed at twenty (20) feet spacing on center. Grade beams shall be one foot wide, one foot-six inches deep, and run the width of the channel bottom.

c. Rectangular Concrete Pilot Channels (Low Flow Sections)

In limited right-of-way, it is sometimes necessary to have a vertical walled rectangular section. Presented below are minimum requirements for rectangular concrete pilot channels:

1. The structural steel design is based on Grade 60 steel. This should be confirmed by a design check based on local soil conditions.
2. Minimum bottom width should be eight (8) feet to allow for maintenance.
3. For bottom widths twelve (12) feet or greater, a center depression is required.
4. For bottom widths twenty (20) feet or greater, transverse grade beams shall be installed at twenty (20) feet spacing on center. Grade beams shall be one foot wide, one foot-six inches deep, and run the width of the channel bottom.
5. Minimum height of vertical walls should be four (4) feet. Heights above this shall be in two (2) foot increments. Exceptions shall be on a case by case basis.
6. Escape stairways shall be constructed. Escape stairways shall be located at the upstream side of all street crossings, but not to exceed 1,400 feet intervals.
7. For rectangular concrete pilot channels with earthen side slopes, the top of the vertical wall should be constructed to allow for future placement of concrete slope paving.
8. Weep holes should be used to relieve hydrostatic pressure.
9. Where construction is to take place under conditions of mud and/or standing water, a seal slab of Class C concrete should be placed in channel bottom prior to placement of concrete slope paving.
10. Concrete pilot channels may be used in combination with slope paving or a maintenance shelf. Horizontal paving sections should be analyzed as one way paving capable of supporting maintenance equipment.

11. A geotechnical investigation and report shall be performed. Soil borings shall be obtained at a minimum of every 1,000 feet to a depth of 1.5 times the proposed channel depth.

D. Water-Surface Profiles

a. General

For steady, gradually varied flow conditions in natural or improved open channels, the computational procedure known as the standard step method is recommended for computing water-surface profiles. The one-dimensional energy equation is solved by using an iterative procedure to calculate a water-surface elevation at a cross section. Manning's equation is used to compute energy losses due to friction (Section 5.7.2.D.b), while losses due to obstructions and transitions are calculated using the appropriate equations discussed in this chapter. For cases where the flow is strictly uniform, as determined by the design engineer, the standard step method can be reduced to a direct step method or to a uniform flow computation.

The recommended computer program available for computing water-surface profiles when using the standard step method is HEC-RAS. As indicated previously, the City of Pearland prefers this program primarily because it is widely accepted and the program readily facilitates the design of channel improvements.

Good judgment must be exercised when determining cross-section locations for water-surface profile calculations. Cross sections should divide the channel into reaches, which approximate uniform flow conditions. For example, closely spaced cross sections are required at an abrupt transition such as a bridge, while relatively uniform channel reaches with no significant changes in conveyance require fewer cross sections. As a general guideline, the spacing should not exceed about 1,000 feet.

b. Manning's Equation

Manning's equation is an empirical formula used to evaluate the effects of friction and resistance in open channels. For uniform flow conditions where the channel bottom and energy line are essentially parallel, Manning's equation should be used to compute the normal depth. For gradually varied flow conditions, the slope of the energy line at a given channel section should be computed using Manning's equation.

The equation is:

$$Q = \frac{1.49}{n} \times A \times R^{\frac{2}{3}} \times S^{\frac{1}{2}}$$

where, Q = total discharge in cubic feet per second.
n = coefficient of roughness
A = cross-sectional area of channel in square feet
R = hydraulic radius of channel in feet
S = slope of energy line in feet per foot (same as Channel bottom slope for uniform flow).

Channel and overbank sections may have to be subdivided to represent differences in roughness across the section. Subdividing may also be helpful in computing Manning's equation for natural, compound or non-prismatic sections (Section 5.3 References (5, 9)).

c. Manning's "n" Values

Manning's "n" values for design purposes should conform with Table 5.7-2. An "n" value of 0.04 for unlined channels represents a moderate vegetal growth. For unlined channels, with a design flow larger than 10,000 cubic feet per second, "n" value of 0.035 may be used. For existing, unimproved channels and overbank areas, "n" values should be determined in accordance with Section 5.3 References (9, 10, 11, 12)

Table 5.7-2. Manning’s “n” Values and Allowable 25-year Velocities for Channel Design

Channel Description	Roughness Coefficient or Manning’s “n” Value	Average Velocity (ft/s)	Maximum Velocity (ft/s)
Unmaintained Earthen	0.05	3.0	5.0
Grass Lined:			
Predominately Clay	0.045	3.0	5.0
Predominately Sand	0.045	2.0	4.0
Concrete Lined	0.015	6.0	10.0
Articulated Block	0.045	5.0	8.0
Overbanks and Existing Unimproved Channels	See Section 5.3 References (5)	Not Applicable	Not Applicable

d. Velocities

Average and maximum allowable velocities based on 25-year flows are given in Table 5.7-2. In the portion of Brazoria County where sandy soils are known to exist, soils information may be needed to determine the predominant type of soil and the corresponding allowable velocities for unlined channels. Maximum velocities also apply to bridges, culverts, transitions, etc. Where velocities exceed the maximum allowed, erosion protection must be provided.

e. Channel Slope

Maximum channel slopes are generally controlled by the maximum allowable velocity. Channel slopes shall not be less than 0.05%.

f. Starting Water-Surface Elevations

For design of open channels, starting water-surface elevations at the channel mouth will generally be based on the normal depth in the design channel.

In determining actual flood profiles or floodplain delineation, the water-surface elevation from the outfall channel should be projected horizontally upstream until it intersects the flood profile on the design channel. An assumption that the peaks occur at the same time will generally produce a conservative flood profile. Otherwise, an analysis of coincident flow may be conducted to determine the flow in the outfall channel at the time the peak flow occurs on the design channel.

g. Headlosses

Manning's equation is used to estimate energy or headlosses due to channel friction and resistance. Other sources of losses in open channels include confluences, transitions, bends, bridges, culverts, and drop structures. When computing water surface profiles either by hand or with the help of a computer program, the engineer must include the significant sources of headloss.

E. Confluences

The alignment of confluences is critical with regards to channel erosion and energy losses caused by turbulence and eddies. The primary variables used in designing channel junctions are angle of intersection, shape and dimensions of the channel, flow rates, and flow velocities.

The angle of intersection between the main channel and tributary channels or storm sewers shall be 30 degrees. Outfalls or junctions perpendicular to the receiving channel will create severe hydraulic problems, and therefore, will not be allowed without approval by the office of the City Engineer.

Any protective lining must extend far enough upstream and downstream on both channels to prevent serious erosion. The slope protection must be carried up to at least the 10-year flood level in both channels. A good grass cover must also be established from the edge of the protection to the top of bank.

If the main channel flowline is lower than the side channel flowline, an erosion control structure must be used in the side channel.

F. Transitions

a. Design

Transitions in channels should be designed to create a minimum of flow disturbance and thus minimal energy loss. Transitions generally occur at bridges or culverts, and where cross-sections change due to hydraulic reasons or right-of-way restrictions. The transition can consist of either a change in cross-section size or geometry.

All angles of transition should be less than 12 degrees (20 feet in 100 feet). When connecting trapezoidal and rectangular channels, the warped or wedge type transition is recommended. If super-critical flow conditions are encountered, standing waves, superelevation, and hydraulic jumps must be considered.

b. Analysis

Expansion and contraction losses must be accounted for in backwater computations. Transition losses are usually computed using the energy equation and are expressed in terms of the change in velocity head from downstream to upstream of the transition. The headloss between cross sections is expressed by:

$$h_L = C \left[\frac{V_2^2}{2g} - \frac{V_1^2}{2g} \right]$$

where: h_L = headloss (feet),

c = expansion or contraction coefficient

V_2 = average channel velocity of downstream section (ft/s),

V_1 = average channel velocity of upstream section (ft/s), and

g = acceleration of gravity (32.2 ft/sec²).

Typical transition loss coefficients to be used in HEC-RAS are given below:

Transition Type	Coefficient	
	Contraction	Expansion
Gradual or Warped	0.10	0.30
Bridge Sections, Wedge, or Straight Lined	0.30	0.50
Abrupt or Squared End	0.60	0.80

When computing the backwater profile through a transition, engineering judgment must be used in selecting the reach lengths. Smooth transitions require fewer computation steps than the abrupt transitions.

G. Bends

a. Design

Channel bends or curves should be as gradual as possible to reduce erosion and deposition tendencies. For channel bends with a radius of curvature measured from the channel centerline of less than three times the top width of the ultimate channel, slope protection is required. For both lined and unlined channels, a 90 degree bend is the maximum curve allowed. Erosion protection on bends must extend at least along and 20 feet downstream of the curved section on the outside bank. Additional protection may be required on the channel bottom and inside bank, or further downstream than 20 feet, if the channel geometry and velocities indicates a potential erosion problem.

b. Analysis

Headlosses should be incorporated into the backwater computations for bends with a radius of curvature less than three times the channel top width. Energy loss due to curve resistance can be expressed as:

$$h_L = c_f V^2 / 2g$$

Where, h_L = headloss (feet),

c_f = coefficient of resistance,

V = average channel velocity (feet per second), and

g = coefficient of gravity (32.2 ft/sec²).

Guidelines for selecting c_f can be found in Section 5.3 Reference (10).

HEC-RAS has the ability to incorporate a bend loss computation in terms of a minor loss coefficient ranging from 0.0 to 1.0. If HEC-RAS is used and bend losses are significant, the loss must be added at the appropriate point in the minor loss table. Bends with a radius of curvature greater than three times the top width of the channel generally have insignificant losses and no computation is required.

5.8. DETENTION SYSTEM DESIGN

5.8.1 Introduction

In situations where on-site storage of stormwater runoff is the most effective way to allow development of properties without increasing the flood potential downstream, detention systems will be permitted. This section of the Manual presents background information on stormwater storage techniques and detailed guidelines and criteria for the design of stormwater storage facilities.

A. Types of Storage Facilities

The physical features of a particular site, as well as the type of development proposed, will dictate, in many cases, the type of detention storage facility that may be utilized. Since detention facilities are often designed to remain dry, they can provide dual purpose functions such as playground and recreational areas. In limited instances, on-site detention facilities have been designed to be buried underground and thus are completely out of sight.

All of these types of facilities are considered acceptable methods of stormwater detention and can be designed hydraulically to accomplish the intended purpose. All stormwater detention facilities are subject to periodic inspection by the City Engineer to insure proper construction and maintenance.

Dual use of stormwater detention facilities is encouraged. However, when a dual use is proposed, such as recreation, a joint use agreement is required between the owner and the entity sponsoring the secondary use. This agreement must outline the maintenance responsibilities of the entity and of the owner and must be submitted to the City of Pearland for approval. For privately maintained or dual use systems, each stormwater detention facility will be reviewed and approved by the City only if the following assurances can be provided:

- a. Adequate storage is available to provide necessary peak flow reduction;
- b. The facility will perform as designed over the expected life of the project;
- c. Provisions for maintenance, including long-term funding for maintenance, to ensure that the facility does not detract from the value of adjacent properties;

- d. The stormwater detention pond should be designed to drain the stormwater within 72 hours so as to provide storage room for the following storm event.
- e. The property owner/owners shall enter into a Detention Pond Maintenance Agreement with the City as described in the Illicit Discharge Ordinance no. 1570 and Maintenance of Stormwater Storage Facilities Ordinance no 1059 prior to the final approval of construction plan by the City.

Detention ponds may be either on-site or off-site facilities. An off-site detention basin is defined as one that is located on a City of Pearland, BDD4, or HCFCD ditch and is receiving runoff from areas significantly larger than the development project under design. An on-site basin generally receives runoff from a small drainage area consisting primarily of one development project. An offsite detention facility shall be located within $\frac{1}{4}$ mile of the proposed site. In the discussions that follow, the design methods presented are generally oriented to on-site detention facilities. Specific reference will be made to methods for off-site facilities.

B. Geotechnical Design

Before initiating final design of detention ponds over 6 feet deep and 2 acres in size, a detailed soils investigation by a geotechnical engineer shall be undertaken. Geotechnical investigation, at a minimum, should address:

- a. The ground water conditions at the proposed site;
- b. The type of material to be excavated from the pond site and its suitability for fill material;
- c. If an embankment is to be constructed, adequate investigation of potential seepage problems through the embankment and attendant control requirements, the availability of suitable embankment material and the stability requirements for the embankment itself;
- d. Potential for structural movement on areas adjacent to the pond due to the induced loads from existing or proposed structures and methods of control that may be required; and,
- e. Stability of the pond side slopes.

5.8.2 Hydrologic Design

Detention basin design shall conform to City of Pearland criteria, BDD4 rules, or HCFCD criteria on a case-by-case basis as approved by the office of the City

Engineer. The hydrologic methods for detention design should be in accordance with Section 5.6 of this Manual. The hydrologic design criteria for stormwater mitigation is divided into three design categories based on the size of the contributing drainage area.

Small Projects: less than 2 acres

Medium Project: 2 acres to 200 acres

Large Project: more than 200 acres

5.8.3 On-Site Facilities

A. Small Projects (Projects 2 Acres or Smaller)

Small Projects are defined as those projects that are 2 acres or smaller. The following criteria is applicable for the provision of detention mitigation calculation:

- a. For all small projects located adjacent to the BDD4 drainage system or projects of any size directly outfalling into BDD4 drainage system requires approval from BDD4.
- b. Single Family Residential (SFR) in-fill lots of 15,000 Square Feet (SR15) or less and located outside the FEMA delineated 100-Year Floodplain are exempt from detention if proposed impervious cover is less than or equal to 50%. Grading and drainage plan is required to show no impact to the neighboring property due to proposed site development. This provision is not applicable for the subdivision in which bigger lots are divided into smaller lots.
- c. SFR in-fill lots ($15,000 \text{ SF} < \text{Area} < 1/2 \text{ Acres}$). The first 7,500 square feet per SR15 is exempt from detention. All coverage above threshold is required to provide stormwater detention **at a rate of 0.65 ac-ft/ac of increased impervious cover.**
- d. SFR in-fill lots with ($1/2 \text{ Acres} < \text{Area} < 2 \text{ Acres}$) is required to provide stormwater detention **at a rate of 0.65 ac-ft/ac of increased impervious cover.**
- e. The SFR in-fill lot construction within FEMA mapped floodplain will not be allowed to bring dirt from offsite and must be pier and beam construction with the use of flood vent as mentioned in the FEMA guideline. Slab on grade construction is allowed if the provision of fill mitigation can be made onsite.
- f. The finished floor elevation of pier and beam construction shall be 18" above base flood elevation.

- g. Private parking areas, private streets, and private storm sewers may be used for detention provided that the maximum depth of ponding does not exceed 9 inches directly over the inlet, and the parking areas are provided with signage stating that the area is subject to flooding during rainfall events.
- h. Commercial properties are not exempt from the provision of detention requirement irrespective to the size of the development.
- i. Use of orifice equation as described in Section 5.8.3 B is required to determine the size of restrictor.

B. Medium Projects (Projects Larger Than 2 Acres, But Less Than 200 Acres)

Medium Projects in the City of Pearland will have their mitigation detention volumes calculated using the Small Watershed Method presented in Section 5.6.2. All calculations shall be presented to the office of the City Engineer, including maps of suitable scale showing the flow paths used to calculate the existing and developed time of concentration. Hydrograph routing through the detention basin is recommended. The outflow structures (low level pipe(s) or opening(s) and high level weir) will be sized as follows:

- a. Determine the storage elevation in the basin for 3-year, 10-year, and 100-year storm events.
- b. Determine water surface elevation in the receiving system (if reasonably able to) for the 3-year, 10-year, and 100-year storm events.
- c. Determine the minimum flowline elevation for the outflow structure.
- d. Use the orifice equation to compute the opening size(s) as follows:

$$Q = CA\sqrt{2gH}$$

where, Q = Basin Outflow (cfs),

C = Pipe Coefficient,

A = Restrictor cross-sectional area (ft²),

g = Acceleration due to gravity (32.2 ft/s²), and

H = The elevation difference between the detention basin water surface elevation for the design storm and the receiving system for a given storm or the center of the restrictor pipe (feet).

Round up to the next half-foot diameter for restrictor pipes above 18-inch diameter. Some additional blockage of the pipe may be necessary to obtain the correct restrictor area (A). No restrictor pipes shall be less than 6 inches

in diameter. The restrictor shall always be placed at the upstream end of a pipe to enable cleaning.

e. Use weir equation to compute the size of the weir;

$$Q = CLH^{3/2} \text{ for rectangular weir equation}$$

Where, Q = Weir discharge in cubic feet per second

C = Weir coefficient

L = Horizontal length of the weir in feet

H = Head on the weir in feet

The value of “C” depends on weir shape. Please see appropriate hydraulic handbook or other applicable references such as HCFCD manual.

For ponds discharging into creeks or ditches, the outfall structure shall be designed for the 3, 10, and 100-year storm frequencies. Determine the 3, 10, and 100-year detention volumes and compute the water surface elevations to determine restrictor size to detain to undeveloped flow rates. Use a vertical structure or multiple pipes separated vertically with the top of the structure or flowline of the second pipe set at the 3-year or 10-year water surface so as to be over topped in greater storms. A weir set below the 100-year developed water surface elevation shall be used to discharge during the 100-year design condition. This weir should be sized so that the peak discharge does not exceed the 100-year pre-developed discharge with the basin full and the tailwater elevation at or below the top of the discharge pipe.

Storm events in excess of the 100-year event must be considered in the design of detention facilities from the standpoint of overtopping. For a detention facility that is an excavated pond and has no dam associated with it, the outflow structure must be designed with an overflow structure or swale. This will allow the passage of extreme events with no adverse impacts to adjacent structures. For detention facilities with a dam, the possibility of dam failure must be considered as part of the design. Specific dam criteria for storm events in excess of the 100-year design storm shall be established by the office of the City Engineer on a case-by-case basis.

Regardless of the results of the methodology selected, the minimum detention required for all medium projects shall be 0.65 acre feet per acre of the project area expected to be disturbed for grading in addition to floodplain fill mitigation.

Use of detention in storm sewer system and parking lot is not allowed for medium projects.

C. Large Projects (Projects larger than 200 acres)

For projects in excess of 200 acres, HEC-HMS, HEC-RAS modeling shall be performed. The HEC-HMS modeling shall include analysis of existing and developed runoff. This analysis must demonstrate no increase in runoff for the 3-year, 10-year, and 100-year storm events. Similarly a HEC-RAS model shall demonstrate no increase in the water surface elevation of the receiving system for the 3-year, 10-year, and 100-year storm events. If the modelling is associated with a FEMA submittal, the models to be used must be acceptable to that agency. See 5.6.3 for specific design requirements.

The design of a detention basin basically consists of the following major phases:

- a. Determination of a 3-year, 10-year and 100-year 24-hour design storm inflow hydrograph to the proposed detention basin.
- b. Determination of the maximum 3-year, 10-year and 100-year 24-hour design storm allowable outflow rate from the detention basin. Outflow rates shall be equal to or less than historical rates or rates for pre-project conditions.
- c. Design tailwater elevation assumed to be equal to the top of the outflow pipe or 10-year water surface elevation of the receiving creek whichever is higher.
- d. Preliminary sizing of basin storage capacity and the outflow structure.
- e. Routing of the design inflow hydrograph through the basin, and adjustment of the storage and outflow structure, if required, to ensure that the maximum allowable outflow rate is not exceeded. This routing should be performed in an appropriate computer program such as Interconnected Pond Routing (ICPR) and XP Stormwater Management Model (XP-SWMM) (or others as approved by the City Engineer). The outflow structure shall include a pipe or pipes sized to restrict discharge to the allowable 3-year and 10-year outflow rates and the allowable 100-year design flow.
- f. Analysis of the hydraulic gradients for storm sewers and inflow channels entering the basin to insure that these systems will operate properly under design water surface conditions in the basin.
- g. Analysis of rainfall events in excess of the design frequency for structural and flood considerations, including provisions for a high level overflow structure. This design shall consider the possibility that should the normal outlet structure from the basin fail, the stormwater can pass through, over or around the detention basin without damaging adjacent structures.

h. Investigation of potential geotechnical and structural problems.

Regardless of the results of the methodology selected, the minimum detention required for all large projects shall be 0.65 acre feet per acre of the project area expected to be disturbed for grading in addition to floodplain fill mitigation.

Use of detention in storm sewer system and parking lot is not allowed for large projects.

5.8.4 Off-Site Facilities

Off-site detention facilities will generally be regional in nature. The facility may be sized for one development, but will be designed to serve the entire watershed by reducing the flood potential of a stream. Most of these facilities are envisioned to be adjacent to a channel to receive flood water from the main drainage artery through a system of multistage inlet pipes and high level weirs.

For the design of an off-site detention basin, the hydraulics of the stream and flood damage relationship of the watershed must be evaluated. This will be performed under the direction and advice of the office of the City Engineer. This evaluation will result in flood frequency/stage-damage estimates of the stream.

Upstream discharge of unmitigated runoff into a stream, on which capacity is reserved in a regional detention basin, may be allowed if analysis of stormwater flow demonstrates that flood water surface elevations will not cause flooding between release point and the detention reservoir.

Sizing of the multistage inlets will be based on a plan that will be most beneficial to the downstream community. Side flow diversions will also be developed and evaluated by iterations to evaluate the impact of the diversion on the downstream hydrographs. The arrangement of pipes/weirs shall be designed to minimize property damages due to different storms within the entire area served by detention. The office of City Engineer will advise the design engineer in regards to specific design configurations.

Off-site facilities will be analyzed using HEC-HMS modeling techniques as discussed in Section 5.6. The 3-year, 10-year and 100-year will be performed. Input from the office of the City Engineer is recommended to determine the most appropriate level to set diversion structures for watershed-wide flood damage mitigation. These facilities will generally be located along a FEMA studied stream with adequate models available for the analysis. Routing of the inflow 3-year, 10-year and 100-year hydrographs through the detention basin may also be performed using a computer model such as ICPR, XP-SWMM or other detention reservoir models approved by the office of the City Engineer. Set the tailwater level in the

receiving stream equal to the top of the outfall pipe or 10-year water surface elevation of the receiving creek, whichever is higher. In addition, the use of a time-stage tailwater hydrograph for the receiving creek is encouraged for setting the tailwater requirement.

For off-site facilities, the existing models will be used to develop a proposed (post project) condition model(s). For such analysis, the proposed development will not be isolated as a separate subarea. The existing hydrograph parameters (Tc+R) will be modified or revised to reflect changes in percent land urbanization (DLU), percent channel improvement (DCI), percent channel conveyance (DCC), and percent impervious cover. Watersheds being developed may lose some or most of the percent ponding (DPP) that may exist in the rural portion of certain watersheds.

Because the project area will not be modeled as a separate subarea, the high inflow to the main drainage artery will not be evident in the model. Rather, because the subarea parameters will be revised to reflect the impact of the project, the total hydrograph along the main artery will increase without detention mitigation. The diversion of the flood waters near the peak of the hydrograph will be effected through the use of multilevel pipes and a weir to mitigate the increase flow to downstream reaches.

Regardless of the results of the methodology selected, the minimum detention required for all projects shall be 0.65 acre feet per acre of the project area expected to be disturbed for grading in addition to floodplain fill mitigation.

5.8.5 Pumped Detention System

All stormwater detention facilities requiring mechanical pumping systems are generally prohibited, with the exception of pumping of dead storage (maintenance or amenity water stored at or below the discharge pipe control level). However, pumped detention shall be allowed under the following conditions:

- A. A combination pump and gravity system shall be constructed.
- B. The minimum detention rate shall be 0.70 ac-ft/ac.
- C. No more than 75% of the total pond capacity shall be pumped.
- D. The detention pond shall be designed to empty the storage volume within 72 hours.
- E. The discharge delivery system shall not have peak discharge and/or peak stages that exceed the pre-developed peak values at any point in time for the 3-year, 10-year and 100-year design storm events.

- F. Two pumps minimum shall be required, each capable of providing the design discharge rate. If three pumps are used, any two pumps must be capable of handling the design discharge rate. The total discharge pumping rate shall not exceed the design discharge rate. A gravity overflow route and outfall must be submitted to the office of the City Engineer for approval. Pumping from detention into an existing storm sewer is prohibited unless the pre-developed land already drains into an inlet and storm sewer system.
- G. Pumped detention shall not be allowed for detention basins that collect public water runoff, except for detention basins owned, operated and maintained by the City or Brazoria Drainage District #4. Public water runoff shall be defined as runoff water that originates from the property of more than one property owner.
- H. Fencing of the control panel is provided to prevent unauthorized operation and vandalism, pursuant to the Texas Commission on Environmental Quality Standards.
- I. Adequate assurance is provided that the system will be operated and maintained on a continuous basis.
- J. Emergency source of power is provided for those cases that loss of power during a 100-year flood event would cause property damage.
- K. Sensors must be placed so that pumps would remain in functions as designed during and after a rain event. Additionally, sensors must be placed so that pumping will not occur when the level of water in the receiving system is at or above 3/4 of its full depth. Verification with BDD4/HCFCD is required when the receiving system is owned and maintained by BDD4/HCFCD.
- L. The Operator shall provide the office of the City Engineer with a quarterly operational report that shall indicate the operational times, total hours of operation, and the amount pumped. This report shall be delivered to the office of City Engineer at the end of each quarter, no later than the 15th of the month.
- M. The City shall have the right to enter the property and inspect the operation of the system at any time for any reason.
- N. Failure to maintain the pump station in working order is a violation of these requirements and the City Ordinance for Maintenance of Stormwater Storage Facilities.

It is recommended that if a pump system is desired, approval by the City of Pearland of the preliminary conceptual design be obtained before any detailed engineering is performed.

5.8.6 Structural and Geometric Parameters for Detention Ponds

A. General

Two types of detention facilities are acceptable in the City of Pearland. The first is a naturalized basin in which standing shallow pools of water and muddy areas are allowed to exist along the bottom of the basin and support natural or wetlands vegetation. This type of basin is only maintained around the sides and perimeter and involves special design considerations at the outfall structure. Designing this type of facility must be approved by the City and must consider the aesthetics of the surrounding area.

The second type of detention facility is a manicured or well-maintained basin, which is mowed regularly and is designed to stay dry between rainfall events. This type of facility may be more aesthetically pleasing in heavily populated areas and is more amenable to multiple uses such as parks or ball fields. The design considerations for each facility are outlined below.

The following parameters shall apply to all detention facilities:

- a. Side slopes shall be 4:1 or greater.
- b. Minimum maintenance berms shall be a minimum of 10 feet from the property line, right of way or structure.
- c. When a detention facility is constructed adjacent to a BDD4 channel, BDD4 requirements prevail.

Maintenance berms shall not be encumbered by any other permanent improvements, easements, fee strips, or right-of-way.

B. Wet Detention Pond (Static Water Level)

Wet detention pond must be approved by the City prior to the design and preparation of construction plans. The design requirements such as maintenance berms, backslope drains, and erosion protection measures are required for all detention ponds. A maintenance plan to remove trash debris and excessive siltation must be provided to and approved by the City. The depth of permanent pool shall not be less than 4 feet. Additional storage volume may be required by the City to offset predicted siltation based on experiences with nearby storage facilities. It will be responsibility of the

developer, MUD, Homeowner Association, or Landowner to own and maintain any wet detention ponds.

C. Bottom Design for Naturalized Detention Facilities

The bottom of a detention facility, which is intentionally meant to support natural vegetation, should be designed as flat as practical but still maintain positive drainage to the outfall structure. Side slopes should be designed to allow for regular maintenance and be grass-lined with a 4:1 slope. The bottom should be graded toward the outfall structure at a minimum slope of 0.002 feet per foot. The remainder of the pond bottom shall be graded toward the flowline of the pond at a minimum of 0.01 feet per foot. Selected vegetation may be introduced to the bottom of the facility to encourage a particular habitat. Other design requirements for channels should be followed, including back slope drains and erosion protection measures. A maintenance plan to remove trash debris and excessive siltation must be provided to and approved by the City. Additional storage volume may be required by the City to offset predicted siltation based on experiences with nearby storage facilities.

D. Bottom Design for Manicured Detention Ponds

The design of the detention basin bottom to remain dry and aesthetically manicured is very important from the standpoint of long term maintenance. A pilot channel is required to facilitate complete drainage of the basin following a runoff event. A lined concrete pilot channel should have a minimum depth of 6 inches and a minimum flowline slope of 0.002 feet per foot. An unlined pilot channel should have a minimum depth of two feet, a minimum flowline slope of 0.005 feet per foot, and maximum side slopes of 4:1.

Bottom slopes of the detention basins should be graded towards the low-flow pilot channel or outfall. The transverse slope of the bottom should be a minimum slope of 1%, with 2% preferred.

Detention basins which make use of a channel section for detention storage may not be required to have pilot channels but should be built in accordance with the requirements for channels, including side slopes, maintenance berms, back slope drains and erosion protection measures previously discussed.

E. Outlet Structure

For low tail water conditions, the outlet structure for a detention basin is subject to higher than normal headwater conditions and possibly erosive

velocities for prolonged periods of time. For this reason, the erosion protective measures are very important.

Reinforced concrete pipe used in the outlet structure should conform to ASTM C-76 Class III with compression type rubber gasket joints conforming to ASTM C- 443. HDPE or aluminized steel pipes may also be used. Pipes, culverts and conduits used in the outlet structures should be carefully constructed with sufficient compaction of the backfill material around the pipe structure as recommended in the geotechnical analysis. Generally, compaction density should be the same as the rest of the structure. The use of pressure grouting around the outlet conduit should be considered where soil types or conditions may prevent satisfactory backfill compaction. Pressure grouting should also be used where headwater depths could cause backfill to wash out around the pipe. The use of seepage cutoff collars is not recommended since such collars are often inadequately installed and prevent satisfactory backfill compaction. A concrete control structure with a grate area equal to ten (10) times the outfall pipe area shall be constructed. Concrete paving extending from the outfall area into the basin a distance of 10 feet shall be placed on the bottom of the basin for maintenance of the structure. Adequate steel grating around the outfall pipe intake must be designed to prevent clogging of the pipe from dead or displaced vegetation.

The construction of stormwater outfall in BDD4/HCFCD channel shall meet respective design standard. Concrete slope paving or articulated block on filter fabric will be allowed for the stormwater outfall into City owned drainage facilities (roadside ditches) within the ROW.

F. Extreme Event Spillways

The drainage system must be designed to adequately deal with an extreme rainfall event. The extreme event shall be defined as an event which includes or exceeds the 100-year flow. A sheet flow analysis shall be provided to show this extreme event flow path to the receiving drainage system.

A concrete lined extreme event overflow swale shall be provided where this event enters and exits the detention pond. The BDD4 or County's standard details shall be used for drainage system outfall into the BDD4 or County's receiving channel.

G. Additional Design Considerations

The following items describe additional design criteria associated with detention basins.

a. Erosion Control

Adequate erosion control and re-vegetation shall be accomplished during and following construction of the basin. The City of Pearland will allow articulated concrete block on filter fabric as an acceptable means of slope protection within privately owned property or City owned facilities.

b. Safety, Aesthetic Consideration and Multi-Purpose Use

The use of a detention basin facility generally requires the commitment of a substantial land area for the basin. The City of Pearland recognizes that such a facility may be used for other purposes which are compatible with the primary intended purpose of providing flood control. Basins may be utilized as parks and recreational facilities on a case-by-case basis. The proposed use and the facilities to be constructed within the basin area must be specifically approved by the City of Pearland. The City of Pearland will not assume any maintenance responsibility on or within private detention facilities.

5.9 MISCELLANEOUS DESIGN CONSIDERATIONS

5.9.1 Storm Sewer Outfalls

All storm sewer outfall structures should be constructed in accordance with the City standard details, Brazoria Drainage District No. 4 details, or Harris County Flood Control District's details depending upon the outfall location. Design criteria for outfall structures is as follows:

- A. All storm sewer outfall pipes within the City of Pearland right-of-way must be reinforced concrete pipe with rubber gasket joints, aluminized steel pipe, or HDPE with a minimum diameter of 18 inches.
- B. All backslope drains shall be 24-inch reinforced concrete pipe, aluminized steel or HDPE.
- C. A standard City of Pearland manhole or junction box must be outside of the City of Pearland ultimate right-of-way. Where a road or railroad right-of-way is located adjacent to the channel, the manhole may be placed within the City of Pearland right-of-way.
- D. The grade of the pipe should be that required to produce a three feet per second velocity when flowing full.

- E. Erosion protection (Concrete slope paving, interlocking concrete block, or other approved product by the City Engineer) is required for all outfall pipes.
- F. Stormwater outfall pipes entering into BDD4/HCFCD drainage facilities shall meet BDD4/HCFCD design standard and standard detail.
- G. Effluent outfalls from treatment plants shall have a paved invert and concrete slope paving.

5.9.2 Special Erosion and Velocity Control Structures

A. General

Special erosion and velocity control structures will generally include stilling basins, baffled aprons, straight drop spillways, sloped drops, and impact basins. Due to the hydraulic and earth loads encountered through these structures, the structural as well as the hydraulic design is very critical.

A geotechnical engineering investigation to determine the characteristics of the supporting soil is required for major hydraulic structures

B. Straight Drop Spillway

Straight drop spillways are usually constructed of steel sheet piling with concrete aprons. Steel sheet pile drop structures can sometimes be considered a temporary structure.

The distance erosion protection aprons extend upstream and downstream of the drop is determined using hydraulic analysis. The City of Pearland recommends using concrete paving upstream and immediately downstream of the drop. Because of the additional impact load on the downstream slope paving, a 6-inch thick pad is recommended. Articulated blocks placed on geotextile fabric should be used at the ends of the concrete paving to decrease flow velocities and protect the concrete toe.

The drop structure should be designed for active and passive soil forces. Design calculations are required for each drop structure along with a copy of a geotechnical report defining soil characteristics of the site.

C. Baffle Chutes

See Section 5.3 Reference (23) for hydraulic design of stilling basins and energy dissipation.

D. Sloped Drop Structures

Sloped drop structures can be made of either monolithic poured-in-place reinforced concrete or articulated cellular concrete block mats. The same design principles hold true for sloped drop structures as for straight drop structures; i.e., the draw down curve and hydraulic jump must be contained within the structures or stilling basin.

The sloped drop structure should have 24-inch toe walls on the upstream and downstream ends. The sides of the structure should have 18-inch toe walls.

If an articulated cellular concrete block drop structure is used, the blocks should be bedded on a filter fabric. The fabric should be heavy duty and designed for the specific soil condition. The size and weight of the blocks should be designed for shear forces.

E. Utility Crossings

Approval must be obtained from the office of the respective authorities (the City, BDD4, HCFCD, TxDOT, or Counties) for all utility lines which cross a drainage facility. The utility crossing should be designed to minimize obstruction of the channel flow and conform with the ultimate channel cross-section. Contact the offices of the respective authorities for information regarding the ultimate channel section and ultimate channel right-of-way at a proposed crossing prior to design.

All utility lines under channels should be constructed with the top portion of the conduit a minimum of five (5) feet below the projected flow line of the ultimate channel. When appropriate, facilities may be constructed on special utility bridges or trestles in accordance with standard bridge design criteria. Pipes or conduits spanning the channel should be located 2' above the base flood elevation for hydraulic and maintenance reasons. For utility crossings on street bridges, contact the appropriate government body for approval.

All manholes required for the utility conduit shall be located outside the City of Pearland ultimate right-of-way. Backfill within the City of Pearland right-of-way shall be in accordance with the backfill requirements specified by the respective city, county, or utility company.

5.9.3 Stormwater Management

Stormwater Management shall always be an integral part of the drainage improvement. See Chapter 8.0 Stormwater Management for details.

5.10 REPORT REQUIREMENTS

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

EXECUTIVE SUMMARY

Include detention summary table for the projects with detention.

SECTION 1: INTRODUCTION

- Project Name and Purpose
- Project Limits
- Project Objectives
- Assumptions and Constraints
- Prior Studies if any

Exhibits

- Vicinity Map/Project Location/Aerial Map

SECTION 2: EXISTING CONDITIONS

- Location and Topography
- Land Use
- FEMA Floodplains
- Right-of-Way
- Pipelines and Utilities
- Survey Datum

Exhibits

- Typical Roadway Section (Existing and Proposed) for roadway projects

SECTION 3: HYDROLOGY AND HYDRAULICS

- Design Criteria-guidelines used, storm frequency, mitigation requirements etc.
- List of programs and software used: include the purpose of uses
- Hydrologic Methodology
- Hydraulic Methodology
- Pre-Project Conditions

Exhibits

- Overall Drainage Area Map
- Existing Drainage Area Map with 3, 10, 100 year flows and water surface elevations at Major Outfall Nodes
- Floodplain Maps with project boundary shown on it

SECTION 4: PROPOSED DRAINAGE PLAN

- Description
- Hydrological Analysis – Rational Method, Small Hydrograph Method, HEC-HMS, etc.
- Hydraulic Analysis – Stormsewer design, Spreadsheet, ICPR, XPSWMM, HEC RAS, Applicable Sheet Flow Analysis, etc.
- Channel and/or detention layout
- ROW requirement
- Pipeline and Utility Conflicts
- Geotechnical Requirement
- Environmental Issues

Exhibits

- Overall Drainage Area Map
- Proposed Drainage Area Map with 3, 10, 100 year flows and water surface elevations at Major Outfall Nodes
- Floodplain Maps with project boundary shown on it
- Detention Pond layout that includes a cross section of the detention pond with 100–year water surface elevation and detention summary
- Plan and Profile with 10-yr and 100-yr WSE in case of Roadway

SECTION 5: CONCLUSION

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

Project Name			
Project Area	Acres		
Detention Pond Service Area	Acres		
Detention Basin Area	Acres		
Detention Storage Rate	Acre-Feet/Acre		
Detention Storage Required	Acre-Feet		
Floodplain Fill Mitigation Volume	Acre-Feet		
Total Storage Required	Acre-Feet		
Total Storage Provided	Acre-Feet		
Storm Event	33% (3-Year)	10% (10-Year)	1% (100-Year)
Design Water Surface Elevation (ft) (-----Datum, -----Adjustment)			
Maximum Allowable Outflow (cfs)			
Maximum Proposed Outflow (cfs)			

APPENDIX

- Detailed Hydrological Calculations
- Detailed Hydraulic Calculations

- Digital Data (Models)
- Other supporting documents

5.11 QUALITY ASSURANCE

Prepare calculations and construction drawings under the supervision of a Professional Engineer (Civil/Structural/Environmental) licensed in the State of Texas. The final construction drawings and all design calculations must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawing.

Appendix A
Calculation Form for Storm Sewers

CITY OF PEARLAND

**CHAPTER 6
ROADWAY DESIGN CRITERIA**

**ENGINEERING DESIGN CRITERIA MANUAL
October 2020**

CHAPTER 6 ROADWAY DESIGN CRITERIA

6.1 GENERAL

- 6.1.1 All construction plans containing proposed roadways, sidewalks, and driveways in a public right-of-way shall be reviewed by the City Engineer for all improvements within the city limits.
- 6.1.2 All new streets installed within the city limits shall be concrete curb and gutter. New street construction that utilizes roadside ditches for storm water drainage is discouraged and must receive specific approval of the City.
- 6.1.3 Street design shall conform to all applicable planning tools such as the City of Pearland Unified Development Code requirements, latest edition of the Texas Manual on Uniform Traffic Control Devices, Pearland Comprehensive Plan, Pearland Thoroughfare Plan, Parks and Recreation Master Plan, and Pearland Trail Master Plan. Other consideration for design shall include roadway function, capacity, level of service, traffic safety, the AASHTO Policy on Geometric Design of Highways and Streets, Americans with Disabilities Act (ADA) regulations on accessibility design, pedestrian safety, and all utility locations including gas, cable and power lines. Any deviation using other materials or other design criteria requires prior approval by the City.
- 6.1.4 Design shall conform to the City of Pearland construction details where applicable. These criteria shall not apply to proposed streets projects located in Texas Department of Transportation (TxDOT), Brazoria County or Harris County owned and/or maintained right-of-way.
- 6.1.5 On a case-by-case basis the City of Pearland reserves the right to allow deviations from these design criteria. These design criteria are not intended to cover repairs to-existing streets or street extensions when such repair work or extensions are performed by City of Pearland in whole or in part. These criteria are not intended to cover existing streets within the City of Pearland that do not already conform to these criteria.
- 6.1.6 These are to be considered minimum guidelines but the City of Pearland may require a Traffic Impact Analysis at no cost to the City where the City of Pearland deems it is warranted.

6.2 GENERAL ROADWAY DESIGN GUIDELINES

- 6.2.1 ***Public Roadways*** - The standard for public roadways within the City of Pearland city limits and extra-territorial jurisdiction are concrete, curb-and-

gutter construction, served by underground storm sewers.

- 6.2.2 **Roadway Classifications** - The City of Pearland recognizes three basic classifications of public roadways that include major and secondary thoroughfares, major and minor collectors, and local streets. Each class provides a certain degree of continuity, capacity, and accessibility to adjacent land uses. While differentiated by function, there is also a variation in geometric design. The typical cross-sections are depicted in Figures 6.3.1 and 6.3.2.
- 6.2.3 **Roadway Geometrics** - Geometrics of city streets may be defined as the geometry of the pavement and curb areas that govern the movement of traffic within the confines of the rights-of-way (ROW). Included in the geometrics are pavement width, degree of curvature, width of traffic lanes, median nose radii, curb radii at street intersections, cross fall, crown height, pavement thickness and geometric shapes of islands separating traffic movements and other features.
- 6.2.4 **Design Speed** - The design speed is a primary factor in the horizontal and vertical alignment of roadways. Design features such as curvature, super-elevation, turning movement radii and sight distance affects roadway lane width, pavement width, pavement cross-slope, pavement crown and clearances.
- 6.2.5 **Grades** - Roadway grades shall be a minimum of three-tenths percent (0.3%) in order to insure proper flow of surface drainage toward inlets and a maximum of six percent (6%). Steeper grades may be permitted on local residential streets and where required by topographical features, as approved by the City Engineer.
- 6.2.6 **Roadway Centerline** - Roadways shall be placed in the center of the ROW, but may be shifted slightly, with prior City approval, to avoid groupings of trees. The centerline of curves shall be tangent to the centerline of street at each end of curve.
- 6.2.7 **Cross Slope/Crown Height** – Thoroughfares shall have a minimum cross slope of one-quarter inch per foot and a maximum cross slope of three-eighths inch per foot. Major and minor collectors and local streets shall have six-inch (6”) crowns.
- 6.2.8 **Pavement Strength & Thickness** - All concrete pavement and curbs shall be a minimum 3,500-psi and shall meet the structural requirements of this manual.
- 6.2.9 **Sight Distance** - All intersections on major thoroughfares and major collectors and intersections of other streets with adjacent community fencing, monument signs or hardscaping, horizontal curves and vertical

curves shall be evaluated for adequate sight distances in accordance with AASHTO guidelines. Sight distance triangles shall be shown on the plan view of construction plans.

6.2.10 **Channelization** - Channelization shall conform to American Association of State Highway and Transportation Officials "A Policy on Geometric Design of Highways and Streets", latest edition.

6.2.11 **Private Streets** – Private streets are streets that are not owned by the City of Pearland, the State of Texas or the County and are not dedicated for public use. All private streets shall be constructed to the same standards as public streets.

6.2.12 Requirements for Thoroughfares within master planned developments and planned unit developments

1. The full right-of-way for major and secondary thoroughfares adjacent to developments shall be dedicated at the time of platting of the development.
2. When the full section of a thoroughfare is located within the city limits and is dedicated on a final plat, the esplanade and all lanes of the thoroughfare shall be constructed at the time of development of the adjacent subdivision.
3. If approved by the City Engineer, one-half of the thoroughfare, including travel lanes, left-turn lanes and the esplanade to the centerline of the right-of-way shall be constructed at the time of initial construction of the adjacent development. The remainder of the thoroughfare shall be constructed at the time the property adjacent to the unconstructed half is developed.
4. Permanent barricades, conforming to the requirements of the Texas Manual of Uniform Traffic Control Devices, shall be constructed at the termination of lanes on partially constructed thoroughfares. The barricades shall include a sign reading FUTURE ROADWAY EXTENSION mounted on a breakaway pole and located one foot behind the barricade, with the bottom of the sign one foot above the top of the barricade.

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

6.2.14 At a T-intersection with a street that has not been improved to its ultimate width, the concrete pavement of the intersecting street shall be stopped either at the right-of-way line or the end of the curb return, whichever would

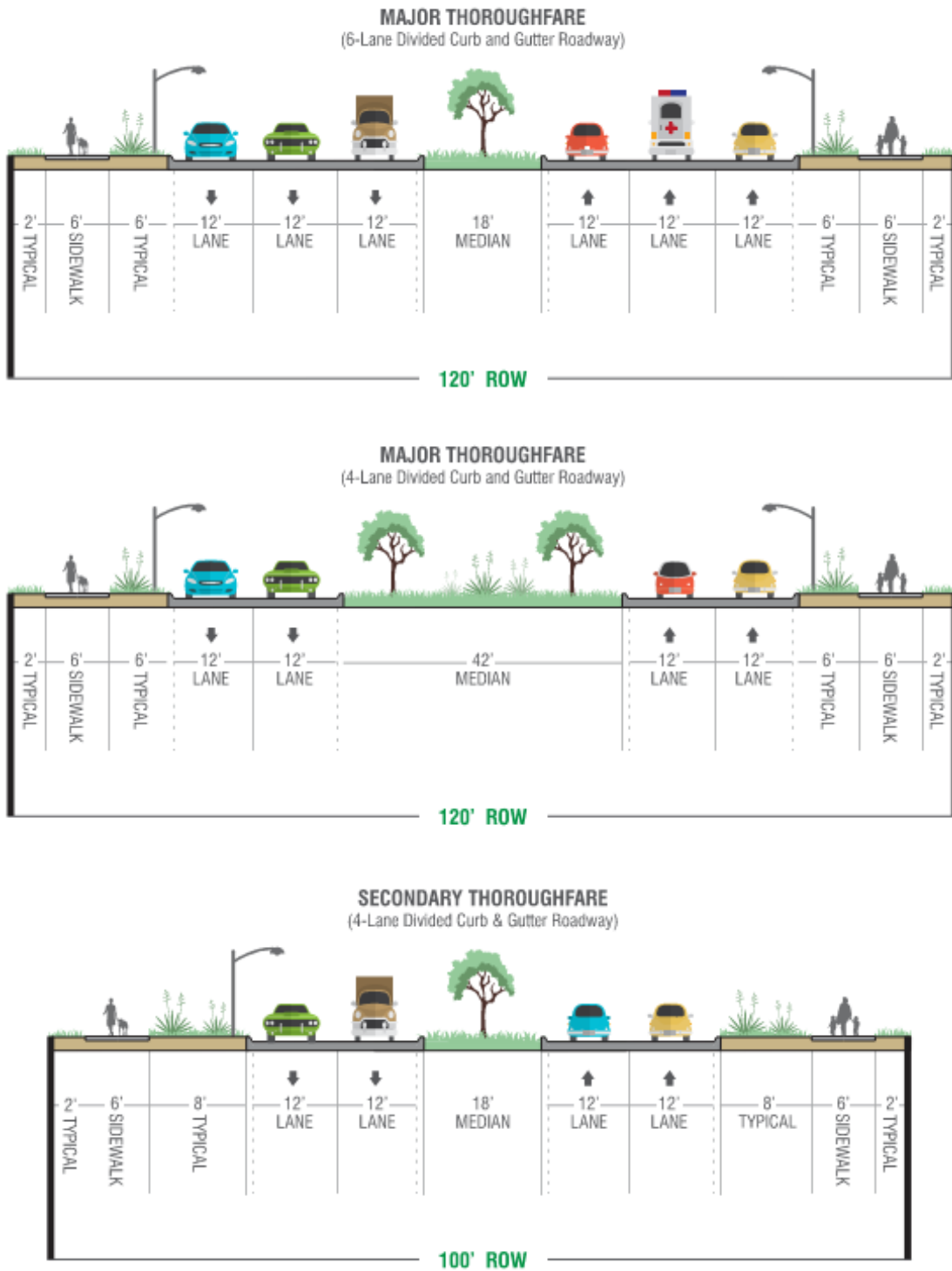
require less concrete removal at a future date.

- 6.2.15 For roadway turnouts placed at an existing cross street intersection, the turnout should be designed to fit the ultimate pavement width of the intersecting cross street and then transitioned to the existing roadway.
- 6.2.16 Residential driveways shall not access major thoroughfares or collector streets without written approval from the City Engineer. Subdivision layouts shall be designed to avoid homes requiring collector street access.

6.3 ROADWAY CLASSIFICATIONS

- 6.3.1 Major Thoroughfare, 4 or 6 lanes, divided roadway: Shall provide a high degree of mobility, serve relatively high traffic volumes, have limited access, have high operational speeds and serve a significant portion of through travel and traffic movement by serving as the major traffic corridors. Usually constructed within a minimum 120 ft. wide right-of-way.
- 6.3.2 Secondary Thoroughfare, 4 lanes, divided or undivided roadway: Serve same function as principal arterials but typically have a lower traffic volume. Usually constructed within a minimum 100 ft. wide right-of-way.
- 6.3.3 Major Collector, 4 lanes, undivided roadway: Shall be used in multi-family, commercial or industrial areas as well as secondary streets. Usually constructed within a minimum 80 ft. wide right-of-way.
- 6.3.4 Minor Collector, 2 or 3 lanes, undivided roadway: Shall be used for minor collector streets in single family residential areas or local multi-family residential, commercial, or industrial areas as well as secondary streets where defined. May have two travel lanes and a center continuous left-turn lane, or 2 lanes with designated on-street parking. Usually constructed within a minimum 60 ft. wide right-of-way.
- 6.3.5 Local, residential, 2 lane, undivided roadway: Includes streets that allow access from residential streets to Collectors and higher volume roads. May have direct access to residential properties and similar traffic destinations and typically have low design speeds and moderate to low traffic volumes. May have up-to one lane of designated on-street parking. Usually constructed within a minimum 50 ft. wide right-of-way.
- 6.3.6 Residential, 2 lane, undivided roadway: Include internal streets that allow direct access to residential properties and similar traffic destinations and typically have low design speeds and low traffic volumes. On-street parking is allowed unless otherwise designated. All parking must be

parallel to the curb, even in cul-de-sacs. Usually constructed within a minimum 50 ft. wide right-of-way.



**Figure 6.3.1 – Cross Sections for Thoroughfare
(All dimensions are face-to-face)**

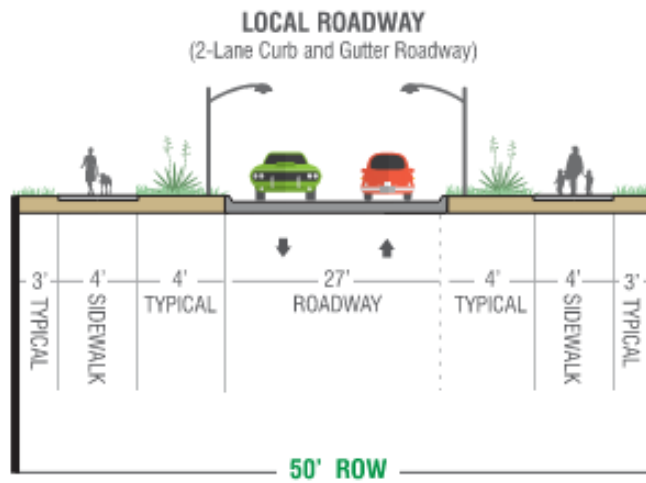
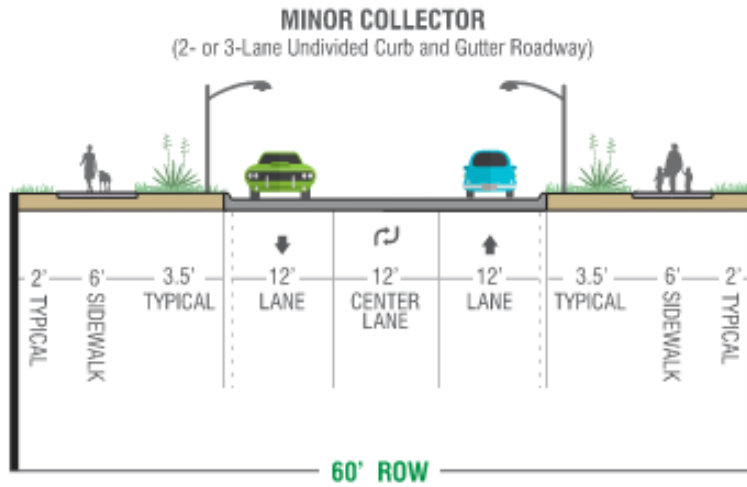
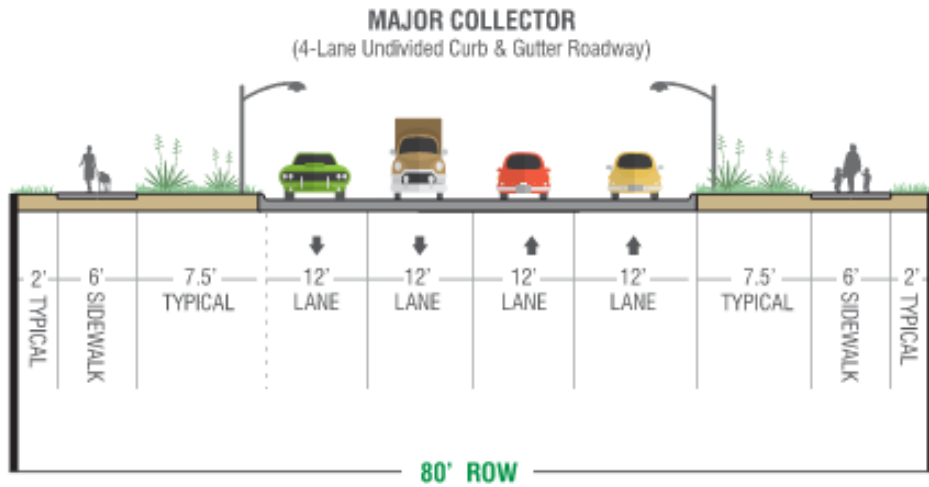


Figure 6.3.2 – Cross Sections for Collector and Local Roads
(All dimensions are face-to-face)

6.4 GEOMETRIC STREET DESIGN STANDARDS

6.4.1 Minimum geometric street design standards for number of lanes, lane widths, right-of-way widths, and median widths shall be as follows:

Table 6.4.1

	Major Thoroughfare	Major Thoroughfare	Secondary Thoroughfare	Major Collector	Minor Collector	Local Street
Right-of-Way Width	120 feet	120 feet	100 feet	80 feet	60 feet	50 feet
Curb Back to Curb Back Distance	N/A	N/A	N/A	45 feet	37 feet	28 feet
Median Width (bc-bc) ⁽²⁾	18 feet	42 feet	18 feet	N/A	N/A	N/A
Distance from Curb Back to ROW line	14 feet	14 feet	16 feet	17.5 feet	11.5 feet	11 feet
Distance from ROW Line to Sidewalk	Varies	Varies	Varies	Varies	Varies	Varies
Max. Number of Lanes (one direction)	3	2	2	2	1	1

(1) *With on-street parallel parking.*

(2) *Median turning lanes are included in median widths.*

6.4.2 The design speeds shall conform to the following design standards. The posted speed limit shall never exceed the design speed. The design speed should be a minimum of 5 mph greater than the posted speed limit.

Table 6.4.2

Urban	
Thoroughfares	40-60 mph
Collectors	30-50 mph
Local	30 mph

6.4.3 The maximum grade allowed refers to the uphill or downhill slope of the street and shall conform to the following design standards:

Table 6.4.3

Thoroughfares							
	Design Speeds (mph)						
	30	35	40	45	50	55	60
Type of Terrain	Maximum Grades (%) ⁽¹⁾						
Level	8	7	7	6	6	5	5

Table 6.4.4

Collectors									
	Design Speeds (mph)								
	20	25	30	35	40	45	50	55	60
Type of Terrain	Maximum Grades (%) ⁽¹⁾								
Level	9	9	9	9	9	8	7	7	6

(1) Short lengths of grade in urban areas, such as grades less than 500 ft in length, one-way downgrades, and grades on low-volume urban collectors may be up to 2% steeper than the grades shown above. Note: Sidewalks along these roadways shall not exceed ADA maximum grade requirements.

6.4.4 Local Roads

- A. Grades for local residential streets should be as level as practical, consistent with the surrounding terrain. The gradient for local urban streets should be less than 9%. Where grades of 4% or steeper are necessary, the drainage design shall be the critical governing design parameter. On such grades special care should be taken to prevent erosion on slopes of roadside ditches and earthen/grass lined open drainage facilities. For streets in commercial and industrial areas, grades should be less than 5% and flatter grades are encouraged.

6.4.5 Vertical curves

- A. Vertical curves shall be designed when algebraic difference in grade exceeds 1%. Elevations shall be shown on the construction plans at a minimum of ten foot (10') horizontal intervals through vertical curves. The gradient for tangents to vertical curves at railroad crossings shall be a maximum of three and one-half percent (3.5%). All crest vertical curves shall be determined by sight distance requirements for the design speed. The minimum design speed on any vertical curve shall be based on roadway classification.
- B. Vertical curves are utilized in roadway design to affect gradual change between tangent grades and will result in design that is safe, comfortable in operation, pleasing in appearance and adequate for drainage. Vertical curve alignment shall also provide Stopping Sight Distance (SSD) in all cases. SSD is a function of design speed, perception-reaction time, grade, and dynamic friction. The perception-reaction time is assumed to be 2.5 seconds as stated by American Association of Highway and Transportation Officials (AASHTO). The dynamic friction is the force that resists movement of the vehicle while the tires are in a locked position. The equation for SSD appears below:

$$SSD = 1.47PV + \left(\frac{V^2}{30(f + g)} \right)$$

Where:

SSD = Stopping Sight Distance (ft); P = perception Reaction Time (2.5 sec.); V = vehicle design speed (MPH); f = coefficient of friction between tires and roadway; g = percent grade divided by 100

- C. To determine the minimum acceptable length of Crest and Sag curves shown in Tables 6.4.5 and 6.4.6, it is assumed that $g=0$ in the SSD calculation. Tables 6.4.5 and 6.4.6 also show values of K. K is defined as the rate of vertical curvature and is equivalent to the horizontal distance in feet required to make a one percent (1%) change in grade. The values of A are equivalent to the algebraic difference in grade

between the two grades that are being joined together by the vertical curve.

Table 6.4.5: Minimum Acceptable Crest Curve Given Speed and Difference in Grade of Road

Design Speed, V (MPH)	SSD (ft)	K	Length of Vertical Curve (L=KA)									
			A=1.2 ⁽¹⁾	A=2	A=3	A=4	A=5	A=6	A=7	A=8	A=9	A=10
25	155	12	--	24	36	48	60	72	84	96	108	120
30	200	19	--	38	57	76	95	114	133	152	171	190
35	250	29	--	58	87	116	145	174	203	232	261	290
40	305	44	50	88	132	176	220	264	308	352	396	440
45	360	61	50	122	183	244	305	366	427	488	549	610
50	425	84	50	168	252	336	420	504	588	672	756	840

- (1) Speeds less than forty miles per hour (40MPH), no vertical curve is necessary. Speeds greater than forty miles per hour (40MPH), use length of fifty feet (50’).
- (2) If the algebraic difference (A) is between 1.2 and 2 the length of vertical curve shall be calculated.

Table 6.4.6: Minimum Acceptable Sag Curve Given Speed and Difference in Grade of Road

Design Speed, V (MPH)	SSD (ft)	K	Length of Vertical Curve (L=KA)									
			A=1.2 ⁽¹⁾	A=2	A=3	A=4	A=5	A=6	A=7	A=8	A=9	A=10
25	155	26	--	52	78	104	130	156	182	208	234	260
30	200	37	--	74	111	148	185	222	259	296	333	370
35	250	50	--	98	147	186	245	294	343	392	441	490
40	305	64	50	128	192	256	320	384	448	512	576	640
45	360	79	50	158	237	316	395	474	553	632	711	790
50	425	96	50	192	288	364	480	576	672	768	864	960

- (1) Speeds less than forty miles per hour (40MPH), no vertical curve is necessary. Speeds greater than forty miles per hour (40MPH), use length of fifty feet (50’).
- (2) If the algebraic difference (A) is between 1.2 and 2 the length of sag curve shall be calculated

6.4.6 Intersections and curves shall be evaluated for adequate sight stopping distances based on the design speed.

A. Minimum stopping sight distances shall conform to the following design standards:

- a. The driver’s eye height shall be assumed to be 3.5 feet above the finished pavement.

- b. The height of the object seen by the driver shall be assumed to be 2.0 feet.
 - c. A deceleration rate of 11.2 feet/s² shall be used.
 - d. A brake reaction time of 2.5 seconds shall be used.
 - e. Minimum sight stopping distances shall be adjusted by the Professional Engineer of Record, when there is a presence of vertical curves within the distance needed for stopping as recommended by AASHTO's *A Policy on Geometric Design of Highways and Streets* where applicable.
- B. Open space clips shall be established at all intersections. Unless larger clips are required at a particular intersection, a minimum 10-foot x 10-foot triangular open space corner clip for zoned residential areas, as measured from the projected property line, is required at the intersection of two streets. At intersection of collector streets or greater, minimum 25-foot x 25-foot open space corner clip or larger, as design requires, shall be provided. Such clips shall be part of the public right-of-way and may not be located on private property.
- C. Major and secondary thoroughfares with a centerline radius of the right-of-way less than 2000 feet shall be designed in accordance with the guidelines for superelevation as specified in the AASHTO *A Policy on Geometric Design of Highways and Streets*. Signage and design speed shall be accounted for in all curved thoroughfares. The maximum rate of superelevation shall be 0.06 for urban conditions. Streets with a centerline radius of over 2000 feet are not required to have superelevation.
- D. Collector and local streets horizontal curves may be designed without superelevation.
- E. Minimum Horizontal Curve Radii Lengths:
- a. Major Thoroughfares: 2000 feet.
 - b. Secondary Thoroughfares: 2000 feet.
 - c. Major Collector Streets: 850 feet
 - d. Minor Collector Streets: 850 feet.
 - e. Local Streets: 450 feet.
 - f. Residential Street: 300 Feet.

For radii less than above, designer must receive specific approval from the City Engineer.

- 6.4.7 For the purposes of these design standards, tangent length is defined as the distance between the point of tangency and the point of curvature of two adjacent curves along the centerline of the street right-of-way.

- A. The minimum tangent length between reverse curves shall be 100 feet on principal arterials, minor arterials, major collector streets, and minor collector streets.
- B. The minimum tangent length between reverse curves shall be 50 feet on all local streets.

6.4.8 Intersections

- A. Curb radii, measured from the face of curb, shall be 35 feet minimum on major and secondary thoroughfares. The minimum curb radius shall be 25 feet on collector and local streets. Skewed intersections shall be designed with larger radius.
- B. Streets and traffic lanes should be aligned across an intersection. Except where existing conditions will not permit, all streets should intersect at a 90 degree angle. The maximum allowable skew across an intersection shall be 5 degrees for arterial streets, and 10 degrees on all collector and local streets.
- C. When turnouts are provided at an existing street, the ultimate cross section is required to the end of the curb return. Pavement transition is required to reduce the pavement width to the existing cross section.
- D. Taper rates for adding or dropping a lane shall be at a minimum of straight line tapers with a minimum of an 8:1 rate for design speeds up to 30 mph and 15:1 for design speeds up to 50 mph. For design speeds over 50 mph the Professional Engineer of Record shall submit a design providing adequate taper lengths appropriate for the corresponding design speed. The use of partial tangent tapers, symmetrical reverse curves, and asymmetrical reverse curves are encouraged and should be designed to fit the design speed of the design road but are not required.
- E. Right-of-Way corner clips are required and shall meet visibility requirements per Section 6.6.
- F. Collector, local, and residential roadways shall have a 25 ft radius for the right-of-way at all intersections.

6.4.9 Minimum lane transition lengths shall meet or exceed requirements of the A Policy on Geometric Design of Highways and Streets. Pavement width transitions shall conform to the following design standards:

- A. Minimum deceleration lengths for auxiliary turning lanes on grades of less than or equal to 3%, with an accompanying stop condition, for

design speeds of 30, 40, 45, 50, 55 mph are 230, 330, 430, 550 and 680 feet respectively. These lengths exclude the taper lengths.

- B. Taper lengths should be calculated for roads with design speeds greater than or equal to 45 mph by using taper lengths (L) equal to 0.6 times the design speed (S) multiplied by the offset (W), $L=0.6SW$. For design speeds less than 45 mph, the taper length (L) equals the offset multiplied by the design speed(s) squared, then divided by 155, $L=WS^2/155$. The distance for tapers should be lengthened if the road is curved based on recommendations from the Professional Engineer of Record.

6.4.10 Left Turn Lanes

- A. Minimum storage bay length shall be 100' for collector streets and 150' for thoroughfare streets. Longer storage bay lengths may be required based on the results of a Traffic Impact Analysis.
- B. Mid-block left turn lanes may be allowed if a Traffic Impact Analysis and the City Engineer recommends their use in relation to a proposed development. Left turn lanes shall be provided at the intersection of public street rights-of-way.
- C. Minimum transition taper length with 500' Radius shall be 180' for Collector streets and 200' for thoroughfares.
- D. The City Engineer reserves the right to require that a Traffic Impact Analysis be submitted for any proposed development.
- E. Left-turn lane width shall be a minimum of 12 ft.

6.4.11 On major and secondary thoroughfares esplanade openings may be spaced a minimum of 600 feet apart. Median openings shall conform to the following design standards:

- A. For median openings including left turn lanes, the storage and taper lengths mentioned in these design criteria shall apply.
- B. The median opening at the intersection of two streets shall be at least the width of the minor right-of-way plus 10 feet. These median openings may be wider based on lane configurations or traffic volumes. In such cases sufficient traffic analysis and data should be presented along with design.
- C. Variations to these criteria may be granted on a case by case basis by the City Engineer.

6.4.12 Cul-de-sac Pavement

- A. Residential minimum pavement radii for the cul-de-sac bulb as measured to the face of curb shall be 40 feet.
- B. Commercial and industrial minimum pavement radii for the cul-de-sac bulb as measured to the face of curb shall be 45 feet.
- C. Right-of-way radius shall be clear of permanent obstructions.
- D. Curb radii at the transition to the cul-de-sac shall have a typical radius of 25 feet in single family residential areas and 35 feet in all other areas as measured at the face of curb.
- E. The minimum grade line around a cul-de-sac shall be 0.70%.
- F. The length of a cul-de-sac is defined as the distance from the centerline of the intersecting pavement to the center of the cul-de-sac bulb measured along the centerline of the street right-of-way. Maximum length of cul-de-sac local streets for residential subdivisions shall be 600 feet. Dead end collectors and dead-end major and minor thoroughfares shall not be allowed.
- G. The City Engineer reserves the right to require shorter maximum lengths of commercial and industrial cul-de-sacs or dead-end streets where high traffic volumes are present.

6.4.13 The design of on street parking shall conform to the following design criteria:

- A. All on-street parking shall be parallel parking only.
- B. Designated on-street parking spaces shall be striped with white paint.
- C. The width of on-street parking spaces shall be a minimum of 8 feet in width as measured from the inside of the painted stripe to the face of curb when allowed or approved by special design and with study by and consultation with the Planning Department.

6.5 GATED DEVELOPMENT ENTRANCE REQUIREMENTS

- 6.5.1 Gated developments shall have a median divided street that will allow for a vehicular u-turn prior to the gate in the event that access is denied. The turn-around shall be a minimum of eighteen feet (18') in width.

- 6.5.2 Entry gates shall be set back from the ROW a minimum of sixty feet (60') to provide stacking. There shall be a minimum of forty feet (40') to the entry keypad or first stop to allow room for the longest queue of vehicles expected to access the gate. Length of queue shall be determined by the development TIA and also address the turning movements into and out of the development and if mitigation will be required. Impacts that could cause backups onto the existing roadways due to the gated entrance are not allowed.
- 6.5.3 The travelway shall be a minimum of twenty-four feet (24') in width. See Figure 6.5.
- 6.5.4 The hinge point of the gate shall be a minimum of eighteen inches (18") behind back of the curb.
- 6.5.5 Gates shall be equipped a Knox box for emergency access.
- 6.5.6 Vehicular gates shall not encroach on public sidewalks.
- 6.5.7 Any alternative designs require City Engineer approval.

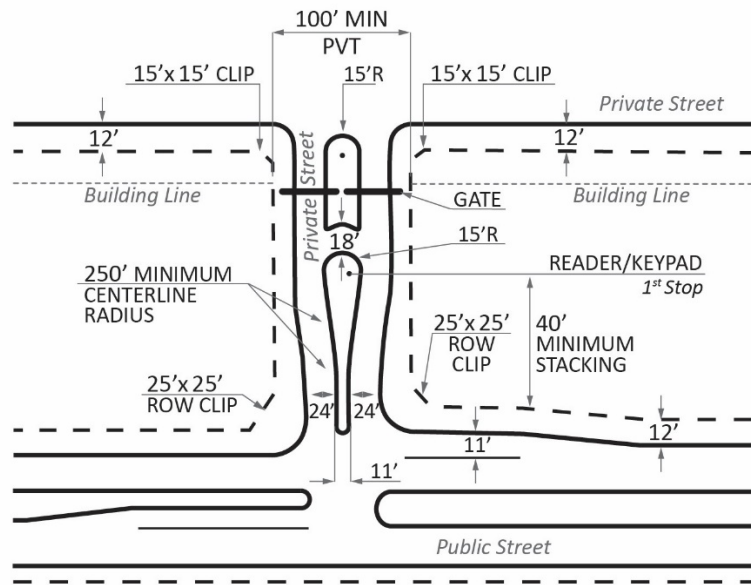


Figure 6.5 – Gated Entrance Detail

6.6 PUBLIC RIGHT-OF-WAY VISIBILITY REQUIREMENTS

6.6.1 Adequate sight distance at the intersection of all streets shall be assured. This sight distance is provided through the use of a Corner Visibility Triangle and/or a Sight Line Triangle. Construction plans for roadways shall show both the Corner Visibility Triangle and the Sight Line Triangle on the plan view of proposed streets. Corner Visibility Triangles shall be dedicated as ROW and Sight Line Triangles shall be identified and dedicated as Visibility, Access and Maintenance Easements or Reserves (VAM's). In addition, a Sight Line Triangle must also be provided for the following cases:

- a. Where a driveway, alley, or any roadway that is controlled by a stop sign intersects with an uncontrolled thoroughfare.
- b. On any signalized intersection approach where right-turn on red operation is permitted, a sight line triangle must be provided for the right turn driver.

6.6.2 Corner Visibility Triangle Defined:

- a. The corner visibility triangle is defined at an intersection by extending the two ROW lines from their point of intersection to a distance as shown on Table 6.6.1. These two points are then connected with an imaginary line to form the corner visibility triangle as shown in Figure 6.6.1.

Table 6.6.1: Corner Visibility Triangle Distances

<u>Type of Roadway On</u>	<u>Type of Roadway At</u>	<u>Distance (X)</u>
4 or 6 lane	ALL	35'
Collector	Collector	25'
Collector	Local	10'
Local	Local	10'

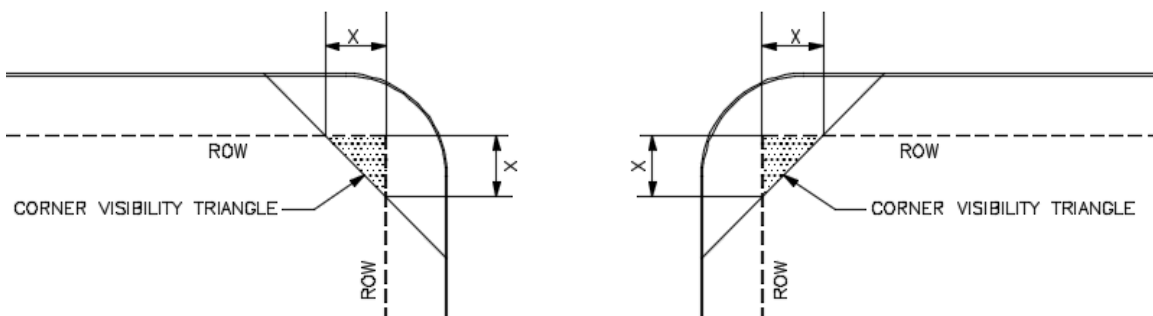


Figure 6.6.1 – Corner Visibility Triangle for an Intersection

- b. Where alleys intersect public streets, the corner visibility triangle is measured as fifteen feet (15') along the residential street ROW and five feet (5') along the alley ROW from the point of intersection. These two points are then connected with an imaginary line to form the corner visibility triangle as shown in Figure 6.6.2. The alley corner visibility triangle shall be dedicated as ROW.

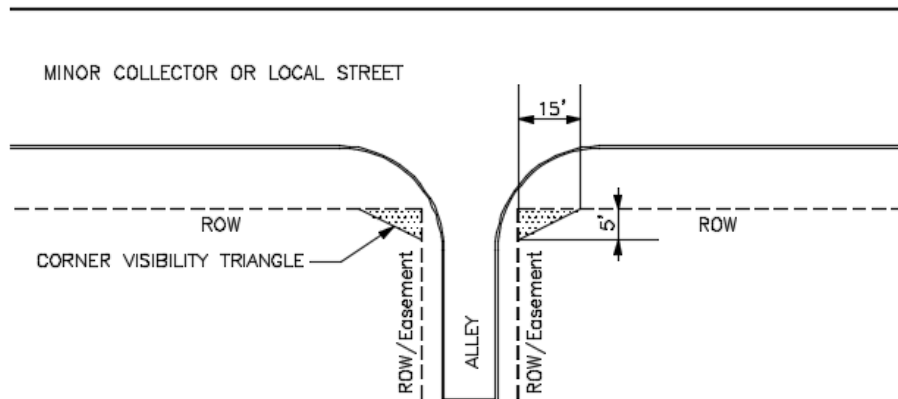
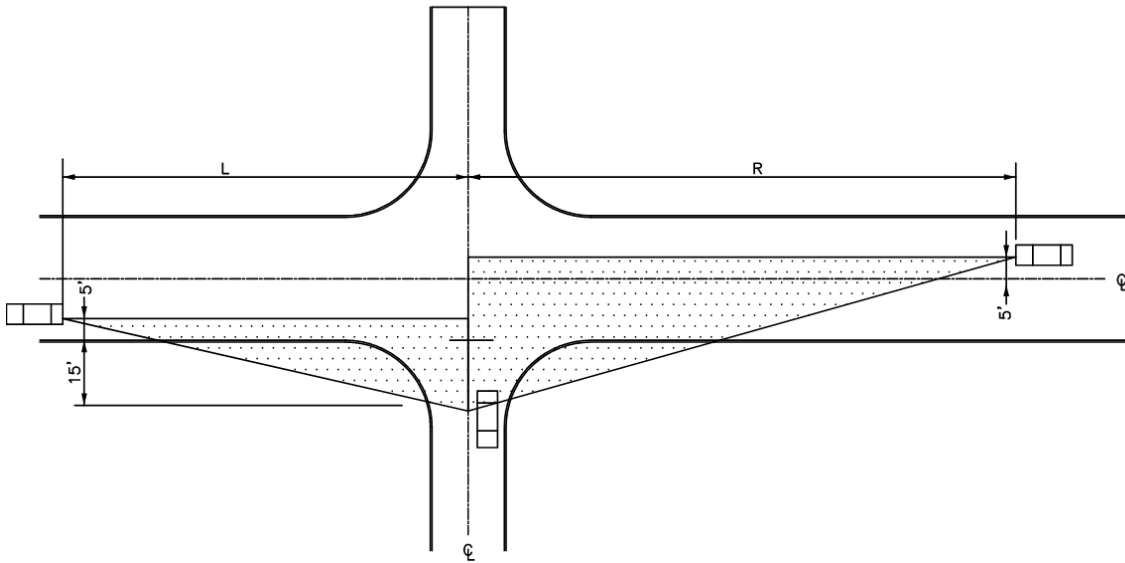


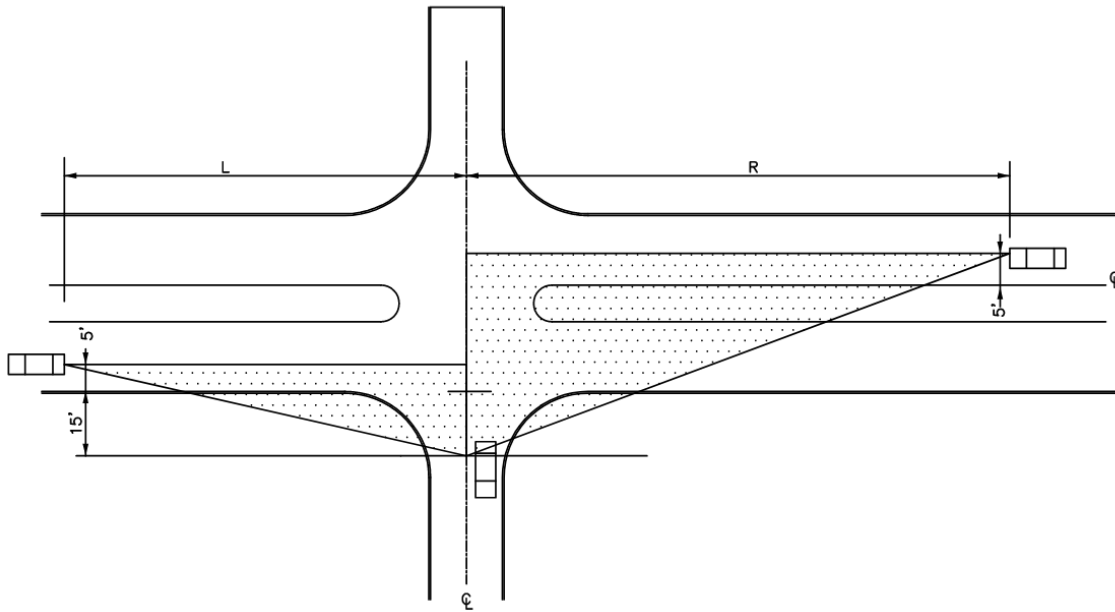
Figure 6.6.2 – Corner Visibility Triangle for an Alley

6.6.3 Sight Line Triangle Defined:

- a. The sight line triangle is formed by first extending a line along the center line of the proposed roadway or driveway that begins at the tangent curb of the intersecting roadway and extends to its endpoint fifteen feet (15') into the proposed thoroughfare or driveway. For the sight line triangle to the left, construct a second imaginary line that is parallel to and five feet (5') out from the intersecting thoroughfare's curb that begins at the centerline of the side street and continues to the left for a distance L to its endpoint. To complete the sight line triangle, connect the endpoints of the first two lines as shown in Figures 6.6.3 and 6.6.4. In the case of the sight line triangle to the right, the second imaginary line is parallel and five feet (5') out from the nearest edge of the conflicting traffic flow (or adjacent median in the event of a divided roadway). It begins at the centerline of the side street and continues to the right for a distance R to its endpoint (See Figures 6.6.3 and 6.6.4). On divided roadways with a median width greater than 30 feet, sight line triangles shall be generated at the intersecting roadway and at the median opening.



**Figure 6.6.3: Typical Sight Line Triangle
(multi-lane approaches require similar analysis)**



**Figure 6.6.4: Typical Sight Line Triangle for a Divided Thoroughfare
(multi-lane approaches require similar analysis)**

- b. Distance to driver's eye for all roadways and driveways that intersect a street is fifteen feet (15') from the intersecting curb line as shown in Figures 6.6.3 and 6.6.4.

- c. In the case where the thoroughfare contains existing horizontal curvature, the distances L and R must be measured along the horizontal curve

Table 6.6.2: Sight Line Triangle Distances

<u>Design Speed</u> <u>V (MPH)</u>	<u>SD to Left</u> ⁽¹⁾ <u>L (ft)</u>	<u>SD to Right by Lanes in Cross Section</u> <u>R (ft)</u>		
		<u>2</u>	<u>4</u> ⁽²⁾	<u>6</u> ⁽²⁾
30	325	325	N/A	N/A
35	425	425	N/A	N/A
40	525	525	N/A	N/A
45	625	625	650	N/A
50	725	725	750	775

- (1) Source AASHTO Green Book
- (2) Manual Calculations of the Procedure in the Green Book indicate a twenty-five-foot (25') increase in sight distance to the right for each increase in cross section.

6.6.4 Landscaping and Obstruction Requirements for Corner Visibility and Site Line Triangles.

- a. No fence, wall, screen, sign, structure, foliage, hedge, tree, bush, shrub, berm, driveway planting, parking, or any other item, either man-made or natural shall be erected, planted, or maintained in a position that will obstruct or interfere with a driver's clear line of sight within both the corner visibility and sight line triangle (i.e., VAM's).
- b. Vision at all intersections shall be clear from obstructions at elevations between thirty inches (30") and ten feet (10') above the average gutter elevation within each sight line triangle. Existing trees shall have a clear trunk of eight feet (8') above average gutter elevation within each sight triangle. Traffic control devices shall remain visible at all times in accordance with the requirements of the TMUTCD.

6.6.5 Landscape Plan Requirements:

- a. A sitework/landscape plan is required that shows the plan of the street on both sides, and the median where necessary, of each proposed driveway/street to the proposed development with the grades, curb elevations, proposed street/drive locations, and all items (both natural and man-made) within both the corner visibility and sight line triangles.
- b. This sitework/landscape plan shall show no horizontal or vertical restrictions (either existing or future) within the corner visibility and sight line triangles.

6.7 PAVEMENT STRUCTURE REQUIREMENTS

- 6.7.1 The pavement structure for all roadways outside of zoned industrial areas shall be designed based on soil data from the site and geotechnical analysis, anticipated traffic volume, desired service life of the proposed pavement. The Professional Engineer of Record is responsible for ensuring that the pavement structure is designed to withstand the anticipated loads that are expected on the roadway. All roadways outside of zoned industrial areas shall be designed to adequately handle the design vehicle weight. Such criteria shall be used to design the roadway when these data, in sum, recommend a pavement larger than the minimums below.
- 6.7.2 For the typical pavement section and detail for local residential streets, minor collectors, major collectors, secondary and major thoroughfares, refer to City's Standard Construction Details.
- 6.7.3 Lime determination shall be made utilizing a soil proctor from the site. Subgrade shall be stabilized to a minimum eight inches (8") thick to reduce Plasticity Index (PI) to twenty (20) as determined by lime series. If a PI of 20 or less cannot be obtained, then the lime treated soils must obtain a pH of 12.4 and compacted to ninety-five percent (95%) standard proctor density. Lime shall be applied as per TXDOT 260. Subgrade stabilization and compaction shall extend a minimum of two feet (2') beyond the back-of-curb or edge of pavement.
- 6.7.4 For the pavement structure for all public roadways inside zoned industrial districts, the concrete pavement design and the calculation of its thickness shall be based on AASHTO design procedures for rigid pavements and shall be based on independent studies of projected truck traffic, projected passenger vehicle traffic, geotechnical investigations, anticipated vehicle loading by design vehicle and with consultation with the Planning Department. Prior to any pavement design the developer shall consult with the City Engineer.
- 6.7.5 The use of rebar dowels or the use of saw-cutting procedures to expose existing steel in concrete pavement is required to create a minimum of 12 inches of overlap of reinforcing steel when making a connection of a proposed concrete street to an existing concrete street or road. When the existing street has no exposed steel the following shall apply:
- A. Dowels shall be number 4 (#4) bars, twenty-four inches (24") long, imbedded twelve inches (12") and epoxied into the existing concrete. Applicable spacings shall be the same as the rebar spacings mentioned in these design criteria for the various concrete thicknesses.

- 6.7.6 Dead-end streets and concrete paved streets designed to be extended in the future shall have paving headers and 15 inches (15”) of reinforcing steel exposed beyond the pavement (coated with asphalt and wrapped with burlap), or dowel type expansion joint for future pavement tie-in.
- 6.7.7 Pavement extensions shall connect to the existing pavement in accordance to the City Standard Detail
- 6.7.8 All concrete paving to be removed shall be removed to either an existing joint or a saw-cut joint. Sawed joints shall be full depth of the pavement and meet the requirements set out in this section.
- 6.7.9 Materials – For all pavement materials, refer to the City’s Standard Details.

6.8 REINFORCED CONCRETE PAVEMENT MATERIALS

- 6.8.1 **Concrete** – All concrete shall be a minimum of five and a half (5.5) sacks cement per cubic yard concrete and achieve an unconfined compressive strength of 3,500 psi at twenty-eight (28) days.
- 6.8.2 **Reinforcing steel** - Grade 60, ASTM A615, current.
- 6.8.3 **Aggregate** – Limestone shall be utilized wherever possible. Granite is permitted only with prior approval by the City Engineer. River rock or similar “hard” aggregates are not permitted.
- 6.8.4 **Fly Ash** – Fly ash may be permitted as an admixture with cement in pavement or curbs. The inclusion of fly ash in pavement requires the submission of the mix design and test history of the mix design, in addition to prior written approval of the City Engineer. Type “C” or Type “F” fly ash of acceptable quality and meeting requirement of ASTM C 618 may be used as admixture in concrete mixture. When fly ash is used, store and inspect in accordance with ASTM C 618. Do not use fly ash in amounts to exceed 20% by weight of cementitious material in mix design. Note: When fly ash is used, term “cement” is defined as cement plus fly ash.
- 6.8.5 All materials and workmanship shall conform to the Texas Department of Transportation Standard Specifications, 2004, and the Texas Manual on Uniform Traffic Control Devices, 2011, and any revisions thereto.

6.9 GRADING AND LAYOUT REQUIREMENTS

- 6.9.1 Minimum gradient on any gutter shall be 0.30%.
- 6.9.2 See Chapter 5 of the Engineering Design Criteria Manual (EDCM) for inlet spacing.

- 6.9.3 The maximum allowable slope for driveways shall be in accordance with the City's Standard Construction Details.
- 6.9.4 The algebraic sum of grades to an inlet at an intersection should not exceed 1%.
- 6.9.5 All new residential and local streets poured with a curb and gutter arrangement shall have a minimum of a 4 inch rollover, lay down curb or approved equal. All new collector and thoroughfare streets poured with a curb and gutter arrangement shall have the standard 6 inch stand up type curb. A standard 6 inch curb shall be used immediately adjacent to all storm sewer inlets; where necessary 4 inch rollover curbs shall be transitioned to a 6 inch curb at the inlet.
- 6.9.6 The minimum grade line around a cul-de-sac shall be 0.70%.
- 6.9.7 The amount of cross slope over the pavement section shall be 2% sloping away from the crown of road or centerline.
- 6.9.8 When connecting to an existing curbed street, the gutter lines for the proposed and existing streets shall be matched.
- 6.9.9 Proposed top of curb elevations should be designed to match the top of the curb at an existing street in cases where a proposed street is being connected to an existing street.
- 6.9.10 Top of curb elevations shall be shown on the construction plans along with a detail of the type of curb used.
- 6.9.11 Gutter line elevations for vertical curves shall be shown on the construction drawings in cases where a railroad track is being crossed. Where railroad crossings are not at right angles to the pavement, vertical curves should be calculated for each curb line and should be posted at 10 foot intervals of the centerline of the road on the construction drawings in both plan and profile view. The grade of the railroad track shall be matched with the centerline of the road at the intersection of the crossing.
- 6.9.12 All Major and Secondary Thoroughfares shall be designed so that, at all valley locations, ponding water from the 100-year rainfall events does not exceed 3-inches of depth along the gutter line of inside curb. This condition is described as "one lane passable".

6.10 TRAFFIC CONTROL DEVICES

- 6.10.1 Standard Type III barricades shall be permanently installed by the developer at the end of all dead-end streets not terminating in a cul-de-sac, and at all turnouts. These barricades shall meet at least the minimum requirements of the TMUTCD. The erection of these Type III barricades shall not preclude the installation of other decorative fencing or landscaping behind the barricade for the purposes of maintaining private property, safety, aesthetics etc.
- 6.10.2 Traffic signage locations, street signage locations, and pavement markings shall be shown on the paving overall layout in the construction drawings and shall be in compliance with the TMUCD. The construction drawings should include pavement marking details where applicable.
- 6.10.3 Pavement markings shall be shown on the final construction plans for a project. Reflectorized paint with supplemental reflectors, or approved equal, shall be used on all major thoroughfares and on major collector streets. Turn lanes shall have proper pavement markings. All pavement markings shall conform to the latest edition of TMUTCD.
- 6.10.4 Prior to final approval of a construction project, all signage and pavement markings shall be installed in accordance with the approved construction plans.
- 6.10.5 A blue reflectorized raised pavement marker or button is required at all fire hydrants and shall be located 6 inches off the pavement centerline toward the fire hydrant.
- 6.10.6 The developer shall install requisite traffic control devices when a signal is warranted by a traffic study.
- 6.10.7 Street layouts shall be designed to avoid the use multi-way stop signs in new developments to the maximum extent practicable.
- 6.10.8 Developer shall install traffic control devices as warranted by an engineering analysis or traffic study. The traffic study shall be performed by the developer and is subject to the approval of the City Engineer.

6.11 SIDEWALKS

- 6.11.1 Sidewalks meeting Americans with Disabilities Act (ADA) and Texas Accessibility Standards (TAS) parameters are required on each side of all public streets. The developer shall be responsible for the installation of all sidewalks in a new development in residential or other areas as required. This shall include but not be limited to along parks, drainage channels,

public utility easements, pipeline easements and detention ponds. Sidewalk width and location shall be in accordance with the City's Standard Construction Details. The developer is responsible for obtaining any and all agreements with the public utilities for the installation of sidewalks across applicable easements.

- 6.11.2 Sidewalk wheelchair ramps shall be required at all intersections and 90 degree bends in the street and shall adhere to ADA design criteria.
- 6.11.3 Sidewalk construction in an esplanade shall be at the esplanade noses only and shall conform to the following parameters: A transverse concrete sidewalk, 6 inches thick, shall be constructed in all esplanades as a pedestrian refuge area. All concrete sidewalks in esplanades shall be 6-10 feet wide as measured from the esplanade nose. Patterned concrete or brick stamp may be used. Any ramps associated with sidewalks in an esplanade shall conform to ADA design criteria.
- 6.11.4 Sidewalk Construction shall be in accordance with the City's Standard Construction Details.
- 6.11.5 Specialty sidewalks such as brick sidewalks or other non-standard sidewalk material must receive special approval from the City Engineer.

6.12 DRIVEWAYS

- 6.12.1 It is desirable to minimize the number of driveways on all thoroughfares and collect 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 and other constraints. When compliance with these criteria is precluded due to the location of driveways on adjoining properties, attempts should be made to obtain alternative access where feasible, including joint access driveways, access easements to adjoining properties or access to intersecting streets.
- 6.12.2 A traffic impact study may be required as a part of the approval process for driveways and other roadway access in accordance with Chapter 7 of this manual. A traffic impact analysis (TIA), when required, shall be prepared by an individual, group, firm or corporation having demonstrated professional emphasis and experience in transportation planning, engineering and in the preparation of similar analyses. The TIA document shall bear the seal and signature of a Texas Registered Professional Engineer.

6.12.3 Definitions

- A. **Collector Streets** - Street routes that have short travel distances and collect traffic from intra-city streets and funnel it into major thoroughfares or other collector streets.
- B. **Development** - means the new construction of any building, structure or improvement, or the enlargement of any exterior dimension of any building, structure or improvement.
- C. **Commercial Driveway Approach** - The portion of a driveway within the public right-of-way that provides access to property on which an office, retail or commercial center is located, to a building having more than five dwelling units or to any driveway approach which accesses property that is primarily used for a non-residential purpose.
- D. **Driveway** - Entrance to and exit from premises where it is possible to park completely off the street, and which is not open for vehicular traffic except by permission of the owner of such private property.
- E. **Driveway Approach** - A way or place including paving and curb returns between the street travel lanes and private property that provides vehicular access between the roadway and said private property.
- F. **Driveway Approach Width** - As the term is used here, the width of a driveway approach refers to the width of driveway pavement at the point where the property line intersects the driveway pavement.
- G. **Lot** - means an undivided tract or parcel of land having frontage on a public or private street, or other approved facility contained within a block and designated on a subdivision plat by numerical or letter identification.
- H. **Intersection** - The area embraced within the prolongation or connection of the lateral curb lines, or, if none, then the lateral boundary lines of two or more roadways, including public street, private street, commercial driveway, residential driveway, driveway approach, alley or combination thereof which join one another at, or approximately at, right angles, or the area within which vehicles traveling upon different roadways joining at any other angle may come into conflict.
- I. **Major Thoroughfare** - Street routes that are identified as major thoroughfares as set forth in the Major Thoroughfare Plan adopted by City Council and as may from time to time be amended.
- J. **Multi-family Dwelling** - means a structure containing more than two separate units for single-family occupancy.

- K. ***Non-Residential Driveway Approach*** - A driveway which provides access to property on which an office, retail or commercial or industrial center is located, or a building having more than five dwelling units is located or any driveway approach which accesses property that is primarily used for a non-residential purpose.
- L. ***Residential Driveway*** - means a driveway intended to provide access from a public or private street to a single adjacent detached residential unit.
- M. ***Right-of-Way*** - Property that is publicly owned or upon which a governmental entity has an express or implied property interest (e.g. fee title, easement, etc.) held for a public purpose. Examples of such public purpose include by way of example and not limitation, a highway, a street, sidewalks, drainage facilities, sewerage and water facilities.
- N. ***Street, Private*** - means a private thoroughfare, not dedicated to public use, which provides vehicular access from a public street to more than two residential dwelling units, or two or more commercial or industrial buildings or parking areas.
- O. ***Street, Public*** - means any public thoroughfare or right-of-way, dedicated for public use, which provides vehicular access to adjacent land

6.12.4 Design Requirement

- A. Large speed differentials among motor vehicles traveling the same or connecting roadways creates unsafe driving conditions. Minimizing speed differentials through the proper design of driveway approaches promotes driver and pedestrian safety. It is the City's policy to require a driveway design that creates no more than a 20 mph maximum speed differential on roadways. The goal of the City policy is to create a balance between optimal access and safety.

Generally, as the widths of streets and vehicular speeds increase, the number of driveway approaches should decrease. Driveway approaches accessing major thoroughfares should be situated in a manner that minimizes the number of potential conflict points. A single piece of property served by multiple driveways may increase speed differentials and is generally considered undesirable. For commercial development shared commercial driveways shall be a requirement. Regulated access, removing turning vehicles from the traffic stream and channelization of traffic should be determined on a site-specific basis, taking into consideration the policies and requirements of the City and other

regulating entities, and following generally-accepted traffic engineering principles.

City policy is to require turn bays and acceleration/deceleration lanes on major thoroughfares or to utilize equally effective traffic-controlling methods that will minimize speed differential and increase overall safety.

A sight distance analysis is required for all driveways located within a horizontal or vertical curve of the frontage roadway

- B. Driveways shall not be located within the functional areas of intersections.
- C. Driveway grades shall be minimized. Desirable driveway slope may vary between 2% to 8%.
- D. At a signalized intersection in which a public street terminates at the intersection of a connecting cross street, a driveway shall not be placed on the cross street as to be in alignment with the terminating street. If the requirements for driveways otherwise allow the placement of a driveway at that location, the driveway width shall match the cross-section of the intersecting public street.
- E. Driveway approaches shall be built with a circular curb radius connecting the raised curb of the roadway to the driveway approach in accordance with the City of Pearland Standard Construction Details. In order that the definition of the location of the edge of pavement for the roadway may be maintained, driveway approach radii shall always be designed to become tangent to the street curb line. Driveway curb returns shall terminate within the boundaries of the lot served by the driveway. Driveway widths shall be measured between the edges of pavement or the face of curbs, as applicable, at the property/ROW line. Driveway approaches within the public right-of-way shall be constructed of the same materials as the adjacent street surface.
- F. Driveways shall not be permitted in the transition area of any right-turn lane, acceleration or deceleration lane.
- G. Driveways that intersect at a mid-block median shall have the driveway centerline intersect with the midpoint of a median opening (measured nose-to-nose).
- H. All nonconforming driveways on a lot, tract, parcel or site shall be allowed to continue until the occurrence of one or more of the following events:

- a. A change in use, or an increase in intensity of use (as defined in the City Uniform Development Code), occurs such that the site requires a ten percent (10%) increase in required parking spaces.
- b. Any modification that changes the design or function of the existing driveway.
- c. The addition of a median opening on the public street by a developer. All driveways that are served by the new median opening shall comply with the requirements of these standards.

Upon the occurrence of the events described, the nonconforming status of the driveway shall cease and the driveway either reconstructed in accordance with this ordinance, or eliminated.

- I. Driveways shall not be grandfathered. Access driveways may be permitted subject to the City Engineer approval. Permanent driveways shall only be constructed in conjunction with the issuance of building permit for the site.

6.12.5 Single Family Residential Driveway Requirements

- A. No direct access to a thoroughfare or collector from a residential driveway approach is allowed.
- B. No lot may have more than two (2) driveways accessing the adjacent street or streets. Side lot access is not allowed within the first one hundred twenty feet (120') of a street serving as the entrance to a subdivision.
- C. Driveways shall be located a minimum of twenty-five feet (25') away from the intersection of streets, measured from the curb return of the street to the curb return of the portion of the driveway closest to the street.
- D. Circular driveways are allowed on residential lots with a street frontage of seventy-five feet (75') or greater on residential streets, and one hundred feet (100') on local roads. A maximum of two driveways are allowed on the street on which the seventy-five foot street frontage is located, provided that the driveways meet all other requirements of this chapter.
- E. Residential driveways shall have a minimum curb radius of ten (10') feet. The driveway curb returns shall terminate within the boundaries of the lot served by the driveway.

- F. Residential driveway approaches shall have a minimum width of twelve (12') feet and a maximum width of twenty (20') feet.
- G. Driveway approaches within the public right-of-way shall be constructed of the same materials as the adjacent street surface.

6.12.6 Multi-Family Residential Requirements

- A. Multi-family residential developments shall meet the same driveway standards as non-residential developments.

6.12.7 Non-Residential Driveway Requirements

- A. Non-residential driveways shall be shared among different property owners or users when necessary to maintain minimum spacing requirements. Cross access drives shall include full drive width and access pavement and be built at the same time as the first development.
- B. Interconnectivity of multiple properties shall be maintained in the frontage of the lot adjacent to the road.
- C. Non-residential driveways shall match existing openings in medians, whenever possible. No cut through of the left turn reservoir of a median shall be permitted.
- D. Along roadways with a continuous, two-way, left turn lane, driveways shall not be located to require vehicles entering the driveway to cross a delineated left turn bay or storage within the limits of the delineated left turn bay.
- E. Non-residential driveways shall be twenty-five feet (25') to thirty-five feet (35') wide. On roadways classified as a major collector or greater, non-residential driveways shall be thirty-five feet (35') wide unless specifically approved by the office of the City Engineer.
- F. Non-residential minimum driveway radii accessing a secondary thoroughfare or greater shall have a radii of 35 feet. Radii for non-residential driveways on other roadways shall be minimum 25 feet.
- G. Non-residential driveways shall be placed no closer (the minimum separation) than the following distances from adjacent streets and driveways, unless specifically approved by the City Engineer.

Roadway Classification (As indicated on Thoroughfare Plan)	Minimum Separation
Major Thoroughfares	350'
Secondary Thoroughfares	250'
Major Collectors	200'
Minor Collectors	165'
Local Streets	100'
Residential Streets	75'

The driveway separation distance is measured from the projected curb line of the intersecting street or drive to the nearest projected curb line of the proposed driveway.

- H. In order to implement the driveway separation, shared access on all non-residential driveways shall be required between adjacent properties.
- I. On collector streets and above, without medians, non-residential driveways shall maintain alignment with opposing driveways or meet minimum separation stated in this section, unless specifically approved by the office of the City Engineer.
- J. The spacing and location requirements for driveways shall be applied to both existing driveways and those shown on approved development plans and plats. Driveway locations and requirements shall be considered at the earliest possible stage of development of a tract.
- K. Non-residential driveway connections to the public street shall be approved and inspected by the City of Pearland.

6.12.8 Single access driveway radii shall not extend beyond the projection of a property corner to the back of curb.

6.12.9 Driveways shall be installed in accordance with the City of Pearland standards.

6.12.10 Driveways shall be evaluated with respect to signage, landscaping and structures for adequate sight distances.

6.12.11 Driveways connecting to the Texas Department of Transportation (TxDOT) roadways will require City approval and a TxDOT permit. The TxDOT permit application shall be completed by the landowner and

submitted to the City Engineer for approval and forwarding to TxDOT. The permit will be sent to the applicant by TxDOT upon completion.

6.13 TRAILS

The City of Pearland Multi-modal Master Plan defines the existing and future City trails network. The Multi-Modal plan is a living document and a design guideline for the trail system. This section is utilized to provide construction and expectations to comply to all future trails presented in the Multi-modal Master Plan. Contact engineering department prior to designing the trails system.

- 6.13.1 Trails are a specific feature that must accommodate multiple non-motorized use (pedestrian and bicycle).
- 6.13.2 Trail construction must comply with all applicable Municipal, State and Federal regulations to include TAS and ADA.
- 6.13.3 Trails not meeting the Design Standards will not count towards Parkland Dedication requirements.
- 6.13.4 Trails in utility corridors require the written consent of the corresponding utility company, and the approval of the City Engineer at the time of subdivision application.
- 6.13.5 Removable barrier(s) will be provided to prevent unauthorized vehicular access on to trail.
- 6.13.6 Bollards or operable guard rails are acceptable as removable barriers. Bollards are to be set at 4 foot on center, on the width of the pedestrian right-of-way.
- 6.13.7 Provide Trail Rule signage, pedestrian caution signage, and no motorized vehicle warning signage where trail intersects with public roadways. Provide signage submittal with color rendering for the City Engineer approval.
- 6.13.8 Trails along street rights-of-way shall be a minimum of 10 feet wide and constructed of concrete, or pervious concrete/materials (if approved by the office of the City Engineer). The City may elect to contribute to the cost of the trail if a width wider than 10 feet is deemed appropriate for that specific location.
- 6.13.9 Concrete curb on roadway to be standard 6-inch concrete curb and gutter along street frontage that abuts trail right-of-way.

- 6.13.10 Trails in the street rights-of-way shall include landscaping (trees and shrubs) on each side of the trail for the remaining area of parkway, from the back of the curb to the right-of-way line. The landscape plans shall be submitted to the City Planning Department for approval.
- 6.13.11 Trails within parkland shall be constructed of concrete, except as indicated below:
- A. Proposals for alternative surface trails in parkland and areas not designated as “Natural Open Space” may be submitted through the Alternative Design Process and require the approval of the office of City Engineer prior to subdivision approval.
- 6.13.12 Trail amenities (benches, signage, etc.) shall be in conformance with City of Pearland Parks and Trail Multi-model Master Plan requirements.
- 6.13.13 Concrete trail shall be minimum 10 feet wide with minimum 6 inches thick, reinforced with #4 rebars on 12” spacing, continuous each way, on 8 inches of sub-grade to be scarified and compacted to minimum 95% density per ASTM D – 1557. Concrete shall have minimum 3,500 psi strength as specified in standard specification. Surface shall be rough broom finish. Cross-slope shall not exceed 1%, sloped into park. Expansion joint must be provided along back of concrete curb and be provided with 0.5 inch expansion joint material. Control joints shall be 0.25 inch wide. The depth of the control joint shall be 25% of the thickness of the slab. Control joints to be placed every 10 feet on center. Expansion Cold joint every twenty feet with 0.5 inch thick expansion joint material. Running slope of trail may not exceed five percent (5%) in any direction.
- 6.13.14 Trails in natural open space areas shall remain undisturbed except for trail corridors, as approved by the City Engineer. Use of concrete and/or asphalt is prohibited in natural open space areas. In the event that natural open space is disturbed outside of the designated trail corridor, the City Engineer must be immediately notified and an inspection will be conducted to determine the appropriate remedy. The design, surface and treatment of trails in natural open space areas require the approval of the City Engineer prior to subdivision approval. In natural open space areas, additional signage advising users to stay within the designated trail corridor is required.
- 6.13.15 Trail surfaces in non-right-of-way areas can be concrete or asphalt with concrete header curbs, meeting following requirements:
- A. Concrete trail shall be minimum 10 feet wide with minimum 6 inches thick reinforced with #4 rebar on 12” spacing, continuous each way, on 8 inches of sub-grade to be scarified and compacted to minimum 95%

density per ASTM D – 1557. Concrete shall have minimum 3,500 psi strength as specified in standard specification. Surface shall be rough broom finish. Cross-slope shall not exceed 1%, sloped into park. Expansion joint must be provided along back of concrete curb and be provided with 0.5 inch expansion joint material. Control joints shall be 0.25 inch wide. The depth of the control joint shall be 25% of the thickness of the slab. Control joints to be placed every 10 feet on center. Expansion Cold joint every twenty feet with 0.5 inch thick expansion joint material. Running slope of trail may not exceed five percent (5%) in any direction.

- B. Asphalt trail shall be 10 feet wide plus (2) 6 inch concrete header curbs, for an overall width of 11 feet. Asphalt pavement shall be a minimum of 1.5 inches thick, Type “D” HMA, City of Pearland standards, seal coated (2 coats), compacted to 98% minimum density as per ASTM D-1557. Pavement structure shall be placed over a minimum 4.5 inches of 2 sacks per cubic yard cement stabilized base course material compacted at 100% density as per ASTM D-1557 and minimum 8 inches scarified sub-grade compacted at 95% minimum density as per ASTM D-1557. Header curbs shall be 3,000 psi concrete strength with 2 continuous #4 rebars. Provide ½ inch expansion joints every 20 feet and control joints every 5 feet. Provide a broom finish.
- C. Alternative trail surface proposals require the approval of the City Engineer prior to subdivision approval. Trail must be stabilized with 2 sacks of cement per cubic yard, and shall comply with all applicable TAS and ADA standards. Alternative Surfaces may include earthen; organic or inorganic material, such as mulch, chat, gravel, or hardscape; permeable pavement or other environmentally friendly material.

CITY OF PEARLAND

**CHAPTER 7
TRAFFIC DESIGN CRITERIA**

**ENGINEERING DESIGN CRITERIA MANUAL
October 2020**

CHAPTER 7 TRAFFIC DESIGN CRITERIA

7.1 TRAFFIC IMPACT ANALYSIS (TIA)

7.1.1 Purpose

The City requires a TIA be performed if it is determined that a proposed site development is expected to have an impact on operation of a City street or State road within the City limits. Such studies are necessary to define the possible magnitude of impact(s) of the proposed development on traffic operation of affected streets. The City may require any and all public improvements, or a proportionate share, as recommended by the TIA be implemented to provide accommodation of the traffic generated by the proposed development. These guidelines detail the procedures to be utilized when conducting a TIA for a proposed site development. These guidelines have been developed to ensure that the TIA will include the necessary information in a format that allows the Engineering Department to review and make informed comments and decisions in a timely manner.

Before any work is performed on the TIA, it is required that the applicant and engineer conduct an in-person meeting with the Engineering Department to determine the scope of requirements for the TIA. Items to be determined to include, but not limited to, study area and intersections, applicable standards and methodologies, ultimate analysis year, growth rate methodologies, nearby proposed developments to be accounted for, etc. Final determination of all TIA parameters is subject to the discretion of the Engineering Department. TIA's submitted without a scoping meeting may incur significant delays due to substantial comments, and require additional analysis.

7.1.2 Determining the Need for a Traffic Impact Analysis

A Traffic Impact Analysis is conducted to enable the City to identify the potential impacts of a proposed development and determine any roadway improvements necessary to provide an acceptable level of service. The TIA should be conducted during the initial stages of the site development review and approval process in order to adequately consider the impacts the development will have on the City's transportation network.

A TIA is required as a part of the approval process for zoning changes; building permits applications, subdivision platting or changes of occupancy.

A TIA is required at the earliest stage of development process to provide technical basis for driveway placement and other traffic improvements.

A TIA, when required, shall be prepared by an individual, group, firm or corporation having demonstrated professional emphasis and experience in

transportation planning, engineering and in the preparation of similar analyses. The TIA document shall bear the seal and signature of a Texas Registered Professional Engineer.

The submitted TIA must be approved by the Engineering Department. Approval is valid for a period of twenty-four (24) months from the date of acceptance, provided significant changes in the development proposal or surrounding conditions have not occurred. Renewal of the TIA may be required by the Engineering Department, and is at the sole discretion of the Engineering Department.

The goal of the traffic impact analysis is to ensure the level of service (LOS) resulting from the new development conforms to the following requirements:

Table 7.1

Existing LOS	Minimum LOS
A-C*	1 LOS less than Current
D*-F	Maintain Current LOS

In line with best management practices, the City aims to maintain a minimum LOS of C. Projects that drop an existing LOS of C should coordinate with the City to determine opportunities to maintain the current LOS. Please reference the section 7.1.4 Funding Sources for additional information.

Not all developments will have a significant enough impact to require a TIA. The use of engineering judgment is necessary in making this determination and consideration should be given not only to changes in projected traffic volumes but also safety and capacity deficiencies which could impact the highway system. At a minimum, a TIA shall be performed when any of the following conditions are satisfied:

- A. The proposed development is expected to generate 750 or more vehicle trips per day (total inbound and outbound development traffic.)
- B. The proposed development is expected to generate 100 or more vehicle trips during a peak hour of the adjacent roadway.
- C. Redevelopment, rezoning, additions or changes of occupancy that are expected to increase trip generation or directional flows by 20% or greater over existing conditions.
- D. Zoning or rezoning requests.
- E. Amendment to City Thoroughfare Plan.
- F. When required by the Engineering Department.

The following table lists development sizes for typical uses that are assumed to meet the minimum threshold levels requiring a traffic impact analysis. A traffic impact study can be required at the discretion of the City Engineer, even if the threshold levels are not met, if based on his professional judgment the development may have an adverse impact on traffic safety due to the design, location or use of the proposed development.

Table 7.2

Land Use	ITE Code	Per Unit	AM Peak	PM Peak	Daily
Apartments, High Rise	222	Dwelling Units	0.34	0.39	4.45
Apartments, Low Rise	221	Dwelling Units	0.32	0.41	5.44
Automobile Care Center	942	1000 SQ FT	2.83	3.51	
Automobile Parts Sales	943	1000 SQ FT	2.75	2.62	16.28
Automobile Sales	841	1000 SQ FT	4.21	4.92	27.06
Bank with ATM and Drive Through	912	1000 SQ FT	14.67	20.06	100.03
Business Park	770	1000 SQ FT	1.4	1.26	12.44
Car Wash, Automated	948	1000 SQ FT		11.66	
Car Wash, Self Service	947	Wash Stalls	8	8	108
Church (Sunday Value)	560	1000 SQ FT	9.99	NA	27.63
Convenience Store	851	1000 SQ FT	68.83	53.51	762.28
Convenience Store w/Gas Pumps	853	1000 SQ FT	42.19	49.59	624.2
Day Care Center	565	Enrolled Child	0.79	0.81	4.09
Discount Store	815	1000 SQ FT	5.43	5.33	53.12
Drinking Place	925	1000 SQ FT	NA	15.53	NA
Hospital	610	1000 SQ FT	0.85	0.97	10.72
Hotel	310	Rooms	0.54	0.61	8.36
Industrial Park	130	1000 SQ FT	0.41	0.4	3.37
Industrial, Light	110	1000 SQ FT	0.92	0.83	4.96
Manufacturing	140	1000 SQ FT	0.81	0.79	3.93
Motel	320	Rooms	0.43	0.44	3.35
Office Building, General	710	1000 SQ FT	1.47	1.42	9.74
Office Building, Medical-Dental	720	1000 SQ FT	3.53	4.1	34.8
Office Building, Single Tenant	715	1000 SQ FT	1.78	1.71	11.25
Office Park	750	1000 SQ FT	1.49	1.33	11.07
Pharmacy w/ Drive-through	881	1000 SQ FT	9.13	11.32	109.16
Quick Oil Change Shop	941	Service Bays	4	4.6	40
Recreational Community Center	495	1000 SQ FT	1.73	2.3	28.82
Residential, Multi-use PUD	270	Dwelling Units	0.58	0.72	7.38
Residential, Single Family	210	Dwelling Units	0.76	1	9.44
Restaurant, Fast Food	934	1000 SQ FT	50.97	51.36	470.95
Restaurant, High Turnover	932	1000 SQ FT	14.04	17.41	112.18
School, Elementary	520	1000 SQ FT	6.8	3.16	19.52
Service Station, w/Convenience Market	945	Fueling Positions	13.66	15.87	205.36
Shopping Center	820	1000 SQ FT	3	4.21	37.75
Supermarket	850	1000 SQ FT	6.67	7.6	106.78
Variety Store	814	1000 SQ FT	4.52	7.42	63.47
Warehouse, General	150	1000 SQ FT	0.22	0.24	1.74
Warehouse, Mini	151	1000 SQ FT	0.2	0.2	1.51

Values provided from 10th Edition ITE Manual - refer to ITE Manual for additional trip rates

In order to assist City in determining whether a TIA should be performed, the applicant must fill out a Trip Generation Worksheet available online on the City' Website. This worksheet must be submitted with each plat and/or permit for developments that either do not have an approved TIA, or have a TIA that has not been approved within the last 120 days. The purpose of this request is to evaluate the need for either a TIA or to determine if significant

changes have occurred from the previously approved TIA. This worksheet must be filled out using the latest edition of the Institute of Transportation Engineers Trip Generation Manual. If the development land use is not known at the time of the submittal then the applicant should make assumption based on the worst-case scenario for the site. Should this be the case, at a minimum, designer should evaluate the type of land use allowed by the city's zoning ordinance criteria, the maximum amount of developable land taking into account setbacks and other restrictions such as detention, easement, etc., logical assumptions by the designer, and adjacent land uses. If the proposed land use is not listed in the Trip Generation Manual, the City shall require a letter from a Texas registered professional engineer, in lieu of the trip generation worksheet, documenting the type of development proposed and identify the number of trips generated based on either a trip generation study performed for a similar land use or designer's professional opinion if such report is not available. This letter report must be signed and sealed by a registered professional engineer in the State of Texas.

- 7.1.3 A Traffic Impact Analysis report shall include, at a minimum, the following information:
- A. An executive summary that clearly states all required infrastructure improvements.
 - B. Study purpose, objectives, and assumptions.
 - C. Description of the proposed development and study area,
 - D. Existing conditions in the area of the development,
 - E. Recorded or approved nearby development
 - F. Trip generation and trip distribution, including all count locations, times and duration.
 - G. Projected future traffic volumes,
 - H. An assessment of the change in roadway operating conditions resulting from the development traffic,
 - I. A feasibility study of placing a roundabout in lieu of a traditional traffic signal is required.
 - J. If a new signal is warranted, the existing traffic corridor must be examined for changes that need to be made in conjunction with the new signal.

- K. Recommendations for site access and transportation improvements needed to maintain traffic flow to, from, within, and past the site at an acceptable and safe level of service.
- L. Exhibits to show all existing, proposed and future facilities on the site, all proposed traffic movements, and all existing, generated, future background and proposed traffic volumes within the existing and proposed street network
- M. Appendices to include detailed site plan, existing 24-hour directional counts, existing AM & PM peak hour turning movement counts, all Synchro (or similar software) report, traffic signal warrant analysis, and digital containing Synchro (or similar software) files, count data, and any other pertinent information.
- N. List of development close to the site to be considered.
- O. Consideration of phased development and transportation improvements.
- P. Identification of high accident areas for Project Category II per City Engineer discretion and Project Category III located in Table 7.3.
- Q. If modification is required of an existing traffic signal, the timing and phasing must be examined. In addition, the implementation of any recommendations called for in the TIA report shall be required.

Prior to preparation of a Traffic Impact Analysis report, the design engineer is to meet with the Engineering Department to identify the study area, define the area of influence, and non-site traffic impacts.

Three levels of study have been identified based on the number of trips that a development is projected to generate in a 24-hour period (ADT) and during peak hour. The following table is offered as a general guideline of typical requirements. The Engineering Department may have further requirements based on site-specific conditions

Table 7.3 - Levels of Traffic Impact Study

Project Category	Criteria	Study Horizon	Study Area
I	Projected site-generated ADT of 750 OR Projected site-generated peak hour trips of 100 per hour AND No significant modification of traffic signals or roadway geometry proposed	Year of completion, assuming full build- out and occupancy	All site access points, adjacent roadways, and major intersections. All signalized intersections on each street serving the site within 1/4 mile
II	Projected site-generated ADT of 1000-2000 OR Projected site-generated peak hour trips of 100-250 per hour OR Installation or modification of traffic signals or roadway geometry proposed, regardless of project size	Year of completion, assuming full build- out and occupancy AND Five years after completion	All site access points, adjacent roadways, and major intersections. All signalized and major un-signalized intersections along each street serving the site
III	Projected site-generated ADT > 2000 OR Projected site-generated peak hour trips > 250 per hour and Installation or modification of no more than one traffic signal, addition of one axillary lane in each direction, regardless of project size	Year of completion, assuming full build- out and occupancy AND Five years after completion	All site access points, adjacent roadways, and major intersections. All signalized and major un-signalized intersections within 1 mile on each street serving the site.
IV	Installation or modification of two or more traffic signals, addition of travel lanes, or modification of interchange proposed, regardless of project size	Year of completion, assuming full build- out and occupancy AND Five years after completion	All site access points, adjacent roadways, and major intersections. All signalized and major un-signalized intersections on each street within 1 mile radius

The TIA should incorporate all transportation and land development information that is current and available. The ITE Traffic Engineering Studies Handbook should be reviewed to determine if any additional information on background data is needed

7.1.4 Funding Resources

The TIA may take into account the city/state/county approved traffic improvements with dedicated funding that are scheduled for completion prior to build out of the proposed site. Phased projects with more than one build out year must analyze the project and determine that they meet all LOS requirements for each phase regardless of whether a City project is scheduled to be completed. The City Engineer will determine what approved traffic improvements may be considered. The developer, prior to the issuance of the occupancy permit, shall complete any required traffic

improvements, which have not been funded or otherwise completed by the government agencies.

When it can be demonstrated to the satisfaction of the City that a development will only partially contribute to the need for additional off-site improvements, the city may approve the use of pro-rated contribution according to the percentage of traffic added by the development. It may be necessary to conduct a contribution study separate from the TIA, as the TIA is only intended to determine the minimum required infrastructure improvements to support the development. The contribution study may be included as an addendum to the TIA. Developments approved for pro-rata participation will need to enter into an agreement with the City that will outline the funding participation, the cost share mechanisms, and the adjusted timeline for completion of offsite improvements and the development.

The City will verify that all traffic improvements to be provided by the developer or property owner have been completed before a Certificate of Occupancy shall be issued.

7.1.5 Submission and Review Procedures

A preliminary trip generation worksheet (TIA Worksheet) of the proposed development shall be conducted to determine if a traffic study would be required. The trip generation worksheet should be submitted at the earliest stage possible. In general, the worksheet is required during the platting process for properties with known developments, or during the permitting process for projects not requiring a plat. If a study is required, the applicant will apply for a Traffic Impact Analysis permit through the City's Community Development electronic application process (eTRACKiT). Information for the application process is available on the Engineering Website under the *Traffic Impact Analysis (TIA) Application Process* document. All TIAs will be submitted through this process.

All TIAs require a scoping meeting. TIAs submitted prior to a scoping meeting may be rejected at the discretion of the City Engineer. The purpose of the scoping meeting is to fully define all of the parameters of the TIA including but not limited to:

- Study radius
- Count locations
- Historical growth factors
- Seasonal count adjustment
- Build-out year
- Future analysis year
- Turn warrants
- Signal warrants

The City Engineer shall review the traffic impact analysis in conjunction with the other elements of the development application. If the draft study is not of the proper scope or is executed improperly, the applicant shall be notified of the deficiencies and be required to submit corrections on the same schedule that applies to the other elements of the development application. Failure to submit corrections in a timely fashion may lead to a postponement of the application

The submission shall include all, but not limited to, the following data: 1) separate traffic count, 2) all Synchro traffic modeling data and 3) all relevant data files. These files are to be submitted with the final approved TIA.

Any traffic study will need to be revised if the proposed land use is changed by type or size. In addition, any traffic study may need to be revised if the study is older than two years and the City Engineer determines that the existing conditions have changed such that it would invalidate the study results or if the initial study assumes an incorrect build out period

7.1.6 Traffic Impact Studies Report Requirements

A. It is recommended that along with the requirements provided in these guidelines, the most recent version of the following resources should be referenced during the development of a traffic impact study.

1. Highway Capacity Manual
2. Manual of Uniform Traffic Control Devices
3. Trip Generation, ITE
4. Trip Generation Handbook, ITE
5. Trip Generation User's Guide, ITE
6. Traffic Engineering Handbook, ITE
7. Manual of Transportation Engineering Studies, ITE
8. SYNCHRO Traffic Modeling Software

B. This section defines the elements that are required in a TIA. A thorough report shall address each of the items below.

1. Introduction

- a. Include a description of the site location and study area, including a location map identifying key intersections and other approved projects in the vicinity.
- b. Development Description shall include type of land use and the following information where applicable:
 - i. If residential, number and type of dwelling units
 - ii. If commercial or industrial, square footage and type of development

- iii. Detailed site plan
 - iv. Development phasing and timing
- c. Selection of analysis period shall be based on the proposed land use and the typical peak hours. Many nearby land uses may influence peak times of a particular intersection. For example an intersection near a hospital may peak during a mid-afternoon shift change rather than the typical pm peak hour. Schools, churches, hospitals or shopping centers may impact peak periods due to their individual peaking characteristics. Care should be given to understand the surrounding land uses before deciding upon the peak hours. An investigation of the daily counts prior to collecting the peak-hour counts would allow a determination of a typical range of peak hour traffic movements on a roadway facility.

2. Existing Conditions

- a. A thorough review of available data and existing conditions at the site shall include at a minimum the following items:
 - i. A site visit by the engineer of record.
 - ii. Study area land use
 - a. Existing land use
 - b. Existing zoning
 - iii. Site access will be shown on the plan and reviewed for sufficiency of operation and impacts to the surrounding roadway system.
 - iv. Posted speed on all existing roads that may be significantly impacted by the development.
 - v. Distances from existing streets, driveways, and/or median cuts to development access.
 - vi. Alignment with existing streets, driveways, and/or median cuts to development access.
 - vii. Intersection layout, lane usage and roadway configuration.
 - viii. Traffic control devices such as traffic signals or stop signs.
 - ix. Traffic signal timing and phasing – Offset times should be shown if any coordination with adjacent signals is being used.
 - x. Right of way width(s) all existing roads that may be significantly impacted by the development.
 - xi. Lane width(s) for all lanes
 - xii. Daily and peak-hour traffic counts should be collected for use in the traffic impact study. At a minimum a 24-hour count should be taken on a typical Tuesday, Wednesday or Thursday for all

roadways in the study area. However, the type of development or local conditions may require counts be taken on weekends. Peak-hour intersection turning movement counts (15 min. increment) at key intersections should also be taken. As with the daily counts, peak-hour counts may vary. Traffic counts used in a study should be less than one year old. The City reserves the right to request more counts if they are deemed necessary based on specific conditions. The existing counts should be presented in a diagram form for each intersection counted.

- xiii. Pedestrian facilities and volumes (If appropriate)
- xiv. Level of service of roadway sections and intersections - The latest edition of the Highway Capacity Manual (HCM) or approved traffic analysis software (SYNCHRO) may be used. Prior approval of alternate software may be requested from the City Engineer during the preliminary study meeting.
- xv. Photographs may be used to document existing conditions of the site.

3. Projected Traffic

- a. The calculation of the project traffic shall be shown in sufficient detail so that all calculations can be verified. In addition, descriptions of the following items shall be included in the report.
- b. Site Traffic (Daily, a.m. and p.m. peak)
 - i. Trip Generation - List of trip generation rates and sources of rates used for the study. The latest edition of the Trip Generation Manual from ITE shall be used. Calculation of trip ends assuming 100% occupancy and development
 - ii. Trip Distribution and Assignment - The gravity model or other acceptable trip distribution model can be used to estimate site trip distribution. Trip Distribution and Assignment can be accomplished either manually or with applicable computer models. A figure showing the trip distribution is required.
- c. Background Traffic (Daily, a.m. and p.m. peak) - This shall account for all approved developments in the study area as well as area growth beyond study area. Typically this is determined through analysis of historical trends in the region. This should be discussed at the preliminary study meeting. If necessary, this peak-hour data shall also be

shown in a figure similar to that for the existing traffic.

- d. Reassignment rates for pass-by and diverted trips - A procedure for calculating pass-by trips is described in Chapter 5 of the ITE Trip Generation Handbook based on different land use classifications. The table below shows values to be used for the most typical land use. Reduction for any other land use types must be thoroughly documented and approved by the City Engineer. Internal capture can be accounted for using the procedures described in Chapter 7 of the ITE Traffic Engineering Handbook. Typical trip rate reductions for pass by trips are provided in better detail in section 7.1.7.
- e. Total Traffic shall be shown combining project and background traffic and shown in figure form for each intersection.
- f. Future Traffic (if required) shall also be calculated and shown in similar figure format.

4. Traffic Analysis

The following information should be included in the report describing the detailed analysis performed for this study.

- a. Projected Capacity and Level of Service (Background traffic and total traffic) for the study horizon
 - i. Signalized intersection analysis.
 - ii. A capacity analysis using projected traffic volumes must be conducted using the latest edition of the Highway Capacity Manual (HCM).
 - iii. Traffic analysis software may be used. The latest edition of Highway Capacity Software shall be used or prior approval of alternate software may be requested from the City Engineer.
 - iv. Un-signalized intersections and traffic signal warrant analysis, if applicable. A capacity analysis using projected traffic volumes must be conducted using the latest edition of the Highway Capacity Manual (HCM). If signalization is warranted by the traffic signal warrants outlined in the Manual on Uniform Traffic Control Devices (MUTCD), conduct a complete warrant analysis and analyze the intersection(s) as signalized intersection(s).
 - v. Roadway network - Impacts to LOS on key mainline roadway links should be determined.

- vi. Turning vehicle storage space needed or the adequacy of storage space for turning vehicles at study intersections should also be analyzed. This analysis should consider signal phasing and overall signal cycle length, as well as vehicle volumes. Analysis of queuing may be required.
- b. A table for each of the following information will be provided. The AM and PM peak-hour data will both be shown unless determined otherwise by the City Engineer.
 - i. Existing LOS and delay.
 - ii. Background LOS and delay without development.
 - iii. Future LOS and delay with development.
- c. Site circulation and parking requirements - Driveways should be designed considering the amount and type of traffic that will be using both the driveway and the adjacent street. Adequate access for service vehicles should be reviewed by determining the size and operating characteristics of service vehicles, particularly the turning radii. In addition, driveway throat lengths should also be considered.
- d. Determine impacts to nearby neighborhoods and evaluate the potential need for any traffic calming.
- e. Accident analysis may be required at intersections that currently have a high number of accidents.
- f. Additional facilities
 - i. Sidewalks
 - ii. Transit stop(s)
 - iii. School bus stops

5. Conclusions and Recommendations

The final section of the report should summarize the overall impact of the development and include the following information:

- a. Site access/circulation plan
- b. Intersection improvements addressing, at a minimum, the following:
 - i. Traffic control device(s) - modify existing or need for new

- ii. Additional lanes needed (left, right or thru)
 - iii. Acceleration and/or deceleration lanes
 - iv. Length of storage bays
 - v. A detailed drawing of any intersection improvements shall be included in the report.
 - vi. Implementation schedule
- c. Off-site improvements
- i. Modification to existing traffic control device(s)
 - ii. Additional traffic control device(s), additional lane at major intersections, and additional roads
 - iii. Other improvements if applicable

VI. Appendix

The following appendices should be included in a bound report submitted to the public works department:

- a. Raw traffic count data
- b. Printouts of analysis results
- c. Photographs of site
- d. Additional tables or figures not included in report
- e. Professional staff qualifications and experience
- f. Electronic Disc of report and data

7.1.7 Technical Notes

Trip Generation: Average trip generation rates or regression equations for the peak hour of the adjacent street will be obtained from the current edition of the Institute of Transportation Engineer's Trip Generation Manual. Other local data may be acceptable provided it was collected using recommended methodology and can be properly document.

Peak Hour: Generally, the petitioner shall use the peak one hour period which occurs during either 7-9 A.M. or 4-6 P.M. periods or both, as agreed to by the City Engineer and petitioner. In some cases, however, the City Engineer may require additional hours, for example, Friday nights or Saturday afternoon, to also be analyzed.

Directional Split: The directional split of the entering and exiting traffic associated with the development will be derived from the ITE Trip Generation manual unless other acceptable locally generated data is available.

Pass-by Trips: The percent of pass-by trips shall be applied to the trips generated by the proposed development and assigned to the adjacent street network. This rate does not affect the proposed project's driveway volumes

but rather reassigns existing trips to movements entering and existing the proposed development. The following pass-by trip rates have been determined for some land uses:

Land Use	Acceptable Trip Reduction
Retail > 400,000 GLA	20 %
Retail 100,000-400,000 GLA	25 %
Retail <100,000 GLA	35 %
Quality / Sit-down Restaurants	15 %
Fast-food Restaurants	35 %
Convenience/Gas Stations	40 %
Banks	15 %
Supermarket	20 %
Discount Club/Warehouse Store	20 %

Diverted Linked Trips: A reassignment for diverted trips will generally occur outside the impacted study area; therefore, for the purpose of these traffic impact studies, diverted trips would be considered “new trips” within the study area and can be ignored in most cases. This factor, if applicable, will be decided during the preliminary meeting.

Internal Circulation Trips: Reductions for internal circulation trips are applicable for projects such as shopping centers with out-lots and represents a reduction in projected driveway trips. The internal circulation trip rate will be agreed upon during the preliminary meeting and shall not exceed 10 percent.

Trip Distribution: The directional distribution of the generated trips entering and exiting the proposed development via all access points must be justified by the relative locations of other traffic generators (e.g., employment centers, transportation terminals, etc.) and/or trip table information. These factors, or other factors agreed upon by the Department of Public Works, shall be applied to the traffic generated by the proposed development as well as the traffic generated by nearby approved projects.

Trip Assignment: The distribution factors shall be applied to the trips generated by the proposed development and nearby approved projects and assigned to the existing traffic on the road network providing access to the proposed development.

Capacity Analysis: At the identified critical intersection(s), the existing and generated traffic is to be related to the adequacy of the intersection by using the techniques described in the latest edition of the Highway Capacity Manual or utilizing SYNCHRO modeling software. The analysis should be carried out for the A.M. and/or P.M. peaks, as agreed to by the City Engineer and applicant. It is also recommended that the operational methodology be used in the analysis of signalized intersections

Traffic Data:

- A. Traffic volume data may be available from the Engineering Department for some locations within the City. If, however, acceptable data is not available, the petitioner is responsible for obtaining all required data.
- B. Traffic count data should be no older than one year or the City may require new counts be collected. If, in the opinion of the Engineering Department staff, traffic volumes have significantly increased due to some change(s) in the traffic pattern, such as the completion of a development project after the count was made new counts may also be required.
- C. If turning movement data is outdated or if there are locations for which data is non-existent, data must be acquired.
- D. Intersection traffic counts conducted by the petitioner should be comprised of a minimum of 2 hour turning movement counts covering the peak A.M. and P.M. periods in order to allow for the selection of the peak hour within the next fifteen minutes (e.g., 4:00-5:00, 4:15-5:15, etc.) The inclusion of all A.M. and P.M. peak period turning movement data is requested as part of the traffic impact analysis.
- E. Ideally the traffic analysis should be performed for the design hour which represents the 30th highest hourly traffic volume on an annual basis. However, most peak hour traffic volume counts in urban areas closely approximate the 30th highest hour. Historical counts and staff knowledge of the area will be used to judge the adequacy of counts used by the applicant.
- F. If the proposed development includes plans for the installation of a new traffic control signal, the petitioner must conduct a Traffic Signal Warrant Analysis. This analysis would produce documentation that indicates the conditions at the proposed location warrant a traffic signal by meeting the recommended minimum warrants presented in the Manual for Uniform Traffic Control Devices, (MUTCD). Documentation of this analysis should be included in the appendix of the final report and should include, but not be limited to, the methodology used, daily traffic count data used in the analysis, and the resulting capacity analysis results at this location.

Adequate Accommodation of Traffic: The ability of a highway system to carry traffic is expressed in terms of volume-to-capacity (V/C) ratios and level of service at the critical locations, usually intersections. The V/C ratios clearly define the degree of saturation at an intersection. A V/C ratio of 1.0 indicates that the intersection is operating at its theoretical capacity,

that is, the traffic volume demand equals the estimated number of vehicles that may pass through the intersection in a given period of time. A value of over 1.0 depicts a situation where the demand exceeds the intersection's capacity and operational problems exist, either in geometrics or signalization. As the V/C ratio approaches 0.9, breakdowns in the operational efficiency of the intersection tend to develop. When the V/C increases above 0.9, operational breakdowns also increase in frequency and may result in a high level of delay to motorists.

In considering mitigation measures, the change in V/C ratio and level of service must be taken into account as well as the actual V/C values of individual approaches and the overall intersection. If no mitigation exists or if the improvements required are beyond what could reasonably be expected from the applicant, then negotiations between the petitioner and the City will be conducted to determine the level of petitioner responsibility for improvements at the intersection.

Level-of-service for signalized intersections is defined by the Transportation Research Board's Highway Capacity Manual, in terms of delay. Generally, delay is considered a measure of driver discomfort, frustration, lost time and fuel consumption. Delay at signalized intersections is a result of a number of factors, including the signal's cycle length, phasing, progression in relation to other signals, traffic volumes and the intersection's lane configuration and geometrics.

Traffic Impact Study Checklist

Preliminary Meeting

- Contact the City Prior to beginning the study
- Analysis needed for AM and PM Weekday
- Analysis needed for Weekend
- Analysis needed for Mid-day Weekday or school period

Existing Conditions

- Existing zoning (source cited)
- Geometric parameters of existing roads from governing body
- Existing traffic counts
- Intersection counts (eight hours if a traffic signal warrant will be conducted)
- 24-hour volume counts (Tuesday to Thursday, or possibly weekend)

Site Traffic

- Clear and concise description for trip generation purpose (source cited)
- Vicinity map
- Site plan
- Trip generation using the latest edition of ITE Trip Generation Manual
- Trip distribution (Each step of this procedure should be clearly shown in enough detail so that all calculations can be verified)
- Account for pass-by trip and internal capture reductions.

Background Traffic

- Clear and concise description for trip generation purpose (source cited)
- Vicinity maps of background sources
- Trip generation using the latest edition of ITE Trip Generation
- Trip distribution (Each step of this procedure should be clearly shown in enough detail so that all calculations can be verified)

Traffic Analysis

- Existing level of service (LOS) analysis using latest version of HCS software or other software approved by the city.
- Background LOS analysis using latest version of HCS software or other software approved by the city.
 - Capacity analysis for un-signalized intersection using latest version of HCS software or other software approved by the city.
 - Signal warrants analysis using Manual on Uniform Traffic Control Devices
 - Capacity analysis for signalized intersection using latest version of HCS software or other software approved by the city (if existing or warranted)
 - Turning vehicle storage space (queuing) analysis
- Projected LOS analysis using latest version of HCS software or other software approved by the city.
 - Capacity analysis for un-signalized intersection using latest version of HCS software or other software approved by the city.
 - Signal warrants analysis using Manual on Uniform Traffic Control Devices
 - Capacity analysis for signalized intersection using latest version of HCS software or other software approved by the city. (if existing or warranted)
 - Turning vehicle storage space (queuing) analysis
- Site circulation/parking analysis
- Safety / site distance analysis
- Discussion of additional facilities (sidewalks, bus stops, etc.)

Conclusions and Recommendations

- Recommended site modifications (include drawings)
- Recommended intersection improvements (include drawings, timing methods, etc.)
- Recommended off-site improvements (include drawings)

Documentation

- Electronic version of raw traffic count data
- Electronic version of Synchro traffic modeling output files and other traffic software data used for analysis
- ITE Trip Generation summary
- Capacity analysis printouts and data file
- MUTCD Traffic Signal Warrant worksheets

Report

- Signed and stamped by registered Professional Engineer in the State of Texas

NOTE: This checklist is provided for convenience only and represents only a partial list of the requirements for any given study.

CITY OF PEARLAND

CHAPTER 8
STORMWATER MANAGEMENT

ENGINEERING DESIGN CRITERIA MANUAL

October 2020

CHAPTER 8

STORMWATER MANAGEMENT

8.1 GENERAL

The City of Pearland is a Small Municipal Separate Storm Sewer System (MS4) operator since 2008 under TPDES Phase II MS4 General Permit. Based on census data of 2010, the City is a level III MS4 operator. This chapter provides design guidelines to improve the Stormwater Quality through the implementation of certain Best Management Practices (BMPs). Use of BMPs presented here does not guarantee acceptance of a Storm Water Pollution Prevention Plan (SW3P) or the effectiveness of the BMP to reduce pollutant but establishes generally acceptable guideline. The SW3P and BMPs shall be prepared and designed in accordance with TCEQ and other regulatory guidelines. The specification section prepared by the City for TPDES Requirements should be referred for detailed Best Management Practices for Erosion and Sediment Controls, Stormwater Management Plans, Waste collection and disposal, off-site vehicle tracking, and other practices.

8.2 DEFINITIONS

- 8.2.1 Best Management Practices (BMPs): Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs shall include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.
- 8.2.2 Catch basins: Storm drain inlet and curb inlet to the City's storm drain system. Catch basins may include a grate or curb inlet that may accumulate sediment, debris, and other pollutants.
- 8.2.3 City: The City of Pearland, Texas
- 8.2.4 City Engineer: The City Engineer/Director of Engineering or his/her designee
- 8.2.5 Commercial: Pertaining to any business, trade, industry, or similar activity
- 8.2.6 Construction Activity: Soil disturbances, including, but not limited to clearing, grading, and excavating; and other construction related activities (e.g., stockpiling of fill material, demolition, and reconstruction); but not including routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the site (e.g. the routine grading of existing dirt roads, asphalt overlays of existing roads, the routine clearing of existing right-of-ways, and similar maintenance activities). Regulated

construction activity shall be defined in terms of small and large construction activities:

- (a) **Small Construction Activity:** Construction activity that results in land disturbance equal to or greater than one (1) acre and less than five (5) acres of land. Small construction activity shall also include the disturbance of less than one (1) acre of total land area that is part of a larger common plan of development or sale if the larger common plan ultimately disturbs an area equal to or greater than one (1) and less than five (5) acres of land.
- (b) **Large Construction Activity:** Construction activity that results in land disturbance of equal to or greater than five (5) acres of land. Large construction activity shall also include the disturbance of less than five (5) acres of total land area that is part of a larger common plan of development or sale if the area common plan ultimately disturbs an area equal or greater than five acres of land.

8.2.7 **Control Measure:** Any BMP or other method used to prevent or reduce the discharge of pollutants into the MS4.

8.2.8 **Conveyance:** Curbs, gutters, man-made channels and ditches, drains, pipes, and other constructed features designed or used for flood control or to otherwise transport stormwater runoff.

8.2.9 **Discharge:** Any addition or introduction of any pollutant, storm water, or any other substance whatsoever into the MS4 or into waters of the United States.

8.2.10 **Domestic Sewage:** Human excrement, gray water, and other wastewater discharged from the sanitary conveniences of a Facility that is free from industrial waste.

8.2.11 **Facility:** Any residential or commercial building, structure, installation, process, or activity from which there is or may be a discharge of a pollutant.

8.2.12 **Final Stabilization:** The status achieved when all soil disturbing activities at a site have been completed, and a uniform perennial vegetative cover with a density of 70 percent of the cover for unpaved areas and areas not covered by permanent structures has been established, or equivalent permanent stabilization measures (such as the use of concrete slope paving, articulated concrete block) have been employed.

8.2.13 **Garbage:** Animal and vegetable waste materials from the handling, preparation, cooking, or consumption of food, including waste materials from markets, storage facilities, and the handling and sale of produce and other food products.

- 8.2.14 Gray Water: Liquid from home clothes washing, bathing, showers, dishwashing, or food preparation.
- 8.2.15 Hazardous Substance: Any substance identified or listed in Code of Federal Regulations (CFR) Table 302.4 of 40 CFR Part 302.
- 8.2.16 Hazardous Waste: Any substance identified or listed as a hazardous waste by the EPA pursuant to 40 CFR Part 261.
- 8.2.17 Illicit Connection - Any man-made conveyance connecting an Illicit Discharge directly to an MS4.
- 8.2.18 Illicit Discharge - Any discharge into an MS4 not entirely composed of storm water, except discharges pursuant to an authorized permit and discharges resulting from emergency firefighting activities.
- 8.2.19 Industrial Waste: Any liquid or solid substance that results from any process of industry, manufacturing, mining, production, trade, or business.
- 8.2.20 Land Disturbance Activity: Any activity which changes the volume or discharge rate of storm water runoff from the land surface. Land Disturbance Activity includes grading, digging, cutting, scrapping, or excavating of soil, placement of fill materials, paving, construction, substantial removal of vegetation, or any activity which bares soil or rock or involves the diversion or piping of any natural or man-made watercourse.
- 8.2.21 Maintenance Agreement: A formal contract between a local government and a property owner to guarantee long-term maintenance of storm water management practices.
- 8.2.22 Maximum Extent Practicable (MEP): The technology-based discharge standard, for MS4s designed to reduce pollutants in storm water discharges that was established by the Clean Water Act § 402(p).
- 8.2.23 Municipal Landfill (or Landfill): An area of land or an excavation in which municipal solid waste is placed for permanent disposal, but which is not a land treatment facility, a surface impoundment, an injection well, or a pile as such terms are defined in regulations promulgated by the Texas Water Commission.
- 8.2.24 Municipal Separate Storm Sewer System (MS4): The system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned and operated by the City and designed or used for collecting or conveying storm water, but which is not used for collecting or conveying sewage.
- a. Phase I - An MS4 permitted by the EPA after November 16, 1990.

b. Phase II - An MS4 permitted by the EPA after December 8, 1999.

- 8.2.25 NPDES Permit: A permit issued by EPA (or by the State of Texas, most notably by but not limited to the TCEQ that authorizes the discharge of pollutants to waters of the United States, whether the permit is applicable on an individual, group, or general area-wide basis.
- 8.2.26 Notice of Intent (NOI): The Notice of Intent required by either the Industrial General Permit or the Construction General Permit issued by the TCEQ.
- 8.2.27 Notice of Change (NOC) - A written notification from the permittee to the executive director providing changes to information that was previously provided to the agency in a notice of intent.
- 8.2.28 Notice of Termination (NOT): A written submission from a permittee authorized under the Construction General Permit requesting termination of coverage.
- 8.2.29 Person: Any individual, partnership, co-partnership, firm, company, corporation, association, joint stock company, trust, estate, governmental entity, or any other legal entity; or their legal representatives, agents, or assigns. This definition includes all federal, state, and local governmental entities.
- 8.2.30 Premise: Any building, lot, parcel of land, or portion of land whether improved or unimproved including adjacent sidewalks and parking strips.
- 8.2.31 Pollutant: Solid waste; incinerator residue; sewage; garbage; sewage sludge; munitions; chemical waste; biological materials; radioactive materials; heat; wrecked or discarded equipment; rock; sand; cellar dirt; or industrial, municipal, and agricultural waste discharged into water. The term “pollutant” shall not include tail water or runoff water from irrigation or rainwater runoff from cultivated or uncultivated range land, pasture land, and farm land.
- 8.2.32: Pollution: The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.
- 8.2.33 Release: Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the MS4 or the waters of the United States.
- 8.2.34 Rubbish: Non-decaying solid waste, excluding ashes, that consist of (A) combustible waste materials, including paper, rags, cartons, wood, excelsior, furniture, rubber, plastics, yard trimmings, leaves, and similar materials; and

(B) noncombustible waste materials, including glass, crockery, tin cans, aluminum cans, metal furniture, and similar materials that do not burn at ordinary incinerator temperatures (1600 to 1800 degrees Fahrenheit).

- 8.2.35 Sanitary Sewer (or Sewer): The system of pipes, conduits, and other conveyances which carry industrial waste and domestic sewage from Facilities, residential dwellings, commercial buildings, industrial and manufacturing facilities, and institutions, whether treated or untreated, to the City sewage treatment plant (and to which storm water, surface water, and groundwater are not intentionally admitted).
- 8.2.36 Sewage (or Sanitary Sewage): The domestic sewage and/or industrial waste that is discharged into the City sanitary sewer system and passes through the sanitary sewer system to a City sewage treatment plant for treatment.
- 8.2.37 Site: The land or water area where any Facility or activity is physically located or conducted, including adjacent land used in connection with the Facility or activity.
- 8.2.38 Solid Waste: Any and all garbage trash refuse and other discarded materials held or accumulated in containers including without limitation animal and waste materials resulting from the preparation processing or consumption of food combustible waste materials such as paper rags cartons boxes plastics noncombustible materials such as glass crockery and metal cans. Solid waste shall not include Hazardous.
- 8.2.39 State: The State of Texas.
- 8.2.40 Stormwater: Stormwater runoff, snow melt runoff, and surface runoff drainage.
- 8.2.41 Storm Water Pollution Prevention Plan: Plan required by either the Construction General Permit or the Industrial General Permit and which describes and ensures the implementation of practices that are to be used to reduce the pollutants in storm water discharge associated with construction or industrial activity.
- 8.2.42 Texas Pollutant Discharge Elimination System (TPDES) Storm Water Discharge Permit: A permit issued by the TCEQ, under the authority of Texas Water Code Sections 26.027 or 26.040 authorizing the discharge of pollutants into or adjacent water in the State.
- 8.2.43 Oil: Any kind of oil in any form, including, but not limited to, petroleum, fuel oil, crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure, sludge, oil refuse, and oil mixed with waste.

- 8.2.44 Used Oil (or Used Motor Oil): Any oil that has been refined from crude oil or synthetic oil that, as a result of use, storage, or handling, has become unsuitable for its original purpose because of impurities or the loss of original properties but that may be suitable for further use and is recyclable under State and Federal law.
- 8.2.45 Water Quality Standard: The designation of a body or segment of surface water in the State for desirable uses and the narrative and numerical criteria deemed by the State to be necessary to protect those uses, as described in Chapter 307 of Title 30 of the Texas Administrative Code.
- 8.2.46 Waters of the United States: All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; all interstate waters, including interstate wetlands; all other waters the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce; all impoundments of waters otherwise defined as waters of the United States under this definition; all tributaries of waters identified in this definition; all wetlands adjacent to waters identified in this definition; and any waters within the federal definition of “waters of the United States” in 40 CFR § 122.2; but not including any waste treatment systems, treatment ponds, or lagoons designed to meet the requirements of the Federal Clean Water Act.
- 8.2.47 Wetland: An area that inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

8.3 ALLOWABLE STORMWATER DISCHARGES

Allowable non-storm water discharges listed in TPDES General Permit No. TXR040000: the following non-storm water sources may be discharged from the Phase II MS4 and are not required to be addressed in the Phase II MS4's Illicit Discharge and Detection or other minimum control measures (MCMs), unless it is determined by the permittee or the TCEQ to be significant contributors of pollutants to the Phase II MS4, or such discharges are otherwise prohibited by the MS4 operator:

1. Water line flushing (excluding discharges of hyper-chlorinated water, unless the water is first dechlorinated, and discharges not expected to adversely affect aquatic life);
2. Runoff or return flow from landscape irrigation, lawn irrigation, and other irrigation utilizing potable water, groundwater, or surface water sources;
3. Discharges from potable water sources not in violation of Texas Surface Water Quality Standards, Title 30, Texas Admin. Code. Ch. 307;

4. Diverted stream flows, which the City does not maintain, but are maintained by the Brazoria County Drainage District No. 4;
5. Rising ground waters and springs;
6. Uncontaminated ground water infiltration;
7. Uncontaminated pumped ground water;
8. Foundation and footing drains;
9. Air conditioning condensation;
10. Water from crawl space pumps;
11. Individual residential vehicle washing;
12. Flows from wetlands and riparian habitats;
13. Dechlorinated swimming pool discharges not in violation of Texas Surface Water Quality Standards Title 30, Texas Admin. Code. Ch. 307;
14. Street wash water, excluding street sweeper waste water;
15. Discharges or flows from emergency firefighting activities (firefighting activities shall not include washing of trucks, run-off water from training activities, test water from fire suppression systems, and similar activities);
16. Allowable non-storm water discharges identified in 40 CFR § 122.26 (d) (2) (iv)(B)(1);
17. Non-storm water discharges that are identified and listed in the TPDES Multi Sector General Permit (MSGP) TXR050000 or the TPDES Construction General Permit (CGP) TXR150000;
18. Discharges authorized by a TPDES or NPDES permit and discharges not required to be permitted; and
19. Other similar occasional incidental non-storm water discharges such as spray park water.

8.4 STORMWATER POLLUTION PREVENTION PLAN (SW3P) REQUIREMENTS

The U.S. Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) requires that a Storm Water Pollution Prevention Plan (SW3P) be prepared for construction activities. Construction plans shall show proposed SW3P measures to control soil erosion and sediment pollution in storm water discharges during construction. A notice of Intent (NOI) for Stormwater Discharge Associated with Construction Activity under TPDES General Permit (TXR150000) shall be completed and submitted to TCEQ. Copies of NOI, "Primary and Secondary Operator" Notice shall be posted at the Project Site or at a prominent place for public to viewing. The Contractor's office must keep and maintain the updated SW3P. It shall be unlawful for a person/contractor to conduct any land disturbing activity in the absence of a City issued permit authorizing such work. Such permits include, without limitation, site work permit, building permits, grading permits, and major construction improvement permits.

Large Construction Activity: The operator of a development shall maintain an NPDES or TPDES permit to discharge stormwater associated with construction

activity. The following information shall be provided to the City Engineer prior to obtaining a construction permit from the City for that activity:

- a. Copy of the Notice of Intent (NOI) submitted to the EPA or TCEQ;
- b. Copy of a site plan detailing the location of erosion control measures; and
- c. Copy of the construction site stormwater pollution prevention plan (SW3P) developed in compliance with applicable NPDES or TPDES permit requirements.

For Small Construction Activity: The operator of a development shall comply with an NPDES or TPDES permit to discharge stormwater associated with construction activity. The following information shall be provided to the City Engineer prior to obtaining a construction permit from the City for that activity:

- a. A copy of the small construction site notice posted at the construction site in accordance with applicable NPDES or TPDES permit requirements;
- b. A copy of a site plan detailing the location of erosion control measures; and
- c. A copy of the construction site stormwater pollution prevention plan (SW3P) developed in compliance with applicable NPDES or TPDES permit requirements.

For construction activity disturbing less than one acre: The operator of a development shall implement and maintain a copy of the City approved erosion control plan at the site.

The TCEQ requires that regular weekly inspections and inspections after each storm be made of the storm water pollution measures. A record of all inspections shall be kept. The SW3P shall be maintained throughout the entire length (time) of the project. Should the pollution protections not be working, the Contractor shall make adjustments in the measures to correct the problems.

Proposed SW3P shall contain minimum the following items:

- (i) The proposed location of Refuse Area
- (ii) The proposed location of Construction Exit with standard details
- (iii) The proposed location of Concrete Washout Area
- (iv) The proposed location of Portable Toilets
- (v) The proposed location of various BMPs
- (vi) The size of affected area in acreage
- (vii) The location of all outfalls for stormwater discharge
- (viii) Locations where temporary or permanent stabilization practices are expected to be used
- (ix) locations of construction support activities, including off-site activities, that are authorized under the permittee's NOI, including material, waste, borrow, fill, or equipment or chemical storage areas.

8.5 BEST MANAGEMENT PRACTICES

The SWP3 shall be prepared in accordance with TCEQ guidelines and should include the implementation and maintenance of structural and non-structural best management practices to reduce pollutants in storm water runoff from residential, commercial, industrial, and Capital Improvement construction sites. The SW3P standard details are available for download on the City's engineering webpage. It shall be responsibility of the design engineer to ensure the appropriate use of the standard detail as means of BMP. Listed below are recommended best management practices that may include but are not limited to:

Non-Structural Practices

- (i) Temporary seeding
- (ii) Permanent planting, sodding, or seeding
- (iii) Soil Retention Blanket/Erosion Control Blanket
- (iv) Buffer Zone
- (v) Preservation of Natural Resources

Structural Practices

- (i) Reinforced Silt Fence/ silt fence
- (ii) Hay Bales
- (iii) Rock Filter Dams
- (iv) Pipe Slope Drains
- (v) Paved Flumes
- (vi) Channel Liners
- (vii) Sediment Basins/ Detention Basin
- (viii) Rock bedding at Construction exit
- (ix) Curb and Gutters
- (x) Velocity control devices
- (xi) Erosion Control logs
- (xii) Concrete Washout Area

All protective measures identified in the SW3P must be maintained in effective operating condition. If, through inspections or other means, the construction site operator determines that BMPs are not operating effectively, then the construction site operator shall perform maintenance as necessary to maintain the continued effectiveness of storm water controls, and prior to the next rain event if feasible. Erosion and sediment controls that have been intentionally disabled, run-over, removed, or otherwise rendered ineffective must be replaced or corrected immediately upon discovery. If periodic inspections or other information indicates a control has been used incorrectly, is performing inadequately, or is damaged, then the operator must replace or modify the control as soon as practicable after making the discovery. If sediment escapes the site, accumulations must be removed at a frequency that minimizes off-site impacts, and prior to the next rain

event, if feasible. If the construction site operator does not own or operate the off-site conveyance, then the permittee must work with the owner or operator of the property to remove the sediment.

- a. Rock Filter Dam Maintenance - The rock filter dam shall be inspected every two weeks or after each 1/2" rain event and shall be replaced when the structure ceases to function as intended due to silt accumulation among the rocks, washout, construction traffic damage, etc. When silt reaches a depth equal to one-third of the height of the berm or one foot, whichever is less; the silt shall be removed and disposed of properly. When the site is completely stabilized, the berm and accumulated silt shall be removed and disposed of in an approved manner.
- b. Stabilized Construction Exit Maintenance - When sediment has substantially clogged the void area between the rocks, the aggregate mat must be washed down or replaced. Periodic re-grading and top dressing with additional stone must be done to keep the efficiency of the entrance from diminishing. See City specification for Stabilized Construction Exit for details.
- c. Curb Inlet Protection Maintenance - Inspection shall be made by the contractor and silt accumulation must be removed when depth reaches 2". Contractor shall monitor the performance of inlet protection during each rainfall event and immediately remove the inlet protections if the stormwater begins to overtop the curb. Inlet protection shall be removed as soon as the site has reached final stabilized.
- d. Silt Fence Maintenance - Inspection shall be made after each 1/2" rainfall, daily during period of prolonged rainfall, and at a minimum once each week. Repair or replacement shall be made promptly as needed. Silt fence shall be removed when the site is completely stabilized so as not to block or impede storm flow or drainage. Accumulated sediment shall be removed when it reaches a depth of one-third the height of the fence or 6 inches, whichever is less. The silt shall be disposed of at an approved site and in such a manner as to not contribute to additional siltation.
- e. Erosion Control Blanket Maintenance - Erosion control blankets should be inspected regularly for bare spots caused by weather or other events. Missing or loosened blankets must be replaced or re-anchored. Check for excess sediment deposited from runoff. Remove sediment and/or replace blanket as necessary. In addition, determine the source of excess sediment and implement appropriate measures to control the erosion. Also check for rill erosion developing under the blankets. If found, repair the eroded area. Determine the source of water causing the erosion and add controls to prevent its reoccurrence.

- f. Dewatering Controls Maintenance - Dewatering controls should be inspected regularly. Dewatering discharge points should be checked for erosion. Eroded areas should be repaired, and erosion controls should be installed to prevent future erosion. Dewatering pumps and sediment controls should be monitored, at least hourly, while pumps are in operation to prevent unauthorized discharge and to catch erosion problems or control failure. Conventional sediment controls should be inspected at least weekly when used for continuous dewatering, because they will become overcome with sediment more quickly than when used to control runoff from storm events. The controls shall be maintained according to the criteria in their respective sections.

They should be replaced when they no longer provide the necessary level of sediment removal. Sediment filter bags should be checked to determine if they need replacing. The bags cannot be cleaned or reused. They should be used until they reach the manufacturer's recommended capacity. The entire bag with sediment can be disposed of as solid waste. If a controlled location onsite or a spoil site is available, the bag can be cut open and the sediment spread on the ground. Only the bag is waste in this case.

- g. Concrete Washout Maintenance - Concrete waste management controls should be inspected regularly for proper handling of concrete waste. Check concrete washout pits and make repairs as needed. Washout pits should not be allowed to overflow. Maintain a schedule to regularly remove concrete waste and prevent over-filling. If illicit dumping of concrete is found, remove the waste and reinforce proper disposal methods through education of employees.

Per TCEQ requirements, erosion control and stabilization measures must be initiated as soon as practicable in portions of the site where construction activities have temporarily ceased. Stabilization measures that provide a protective cover must be initiated as soon as practicable in portions of the site where construction activities have permanently ceased. Except as provided in (A) through (C) below, these measures must be initiated no more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased:

- A. Where the initiation of stabilization measures by the 14th day after construction activity temporarily or permanently ceased is precluded by snow cover or frozen ground conditions, stabilization measures must be initiated as soon as practicable.
- B. Where construction activity on a portion of the site has temporarily ceased, and earth disturbing activities will be resumed within 21 days, temporary erosion control and stabilization measures are not required on that portion of site.
- C. In areas where temporary stabilization measures are infeasible, the operator may alternatively utilize temporary perimeter controls. The operator must

document in the SW3P the reason why stabilization measures are not feasible and must demonstrate that the perimeter controls will retain sediment on site to the extent practicable.

8.6 POST CONSTRUCTION STORMWATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT

Post-construction storm water management in new development and redevelopment should include minimum control measures to control post-construction runoff. The minimum control measures below are acceptable, and others may be considered on the case-by-case basis.

Minimum Control Measures:

- a) *Alternative Turnarounds* - Dead end streets in residential subdivisions are usually required to have an acceptable option for vehicles to turnaround, with the circular cul-de-sac being the most common. The amount of impervious cover can be reduced from the standard impervious cul-de-sac. It is acceptable to place a landscaped island in the center of the cul-de-sac turnaround as long as it maintains an acceptable turning radius. Alternative turnarounds can be applied in the design of residential, commercial, and mixed-use development. They may be combined with alternative pavers, bio-retention areas, and other techniques in an effort to reduce the runoff from the site.
- b) *Grassed Swales* - A grass swale is a stable turf, parabolic or trapezoidal channel used for water quality or to convey stormwater runoff, which does not rely on the permeability of the soil as a pollutant removal mechanism. Grass swales are used to reduce particulate pollutants due to settling and filtration. Particulate pollutant removal occurs when the low velocities and shallow depths allow particulate settling and the grass blades act to filter runoff from the water quality design storm. Grass swales are best suited to transport and treat stormwater runoff generated from impervious surfaces with small drainage areas. Grass swales can be used wherever soil conditions and slopes permit the establishment and maintenance of a dense stand of vegetative cover. Typically, swales have a minimum bottom width of 2 feet to 10 feet and have a recommended side slope of 4:1.
- c) *Catch Basin Insert* - Catch basins, also known as storm drain inlets and curb inlets, are inlets to the storm drain system. Inserts can be designed to improve water quality by removing oil and grease, trash, debris, and sediment. Some inserts are designed to drop directly into existing catch basins, while others may require retrofit construction.
- d) *Wet Ponds* - Wet ponds (a.k.a. stormwater ponds, wet retention ponds, wet extended detention ponds) are constructed basins that have a permanent pool of water throughout the year (or at least throughout the wet season). Ponds treat incoming stormwater runoff by allowing particles to settle and algae to take up

nutrients. The primary removal mechanism is settling as stormwater runoff resides in this pool, and pollutant uptake, particularly of nutrients, also occurs through biological activity in the pond. Wet ponds are generally on-line, end-of-pipe BMPs. The primary pollutant removal mechanism in a wet pond is sedimentation. Significant loads of suspended pollutants, such as metals, nutrients, sediments, and organics, can be removed by sedimentation. Wet ponds can be used at residential, commercial and industrial sites. Wet ponds may be single-purpose facilities, providing only runoff treatment, or they may be incorporated into an extended storage or a detention pond design to provide flow control.

e) Dry Ponds – Dry pond or stormwater detention pond temporarily stores stormwater runoff, thereby reducing peak rate of runoff to the adjacent drainage system. Although primary function of dry pond is to prevent localized flooding, it also provides some water quality benefits and reduces downstream erosion.

8.7 MAINTENANCE OF STORMWATER FACILITY (ORDINANCE NO. 1059)

The City of Pearland Maintenance of Stormwater Storage Facility Ordinance requires the property owner for continuous maintenance of all existing and new detention/retention facilities. Maintenance of Stormwater Storage Facility Ordinance No. 1059 (current version) shall be referred for the details of responsibilities, noncompliance and penalty for violation of the ordinance.

8.8 STORMWATER AND ILLICIT DISCHARGE (ORDINANCE NO. 1570)

The City of Pearland Illicit Discharge Ordinance No. 1570 (current version) shall be referred for the details of the design, construction and maintenance requirements as well as the legal consequences for violation including penalties. Some of the specific details includes;

1. Specific prohibitions and requirements,
2. Compliance Monitoring,
3. Stormwater Discharge Associated with Construction Activities,
4. Post Construction Stormwater Runoff.

CITY OF PEARLAND

**CHAPTER 9
TRAFFIC SIGNAL REQUIREMENTS**

**ENGINEERING DESIGN CRITERIA MANUAL
October 2020**

CHAPTER 9 TRAFFIC SIGNAL REQUIREMENTS

9.1 GENERAL

- 9.1.1 These standards describe the general requirements for the design and construction or the modification of a Traffic Signal for within the City of Pearland. Traffic roundabouts are required to be installed in lieu of a traffic signal whenever feasible. Design for roundabouts must meet current industry standards and individually approved by the city. A traffic signal warrant analysis and report recommending the signal and the intersection requirements shall be submitted. The report shall be signed and sealed by a Registered Engineer registered in the State of Texas and in good standing.
- 9.1.2 The City of Pearland Engineering Department shall approve all required traffic signals within the Pearland City limits or extraterritorial jurisdiction. Improvements within Texas Department of Transportation (TxDOT) Right of Way must obtain all permits and any necessary approval from TxDOT prior to city approval.
- 9.1.3 All traffic signal work shall utilize the latest design guideline details required by the State of Texas. Traffic signal design shall incorporate energy saving measures and modular design for expansion to the maximum extent practical.
- 9.1.4 This guideline serves as a reference standard, and does not supersede any design standards set forth by the Texas Manual on Uniform Traffic Control Devices (MUTCD), Texas Accessibility Standards (TAS) of the Architectural Barriers Act, or any other federal, state, or local law or regulation. The intent is to provide a standard reference to promote the highest quality and latest engineering practices available.
- 9.1.5 Traffic signals shall be prepared by an individual, group, firm or corporation having demonstrated professional emphasis and experience in transportation planning, engineering and in the preparation of similar analyses. The construction documents shall bear the seal and signature of a Texas Registered Professional Engineer.
- 9.1.6 A paper and an electronic copy of the project as-built, in PDF and dxf or dwg format, and shapefile (applicable with street alignment changes) are required prior to project acceptance into the one-year maintenance period for all traffic signals constructed within the city limits and extra-territorial jurisdiction of City of Pearland.

9.2 TRAFFIC SIGNAL SYSTEM DESIGN GUIDELINES

- 9.2.1 Prior to beginning design, the engineer shall contact City of Pearland to determine special design criteria, which may include pole types, interconnection with existing signals, detection, etc.
- 9.2.2 The City of Pearland is standardizing the layout of the signal intersections. All intersections for new traffic signals or reconstruction of signals shall be equipped with a separate pedestal and mast for each direction of traffic.
- 9.2.3 All new traffic signals shall be decorative mast arm signals, follow City of Pearland equipment standards and interconnected with the City of Pearland Traffic Management Center. All traffic signals that are subject to modification or reconstruction to the degree that the modification or reconstruction is greater than 50% of the value of the traffic signal poles and equipment shall be reconstructed as mast arm signals and signal interconnection.
- 9.2.4 All vehicle and pedestrian signal heads shall be Light Emitting Diode (Led).
- 9.2.5 Pedestrian Signals shall be countdown type.
- 9.2.6 Battery backup shall be provided for all signals in the bottom of the signal cabinets.
- 9.2.7 All traffic signal drawings shall be designed in accordance with the latest City of Pearland design standards and specifications, Texas Department of Transportation's (TxDOT) latest specifications and standard drawings, including the Houston district standards.
- 9.2.8 All drawings shall be designed in accordance with the latest Texas Manual on Uniform Traffic Control Devices and acceptable engineering practices to ensure a safe and efficient operation. All traffic signal drawings shall be designed to meet the latest state-of-the-art operational and functional features for traffic signal systems required by the City of Pearland. Refer to the design check list attached to the end of this chapter for minimum requirements.
- 9.2.9 Any drawing that cannot provide all the required information or reaches the capacity of one sheet is subject to additional sheets. Every drawing shall best represent the condition of the existing and/or proposed work. The drawings shall follow all construction design phases. All drawings shall conform to the next phase of construction and provide a consistent design.
- 9.2.10 All design criteria shall be determined by the Department of Engineering.

- 9.2.11 Connectivity survey is required to be performed by design engineer to determine How to install fiber to connect the signal to the traffic system.
- 9.2.12 For City funded projects, typical project milestone design reviews are for 30%, 60%, 90% and 100% of the signal system design. The following is a list of review requirements that should be included at each milestone stage.
- A. The red-lined drawings and a written response of review comments from the latest review should always be included with the next submittal. City of Pearland reserves the right to alter the list in a manner that will best benefit the project.
- B. The in-progress (30%) design stage review shall consist of a field meeting at the project site(s) with the consultant and the City of Pearland Project Manager or appointed designee. The review requirements are a working drawing showing, as a minimum, the following:
- i. Right-of-way.
 - ii. Base line/Center line.
 - iii. All above ground and underground utilities. Underground utilities shall be located as accurately as possible.
 - iv. Existing roadway geometric layout.
 - v. If making geometric improvements, show proposed geometric improvements and signal design based on those improvements.
 - vi. Existing sidewalks and/or driveways.
 - vii. Proposed wheelchair ramps, pads, and sidewalks, if required.
 - viii. Proposed crosswalks, if required.
 - ix. Proposed service outlet location.
 - x. Proposed controller location.
 - xi. Proposed signal pole locations.
 - xii. Proposed pedestrian signal pole locations, if required.
- C. The in-progress (60%) the review requirements are a working drawing showing, as a minimum, the following:
- i. Proposed Trafficware pod locations
 - ii. Proposed PTZ Camera
 - iii. Proposed ground box locations.
 - iv. Proposed signal head locations.
 - v. All proposed overhead signing.
 - vi. Proposed advance warning signs and flashers, if required.
 - vii. Proposed conduit, including bore locations.
 - viii. Proposed stop line locations.
 - ix. For projects with road widening, construction phasing for traffic control should be included for a discussion in the field meeting.
 - x. Any construction easements or right-of-entry that may be needed.

- xi. Provide documentation to City of Pearland of posted speed and 85th percentile speed, if known.
- xii. For signal interconnect drawings, prepare pole attachment drawings in accordance with pole owner's requirements, if required.
- xiii. At this stage, the proper power company should be contacted to request a Service Outlet and Data Statement for each intersection.
- xiv. Proposed communication line routing layout to the Traffic Management Center.

D. The 90% Design stage review shall consist of one (1) full set of construction drawings and one (1) set of bid sheets including detailed bid items with quantities, and the respective City of Pearland specification designations. An electronic PDF copy of all submittals is required.

9.3 CONSTRUCTION PLAN REQUIREMENTS

9.3.1 Unless otherwise specified, all drawings are to be 11" x 17" in size. The basic set of signal system construction drawings shall include, but is not limited to the following categories:

- A. Title Sheet and/or Index of Sheets
- B. Utility notes
- C. Basis of estimate
- D. Condition Layout
- E. Paving Layout (when applicable)
- F. Pavement Marking and Signing Layout
- G. Plan Layout- Need to provide station offset for each of the pole location and indicate the length of each mast arm
- H. Legend for Plan Layout
- I. Signal Elevations (when applicable)
- J. Anchor Bolt Details (when applicable)
- K. Signal Connectivity to Traffic Management Center Sheet (when applicable)
- L. Pedestrian Walkway Details
- M. Notes for Plan Layout
- N. Standard Detail Sheets (all required and latest) Note: All detail sheets shall be signed and sealed.

9.3.2 This section defines the minimum elements that are required on the construction sheets.

- A. Title Sheet
 - i. Include intersection(s) and street name(s), Engineer, City of Pearland Logo, etc.
 - ii. Date when plans are completed
 - iii. Vicinity map/key map location

- iv. Project title including project scope and proper road names
- v. Funding for construction.
- vi. Site map with north arrow.
- vii. Signature block, including a block for private utility sign-offs.

B. Index Sheet

C. City of Pearland General & Construction Notes

D. TxDOT specification note, barricade note, etc. when applicable.

E. Private Utility Notes (Utility notes for all known utilities.)

F. Project-specific traffic signal notes.

G. Basis of Estimate or Summary of Traffic Signal Quantities Sheet

- i. This sheet includes all wires/cables, conduits, ground boxes, span wires, etc. providing quantities.
- ii. Detailed estimated quantities per location or per specific system.
- iii. Provide all detailed items with TxDOT reference item and numbers.
- iv. Bid items will be discussed under bid documents.
- v. Identify materials to be furnished by City of Pearland or others (when applicable).
- vi. Quantities are for estimate purposes only.

H. Existing Conditions Layout

- i. Show all existing signing, (including speed limits, all approaches), joints in pavement, type of pavement, condition of pavement (for loops if applicable), overhead power lines, etc.
- ii. Show scale
- iii. Existing pavement markings and signing
- iv. Existing geometrics.
- v. Existing utility locations.
- vi. Any existing signal equipment.
- vii. North arrow up or to the right.
- viii. Right-of-way and easements.

I. Paving Plan (when applicable)

- i. Provide a proposed design showing required wheelchair ramps/landings to access pedestrian push buttons. These paving improvements must comply with the current Texas Accessibility Standards (TAS) of the Architectural Barriers Act.
- ii. Provide applicable construction notes and/or paving details.

- iii. Provide various notes to contractor.
- iv. Provide ramp/landing dimensions as required.

J. Proposed Traffic Signal Layout Sheet A

- i. This base shall show all proposed paving improvements, signing and striping as existing.
- ii. Westbound left turn is signal head 1 and continues clockwise.
- iii. Northwest corner pedestrian signal for westbound is P1 and continues clockwise.
- iv. Provide separate pole for service-meter with service enclosure and photo electric-cell.
- v. Locate controller/cabinet nearest power service.
- vi. Locate controller/cabinet to not restrict sight distance for right turns on red.
- vii. LED Luminaires are required on all ornamental traffic signal poles. Ornamental lamps are required.
- viii. Trafficware pod detection system placement

K. Wiring

- i. All wiring is stranded, except for #6 solid bond bare wire
- ii. One (1) 2/C #12 for push buttons and one (1) 4/C #12 for pedestrian signals per phase
- iii. Luminaire cables, two (2) #8 XHHW, shall by-pass the controller/cabinet and go directly to the service enclosure
- iv. One (1) 7/C #12 for vehicular signals, generally one (1) 7/C #12 for two 3-section heads and one (1) 7/C #12 for a left turn signal
- v. No sign light or base light for left turn signals
- vi. Three (3) 1/C #4 with one (1) #6 bare copper wire in a 2" PVC conduit between the controller/cabinet and service enclosure
- vii. Provide one (1) #6 bare copper wire in all conduits other than #14 XHHW stranded wire cable for loops
- viii. Any other cable(s) shall conform to the manufacturers recommended design

L. Conduit

- i. All work shall conform to NEC codes
- ii. All conduits shall be PVC except where there are risers, 45 degree or more bends and exposed or above ground conduit
- iii. Typically 1" conduit for loops (between ground box and edge of pavement), 2" conduit for loop home runs (2/C #14). Size all conduits by calculating the maximum fill as per NEC code
- iv. Proposed conduits shall be bored and jacked under paved areas and shall be identified on layout(s)

- v. At each pole provide a 3" (minimum) conduit from pole foundation to ground box for future use
- vi. Provide a distance of 5 feet from ground box to any pole for future wheelchair ramps
- vii. Provide long sweep 90's for conduit for fiber optic cable

M. Signal Head Mounting

- i. Mast Arm: One (1) Astro brackets for each 4-section and larger traffic signal heads
- ii. Back plates are required on all signal heads

N. Legend and Notes

- i. Provide this note: "Contractor shall expose utilities as needed to install pole foundations.
- ii. Right-of-way and easements.
- iii. Roadway geometrics.
- iv. Utilities.
- v. Advance signal signing and/or flashers, if required.
- vi. Trafficware Pod detection design (call out size, quantity and distance from stop bar).
- vii. Poles (meter, signal and pedestrian signal) and controller/cabinet locations.
- viii. Signal head locations.
- ix. Luminaires.
- x. Conduit runs and bores.
- xi. Ground boxes.
- xii. Stop bars.
- xiii. Crosswalks.
- xiv. Wheelchair ramps.
- xv. Elevation callouts.
- xvi. Utility contact note.
- xvii. Any other signal equipment.
- xviii. North arrow up or to the right.
- xix. Scale.

O. Proposed Traffic Signal Layout Sheet B

- i. Provide signal head schedule illustrating all vehicle signal heads and signs attached to signal heads.
- ii. Provide sign schedule and dimensions showing all overhead signs.
- iii. Pole schedule and notes.
- iv. Electrical schedule and notes.
- v. Provide various notes to contractor and any additional notes or details.

- vi. Overhead street name signs shall conform to the City of Pearland sign detail (size and color).
- vii. Detection phasing

P. Signal Elevations (for mast arm systems and strain pole type design)

- i. Poles, signals and pedestrian signals numbered and details.
- ii. Show detection or any other directional devices in their proper place.
- iii. Elevation views for all approaches and proper callout.
- iv. Electrical schedule callouts and guy wire details.
- v. Show all conduits in foundations and call out what conduit runs serve.
- vi. Add note: “For Legend and Callouts See Traffic Signal Layout Sheet”.
 - a) Luminary locations.
 - b) Centerline of street.
 - c) Special notes or details.

Q. Anchor Bolt Orientation Details (for strain pole type design only)

- i. Show all items located on span wires.
- ii. Show angle between span wires and angle of resultant force for each pole.
- iii. Show anchor bolt orientation for each pole, two (2) bolts compression and two (2) bolts tension.
- iv. Provide same scale and orientation as Plan Layout.
 - a) Street names
 - b) North arrow up or to the right.
 - c) Special notes or details.

R. Signal Interconnect Sheet

- i. Show all existing/proposed intersections involved.
- ii. Design notes for connections.
- iii. Electrical chart for interconnect cable(s).
- iv. Add Note: “Refer to Intersection Layouts and Legends for Plan Layout Sheets for Additional Information Regarding Interconnect Cable”.
- v. All required details and elevation details.
- vi. Intersection locations for interconnect system.
- vii. North arrow up or to the right.
- viii. Scale
- ix. No splices will be allowed while installing and/or modifying interconnect cables. Damaged cable will be replaced from controller to controller.

S. Pavement Marking and Signing Layout

- A. This base shall show all proposed paving improvements as existing and include all existing signing and striping.
- B. Provide proposed design of all applicable pavement markings.
- C. Signal Ahead” signs are typically provided on approaches per MUTCD requirements.
- D. Show on drawings:
 - i. Right-of-way and easements.
 - ii. Roadway geometrics.
 - iii. Utilities.
 - iv. Existing Pavement Markings and Sign details (complete).
 - v. Proposed Pavement Markings and Sign details (complete, including removal of existing pavement markings and signing as needed).
 - vi. Construction signing.
 - vii. Stop bars.
 - viii. Crosswalks, if required.
 - ix. Wheelchair ramps, if required.
 - x. North arrow up or to the right.
 - xi. Legend.
 - xii. Scale.
 - xiii. Special notes.

T. Pedestrian Walkway Details

- i. Current pedestrian walkway details with the following plan layout details:
- ii. Existing intersection condition.
- iii. Proposed pole locations and identified.
- iv. Proposed pedestrian walkway design layout.

U. Notes for Plan Layout

- i. Callouts for all signals and sign types.
- ii. Callouts for all signs and all sign types.
- iii. Notes to reference specific sheet(s).
- iv. Any note pertaining to signal design shall be included.
- v. Special VIVDS specification if required.
- vi. Special equipment descriptions.
- vii. Maintenance of existing traffic signals and operation parameters.

V. Standard Detail Sheets

- i. Any details pertaining to the proposed signal design shall be included.
- ii. The details shall be the latest available from the City of Pearland and TxDOT.
- iii. Any necessary quantities, i.e. pole and foundation details, shall be filled out.
- iv. All detail sheets to be sealed.

W. Timings

- i. All signalized intersections shall be provided with initial signal timings.
- ii. New signalized intersections that will be constructed within an existing system shall obtain prior approval from the Director of Public Works in order to match cycle lengths and time of day plans, not only for the proposed signal, but corridor wide. Timing plans shall include splits and offsets.
- iii. All timing plans will be submitted to the City of Pearland for approval prior to being implemented.

9.4 APPROVED PRODUCTS

- 9.4.1 All equipment and materials utilized on traffic signals within the City of Pearland shall conform to the latest Approved Products list and shall be subject to the approval of the Department of Engineering.

9.5 SIGNAL ACTIVATION

- 9.5.1 Once the signal and intersection are constructed, approved and prior to activation and final acceptance, the traffic control change shall be notified to the public via sign boards in each direction. The notification period shall be for a seven (7) day period. The City shall approved the notification message and the location and plan for the traffic control change signage.

CITY OF PEARLAND

**CHAPTER 10
QUALITY CONTROL & CONSTRUCTION
MATERIAL TESTING REQUIREMENTS**

**ENGINEERING DESIGN CRITERIA MANUAL
October 2020**

CHAPTER 10
QUALITY CONTROL & CONSTRUCTION
MATERIAL TESTING REQUIREMENTS

10.1 GENERAL

- 10.1.1 These standards describe the general requirements for construction material testing on all public projects within the city limits and extra-territorial jurisdiction of the City of Pearland.
- 10.1.2 The City Engineer shall approve construction plans and construction material testing plans for public improvements within the Pearland city limits or extraterritorial jurisdiction.
- 10.1.3 Construction plans for private improvements, within public right-of-ways and public easements that connect to or affect the public infrastructure shall be approved by the City of Pearland subject to the requirements of this manual and are subject to review and approval using the process defined in this manual.
- 10.1.4 Public projects are defined as projects that are within public rights-of-way or public easements, projects that will be owned, operated or maintained by public agencies or projects that are funded by public agencies.
- 10.1.5 It is the responsibility of the contractor to deliver a finished product in compliance with the contract documents and applicable Federal, State and local requirements. An independent certified testing laboratory shall be utilized to verify contract document compliance.
- 10.1.6 The contractor is responsible for notification of the City and the independent testing laboratory in accordance with the City's notification requirements. In the event construction activity occurs without proper notification to the City, the work in question is subject to removal and replacement in accordance with these Standards at the discretion of the City Engineer.
- 10.1.7 The City Engineer shall develop and maintain an Approved Products List. All material and appurtenances used in construction in public right-of-ways and easements shall conform to the Approved Products List.

10.2 REFERENCES AND REQUIREMENTS

- 10.2.1 All construction material testing shall be performed by an independent testing laboratory, certified by the appropriate agency for the field of testing being conducted and supervised by a Licensed Texas Professional Engineer in good standing. All testing shall be performed in accordance with generally accepted standards, including:

1. Rules and Regulations published by the Texas Commission on Environmental Quality (TCEQ).
 2. American Society of Testing Materials (ASTM)
 3. American Concrete Institute (ACI)
 4. The Asphalt Institute
 5. Texas Department of Transportation Standard Specifications
- 10.2.2 Testing laboratories shall be hired by the project owner or project engineer and contracts shall avoid conflicts of interest.
- 10.2.3 City projects – The costs of initial tests may be borne by the City or may be a part of the construction contract. When initial tests indicate noncompliance with the contract documents, the cost of subsequent retesting and laboratory technician time shall be borne by the contractor. The costs of inspections or testing performed exclusively for the contractor's convenience or information shall be borne by the contractor.
- 10.2.4 The City shall be copied on all testing reports for public projects. Testing reports shall be completed and submitted to the City in a timely manner and signed by a licensed Texas Professional Engineer in good standing.
- 10.2.5 It is the responsibility of the contractor to provide proper and timely notification of construction activity to the City inspector to allow for scheduling of the testing laboratory.
- 10.2.6 All retests of failed densities shall be taken within five linear feet (5') of the failed test.
- 10.2.7 Moisture content on all soil density tests shall be within plus or minus two percent (2%) to achieve a passing test, unless approval is granted by the City Engineer based upon site-specific testing.
- 10.2.8 Independent testing laboratories are not authorized to revoke, modify, or release any requirement of the specifications and they may not approve or accept any portion of work on a project. When it appears that the material furnished or work performed fails to meet the contract document requirements, the testing laboratory shall promptly inform the City, in writing or by electronic mail, of such deficiencies.

10.3 PAVEMENT SUBGRADE

- 10.3.1 Pavement subgrade shall be a minimum of eight inches (8") thick and shall

be within 0.2 inches (0.2") of final lines and grade and shall vary uniformly between points. Subgrade stabilization and compaction shall extend a minimum of two feet (2') beyond the back-of-curb or edge of pavement. All subgrade shall be compacted to a minimum of 95% of the maximum dry density of the material as determined by Standard Proctor Compaction Test ASTM D-698. Moisture content on all density tests shall be within plus or minus two (3%) percent of optimum moisture to achieve a passing test.

- 10.3.2 Subgrade density tests shall be required at a maximum longitudinal spacing of every 150 linear feet, (150') staggered across both lanes of traffic, on pavement cast full width on undivided roadways. Density tests shall include the entire cross-section of the subgrade, including the area two feet (2') outside of the form boards. For pavement cast half-width, density tests are required every 300 linear feet (300') for each half of the roadway, with the tests offset from tests in the adjacent half of pavement by 150 linear feet (150'). Regardless of any other requirement, all cul-de-sacs and streets shall have a minimum of one (1) density test within the cul-de-sac.
- 10.3.3 Lime depth checks shall be required for all pavement subgrades at the same spacing and frequency requirement as density tests.
- 10.3.4 Lime determination shall be made utilizing a soil proctor from the site. Subgrade shall be stabilized to a minimum eight inches (8") thick to reduce Plasticity Index (PI) to twenty (20) as determined by lime series. If a PI of 20 or less cannot be obtained, then the lime treated soils must obtain a pH of 12.4 and compacted to ninety-five percent (95%) standard proctor density. Lime subgrade shall be mixed evenly and allowed 72 hours between mixing to cure. Remixed lime shall have 100% of the representative sample passing a 1 3/4" sieve and 85% of the sample passing a 3/4" sieve and 60% passing the No. 4 sieve.
- 10.3.5 Prior to the application of lime slurry the roadbed shall be excavated to subgrade, shaped to conform to the typical sections, lines and grades as shown on plans. The material, before lime is added, shall be scarified to the secondary grade (proposed bottom of the lime stabilized subgrade). A "proof roll" shall be performed prior to the application of lime slurry to identify any wet or unstable materials. Any wet or unstable materials below the secondary grade shall be corrected, by scarifying, adding lime and compacting until it is of uniform quality. The results of the proof roll and any correcting action shall be documented by the testing laboratory. Place base, surface, or seal course within 14 days after final mixing and compacting (unless prior approval from engineer). If more than 14 days has elapsed between final mix and cover, the lime treated subgrade will be required to mix in an additional 3% lime slurry to the subgrade and re-compact.

- 10.3.6 Lime operations shall not occur if the ambient temperature is 40 degrees Fahrenheit and falling. Lime operations may occur if the ambient temperature is 35 degrees Fahrenheit and rising.
- 10.3.7 Subgrade densities shall be retaken in the event of a ½ inch or greater rainfall or in the event the ambient air temperature falls below 32 degrees Fahrenheit for greater than three hours.
- 10.3.8 Subgrade density testing shall occur after the subgrade has been cut to final lines and grade. No subgrade/earthen material may be placed on the subgrade after passing density tests have been achieved.

10.4 CONCRETE PAVEMENT AND UTILITY CONSTRUCTION CONCRETE

- 10.4.1 All concrete mix designs shall be approved by both the independent testing laboratory and the City prior to the placement of concrete on any project.
- 10.4.2 Fly ash may be permitted as an admixture with cement in pavement or curbs. The inclusion of fly ash in pavement requires the submission of the mix design and test history of the mix design, in addition to prior written approval of the City Engineer. Type “C” or Type “F” fly ash of acceptable quality and meeting requirement of ASTM C 618 may be used as admixture in concrete mixture. When fly ash is used, store and inspect in accordance with ASTM C 618. Do not use fly ash in amounts to exceed 20% by weight of cementitious material in mix design. Note: When fly ash is used, term “cement” is defined as cement plus fly ash.
- 10.4.3 Concrete operations shall not occur if the ambient temperature is 40 degrees Fahrenheit and falling. Concrete operations may occur if the ambient temperature is 35 degrees Fahrenheit and rising. Place concrete only on rain free days.
- 10.4.4 Place concrete that is between 40 degrees Fahrenheit and 95 degrees Fahrenheit at the time of discharge. Do not exceed 90 minutes between introduction of cement to aggregates and discharge. When the weather is such that the temperature would exceed 90 degrees Fahrenheit, employ effective means as necessary to maintain concrete temperature below 95 degrees Fahrenheit.
- 10.4.5 Concrete shall be tested every 150 cubic yards or less of concrete that is placed each day. Tests shall be conducted for the following criteria:
1. Entrained air – Not to exceed five percent (5%)
 2. Slump – Between two and one-half inches (2 1/2”) and five inches (5”). Slip form paving shall be a max of 3 inches (3”)

3. Concrete Temperature – Not to exceed 95 degrees Fahrenheit (without appropriate admixtures)
 4. Cylinders – A minimum of one set of four cylinders to be tested for compressive strength. 2 cylinders tested at 7 days, 2 cylinders tested at 28 days
- 10.4.6 Finished pavement shall have core samples taken every 300 linear feet (300'), staggered across the roadway cross-section, and in every cul-de-sac. Additional core samples may be required at the discretion of the City Engineer. These core samples shall be tested to insure that the pavement thickness meets the required project thickness. Core shall be “nine point” measured per ASTM C174
- 10.4.7 Concrete cylinders, taken at the time of placement, shall be the standard for testing for compressive strength. In limited, unique circumstances, concrete cores of the finished pavement may be tested for compressive strength, with prior approval by the City Engineer. In the event that concrete cores are approved for testing, the pavement shall meet the required compressive strength without consideration of an allowance for cut cores or any other reduction in strength allowance.
- 10.4.8 Pavement shall meet both the minimum compressive strength and the minimum thickness requirements prior to acceptance by the City Engineer. Pavement that fails to meet both requirements shall be removed and replaced prior to acceptance by the City.
- 10.4.9 In the event that pavement thickness requirements are not met, the limits of the short pavement shall be identified through the use of additional cores at ten foot (10') spacing on each side of the deficient pavement until the minimum thickness requirement is met.
- 10.4.10 In the event a variance for deficient pavement thickness is considered by the City, the City shall consider the extent of the thickness deficiency in area and thickness, the concrete compressive strength, the thickness of the subgrade, the performance of the remainder of the pavement on the project and the performance history of the contractor on the project when reviewing the variance. In addition, the impact of the deficient pavement on the City's long-term maintenance costs shall be considered.
1. Accepted pavement deficient in thickness between 0.00” and 0.1” shall be considered without a maintenance fund payment based upon the recommendation of the design engineer, the extent and location of the deficient pavement, verification of subgrade and other relevant specifications being met and other relevant factors.

2. Pavement deficient in thickness between 0.11” and 0.20” shall require a maintenance fund payment to the City of 25% of the contract unit price times the area of deficient thickness pavement.
 3. Pavement deficient in thickness between 0.21” and 0.25” shall require a maintenance fund payment to the City of 50% of the contract unit price times the area of deficient thickness pavement.
 4. Pavement deficient in thickness greater than 0.25” shall not be considered for acceptance.
- 10.4.11 Finished pavement shall have either a burlap drag or a tight (less than 12” between centerlines) belt finish. Pavements that are excessively smooth or rough shall be subject to removal and replacement.
- 10.4.12 Finished streets shall positively drain and be free from areas of standing water (birdbaths) within 12 hours after water has ceased to flow by gravity. Street subject to acceptance by the City for City maintenance shall be flooded with sufficient water along the gutter line to identify potential birdbaths prior to acceptance into the two (2) year maintenance period. Pavement scarifying or grinding is not allowed to remediate “birdbaths” on newly constructed pavement.
- 10.4.13 All concrete placed shall be uniformly sprayed with a membrane curing compound as described in Item 526 in the TxDOT standard specification for construction. Improper application will result in rejection of the concrete.

10.5 ASPHALTIC CONCRETE PAVEMENT

- 10.5.1 Stabilized base courses shall be compacted under the controlled density method. The base courses shall be compacted to not less than 95% of that density obtained in Test Method Tex-114-E of the Texas Department of Transportation testing procedures using a compactive effort of 13.26 Ft-lbs per cubic inch.
- 10.5.2 All asphalt riding surface and base course density tests shall be taken a minimum of once every 250 square yards or once for every 300 linear feet (300') of driving lane, whichever may apply. Testing of multiple lanes shall be staggered.
- 10.5.3 Finished base course grades shall not deviate more than ¼ inch in sixteen feet (16') from the designated grade line.
- 10.5.4 Asphaltic base courses shall be installed in maximum lifts of four inches

(4"). Asphalt riding surfaces shall be placed in maximum lifts of two inches (2"). Densities shall be taken on each lift prior to placement of subsequent lifts.

- 10.5.5 Hot mix asphaltic materials, shall be at temperatures between 250 degrees Fahrenheit and 325 degrees Fahrenheit when laid. This shall be verified by tests. Compaction shall begin while the material is still hot and as soon as it will bear the weight of the roller/compactor without undue displacement or hairline cracking.
- 10.5.6 All asphalt roadway materials shall not be placed in wet conditions or if the ambient temperature is below 50 degrees Fahrenheit and falling. Material shall be placed if the ambient temperature, taken in the shade, is 40 degrees Fahrenheit and rising.
- 10.5.7 Asphaltic materials and base courses adjacent to existing asphalt roadways shall be placed against clean, straight edges. It is the responsibility of the contractor to saw cut, full-depth to establish this edge and apply tackcoat to saw cut edge, if necessary.
- 10.5.8 Finished pavement shall have core samples taken every 250 linear feet, staggered across the roadway cross-section, and in every cul-de-sac. Additional core samples may be required at the discretion of the City Engineer. This core samples shall be tested to insure that the pavement thickness meets the required project thickness.

10.6 CEMENT STABILIZED SAND

- 10.6.1 All cement stabilized sand shall be a minimum of 1.5 sacks cement per ton sand. Cement stabilized sand shall comply with ASTM C31. Cement stabilized sand shall achieve a minimum of 100 PSI compressive strength at 48 hours from placement. All cement stabilized sand used for backfill or subgrade shall be compacted to a minimum of 95% of the maximum dry density of the material as determined by Standard Proctor Compaction Test ASTM D-698.
- 10.6.2 Cement stabilized sand shall be placed and compacted within four (4) hours of batching.
- 10.6.3 A minimum of two (2) random samples for compressive strength shall be taken each week. For smaller projects, one sample may suffice with City approval. The City Engineer reserves the right to require additional tests, at the contractor's expense, if it is deemed necessary. In the event of a change in supplier, samples shall be drawn on the first day of delivery from the new supplier, regardless of previous samples taken.

- 10.6.4 Cement stabilized sand samples shall be taken at the point of placement of the cement stabilized sand and identified as to the location of the sample.
- 10.6.5 Cement stabilized sand densities shall be taken a minimum of every 150 linear feet of trench per lift, with a minimum of two (2) tests (one per direction of travel) at each road crossing. When utilized as subgrade on roadway repairs, density tests shall be taken every 100 square feet of subgrade, with a minimum of one (1) test per repair.
- 10.6.6 Cement stabilized sand shall not be placed in loose lifts greater than eight inches (8") and shall be compacted to 95% of the maximum dry density of the material as determined by Standard Proctor Compaction Test ASTM D-698. Moisture content on all density tests shall be within plus or minus two percent (3%) of optimum moisture to achieve a passing test.

10.7 BEDDING, BACKFILL, EMBANKMENTS AND LOT FILL

- 10.7.1 No bedding, backfill, embankment or lot fill shall be placed in loose lifts exceeding eight inches (8") in thickness without prior, written approval of the City Engineer.
- 10.7.2 All trench backfill and lot fill, regardless of material, shall be compacted to 95% of the maximum dry density of the material as determined by Standard Proctor Compaction Test ASTM D-698. Moisture content on all density tests shall be within plus or minus two (2%) percent of optimum moisture to achieve a passing test. Test frequency will be required as follows.
 - 1. Bedding and density tests shall be performed a maximum of every 150 linear feet (150') of trench in each lift. Density tests shall be offset on alternating lifts and tests locations shall be identified by station number.
 - 2. Embankments shall be tested at intervals not to exceed 300 linear feet (300') of roadway and/or as conditions may require in each lift.
 - 3. All lots shall be proof-rolled and a minimum of one density test per lift shall occur on all lots on which fill operations have occurred. The city reserves the right to require additional, certified density testing.

10.8 UTILITY CONSTRUCTION

- 10.8.1 Utility construction shall be tested in accordance with the requirements of this chapter, the appropriate utility construction chapter and the Standard Construction Details, as well as the requirements of any other agency having jurisdiction.
- 10.8.2 The City reserves the right to require that any storm, sanitary or water utility

line be inspected by video, and a copy of the video be submitted to the City, prior to acceptance by the City.

Table 10.8.1 – Water Test Allowable Leakage

DIAMETER OF RISER OR STACK IN INCHES	VOLUME PER INCH OF DEPTH		ALLOWANCE LEAKAGE*	
	INCH	GALLONS	PIPE SIZE IN INCHES	GALLONS/MINUTE PER 100 FT.
1	0.7854	.0034	6	0.0039
2	3.1416	.0136	8	0.0053
2.5	4.9087	.0212	10	0.0066
3	7.0686	.0306	12	0.0079
4	12.5664	.0306	15	0.0099
5	19.6350	.0544	18	0.0118
6	28.2743	.1224	21	0.0138
8	50.2655	.2176	24	0.0518
			27	0.0177
			30	0.0197
			36	0.0237
			42	0.0276
For other diameters, multiply square of diameters by value for 1" diameter			Equivalent to 50 gallons per inch inside diameter per mile per 24 hours	

* Allowable leakage rate shall be reduced to 10 gallons per inch of inside diameter per mile per 24 hours, when sewer is identified as located within the 25-year flood plain.

Table 10.8.2 – Acceptance Testing for Sanitary Sewers

TIME ALLOWED FOR PRESSURE LOSS FROM 3.5 PSIG TO 2.5 PSIG														
Pipe Diam (in)	Min. Time (min:sec)	Length for Min. Time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)										
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	500 ft	550 ft	600 ft
6	5:40	398	0.8548	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07	7:50	8:33
8	7:33	298	1.5196	7:33	7:33	7:33	7:33	7:36	8:52	10:08	11:24	12:40	13:36	15:12
10	9:27	239	2.3743	9:27	9:27	9:27	9:54	11:52	13:51	15:50	17:48	19:47	21:46	23:45
12	11:20	199	3.4190	11:20	11:20	11:20	14:15	17:06	19:57	22:48	25:39	28:30	31:20	34:11
15	14:10	159	5.3423	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31	48:58	53:25
18	17:00	133	7.6928	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06	70:31	76:56
21	19:50	114	10.4708	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15	95:59	104:42
24	22:40	99	13.6762	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58	125:22	136:46
27	25:30	88	17.3089	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	144:14	158:40	173:05
30	28:20	80	21.3690	35:37	53:37	71:14	89:02	106:51	124:39	142:28	160:16	178:05	195:53	213:41
33	31:10	72	25.8565	43:06	64:38	86:11	107:44	129:17	150:50	172:23	193:55	215:28	237:01	258:34

Table 10.8.3 – Minimum Testing Times for Low Pressure Air Test

PIPE DIAMETER (INCHES)	MINIMUM TIME (SECONDS)	LENGTH FOR MINIMUM TIME (FEET)	TIME FOR LONGER LENGTH (SECONDS)
6	340	398	0.855 (L)
8	454	298	1.520 (L)
10	567	239	2.374 (L)
12	680	199	3.419 (L)
15	850	159	5.342 (L)
18	1020	133	7.693 (L)
21	1190	114	10.471 (L)
24	1360	100	13.676 (L)
27	1530	88	17.309 (L)
30	1700	80	21.369 (L)
33	1870	72	25.856 (L)

Table 10.8.4 – Vacuum Test Time Table

DEPTH IN FEET	TIME IN SECONDS BY PIPE DIAMETER		
	48"	60"	72"
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
*	5.0	6.5	8.0

*Add T times for each additional 2-foot depth.
 (The values listed above have been extrapolated from ASTM C 924-85)

CITY OF PEARLAND

**CHAPTER 11
GRAPHIC STANDARDS & DRAWING REQUIREMENTS**

**ENGINEERING DESIGN CRITERIA MANUAL
October 2020**

CHAPTER 11

GRAPHIC STANDARDS & DRAWING REQUIREMENTS

11.1 GENERAL

- 11.1.1 These standards describe the general requirements for construction plan graphics and drawing layering requirements.
- 11.1.2 The Engineering Department shall approve construction plans for all public improvements within the Pearland City limits or extraterritorial jurisdiction.
- 11.1.3 Construction plans for private improvements, within public right-of-ways and public easements that connect to or affect the public infrastructure shall be approved by the Department of Engineering subject to the requirements of this manual and are subject to review and approval using the process defined in this manual.
- 11.1.4 All as-built construction plans shall be submitted to the Engineering Department in electronic format. GIS features class within geodatabase or shapefiles (ESRI format) and AutoCAD formats are required. A pdf version of the as-built drawing is also required along with the GIS shapefiles. See GIS and AutoCAD graphics standards below.

11.2 GIS STANDARDS AND DATA REQUIREMENTS

The City now requires GIS files on all projects as a part of record drawing. CAD files will not be accepted as a substitute, however may be requested on a project basis.

- 11.2.1 Preferred Method of Delivery
All Files shall be delivered in electronic format by either CD, USB Drive, or Drop Box.
- 11.2.2 Acceptable Formats, all formats shall include a layer file to maintain line types:
 - 1. ESRI File Geodatabase
 - 2. ESRI Shape files (.SHP)
- 11.2.3 GIS Coordinate System & Projections
All GIS information shall be provided in the following coordinate system:
Coordinate system: NAD 1983 State Plane Texas South Central
FIPS 4204 Feet
Geographic Coordinate System: GCS_North_American_1983
Datum: D_North_American_1983
WKID: 2278
Grid Units
Projection: Lambert Conformal Conic

11.2.4 Minimum Information Requirements

GIS files shall contain at minimum the information provided below. Additional layers or information may be required based on the complexity of the project and the work completed. These additional layers will be identified and requested by either the Engineering Department or the GIS department.

- 1) Parcels – lot lines and easements
- 2) Platted Subdivision outline boundary
- 3) Street Centerlines – Street ROW centerline
- 4) Water lines - Distribution layout and Attributes
 - a) Size (numeric field)
 - b) Material (text field)
 - c) Date Constructed (date field)
- 5) Water points and Attributes
 - a) Hydrants
 - i) Type (text field)
 - b) Valves
 - i) Size – (numeric field)
 - c) Blow off Valves
 - i) Size – (numeric field)
 - d) Meter Boxes
 - i) Single or Double meter (numeric field)
 - e) Reducers
 - i) Size (numeric field)
- 6) Sanitary Sewer lines (and Force mains) - Collection layout and Attributes
 - a) Size (numeric field)
 - b) Material (text field)
 - c) Date constructed (date field)
- 7) Sanitary Sewer points and Attributes
 - a) Manholes
 - i) # of pipes (numeric field)
 - ii) Material (text field)
 - iii) Invert Elevation (numeric field)
 - iv) Inflow Protector (0 or 1)
 - b) Lift stations
 - i) Depth (numeric field)
 - c) Clean outs
 - d) WACS
 - e) FM Air Relief Valves
- 8) Storm Sewer lines and Attributes
 - a) Size (numeric field)
 - b) # of pipes (numeric field)
 - c) Shape (text field)
 - d) Material (text field)

- e) Date constructed (date field)
- f) Flowline elevation (numeric field)
- 9) Storm Sewer points and Attributes
 - a) Manholes
 - i) Material (text field)
 - ii) Date constructed (date field)
 - iii) Invert Elevation (numeric field)
 - b) Inlets
 - i) Type (text field)
 - ii) Invert Elevation (numeric field)
- 10) Pavement outline
- 11) Side Walks
- 12) Light Poles

11.2.5 City Of Pearland GIS Layers

The City maintains a diverse database of current information. These files are available for download and to be used as a reference. The address to these files is provided below:

<http://copgisweb.ci.pearland.tx.us/web/gis-data.htm>

11.3 AUTOCAD DRAWING LAYER REQUIREMENTS

As built construction drawings are to be provided with the construction information provided in layers according the order show in Table 11.4.1. Additional layers may be added as necessary

Table 11.3.1: Layer Symbology for Construction Plans

LAYER	LAYER NAME	DESCRIPTION
1	CL	Centerline
2	ROW	Right of Way
3	LOTLINE_PRO	Lot Lines/Reserves (Proposed)
4	BOUNDARY	Boundaries
5	BMARK	City of Pearland Benchmark
6	LOTNOS	Lot Numbers/Block Names
7	SUBDIVNM	Subdivision Names / Section Numbers
8	STREETNM	Street Names
9	WLINES_PRO	Water Lines (Proposed)
10	FHYD_PRO	Fire Hydrants (Proposed)
11	WVALVES_PRO	Water Valves (Proposed)
12	WTEXT_PRO	Water Line Text (Proposed)
13	SSLINES_PRO	Sanitary Sewer Lines (Proposed)
14	SSMH_PRO	Sanitary Sewer Manholes (Proposed)
15	SSFM_PRO	Sanitary Sewer Force Main (Proposed)
16	LS_PRO	Liftstation (Proposed)
17	SSTEXT_PRO	Sanitary Sewer Text (Proposed)

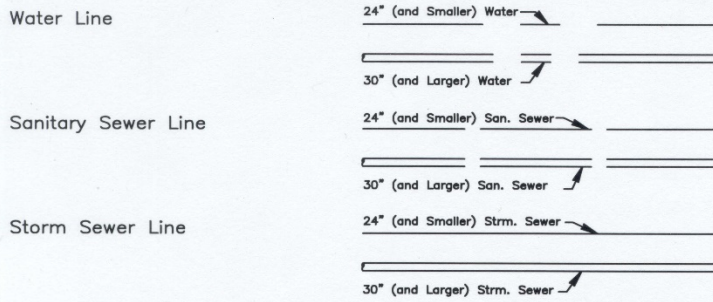
18	STORMLINE_PRO	Storm Sewer Lines (Proposed)
19	STORMMH_PRO	Storm Sewer Manholes (Proposed)
20	STORMIN_PRO	Storm Sewer Inlets (Proposed)
21	STORMCVT_PRO	Storm Sewer Culverts (Proposed)
22	STORMTEXT_PRO	Storm Sewer Text (Proposed)
23	DITCH	Drainage Ditch
24	TOPO	Topography
25	UTIL_PRO	Utilities (Proposed)
26	LAKES	Lakes/Ponds etc.
27	STREAM	Creeks, Bayous, Rivers etc.
28	CANAL	Canals
29	RR	Railroad
30	CITYLIM	City Limits Line
31	COUNTYLN	County Lines
32	ETJ	ETJ Lines
33	NOTES	Notes/ Miscellaneous Text
37	UTIL_EXI	Utilities (Existing)
35	LOTLINE_EXI	Lot Lines/Reserves (Existing)
36	WLINES_EXI	Water Lines (Existing)
37	FHYD_EXI	Fire Hydrants (Existing)
38	WVALVES_EXI	Water Valves (Existing)
39	WTEXT_EXI	Water Line Text (Existing)
40	SSLINES_EXI	Sanitary Sewer Lines (Existing)
41	SSMH_EXI	Sanitary Sewer Manholes (Existing)
42	SSFM_EXI	Sanitary Sewer Force Main (Existing)
43	LS_EXI	Lift station (Existing)
44	SSTEXT_EXI	Sanitary Sewer (Existing)
45	STORMLINE_EXI	Storm Sewer Lines (Existing)
46	STORMMH_EXI	Storm Sewer Manholes (Existing)
47	STORMIN_EXI	Storm Sewer Inlets (Existing)
48	STORMCVT_EXI	Storm Sewer Culverts (Existing)
49	STORMTEXT_EXI	Storm Sewer Text (Existing)
50	SIGN_EXI	Street Sign (Existing)
51	SIGN_PRO	Street Sign (Proposed)
52	SIGNTXT	Street Sign Text
53	STLIGHT_PRO	Street Lights (Proposed)
54	STLIGHT_EXI	Street Light (Existing)
55	STLIGHTTXT	Street Light Text (Proposed)

11.4 AUTOCAD GRAPHIC STANDARDS

The following graphic standards shall apply to all construction plans submitted for approval within the city limits and extra-territorial jurisdictions.

GRAPHIC STANDARDS~EXISTING IMPROVEMENTS (Continued)

WT LC



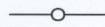
0 7

0 3

0 0

WT LC

Iron Pipe or Iron Rod Monuments (Red Ink for Property Corner)



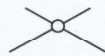
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Water Valve (Gate)



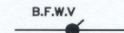
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Point Of Inter-section (P.I.)



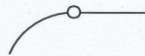
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Water Valve (Butterfly)



0 0

Point of Curve (P.C.) or Point of Tangency (P.T.)



0 0

Fire Hydrant



0 0

Tapping Sleeve & Valve



0 0

Power Pole



0 0

Reducer



0 0

Power Pole Down Guy



0 0

Round Connections



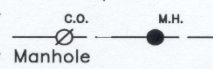
0 7

Gas Meter



0 0

Sanitary Sewer Cleanout and Sanitary Sewer Manhole



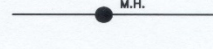
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Gas Valve



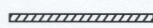
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Storm Sewer Manhole



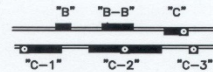
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Header



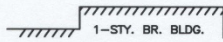
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Storm Sewer Inlets



0 0

Building



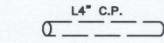
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Tree



0 0

Culvert Pipe



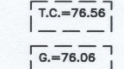
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Hedge



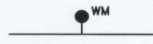
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Top of Curb or Gutter Line Elev.



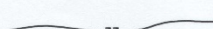
0 2

Water Meter



0 0

Contour Line



0 0

WT	TECHNICAL PEN NUMBER	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	.35mm
1	1	0.020"	.50mm
2	2	0.024"	.60mm
3	3	0.031"	.80mm
4	4	0.047"	1.20mm
6	6	0.055"	1.40mm

LEGEND

WT= LINE WEIGHT
LC= LINE CODE

GRAPHIC STANDARDS~EXISTING IMPROVEMENTS (Continued)

		WT	LC
1.2	Profile View		
	North or East Property Line	1	5
	South or West Property Line	1	6
	North or East Ditch or Curb	1	7
	South or West Ditch or Curb	1	3
	Center Line of Right-of-Way	1	4
	North or East Culvert	1	2
	South or West Culvert	1	2
	Power	1	6
		1	0
	Gas Line	1	1
		1	0
	Communication	1	2
		1	0
	Water Line	1	7
		1	0
	Wastewater Line	1	3
		1	0
		1	3
		1	0
	Storm Sewer Line	1	0
		1	0
		1	0

NOTE: Pipe less than four inches (4") in diameter need not be shown in profile.

WT	TECHNICAL PEN NUMBER	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	.35mm
1	1	0.020"	.50mm
2	2	0.024"	.60mm
3	3	0.031"	.80mm
4	4	0.047"	1.20mm
6	6	0.055"	1.40mm

LEGEND

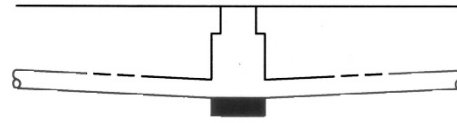
WT= LINE WEIGHT
LC= LINE CODE

GRAPHIC STANDARDS~EXISTING IMPROVEMENTS (Continued)

1.2 Profile View (Cont.)

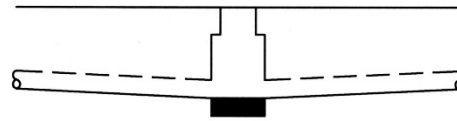
WT LC

Electrical Co. Manhole



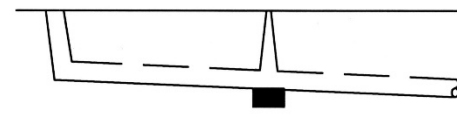
1 6

Telephone/Comm. Manhole



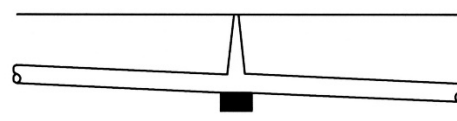
1 2

Sanitary Sewer Manhole and Cleanout



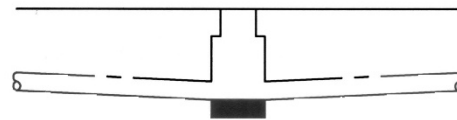
1 3

Storm Sewer Manhole



1 0

Waterline Manhole



1 7

WT	TECHNICAL PEN NUMBER	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	.35mm
1	1	0.020"	.50mm
2	2	0.024"	.60mm
3	3	0.031"	.80mm
4	4	0.047"	1.20mm
6	6	0.055"	1.40mm

LEGEND

WT= LINE WEIGHT
LC= LINE CODE

GRAPHIC STANDARDS~PROPOSED IMPROVEMENTS

2. The following standards are to be used for all proposed water line improvements. Use line weight 3 for all proposed improvements. All fitting descriptions shall be shown in a box with arrow to the fitting or group of fittings. Text for proposed improvements shall not be smaller than 100 Leroy Template.

2.1. Plan View WT LC

Water Line	24" (and Smaller) Water Main	3	7
	30" (and Larger) Water Main	3	7
Water Valve (Gate)	W.V.	3	7
Water Valve (Butterfly)	B.F.W.V.	3	7
Tapping Sleeve and Valve	T.S.&V.	3	7
Fire Hydrant	F.H. W.V.	3	7
Reducers	12" 8"	3	7
Round Connections		3	7

2.2. Profile View WT LC

Water Line	All Sizes	3	7
		3	0

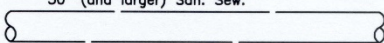
WT	TECHNICAL PEN NUMBER	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	.35mm
1	1	0.020"	.50mm
2	2	0.024"	.60mm
3	3	0.031"	.80mm
4	4	0.047"	1.20mm
6	6	0.055"	1.40mm

LEGEND
WT= LINE WEIGHT
LC= LINE CODE

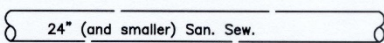
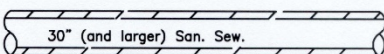
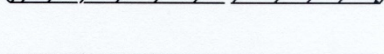
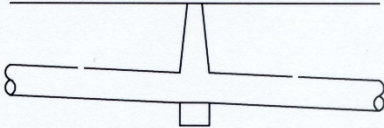
GRAPHIC STANDARDS~PROPOSED IMPROVEMENTS (Continued)

3. The following standards are to be used for all proposed sanitary sewer line improvements. Use line weight 3 for all proposed improvements. All fitting descriptions shall be shown in a box with arrow to the fitting or group of fittings. Text for proposed improvements shall not be smaller than 100 Leroy Template.

3.1. Plan View

		<u>WT</u> <u>LC</u>
Sanitary Sewer Lines	24" (and smaller) San. Sew. _____	3 3
	30" (and larger) San. Sew. 	3 3
Manhole	_____○_____	3 0

3.2. Profile View

		<u>WT</u> <u>LC</u>
Sanitary Sewer Lines	24" (and smaller) San. Sew. 	3 3
	30" (and larger) San. Sew. 	3 3
	30" (and larger) San. Sew. 	3 0
Manhole		3 0

WT	TECHNICAL PEN NUMBER	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	.35mm
1	1	0.020"	.50mm
2	2	0.024"	.60mm
3	3	0.031"	.80mm
4	4	0.047"	1.20mm
6	6	0.055"	1.40mm

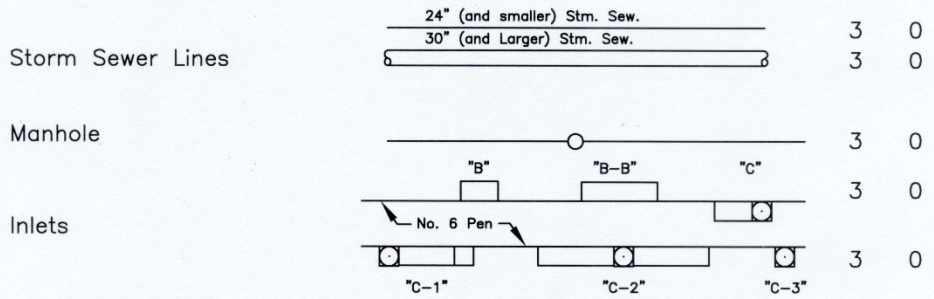
LEGEND

WT= LINE WEIGHT
LC= LINE CODE

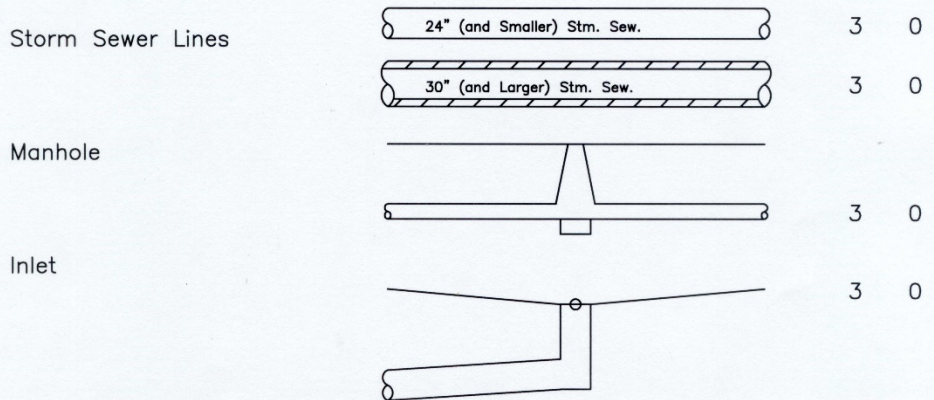
GRAPHIC STANDARDS~PROPOSED IMPROVEMENTS (Continued)

4. The following standards are to be used for all proposed storm sewer line improvements. Use line weight 3 for all proposed improvements. All fitting descriptions shall be shown in a box with arrow to the fitting or group of fittings. Text for proposed improvements shall not be smaller than 100 Leroy Template.

4.1. Plan View WT LC



4.2. Profile View





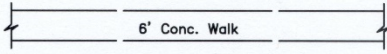
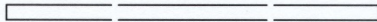

WT	TECHNICAL PEN NUMBER	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	.35mm
1	1	0.020"	.50mm
2	2	0.024"	.60mm
3	3	0.031"	.80mm
4	4	0.047"	1.20mm
6	6	0.055"	1.40mm

LEGEND


WT= LINE WEIGHT
LC= LINE CODE

GRAPHIC STANDARDS~PROPOSED IMPROVEMENTS (Continued)

5. The following standards are to be used for all proposed pavement improvements. Use line weight 3 for all proposed improvements. All fitting descriptions shall be shown in a box with arrow to the fitting or group of fittings. Text for proposed improvements shall not be smaller than 100 Leroy Template.

5.1. Plan View		WT LC
Face of Curb		6 3
Edge of pavement		6 0
Concrete Walk		3 3 2 0 3 3
Concrete Header		3 3
Top of Curb or Gutter Elevation		2 0

5.2. Profile View

Top of Curb or Center Line of Open Ditch Paving		2 0 (TEXT) 3 3
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WT	TECHNICAL PEN NUMBER	LINE WEIGHT/WIDTH	METRIC
0	0	0.014"	.35mm
1	1	0.020"	.50mm
2	2	0.024"	.60mm
3	3	0.031"	.80mm
4	4	0.047"	1.20mm
6	6	0.055"	1.40mm

LEGEND

WT= LINE WEIGHT
LC= LINE CODE

CITY OF PEARLAND

**CHAPTER 12
MISCELLANEOUS REQUIREMENTS**

**ENGINEERING DESIGN CRITERIA MANUAL
October 2020**

CHAPTER 12

MISCELLANEOUS REQUIREMENTS

12.1 BARRICADES AND TRAFFIC CONTROL

- A. It is the responsibility of the developer, contractor, or right-of-way user to maintain traffic control devices in accordance with Texas Manual on Uniform Traffic Control Devices (TMUTCD) on all construction projects.
- B. Construction projects which have not been accepted by the City shall be barricaded or otherwise closed to public use until acceptance by the City. It is the responsibility of the contractor to provide and maintain barricades or other traffic control devices in accordance with the TMUTCD, latest edition, and in a safe manner.

12.2 APPROVED PRODUCTS LIST

- A. The Engineering Department shall develop and maintain an Approved Products List. All materials used in construction within right-of-ways and easements shall be as specified on the City of Pearland Approved Products List. These documents are available in the Engineering Department and are available for review upon request.

12.3 CITY OF PEARLAND STANDARD CONSTRUCTION DETAILS

- A. The Engineering Department shall develop and maintain Standard Construction Details. These Standard Construction Details shall be maintained and updated periodically by the Engineering Department. These documents are available in the Engineering Department and are available for review upon request.