

**CITY OF MANVEL
DESIGN CRITERIA MANUAL**

January 20, 2026



Approved by:

**Manvel City Council
Subdivision Ordinance**

Resolution 2026-R-03

Originally adopted as
Resolution 2008-R-04 on April 28, 2008
and Revised:

1. December 15, 2008
2. August 23, 2010
3. September 26, 2011
4. December 10, 2012
5. December 9, 2013
6. January 12, 2015
7. January 25, 2016
8. April 11, 2016
9. April 24, 2017
10. January 29, 2018
11. April 2, 2018
12. August 5, 2019
13. June 7, 2021
14. October 17, 2022
15. April 17, 2023
16. May 6, 2024

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SECTION 1 GRAPHIC REQUIREMENTS

1.0 GENERAL

1.01 CHAPTER INCLUDES:

Graphic requirements for all construction drawings including City of Manvel (public) projects, non-City of Manvel (private) projects, and all utility projects without a current Franchise Agreement.

1.02 REFERENCES – Refer to the City of Manvel Website for additional information.

1.03 DEFINITIONS

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

1.04 DESIGN REQUIREMENTS

- A. Provide a cover sheet for all projects involving three or more design drawings (excluding standard detail sheets). Plan sheet numbers shall be shown on the cover sheet or area key map. Include a location map and vicinity map, at a scale of 1" = 1/2 mile along with a North arrow, to identify project locations. Also provide approval block for the City of Manvel with a note stating that approval is valid for 2 years from date of signatures, City of Manvel hours of construction as stated in Section 6: Site Development, and a full date of submittal (month/day/year).
- B. Drawings shall be prepared on nominal 24-inch x 36-inch sheet.
- C. Show service area on cover sheet or area map.
- D. The engineer shall also submit, at the time of plan approval, an electronic version (*in .pdf, and .dwg format*) of the CADD drawings of the development showing all lot lines and associated lot information, rights-of-way, easements, contours, utilities, and all drainage and paving improvements.
- E. Details of special structures (not covered by approved standard drawings, such as stream or gully crossings, special manholes, or junction boxes, etc.) shall be drawn with vertical and horizontal scales equal to each other.
- F. Each set of construction drawings shall contain paving and utility key drawings indexing specific plan and profile sheets. Standard City drawings, where applicable, shall be included. All sheets shall have standard title blocks.
- G. Draw key overall layouts to a minimum scale of 1 inch = 100 feet.
- H. Plan stationing must run from left to right, except for short streets or lines originating from a major intersection, where the full length can be shown on one sheet.

- I. A north arrow is required on all sheets and should be oriented either toward the top or to the right. This requirement is waived under the following conditions:
1. A storm or wastewater sewer whose flow is from west to east or from south to north.
 2. A primary outfall ditch drainage facility whose flow is from west to east or from south to north.
 3. Stationing is intended to start from the cardinal points of the compass and proceed in the direction of construction.
- J. Standard scales permitted for plans and profiles of paving and utility construction drawings are as follows:
1. Major thoroughfares, streets with esplanades over 400 feet in length, or special intersections:
1 inch = 20 feet horizontal, 1 inch = 2 feet vertical
 2. Minor or residential single-family streets:
1 inch = 20 feet horizontal, 1 inch = 2 feet vertical
1 inch = 40 feet horizontal, 1 inch = 4 feet vertical
1 inch = 50 feet horizontal, 1 inch = 5 feet vertical
 3. Scales above are minimum; larger scales may be used to show details of construction.
- K. Each sheet shall have a benchmark elevation and description defined, and a current flood zone determination statement.
- L. The seal, date, and original signature of the Registered Professional Engineer responsible for the drawings shall be required on each sheet developed by the engineer. The engineer may use a stamped or embossed imprint for his/her seal; however, the embossed imprint must be shaded such that it will reproduce on prints.
- M. A copy of the proposed Final Plat conforming to the approved Preliminary Plat for new developments shall be included with the final drawings when submitted for final approval.
- N. If a roadway exists where drawings are being prepared to improve or construct new pavement or a utility, label the existing roadway width, surface type, and thickness, if available without destruction of pavement. Pavement thickness can be ascertained by coring with the core hole grout filled to protect pavement prior to construction.
- O. Show all streets and road alignment on drawings. Provide coordinates or bearings at the beginning of all alignments.
- P. Develop drawings to accurate scale showing proposed pavement, typical cross sections, details, lines and grade, and all existing topography within street right-of-way, and any easement contiguous with the right-of-way. At the intersection, the cross-street details shall be shown at sufficient distance (20-foot minimum distance outside the primary roadway right-of-way) in each direction along cross street for designing adequate street crossings.

- Q. Match lines between plan and profile sheets shall not be placed or shown within cross street intersections including cross street right-of-way.
- R. Natural ground profiles shall be shown as follows:
1. For non-City of Manvel (privately funded) projects, center line profiles are satisfactory except where a difference of 0.50 feet or more exists from one right-of-way or easement line to the other, in which case, dual profiles are required.
 2. For City of Manvel (publicly funded) projects, provide natural ground profiles for each right-of-way line. Easement profiles shall conform to S below.
- S. Basic plan and profile sheets shall contain the following information:
1. Identify all lot lines, property lines, easements, right-of-way, and drainage outfalls.
 2. Label each plan sheet as to street/easement widths, pavement widths, pavement thickness where applicable, type of roadway materials, curbs, curb transition lengths, intersection radii, curve data, stationing, existing utilities (type and location), and any other pertinent feature affecting design.
 3. Show all utility lines 4 inches in diameter or larger within the right-of-way or construction easement in profile view. Show all utility lines, regardless of size, in the plan view including fiber optic cables.
 4. Graphically, show flow line elevations and direction of flow for all existing ditches.
 5. Label proposed top of curb grades except at railroad crossings. Center line grades are acceptable only for paving without curb and gutters.
 6. Curb return elevations for turnouts shall be shown in profiles.
 7. The center line elevation at the property line of all existing driveways shall be shown in profile.
 8. Station all esplanade noses or the center line of all esplanade openings with esplanade width shown - both existing and proposed.
 9. The design of both roadways is required on all paving sections with an esplanade.
 10. Station all PCs, PTs, radius returns, and grade change PIs in plan view. Station all radius returns and grade change PIs in profile with their respective elevations.
 11. Show Hydraulic Grade Line (HGL) and identify Ponding Depth on profile drawings.
- T. Provide a pollution prevention plan with legend. See Site Development (Section 6) under Design Requirements.
- U. Submit 1 printed set of civil construction plans on 24" x 36" paper in addition to pdf file for review.

- V. Approved civil construction plans will be valid for a period of 2 years, and a note shall be included on the cover sheet indicating same. No extension will be granted. If work has not commenced by the 2-year expiration date, the civil construction plans will need to be resubmitted and reviewed and new plan review fees paid. The “commencement of work” shall be defined by the following milestones:
1. Preconstruction Meeting has occurred with the selected contractor
 2. Civil Site Improvement Permits have been acquired by the selected contractor
 3. Construction Equipment has been mobilized to the Site.
- W. Identify sidewalks, water meters, sewer taps, manholes, fire hydrants in red, and water valves on Site Plans for residential and commercial projects.
- X. For all projects located within a MUD, a Water and Sewer Utility Availability Summary Table shall be provided with/within every plan and plat submittal. The Table will include a summary of currently platted lots and corresponding connections, along with reserved connections and planned future connections. It will also include the current capacity of the water and wastewater facilities (plant(s), lift stations, etc.) within the MUD.
- Y. Label all proposed and/ or existing water lines in blue, sanitary sewer lines in green, and storm system components private or public on all layouts.
- Z. ROW widths shall be given on all layouts

SECTION 2 WASTEWATER

1.0 GENERAL

1.01 CHAPTER INCLUDES:

Criteria for the design of wastewater collection systems.

1.02 REFERENCES

Texas Commission on Environmental Quality (TCEQ) - "Design Criteria for Domestic Wastewater Systems" - Texas Administration Code - Chapter 217 and "Design Criteria for Sewerage Systems" Chapter 317 (current revision).

1.03 DEFINITIONS

This Chapter addresses the design of the wastewater collection systems within the public right-of-way or a dedicated public easement. Sanitary sewers located on private property that are not in a dedicated easement, are under the jurisdiction of the Plumbing Code, and will be addressed/reviewed by the Building Official. Where used in these regulations, the following terms shall be construed to carry the meanings given below:

- A. Public Sewer - A closed conduit that conveys wastewater flow and which is located within the public right-of-way or dedicated public easement. A public sewer (or public sewer system) is intended to serve more than one (1) "owner" or occupant.
- B. Private Sewer - A closed conduit that conveys wastewater flow and is constructed and maintained by a private entity(s) (i.e., homeowner's association). Private sewers may be located in areas such as a private street or common area. Private sewers are subject to the design and construction requirements of the Plumbing Code and must be discharged to a public sewer.
- C. Sewer Main - A sewer that receives the flow from one or more lateral sewers.
- D. Lateral Sewer - A sewer running laterally down a street, alley, or easement, which receives only the flow from the abutting property.
- E. Service Lead - A sewer that branches off 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 with the said main or lateral sewer, but not directly adjacent thereto. Such a line shall never exceed 150 feet in length. 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.
- F. Service Connection - A private sewer from a single source to the main or lateral sewer in the street, alley, or easement adjacent thereto. Service connections are covered by the Building Code. It will be owned and maintained by the owner of the property being served by said sewer.
- G. Project Area - The area within the immediate vicinity of the public sewer to be constructed.

- H. Stack - A riser pipe constructed on main or lateral sewers which are deeper than 8 feet to facilitate construction of service leads or service connections.
- I. Force Main - A pressure-rated conduit (i.e., ductile iron pipe, pressure-rated PVC, etc.) that conveys wastewater from a pump station to a discharge point.

1.04 DESIGN REQUIREMENTS

A. Easements for wastewater lines.

1. Wastewater lines shall be located within street right-of-way, permanent access easements with overlapping public utility easements, easements adjacent to street rights-of-way or recorded wastewater easements.
2. When outside of a public street right-of-way or permanent access easement with an overlapping public utility easement, easements must be dedicated and restricted for wastewater lines only.
3. When possible, easements should be adjacent to public rights-of-way.
4. Easements containing wastewater lines must be at least 20 feet wide and the wastewater line must be centered in the easement.
5. Wastewater lines along State rights-of-way shall be installed outside of the right-of-way in a separate 20-foot minimum adjacent easement.
6. No backlot easements will be allowed for the installation of wastewater lines.

B. Drawings

1. Before any main or lateral sewer is constructed and before a permit will be issued for the construction of same, plans and profiles of the proposed sewer shall be prepared and submitted to the City for approval.
2. The plan view will show the exact location of the proposed line in the street, alley or easement with respect to the edge of the particular right-of-way, the transit base line, and any nearby utilities, major landscaping, and other structures affecting construction.

C. Main and Lateral Sewers

1. Sewers in curved easements, easements defined by property lines and combined easements containing other public utilities must be shown both in detailed plan and profile views.
2. The profile should show other underground and surface utilities and facilities, both in parallel and at crossings; the size, grade of the proposed line, the elevation of same to hundreds of a foot at all manholes, changes of grade and dead ends; and the proposed finished grade over the sewer. It should show the actual ground line as it exists prior to construction of the sewer. Where proposed fill or cut is contemplated, the proposed new ground line should be shown as a separate line from the actual ground line. Type of pipe and bedding shall comply with City of Manvel Standard Specifications and Standard Details.

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

D. Sewer mains - plan and profile required

1. Sanitary sewer layouts for residential subdivisions should use a minimum horizontal scale of 1 inch = 40 feet with a vertical scale of 1 inch = 4 feet, or as allowed per Section 1, 1.04, J. A scale of 200 feet per inch may be used provided the following information is shown on the layout:
 - a. All easements containing or buffering sanitary sewers are shown at points of size change; all manhole locations are shown.
 - b. The sewer alignment shall accurately reflect the relative location of the sewer as shown on the detailed plan view.
 - c. All service leads that cross-street pavement or serve adjacent property are to be shown on the layout. The detailed plans and profiles shall show the flow lines of all service leads at the street or easement right-of-way.
 - d. The number and size of the lots depicted on both the overall sewer layout sheet and the individual plan and profile sheets shall match the number and size of the lots depicted on the Final Plat after recordation.
 - e. On the overall sanitary sewer layout sheet, the size and direction of flow for all existing and proposed sewers shall be shown.
 - f. The location of the proposed sewer within the public right-of-way, a dedicated easement adjacent to the public right-of-way, or side lot easement (if allowed by the City).
 - g. The overall sanitary sewer layout sheet shall show the area, in acres, which the proposed sewer(s) is (are) designed to serve. Include a location map that references the average to nearby major thoroughfare and boulevard streets. The scale of the location map shall be 1 inch = 2,000 feet or less.
2. Commercial subdivision sanitary sewer layouts for large areas and with a scale of 400 feet or more per inch must have an additional set of layouts at not more than 200 feet per inch, with match lines and a small index map showing which portion of the overall layout that each sheet's layout represents.
3. Acceptable horizontal scales for the detailed plan and profile views are 10 feet, 20 feet, 40 feet and not more than 50 feet maximum per inch. Horizontal scale for major thoroughfares and boulevards shall be 1 inch = 20 feet or less.
4. Acceptable vertical scales for detailed profile views are 2 feet, 4 feet, and not more than 5 feet maximum per inch unless otherwise approved. Vertical scale for major thoroughfares and boulevards shall be 1 inch = 2 feet or less.
5. The plan view shall show, at a minimum, the following information for the project area:
 - a. All topographical features;
 - b. Stationing for the proposed sewers;
 - c. All existing utilities (i.e., telephone, gas, power, etc.);
 - d. Any significant landscaping and/or other structures which might impact construction and/or construction related activities;
 - e. The width and type of all existing and proposed easements;

- f. All proposed service leads;
 - g. The limits of bore and/or tunnel;
 - h. Locations where pressure pipe is to be installed for water line crossings;
 - i. Drawings for residential subdivisions shall show the proposed location, by stations, of all service leads, service connections, and stacks. The distance from the sewer or transit base line station to the nearest existing manhole shall be shown in the plan view or on an additional sewer layout sheet with a scale no more than 1 inch = 100 feet.
6. The profile view shall show, at a minimum, the following information for the project area:
- a. Underground and/or surface utilities/facilities which are either parallel to the proposed sewer or cross the proposed sewers;
 - b. The proposed sewer's diameter and grade for each manhole section;
 - c. The flow line elevation for all sanitary sewers at each manhole;
 - d. The rim elevation of all existing and proposed manholes;
 - e. The flow line elevation at each sheet "break" (i.e., from one sheet to another);
 - f. Type of pipe bedding/backfill shall be noted on each plan/profile sheet;
 - g. The finished grade for proposed and existing pavement where "fill" and/or "cut" is proposed, the proposed new ground line should be shown as a separate line from the existing ground line;
 - h. The existing ground line for the "near side" of the public right-of-way where a sewer is to be placed between the edge of existing pavement and the edge of the public right-of-way;
 - 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 and/or existing pavement.
 - j. The flow line elevation of all service leads where it crosses the edge of the public right-of-way or the dedicated easement adjacent to the public right-of-way;
 - k. The limits of bore and/or tunnel;
 - l. Locations where pressure pipe is to be installed for water line crossings;
 - m. The location of special backfill and/or proposed stacks shall be identified by "stations" indicated on the design plans.
 - n. The location of stacks shall be labeled with stations.
- E. Service leads
- 1. Service leads shall be at the property line between two (2) adjoining lots, or as directed by the City. A single 6-inch service lead located at the property line between two (2) adjoining lots would serve two (2) single-family residences with a wye placed at the end of the service lead. Do not extend the wye clean-outs beyond the edge of either the public right-of-way or dedicated easement.
 - 2. Any service lead extension of more than 50 feet parallel to the street right-of-way shall be treated as a lateral sewer.

3. Service leads from developments with more than 17,500 gallons-per-day flows shall discharge into a proposed or existing manhole. Where the flow line of the service is 24 inches or greater above the flow line of the manhole, provide a standard external drop to manhole.
 - a. Service leads shall be provided to serve each lot within proposed development inside the City limits.
 - b. Service leads shall be 6 inches in diameter (minimum). If the length of a service lead exceeds 100 feet or the width of the public right-of-way by more than 20 feet, the minimum diameter shall be 8 inches, and a manhole shall be utilized for connection to the public sewer.
 - c. Service leads with a diameter of 6 inches shall utilize "full body" fitting (extruded or factory-fabricated) for connection to the proposed public sewer or an approved saddle-type connector for connection to an existing public sewer.
 - d. Saddle-type connectors shall be installed with the "stub" oriented between the "spring line" (3 o'clock and 9 o'clock positions) and 45 degrees from the "spring line" ("1:30" and "10:30" positions). Tees (aka, "full body fittings") shall be oriented in the same manner.
 - e. The service lead shall be designated to minimize the use of bends, as site conditions will permit.
 - f. Service leads exceeding the limits defined in 1.04.E.2. shall have a manhole at each end; as well as, a plan/profile drawing for each right-of-way crossing. All, or part, of these service leads which are located in a public right-of-way, alley or dedicated sanitary sewer or public utility easement may be treated as a public sewer; depending upon the location of the terminal manhole and any intermediate manholes.
 - g. For all existing lots (which are not served in accordance with these guidelines) that need a service lead, if the distance to the nearest existing sewer is less than 50 feet, the service lead is under the jurisdiction of the Plumbing Code.
4. Service leads shall not be connected to a force main. (Grinder pumps and private lift stations are not allowed.)

F. General Requirements

1. Sanitary sewers within the City of Manvel's jurisdiction shall allow for orderly expansion of the system and shall conform to the Master Wastewater Plan for the City of Manvel.
2. Sewers shall be sized based on the minimum requirements set out in this standard and the standard wastewater flow rates as established by the City of Manvel and shall be no less than 315 gallons per connection per day.
3. All sewers shall conform to the minimum requirements of the Texas Department of Health, "Design Criteria for Sewerage Systems".
4. Sewers shall be separated horizontally from water lines by a minimum of four (4) feet. Sewers crossing utilities other than water, a minimum of six (6) inches of vertical clearance must be maintained.

5. The public sanitary sewer, as maintained by the City of Manvel, shall be defined as all sewers, including stacks and service leads, that serve more than one sewer connection, that are located in public easements or street rights-of-way, and that are installed in accordance with these Standards.
6. Sanitary lines greater than 6 inches require stacks with 5 feet minimum cover. (Stacks are to be shown on plans with stations). Place stacks and wyes or tees as shown. Where no stacks are shown, it is the responsibility of the licensed plumber to place a City approved saddle for connection to the line and the responsibility of the City Inspector to determine that such saddle is watertight and properly installed.
7. Materials and construction to conform to latest City of Manvel specifications with all amendments thereto, including standard leak test.
8. Unless noted otherwise, all public sewers and service leads shall be embedded in cement stabilized sand; to 6 inches below the pipe, 12 inches above the pipe and to 6 inches on each side. All such bedding shall be compacted to 95% standard proctor density. The cross-section so described herein shall be termed the "embedment zone."
9. Backfill all excavation areas/trenches under or within 1-foot of existing or proposed pavement with cement-stabilized sand from the top of the pipe "embedment zone" to the bottom of the subgrade. Cement-stabilized sand must develop 100-psi compression at 48 hours. Backfill shall be compacted to 95% standard proctor density.
10. The location of all proposed stacks shall be shown by stations in the drawings.
11. Construction notes shall designate the kind and class of pipe with exceptions to the construction notes to be shown on the plan and profile sheets.
12. Non-sanitary sewer easements or fee strips such as pipeline, power company, drainage district, railroad, etc., are in and of themselves insufficient and unacceptable to permit laying to sanitary sewers and/or force mains across or along the underlying private property or restricted non-sanitary use type of public property.
13. All public sanitary sewers shall be located within a public ROW or easement.
14. Where an easement for a public sewer ends at a public right-of-way, the last manhole shall be extended into the public right-of-way at a minimum of 2 feet beyond the property line; or as close to the public right-of-way as possible due to acceptable clearances required for other utilities (i.e., water line and storm sewers).
15. The drawings for the sewer shall show the location of any existing known pipe or duct that might interfere with the construction of the sewer and call to the attention of the City any known obstacles that might be encountered in constructing the sewer in any location under consideration. The Professional Engineer shall determine the existence of pipes, ducts and/or obstacles from a visual survey on the ground plus research of all public records and private records when available.
16. All sanitary sewer mains shall be constructed utilizing SDR 26.
17. Sanitary sewer lines shall be centered in sanitary sewer line easements.

18. In subdivisions platted or created after January 1, 1988, for single-family dwellings where each lot maintains an individual water well supply and an on-site sewage facility (OSSF) the sewage disposal plan shall show the approved water well location and sanitary control easement around the well within a 100 feet radius in which no subsurface sewage system may be constructed.
19. No back-lot easements will be allowed for the installation of sanitary sewer lines.
20. All new wastewater lines to be installed with 3M EMS warning tape for future line locates.

G. Line Size

1. The minimum pipe diameter for a public sanitary sewer shall be 8 inches.
2. Four-inch service leads shall be confined to the limits of the lot, which they serve and shall serve only the equivalent of one single-family lot. No 4- inch sewer shall be laid in any street, alley, or right-of-way.
3. Six-inch service leads shall not serve more than the equivalent of two single-family lots or other types of small land tracts.
4. Four-inch and six-inch service leads for single-family residential lots shall have a minimum grade of 0.70 percent.
5. For commercial service leads such as street bores, submit a copy of the approved plumbing drawings to establish the required size of the line. The minimum size lead shall be 6 inches.
6. All main and lateral sewers will end in manholes, except for special and/or unusual situations and subject to specific approval by the City.
7. All sewer lines shall be laid at a size and depth to conform to designs permitting an orderly expansion of the sewer system of the City and so as to avoid a duplication of lines in the future.
8. The City shall be the final judge as to sizes and depths required and exceptions to "lateral service leads" as previously defined.

H. Line Depth

1. The sewer should be laid with the top of the pipe a minimum of 3 feet below finished grade or top of curb, whichever is lower.
2. Sewer laid in street rights-of-way with curb and gutter paved streets shall have a minimum cover of 4 feet from the top of the pipe to the top of the curb to anticipate future sewer extension.
3. Sewers laid in street right-of-way with crowned roads and side ditches shall have a minimum cover of 5 feet from the average ground line at the adjacent street right-of-way to the top of pipe.
4. Where the minimum cover as specified in paragraphs H, 1,2, and 3 above is not possible, the sewer shall be laid in Class 150 (150 psi) pressure pipe or rigid factory-made pipe with cement stabilized sand as shown in standard detail. Ductile iron pipe shall be lined with either a polyethylene or polyurethane coating as approved by the pipe manufacturer and applied by either the pipe manufacturer or an approved application. The minimum liner thickness shall be 40 mil.
5. Maximum depth for sanitary sewer lines shall be 20 feet from average ground surface to pipe invert.

I. Line Grades

The following table lists the minimum grades for 6–30-inch public and private sewers. The minimum grade is based on a minimum full pipe velocity of 2.0 feet per second (fps). The maximum grade is based on a maximum full pipe velocity of 10.0 feet per second (fps). In both cases, the Manning Formula has been used with an "n" of 0.013. The use of different pipe materials will not alter the use of 0.013 for the purpose of the Design Manual.

Inside Dimension (I.D.) of Pipe in Inches	Minimum Slope (in Percent)
6	0.70
8	0.33
10	0.25
12	0.20
15	0.15
18	0.11
21	0.10
24	0.08
27	0.07
30	0.06

For sewers larger than 30 inches in diameter, the Professional Engineer of record shall determine the appropriate grade utilizing the Manning Formula, $n = 0.013$ and a full pipe velocity of 2.0 fps.

J. Manholes

1. All manholes shall be precast concrete, unless the Professional Engineer submits a "cast in place" manhole design for review and approval by the City Engineer. All precast manholes to incorporate a "boot" type connector for sewer diameters up to 24". For sewer diameters greater than 24 inches, utilize either the "boot" type connector (if available) or an integral gasket. All precast manholes shall conform to the latest ASTM requirements.
2. For all public sewers, manholes shall be placed at all changes in alignment, changes in grade, junction points, and either at street, alley, or easement intersections as designs may require.
 - a. Sewers laid in easements shall have a manhole in each street crossed by the sewer.
 - b. The maximum distance between manholes shall be 350 feet for public and private sewers.
 - c. Sewers with the same, or approximate flow line elevation shall intersect each other at a 90-degree angle. However, where a true perpendicular intersection cannot be obtained, and where the "entering" sewer intersects the receiving sewer at, or about, the same flow line, one or more manholes shall be utilized to maintain a minimum angle of 80 degrees at the point of intersection. When the "entering" sewer is on the upstream side of the manhole, the minimum angle between the sewers may be reduced to a 45-degree angle; provided:
 - (1) A distinct flow channel can be maintained within the manhole when the flowline elevations of the sewers are at, or within, one (1) pipe diameter of the smaller pipe; or
 - (2) When the flow line elevation of the "entering" pipe is above the crown of the "primary" sewer and clearance can be provided between the sewers.
 - d. Manholes shall be placed at all dead-end mains and laterals.
 - e. Criteria for connections to, and utilization of, manholes.
 - (1) Where manholes are utilized to facilitate connections between public sewers, when possible, the sewers shall match the manhole's flow line, match the elevation of each other's crown or utilize an "outside" manhole drop.
 - (2) Connections between public sewers at the manhole shall adhere to the following criteria when possible:
 - (a) The elevation of the crown of the discharging sewer shall either match the elevation of the crown of the receiving sewer or be approved as special cases by the City.
 - (b) A standard drop connection is required when the difference in elevation between discharging sewer flowline and receiving flowline is greater than 24 inches.
 - (3) The routing of service connection directly to manholes will be allowed only where the flowline elevation of the existing sanitary sewer is more than 10 feet below grade and there is no available stack and either
 - (a) The lot to be so connected is a single-family, owner-occupied, single lot residence connection to an existing manhole; or
 - (b) The lot to be so connected is a single-family, owner- occupied, single lot residence connecting to a proposed manhole at the end of a cul-de-sac.

- (4) When routing an approved service connection to a manhole (see Item "3"), the wall penetration shall not be greater than 10 inches in diameter and shall be cored and sealed using grout as approved by the Standard Wastewater Products Committee.
 - (5) When routing an approved service connection to a manhole (see Item "3"), the connections shall utilize an external drop and shall adhere to the following criteria:
 - (a) The manhole wall penetration shall be a minimum of 10 feet below the manhole rim elevation and shall not be greater than 10 inches in diameter;
 - (b) The drop shall be 6 inches in diameter and shall be constructed of SDR 26 PVC pipe (ATSM D 3034-94);
 - (c) The drop shall be located 45 degrees from the upstream side of the main sewer;
 - (d) The wall penetration (core) shall be sealed using a "grout" as approved by the City Engineer.
 - (6) All public sewers shall terminate in a manhole. Clean-outs will not be utilized except at the end of each service lead.
 - (a) The manhole cover shall have a minimum diameter of 32 inches.
 - (b) All sanitary sewer manholes shall have stainless steel inflow protectors.
- f. Manholes to be coated with Raven 405. Sewper Coat may be used as an approved alternative with Public Works preapproval.
- g. Manholes shall not be located within a driveway, street, parking stalls, or sidewalk.

K. Lift Stations and Wastewater Treatment Plants

1. Lift station design shall comply with the City of Manvel specifications, with a storage volume in the wet well equal to 1.5 times the peak design flow to the lift station. Add 10% to account for volume displaced by pumps.
2. Minimum site size shall be 40 feet by 40 feet. Smaller sites that are adjacent to public rights-of-way are contiguous to green space or similar land use areas, may be approved when adequate odor control provisions are provided.
3. Pumps shall be sized to operate at optimum efficiency. Minimum acceptable efficiency at the operating point will be sixty percent (60%).
4. Operation and maintenance should be considered in the design of the station and the location of the station.
5. Wet well working volume should be sized to allow for the minimum pump cycle of six (6) minutes for each pump.
6. Prior to installation controls and equipment shall be approved by Public Works.
7. Emergency operations shall be considered. Provide fittings and a blind flange that will be readily accessible for emergency bypass pumping.
8. The inlet structure shall be designed to minimize turbulence.

9. The velocity in the Force Main and riser pipes shall be between 3 and 8 fps.
10. The wet well shall be sized to provide adequate clearance between the pumps (refer to manufacturers recommended clearances).
11. A peak factor of four (4) shall be used for Lift Station design.
12. A minimum of two (2) feet of clearance shall be provided between pumps and between pump and wall.
13. Low water levels shall be at least six (6) inches above impeller.
14. Complete immersion of submersible pump motor at low water level is preferred.
15. Tie steel in Lift Station bottom to wall (includes caisson construction situation) to provide watertight wet well.
16. Nuts, bolts, chains and all other metal components within wet well shall be stainless steel.
17. Vent pipe shall be six (6) inches minimum diameter equipped with odor control system.
18. The following Hazen-Williams Coefficient shall be used for various pipe types:

PVC	New	C = 160
	10-year	C = 140
DIP	New	C = 140
	10-year	C = 100
19. Provide minimum 8' board fence (either masonry, cedar or heart redwood) with steel posts in concrete, and a treated 2"x6" (or wider) rot board along the bottom.
20. Entrance drive to be at least fourteen (14) feet wide concrete pavement. Provide enough room to park inside site. Provide rolling gate with minimum 10' wide gate.
21. Indicate method of drainage on site plan. Internal drainage, sheet flow and valley gutter driveways are acceptable. Drain to street or storm sewer, never onto adjacent private property.
22. Locate control panel and wet well hatch above 100-year flood plain. Call out the 100-year flood plain elevation on the plans.
23. Dual stainless steel guide rails (or other pump removal method that avoids entering wet well) are required for submersible pumps.
24. A tee, plug valve (or gate valve), and blind flange assembly is required on the force main on the downstream side of the discharge valves and header. This is required so truck-mounted pumps can bypass the lift station pumps and piping while work is being done.
25. Bedding for PVC force main is bank sand a minimum of 6 inches from all sides of pipe.
26. PVC force mains must be C-900.

27. DIP force mains are to be bedded in bank sand and polyethylene wrapped.
28. When calculating head loss in force main and piping, use of K factors on fittings, with the Hazen-Williams formula, is preferred.
29. Backfill structural excavations (wet well, etc.) with cement stabilized sand.
30. Lift station site plans shall be submitted in scales of 1-inch = 5-feet or 1-inch = 10-feet.
31. Provide a protective coating or concrete additive to interior walls of wet well. Public Works shall approve coating or additive used.
32. Lift station shall be equipped with a telemetry system, approved by City and compatible with existing system. A bubbler system shall be installed and connected to telemetry system to monitor status of lift station.
33. Permanent power supply to lift stations and wastewater treatment plants shall be 3-phase (and 480 volts where possible) and installed prior to City Council acceptance.
34. A system of floats shall be provided to control pumps.
35. A pressure gauge suitable for application shall be installed on each discharge pipe.
36. Emergency backup generator (natural gas or diesel) to be installed on site and hard-wired to the electrical panel, with an automatic transfer switch (permanent installation; not a portable or trailer-mount style). Additionally, a quick-connect style plug to be installed on the panel, as a backup precaution, upon preapproval from Public Works. Generators must be new when installed (not refurbished or previously used). Natural gas generators are to be installed where natural gas is available.
37. Refer to Section 6 Controlled Access Gate Requirements.

1.05 APPURTENANCES - Reserved

1.06 SUBMITTALS

- A. Preliminary design - submit the following for review and comment:
 1. Copies of any documents which grant approval of exceptions to the City design criteria.
 2. Design calculations for line sizes and grades
 3. Contour map for overall area.
 4. Plan and profile sheets showing proposed improvements (City projects only).
 5. Geotechnical soils report for the project (City projects only).
- B. Final design - submit the following for approval:
 1. Final documents of the above plus plan and profile sheets and Geotechnical soils reports.
 2. Review prints.
 3. Original drawings.

1.07 QUALITY ASSURANCE

- A. Prepare calculations and construction drawings under the supervision of a Professional Engineer trained and Licensed under the disciplines required by the drawings. The final construction drawings must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings.
- B. Prior to release of the maintenance bond (and in conjunction with the final walk-thru), the developer shall have all sanitary sewer lines (within the project boundary) inspected with television equipment. Any pipe settlement which causes excess ponding of water in pipeline, any misaligned joints, or other defects shall be cause for rejection. The developer shall provide the City with one copy of the TV videotape and one copy of the TV inspection report. For each segment, the video tape and corresponding written report shall clearly identify:
 - 1. Each line segment being inspected.
 - 2. The size and type of pipe being inspected.
 - 3. Accurate footage of the line segment inspected.
 - 4. Deficiencies in materials, alignment, pipe grade, or any other apparent deficiencies; and
 - 5. Locations of all service connections.
- C. During the final walk-thru, contractor will be required to show public works personnel that all sanitary sewer lines can be located by the 3M Dynatel Line Locator. The developer shall provide the City with at least one 3M Dynatel Line Locator prior to final acceptance.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS

- A. Research existing utility and right-of-way information.
- B. Verify that no restrictions exist that will deny approval of the project concept.

2.02 DESIGN ANALYSIS

Calculations of design flow for overall development project. All wastewater components in the City of Manvel and its ETJ shall be designed for a minimum of 315 gallons per equivalent single-family connection.

2.03 DRAWINGS

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

SECTION 3 WATER

1.0 GENERAL

1.01 CHAPTER INCLUDES: Criteria for the design of water distribution systems.

1.02 REFERENCES

- A. Texas Commission on Environmental Quality (TCEQ), Water Utilities Division "Rules and Regulations for Public Water Systems," latest revision.
- B. American Water Works Association (AWWA).
- C. National Sanitation Foundation (NSF).
- D. Texas Department of Health.
- E. Texas State Board of Insurance.

1.03 DEFINITIONS

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

1.04 DESIGN REQUIREMENTS

- A. Easements for water lines
 - 1. Lines shall be located within street right-of-way, permanent access easements with overlapping public utility easements, easements adjacent to street rights-of-way or recorded water line easements.
 - 2. When outside of a public street right-of-way or permanent access easement with an overlapping public utility easement, easements must be dedicated and restricted for water lines only.
 - 3. When possible, easements should be adjacent to public rights-of-way.
 - 4. When possible, water line easements shall be contiguous to paved access.
 - 5. For water lines located outside of street rights-of-way, the minimum width of easement shall be 20 feet.
 - 6. For water mains located within 5 feet from the right-of-way line, the outside edge of a water line easement shall be located 10 feet from the right-of-way line.
 - 7. Water lines along State rights-of-way shall be installed outside of the right-of-way in a separate 20-foot minimum contiguous easement.

8. No back-lot easements will be allowed for the installation of water lines.
 9. Commercial Developments inside the City requiring on-site fire hydrants must provide a minimum 20-foot water line easement for the water line and fire hydrant.
 10. Water lines shall be centered in water line easements.
 11. When using side lot easements, such easements shall be a minimum of 20 feet in width, located on one lot or centered between lots. If centered between lots, the water line may be centered within the five feet of one lot or centered in the easement.
 12. Location of a water main in an easement not adjoining a public right-of-way shall be prohibited. When approved, these water mains will be centered in a 20-foot-wide exclusive easement restricted to water only.
- B. Location of water lines
1. Locate water lines within a street right-of-way whenever possible.
 2. In the event that a proposed water line cannot be located within the street right-of-way, locate water lines in the center of a dedicated water line easement.
 3. When a water line is placed parallel to another utility line, other than a sanitary sewer, the water line shall have a minimum of 4 feet horizontal clearance from outside wall of the water line to the outside wall of the existing utility.
 4. All new water lines are to be installed with 3M EMS warning tape for future line locates.
 5. All new water lines shall be installed or extended from property line to property line.
 6. End of fire hydrant and valve shall be placed at the beginning and/or end of all new water lines for future City water line extensions as detailed in City of Manvel Water Distribution standards
- C. Water line size
1. 6-inch lines may be used within cul-de-sacs or if the line is less than 1,000 feet in length and interconnected between two lines which are 8 inches in size or larger. The maximum number of fire hydrants or flushing valves on any length of 6-inch line is one.
 2. 8-inch lines may be used for lines over 1,000 feet long, crossing under a major roadway, or when 2 or more fire hydrants or flushing valves are required.
 3. 12 inch and larger lines - lines to be determined by the Professional Engineer (P.E.) and City of Manvel.
 4. Minimum 1-inch lines are to be used for commercial irrigation lines.
 5. Minimum 2-inch lines are to be used for commercial domestic water lines. Meter size to be determined by the developer's design professional or plumber. Meter size cannot exceed the size of the service connection.

- D. Dead-end lines shall be avoided.
- E. Depth of cover
1. 14 inch and smaller mains and fire lines shall have a minimum cover of 4 feet from top of curb. For open ditch roadway sections, 12 inch and smaller shall be installed at least 3 feet below the ultimate flowline of the ditch or 6 feet below natural ground at the right-of-way line, whichever is deeper.
 2. 16 inch and larger mains shall have minimum cover of 5 feet from top of curb. For open ditch roadway sections, 16 inch and larger mains shall be installed at least 3 feet below the flow line of the ditch or 7 feet below natural ground at the right-of-way line, whichever is deeper.
 3. Changes in grade to clear other utilities or underground features may be made by deflecting pipe joints. The maximum designed deflection shall be one-half ($\frac{1}{2}$) of the manufacturer's allowable deflection. If a depth greater than 8 feet to the top of the pipes is required, a welded steel section will be used. The standard depth of cover maintained on the water main and the grade change shall be made using the welded steel section. The installation of fittings for vertical deflections or changes in grade shall not be allowed except with specific approval of the City of Manvel.
- F. Water line crossings
1. Where a water line crosses another utility (public or private) other than a sanitary sewer, a minimum of 6 inches of clearance must be maintained between the outside wall of the water line and the outside wall of the utility.
 2. Elevated Stream and Ditch Crossings
 - a. All water lines shall be steel or restrained joint metallic pipe and shall extend a minimum of 15 feet beyond the last bend or to the right-of-way line, whichever is greater.
 - b. Elevated crossings are preferred to underground crossings.
 - c. Support water lines on existing or proposed bridges. The following criteria may be used when approved in advance by the City Engineer:
 - (1) Have adequate structural capacity.
 - (2) Have sufficient clearance above the bent cap elevation for installation under the bridge.
 - (3) Design elevated crossings with the elevation of the bottom of the water line above the low chord of the nearest adjacent bridge or a minimum of 1 $\frac{1}{2}$ feet above the 100-year flood plain elevation, whichever is higher.
 - (4) Extend pipe from right-of-way to right-of-way for crossings.
 - (5) Provide sufficient span length to accommodate the cross section of future widening of the stream or ditch, if available.
 - (6) Support the line on columns spaced to accommodate the structural capacity of the pipe considering deflection and loading.
 - (7) Base column support design on soil capacity, spacing, loading, and structural requirements.

G. Underground crossings

1. Provide a minimum 3-foot clearance above the top of the pipe to the ultimate flow line of the ditch.
2. Provide sufficient length to exceed the ultimate development of the stream or ditch.
3. All water lines shall be steel or restrained joint pipe and shall extend a minimum of 15 feet beyond the last bend or to the right-of-way, whichever is greater and have valves located on both sides of the crossing.

H. State highway and County Road crossings

1. Extend carrier pipe from right-of-way to right-of-way.
2. Use welded steel pipe or restrained joint pipe in steel casing under existing and future roadways from a point 15 feet outside of the service road or outside of pavement toward the right-of-way, to a similar point on the other side of the highway across the right-of-way. For highway or roadway crossings with open ditch sections, extend the casing from right-of-way to right-of-way.
3. State highway crossings shall be constructed in conformance with the requirements of the Texas Department of Transportation.
4. When additional right-of-way has been acquired or will be required for future widening, the casing should be carried to within 10 feet of each future right-of-way line.

I. Street crossings

1. All street crossings shall be perpendicular to the right-of-way.
2. All water mains, services and sprinkler line crossings under major thoroughfare boulevards shall be encased using a minimum of PVC pipe, SDR, as shown on the construction detail for "Water Main Encasement." Welded steel pipe may be substituted on street crossings, when specifically approved by the City Engineer.
3. Crossings under existing concrete streets, other than major thoroughfares, shall be constructed by boring and jacking. PVC pipe shall be jacked into place with equipment designed for that purpose. Water may be used to facilitate boring and jacking operations. Jetting the pipe main into place will not be permitted. When conditions exist that warrant an open cut across an existing street, the City may specifically approve the crossing.
4. All open-cut installations under existing or proposed streets shall be backfilled as shown in the construction details.
5. All street crossings shall be constructed in accordance with construction plans approved by the City. The City shall inspect all street crossings. All street crossings shall meet the requirements of these standards.
6. All street, road, and creek crossings shall be cased with a larger diameter pipe.

J. Oil and gas pipeline crossings

Do not use metallic pipe when crossing oil or gas transmission lines unless a cathodic system is implemented with City approval. Other pipe may be used, regardless of depth, subject to approval by the City. Maintain minimum 2-foot separation between pipeline and water line.

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

For developments requiring on-site fire hydrants, comply with the following requirements to allow maintenance and future repair operations:

1. Do not allow placement of structures or equipment pads over easement.
2. Provide 10-foot-wide longitudinal pavement joint along easement lines where the water line is located under driveway, parking or street pavement.
3. Locate public fire line within 20' easement or provide fire line meter at the property line.

L. Additional requirements

1. The carrier pipeline shall extend a minimum of 1 foot beyond the end of the casing to allow flanged joints to be constructed.
2. For welded steel bends, extend steel pipe to a minimum of 5 feet beyond the bend. All bends shall be identified with 3M EMS point markers for future bend locates.
3. PVC sleeves to be installed under all concrete driveways and streets for future expansion.
4. PVC sleeves to be installed in medians for irrigation lines.
5. Coordinate sleeve size with Public Works.

M. Auger (bore) construction

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

1. Auger or bore sections shall be clearly shown on drawings.
2. Improved streets - use auger construction to cross the street regardless of surface. Auger length shall be computed as roadway width at proposed bore location plus 5 feet to either side of the roadway, where applicable.
3. Sidewalks - when the water line crosses under a sidewalk in good condition, the sidewalk shall either be bored and jacked or the sidewalk shall be removed and replaced to the City of Manvel 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.
4. Bore Pits - Bore pits shall be at least 3 feet from back of curb and 5 feet from the back of curb on a major thoroughfare. 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.

N. Water quality

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

1. Provide a source of fresh water at each end or at multiple points of a subdivision. Provide ways to create circulation and place valves and fire hydrants to allow simple flushing of all lines.
2. Avoid dead-ends. When necessary, isolate dead-ends with a line valve, fire hydrant at the line's end, along with an Eclipse 9800i-Genesis Auto Flusher.
3. Where stubs are provided for future extensions, isolate the stubs with a valve and do not allow service connections to stubs until extended. Place one full pipe joint between the valve and stub. All stubs shall be identified with 3M EMS point markers for future stub locates.
4. Water mains shall be looped unless physically impossible.
5. All materials which come in contact with public drinking water in any stage must conform with ANSI/NSF Standard 60.
6. Layout and size of all water mains shall be consistent with the overall layout and phasing plan of the City's water system. The overall water system shall be designed to maintain required TCEQ minimum pressure throughout the system.
7. In an unavoidable dead-end situation, reduce the sizes of pipe successively. Carry an 8-inch pipe to the next to last fire hydrant; use a 6-inch PVC to the end of the line. Provide a fire hydrant at the end of the main.

O. Clearance of water line from other utilities.

1. New water lines parallel to sanitary sewers and force mains
 - a. Locate water lines a minimum of 9 feet horizontally, outside wall to outside wall, when parallel to sanitary sewers or force mains. Use the following procedure when 9 feet of separation cannot be achieved:

When a new water line is to parallel an existing sanitary force main or gravity sanitary sewer and the 9-foot minimum separation distance cannot be maintained, the existing sanitary sewer shall be replaced with lined ductile iron or PVC pipe meeting ASTM specifications, having a minimum working pressure rating of 150 psi or greater and equipped with pressure type joints. The water lines and sanitary sewer shall be separated by a minimum vertical distance of 2 feet, and a minimum horizontal distance of 4 feet, measured between the nearest outside walls of the pipe, and in all cases, the water line shall be located above the sewer. When a water main crosses a utility other than sanitary sewer, a minimum of 6 inches of clearance must be maintained, and the water main shall have one joint of pipe, a minimum 18 feet long, centered on the other utility.

- b. Where a sanitary sewer crosses the water main, and that portion of the sewer within 9 feet of the water is constructed as described in Section 290.44(e) of the TCEQ Rules and Regulations, the water line may be placed no closer than 6 inches from the sewer. The separation distance must be measured between the nearest outside pipe diameters. The water line shall be located at a higher elevation than the sewer, wherever possible and one joint, a minimum of 18 feet long, of the new pipe must be centered on the existing line.
2. When water lines are installed in areas which have existing sanitary sewers, every effort should be made to maintain 9 feet of separation between the outside pipe diameters of the two lines. Where this separation cannot be achieved because of local conditions, which must be fully documented in any planning material submitted, the following spaces shall be observed:
 - a. Where a new water line is to cross or be installed in parallel with an existing sanitary sewer, and the sewer is constructed as described in Section 290.44(e) of the TCEQ Rules and Regulations, the separation distances specified in those rules shall apply as though the sewer were new.
 - b. Where a new water line is to be installed in parallel to existing clay, truss, or concrete gravity sewer showing no evidence of leakage vertically and 4 feet horizontally, the sanitary sewer need not be disturbed. Should excavation for the water line produce evidence that the sewer is leaking, and then the sewer must be repaired.
 - c. Where a new water main is to cross an existing clay, truss, or concrete gravity sewer showing no evidence of leakage, the sewer need not be disturbed if the water line is to be installed at least 24 inches above the existing sewer. A full joint of the water line, at least 18 feet long, should be centered over the sewer crossing, in this case, so as to provide maximum protection against contamination.
 - d. Existing clay, truss or concrete sewer pipe which shows no evidence of leakage and because of physical limitations must remain at a higher elevation than the proposed intersecting water line or closer than 2 feet may remain undisturbed if the water line is inserted in a joint of pressure type encasement pipe at least 18 foot long and 2 nominal sizes larger than the water line. The encasement pipe should be centered on the sewer crossing and both ends sealed with cement grout. In lieu of this procedure, that portion of the sewer within 9 feet of the water line may be replaced with cast iron or ductile iron pipe with watertight joints as described in Section 290.44(e) of the TCEQ Rules and Regulations, above.
3. Sanitary manholes - provide a minimum 9-foot horizontal clearance from outside wall of existing or proposed manholes unless manholes and connecting sewers can be made watertight and tested for no leakage. If a 9-foot clearance cannot be obtained, the water line may be located closer to the manhole when prior approval has been obtained from the City of Manvel by using one of the procedures below; however, in no case shall the clearance be less than 4 feet.
 - a. Water line may be encased in a carrier pipe. Encasement shall be a steel water line in a steel carrier pipe. Open cut and backfilled with cement stabilized sand compacted backfill.
 - b. The water line may be augured past the manhole with one 20-foot section of C-900 PVC pipe 150 psi, installed centered about the existing sanitary manhole with pressure grout using a bentonite/clay mixture.

4. Fire hydrants. Do not install fire hydrants within 9 feet vertically or horizontally of sanitary sewer mains, service leads, and force mains regardless of construction.

P. Water Plants

1. All new storage tanks to be elevated; not ground level. Developer to provide proposed timeline, plan, and funding mechanism for Elevated Storage Tank subject to review and approval by the City.
2. Emergency backup generator (natural gas or diesel) to be installed on site and hard-wired to the electrical panel, with an automatic transfer switch (permanent installation; not a portable or trailer-mount style). Additionally, a quick-connect style plug to be installed on the panel, as a backup precaution, upon preapproval by Public Works. Permanent power supply to water plants shall be installed prior to City Council acceptance. Generators must be new when installed (not refurbished or previously used). Natural gas generators are to be installed where natural gas is available.
3. Provide minimum 8' board fence (either masonry, cedar or heart redwood) with steel posts in concrete, and a treated 2"x6" (or wider) rot board along the bottom.
4. Entrance drive to be at least fourteen (14) feet wide concrete pavement. Provide enough room to park inside site. Provide rolling gate with minimum 10' wide gate.
5. Indicate method of drainage on site plan. Internal drainage, sheet flow and valley gutter driveways are acceptable. Drain to street or storm sewer, never onto adjacent private property.
6. Refer to Section 6 Controlled Access Gate Requirements.

1.05 APPURTENANCES

A. Valves - Set at maximum distances along line as follows:

1. Six inch (6") through fourteen inch (14") - 1000 feet.
2. Sixteen inch (16") through twenty inch (20") - 2000 feet.
3. The total number of valves at any intersection shall equal the total number of lines leading out from the intersection point minus one, three (3) valves for a cross, and two (2) valves for a tee, unless otherwise specified.

B. Valve Types - All valves shall open counterclockwise and have mechanical joints:

1. Six inch (6") through fourteen inch (14") shall be gate valves.
2. Sixteen inch (16") through twenty inch (20") shall be butterfly valves.

C. Valve Locations

1. All mains shall be valved within the street right-of-way or within a dedicated water line easement. Valves shall not be placed under or within 2 feet of ultimate pavement.
2. Valves are normally located on the projection of intersecting street right-of-way lines or at the curb return adjoining a paved street across the main. Tapping sleeves and valves are excluded from this requirement.
3. Isolate fire hydrants and flushing valves from the service line with a valve located in the fire hydrant or flushing valve branch. This valve shall not be located in the slope or flowline of ditches on roadside ditch roadways.
4. Intermediate valves, not located on the projection line of the right-of-way line, shall be located on lot lines or 5 feet from fire hydrants but not set in driveways.
5. Locate valves a minimum of 9 feet horizontally from sanitary sewer crossings.
6. Valves shall not be located within a driveway, sidewalk, or street.
7. Valves shall be included at all water loops in cul-de-sacs for isolation should any possible future maintenance issues arrive.
8. All new valves are to be installed with 3M EMS point markers for future valve locates.

D. Fire hydrants and flushing valves.

1. Spacing
 - a. Single Family Residential Development:
300 foot maximum spacing and at all street intersections
 - b. Non-Residential, Commercial Developments and/or Multi-Family Developments:
300 foot maximum spacing and at all street intersections. Fire hydrants shall be placed to locate a hydrant within 300 feet of all points of each building.
2. Location in or along street rights-of-way
 - a. Fire hydrants shall be primarily located at street intersections where possible.
 - b. Locate fire hydrants at P.C.s of the intersection curb radius, 3 feet behind the curb or projected future curb.
 - c. On all State highways and roadside ditch roadways, set the fire hydrants within 3 feet of right-of-way lines. Fire hydrants lead valves shall not be located in the slopes or flowlines of ditches.
 - d. Set intermediate fire hydrants on lot lines, as extended to pavement, when located between right-of-way intersections. These locations may be adjusted 5 feet either way to miss driveways or other obstructions. In either case, do not locate fire hydrants closer than 3 feet from curbed driveways or 5 feet from non- curbed driveways.
 - e. Fire hydrants and flushing valves shall not be installed within 9 feet of a sanitary sewer system under any condition.
 - f. All new flushing valves are to be installed with 3M EMS point markers for future valve locates.

3. Location of fire hydrants or flushing valves outside the street right-of-way
 - a. The City Fire Marshal will establish and approve the location of fire hydrants and flushing valves in apartment complexes and platted private street developments within the City.
 - b. Locate fire hydrants and flushing valves in protected, easily accessible areas behind curb lines.
 - c. For fire hydrants or flushing valves which are located adjacent to water lines constructed in 20-foot-wide water line easements, the fire hydrant or flushing valve shall be centered in a minimum 10'x10' separate easement.
 - d. For commercial and multi-family developments inside the City, provide isolation valves at each end of fire loops requiring on-site fire hydrants.
 - e. All new flushing valves to be installed with 3M EMS point markers for future valve locates.
4. Fire Flow: Fire hydrants must be able to meet current NFPA and adopted Fire Code regulations.
5. Fire hydrants shall be audited and painted per City specifications
 - a. The barrel (base) and caps shall be baked-on paint Safety Red.
 - b. The bonnet (top) shall be baked-on paint according to the size of the line:

Red	4-inch water line
Yellow	6-inch water line
White	8-inch water line
Green	10–20-inch water line
Orange	24-inch water line and above
6. 5" built-in Storz connections and dust covers are required on all hydrants.
7. Fire Department Connections (FDC's) when required shall be remotely located from buildings and have Storz connections. The Fire Department Connection (FDC) shall be located at a point no further than twenty (20) feet from a fire apparatus access road, remotely located at a horizontal distance that is greater than the height of the building on the main street side, and easily accessible to the Fire Department. The location of the FDC shall be such so as to provide hose connections that shall not block access to the building or obstruct other fire apparatus from accessing the building. There shall be an approved sign as specified by the Fire Marshal designating the address served by the FDC. A fire hydrant shall be located within fifty (50) feet of the FDC measured along a fire apparatus road. If there is a conflict between this section and another section of this code, the most restrictive requirement shall apply.
8. All new fire hydrants to be Mueller A423 Super Centurion with 5" Storz outlet. East Jordan WaterMaster 5CD250 fire hydrants, with 5" Storz outlet, are an approved alternative.
9. There shall be a minimum clearance of 3 feet around each fire hydrant.
10. Fire Department Connections (FDC's) shall be located within 50 feet of a fire hydrant.
11. Buildings equipped with a standpipe system shall have a fire hydrant within 50 feet of the FDC.

12. All fire hydrants located in the City and its ETJ shall be identified with a blue reflector affixed to the pavement so that a hydrant is readily visible to arriving fire companies. On unpaved streets, a blue reflector shall be affixed to a post as close as practicable to the edge of the roadway so as to be visible.

E. Fittings

1. All fittings shall be identified and described on the civil construction plans.
2. Fittings are not permitted in fire hydrant leads.
3. Normally, all water main fittings shall be ductile iron mechanical joints only.
4. All plugs shall be provided with retention clamps.
5. 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.
6. Thrust blocking and 3M EMS point marker shall be required on all bends, tees, plugs and combinations thereof.
7. All fittings and fire hydrants to be tied together with 3/4-inch stainless steel all- threads and I-bolts or approved equal (i.e., Mega Lugs).

F. Water main service

1. Water main service for lines in or along street rights-of-way.
 - a. Meters 2 inches and smaller - located in rights-of-way, water line easements, or in a minimum 5'x5' separate water meter easement. Meters shall be located in areas with easy access and protection from traffic and adjacent to right-of-way whenever possible.
 - b. Meters 3 inches and larger - located at the property line or in a minimum 10' x 20' separate water meter easement if necessary.
 - (1) Meters shall be located in areas with easy access and protection from traffic and adjacent to rights-of-ways whenever possible.
 - (2) Meters shall not be located in areas enclosed by fences.
 - c. Separate tap and service leads shall be designed for each meter.
 - d. Long service connections to be minimum 1-inch leads within 2-inch PVC casing.
 - e. No water line service shall exceed 150 feet in length.
 - f. Water line service shall be designed for meter to be at front of property or residential lot.
2. For proposed apartments or town homes in private street developments, provide one master meter sized for the entire development. Exceptions may be granted by the City of Manvel for unusual circumstances. If an exception is approved, do not interconnect multiple meters.

3. All sprinkler and irrigation lines must be equipped with a backflow prevention device according to its application as required by TCEQ. Every new and existing non-single-family residential user is required to install a backflow prevention assembly at any meter servicing such a user's property. The backflow assembly shall be located after the meter for an irrigation system and in a vault near the building for a sprinkler system. A certified tester shall test the backflow prevention assembly annually and submit the results to the City.

1.06 SUBMITTALS

- A. General - Conform to the following submittal requirements in addition to those of general procedure of the City of Manvel.
- B. Water Line Sizes - Submit justification, calculations, and locations for proposed 6-inch lines and for lines 12-inch and larger, for approval by the City of Manvel, unless sizes are provided by the City.
- C. Valves - Submit information for approval by the City of Manvel with justification and locations for use of 16-inch and 20-inch gate valves proposed as substitutes for butterfly valves.
- D. Water Meter Service
 1. For construction inside city limits, submit an application for meter services and metered sprinkler connections, to the Building Inspections Division prior to construction.
 2. Submit requests for more than one service meter in proposed private street or multi-family developments to the City.
 3. All new and replacement water meters to be Neptune E-Coder R900i (minimum $\frac{3}{4}$ inch) unless approved by the City Engineer.
- E. Elevated stream or ditch crossings - Submit design calculations for support columns and column spacing.
- F. Master Development Plan - For multiple phase developments, submit a master development plan.
- G. Backflow Prevention
 1. All irrigation lines must be equipped with backflow prevention devices per TCEQ.
 2. A double check backflow prevention assembly is required for 3" and larger lines.
 3. Every new and existing non-single-family residential user is required to install a backflow prevention assembly at any meter servicing such a user's property.
 4. Refer to Section 71-7 of the City Code.

1.07 QUALITY ASSURANCE

- A. Prepare calculations and construction drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the drawings. The final construction drawings must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings.
- B. During the final walk-thru, contractor will be required to show public works personnel that all water lines and required components within the project boundary can be located by the 3M Dynatel Line Locator. The developer shall provide the City with at least one 3M Dynatel Line Locator prior to final acceptance.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS

- A. Research existing utility and right-of-way information.
- B. Verify that no restrictions exist that will deny approval of the project concept.

2.02 DESIGN ANALYSIS

- A. Water line sizes - Prepare narrative justification and calculations for proposed 6-inch lines and for lines 12-inch and larger, unless sizing is provided by the City of Manvel in advance.
- B. Elevated stream or Ditch Crossings - Prepare design calculations for support columns and column spacing.
- C. Developments of 100 acres or more to provide Regionalization Plan, including interconnection(s) with adjacent properties subject to review and approval by the City.
- D. All water components in the City of Manvel and its ETJ shall be designed for a minimum of 360 gallons per day per equivalent single-family connection.

2.03 DRAWINGS

- A. General: Conform to the following drawing requirements in addition to those of "Graphic Requirements" and the City's standard water line details and standard specifications.
- B. Appurtenances - Identify, describe and enclose in rectangular box on drawings.
 - 1. Valves
 - a. Designate 6-inch through 12-inch gate valves with box as GV&B.
 - b. Provide complete description and size for other valves.
 - 2. Water meters, service leads, and metered sprinkler connections.
 - a. Show the location of service line tees, tapping sleeve and valves, valve boxes, and temporary plugs to be installed to serve future 3-inch or larger meters.
 - b. Develop plan and profile sheets for 4-inch and larger leads and all service connections that cross state rights-of-way (FM1128, SH6, etc.).

C. Construction features

1. Show all special construction features required to complete the project in a safe, convenient and economical manner.
2. Auger Construction
 - a. If the construction is predominately open cut, all portions of the street that must be augured shall be clearly shown on drawings by location and length. Include designation for sections at trees with 6 inches or larger diameters located within 10 feet of water Line.
 - b. Curbs - Include a requirement on drawings for construction of wheelchair ramps at street intersections where curbs are to be removed or are damaged by water line construction. Conform to the City's standards for ramps.

SECTION 4 PAVING

1.0 GENERAL

1.01 CHAPTER INCLUDES:

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

1.02 REFERENCES

- A. AASHTO - American Association of State Highway and Transportation Officials.
- B. ASTM - American Society for Testing Materials.
- C. ACI - American Concrete Institute.
- D. MUTCD - Texas Manual on Uniform Traffic Control Devices.
- E. City of Manvel Transportation Corridor Plan

1.03 DEFINITIONS

- A. Geotechnical Engineer - An engineer certified by the American Association for Laboratory Accreditation (A2LA).
- B. HMAC - Hot Mix Asphaltic Concrete.
- C. Curb and Gutter Sections - Full width concrete pavement with doweled on 4-inch by 12-inch curbs. Curb and gutter sections require inlets and underground storm sewers.
- D. Roadway ditch sections - Ditch sections adjacent to either full-width reinforced concrete pavement or asphaltic pavement. Roadside ditch sections do not require underground storm sewers; however, the ditch sections must be designed to accommodate the storm runoff.

1.04 DESIGN REQUIREMENTS

The following design requirements are applicable to all pavement within the City of Manvel, and its ETJ.

- A. General
 - 1. All paving shall be approved by the City of Manvel for all streets within the City.
 - 2. Street design should conform to all applicable planning tools, such as the Texas Manual on Uniform Traffic Control Devices, major thoroughfare plans, master plans, etc. Other considerations for design should include street function, street capacity, service levels, traffic safety, pedestrian safety, and utility locations. These additional considerations may affect the minimum requirements set forth herein. Refer to the City of Manvel Major Thoroughfare Plan and Transportation Corridor Plan.
 - 3. Design shall conform to the City of Manvel Standard Details.

B. Minimum Width Requirements and Paving

1. The minimum ROW width for all streets in the City of Manvel and its ETJ is 60 feet. The minimum pavement width for all developments is:
 - a. Curb and Gutter sections: 28 feet back-to-back of curb (B/B).
 - b. Open-ditch sections: 26 feet edge to edge of pavement.

2. Per the City of Manvel Thoroughfare Plan, a minimum 80 feet ROW is required for the following:
 - a. Charlotte
 - b. Chocolate Bayou
 - c. Dogwood Avenue
 - d. Iowa Lane
 - e. Jordan Road
 - f. Rodeo Drive
 - g. Uzzell Road

3. Per the City of Manvel Thoroughfare Plan, a minimum 100 feet ROW is required for the following:
 - a. Bahler Avenue (CR 100)
 - b. Bissell Road
 - c. Booth Road
 - d. Cemetery Road (Harkey Road)
 - e. Clark Road
 - f. Lewis Lane
 - g. Oil Field Road (County Road 98)
 - h. Scopel Road

4. Per the City of Manvel Thoroughfare Plan, a minimum 120 feet ROW is required for the following:
 - a. Airline Road (County Road 48)
 - b. Bailey Avenue (County Road 101)
 - c. Croix Road (Country Road 58)
 - d. Del Bello Boulevard (Rodeo Palms Parkway / Belcher / County Road 397)
 - e. Kirby Drive
 - f. Manvel Parkway (County Road 94)
 - g. Markham Road
 - h. Masters Road (FM1128 / County Road 67)
 - i. McCoy Road (Meridiana / Peters / Patterson / County Road 89 / Old Chocolate Bayou)
 - j. Pearland Sites Road (County Road 99 / County Road 143)
 - k. Pollard Boulevard (County Road 90)
 - l. Southfork Drive (County Road 59)

C. Minimum Thickness and Reinforcement Requirements for Concrete Pavement

The following requirements are the minimum allowable. Pavement thickness and reinforcement shall be designed by the Professional Engineer responsible for the project based on current soil analysis and recommendations by a qualified geotechnical engineer.

1. For pavement widths less than or equal to 28 feet B/B of curb:
 - a. Minimum concrete slab thickness shall be 6 inches with $f_c = 4,000$ psi, with a minimum of 6 sacks of cement per cubic yard, and reinforcement shall be Grade 60, $f_y = 60,000$ psi, #4 deformed reinforcing bars spaced at 18 inches center to center both ways and minimum lap lengths of 18 inches. Expansion joints shall be placed at the end of each curb return and at a maximum spacing of 60 feet.
 - b. Minimum stabilized subgrade thickness shall be 6 inches.
2. For pavement widths greater than 28 feet B/B and for major arterial thoroughfares:
 - a. Minimum concrete slab thickness shall be 7 inches with $f_c = 4,000$ psi, with a minimum of 6 sacks of cement per cubic yard, and reinforcement shall be Grade 60, $f_y = 60,000$ psi, #4 deformed reinforcing bars spaced at 18 inches center to center both ways and minimum lap lengths of 18 inches. Expansion joints shall be placed at the end of each curb return and at a maximum spacing of 60 feet on residential and collector streets, and a maximum spacing of 60 feet on boulevards and major thoroughfares.
 - b. Minimum stabilized subgrade thickness shall be 8 inches.

D. Subgrade Treatment

Geotechnical Engineer shall base depth of subgrade stabilization on structural number (SN) in conjunction with pavement thickness design. Following is a general guide for subgrade treatment:

1. For subgrade soil conditions with a clay content of 10.0% or higher and plasticity index (PI) of 10 or more, the subgrade shall be stabilized with lime. Subgrade shall be stabilized with a minimum 6% lime by weight, at required thickness and compacted to 95% standard proctor density. Alternative subgrade stabilization may be substituted when specific recommendations are made by the geotechnical engineer for the project, and when specifically approved by the City Engineer.
2. For subgrade soil conditions containing clean sand with no clay content, the subgrade shall be stabilized with cement.

E. Requirements for Intersections, Turnouts, Transitions, and Thoroughfares

1. At a "T" intersection with a street that has not been improved to its ultimate width, concrete pavement should be stopped either at the right-of-way line or at the end of the curb return, whichever would require less concrete removal at a future date.
2. For roadway turnouts placed at an existing street intersection, the turnout should be designed to fit the ultimate pavement width of the intersecting cross street and then transitioned to the existing roadway.

3. The usual transition length for meeting an open-ditch street is 50 feet for street widths less than or equal to 28 feet B/B; 75 feet for 37 feet B/B width; and 100 feet for 41 feet B/B width.
 - a. Streets other than concrete shall have transitions with a minimum thickness of 8 inches of lime stabilized subgrade, 6 inches of hot-mix asphaltic concrete base with 2 inches of hot-mix asphaltic (TY D) surfacing.
 - b. Concrete streets shall have transitions with a minimum thickness of 6 inches of stabilized subgrade and 6 inches of concrete pavement.
 4. When paving only one roadway of a proposed two-roadway thoroughfare (boulevard section) all left-turn lanes and esplanade crossovers shall be paved to the centerline of the street right-of-way.
- F. Requirements for Roadway Pavement with existing Open-Ditch Sections
1. No new open-ditch drainage systems are permitted.
 2. Minimum grade on ditches shall be 0.20 percent.
 3. Ditch capacity shall be designed to handle runoff as determined by the City Drainage Design Requirements.
 4. The maximum side slope shall not exceed 3:1.
 5. Culverts for roadside ditch only shall be designed to carry ditch discharge, but not less than 18-inch diameter pipe constructed of reinforced concrete.
 6. The radius for cul-de-sac pavement shall be 50 feet in a 60' radius ROW.
- G. Requirements for Roadway Pavement with Curb and Gutter Sections
1. Inlet spacing:
 - a. Curb inlets shall be spaced and sized to intercept the calculated runoff for the design storm. The water surface elevation at the inlet shall be less than or equal to the top of curb for the design storm flow.
 - b. Maximum travel distance of water in the street to a curb inlet shall be 300 feet on a major thoroughfare and in a commercial area. The maximum travel distance of water in the street permitted in a single-family residential area shall be 500 feet.
 - c. Curb inlets should be located on the intersecting side street at an intersection with a major thoroughfare. Locations on the major thoroughfare at intersections shall be specifically approved by the City Engineer.
 - d. Curb inlets shall have grate inlets lids.
 - e. Backfill around inlets with 1.5 sacks per cubic yard of cement stabilized and to top of first stage inlets.
 2. Minimum gutter gradient shall be 0.30 percent.
 3. Maximum cut from finished grade at property line to top of curb shall be 1.75 feet.
 4. The desired slope for driveways is 2% to 8%. A maximum slope of 10% may be allowed with specific approval of the City.

5. Minimum grade shall be 1 percent fall around intersection turnout for a maximum radius of 25 feet. Grades for larger radius shall be determined on an individual basis.
6. Vertical curves shall be installed when algebraic differences in grades exceed 1 percent. Elevations shall be shown at 10-foot intervals through vertical curves. Maintain a minimum of 0.03-foot elevation change at 10-foot intervals by altering the calculated elevations.
7. The radius for cul-de-sac pavement shall be 50 feet in a 60 feet radius ROW.
8. When a curb and gutter section intersects a drainage ditch, the grade of gutter shall be above the designed water surface of the ditch.
9. Minimum gutter grade for cul-de-sac shall be 0.60 percent.
10. Major thoroughfares shall be in accordance with AASHTO.
11. The amount of cross slope over the pavement section should be shown on the drawings. The usual cross slope is 3/8 inch per foot from curb line to quarter, and 1/4-inch per foot from quarter point to the center line, and 7/8-inch per foot for left-turn lanes.
12. A minimum gradient of 0.40 percent around the longest radius is required on an L-Type street intersection.
13. When meeting an existing curbed street, top of curb grades shall be designed to meet an elevation 6 inches above the existing gutter. At existing inlets, top of curb grades shall be designed to match existing top of curb elevations.
14. Fill lines shall be shown on the drawings. If fill is required and the pavement is adjacent to a nonparticipating property owner, fill easements from this property owner shall be obtained, filed, and a copy of the easements shall accompany the final drawings. Construction of this nature will require back-slope drainage design to prevent trapping storm runoff.
15. Grades should be labeled for all tops of curb. Centerline grades are acceptable for open-ditch sections only.

H. Requirements for Inlets with Curb and Gutter Sections:

1. Type "BB" with grate tops or type "H-2" inlets shall be used on all curb and gutter sections within the City depending on runoff requirements.
2. Inlets should be placed away from the major thoroughfare and on the side streets at street intersections.
3. Attempt to keep the proposed inlets away from esplanade openings and out of major thoroughfare intersections.
4. Inlets shall be placed at the end of pavement in order to eliminate drainage from the pavement gutter into an open ditch.

5. On open-ditch streets, place stubs with ring grates from inlets to ditches.
- I. Requirements for Curbs and Sidewalks:
1. Standard curb height is 4-inches and 12-inches wide for curb located along outside edges of residential streets. Curb height for streets other than residential shall be 6 inches. The curb height for all esplanades shall be 6-inches. Changes in curb heights shall have a minimum transition length of 10 feet.
 2. Sidewalk wheelchair ramps are required at all intersections and driveways. The design and installation of such ramps shall comply with Texas Accessibility Standards Architectural Barriers requirements.
 3. All sidewalks are to be constructed in accordance with the City of Manvel Standard Details and Master Thoroughfare Plan. The design and installation of such sidewalks shall comply with Texas Accessibility Standards Architectural Barriers requirements.
 4. Sidewalks are required along all streets. The developer, prior to the City's final acceptance of the infrastructure, must install sidewalks along reserves and ROW.
 5. Sidewalks may be constructed as part of the issuance of a building permit, for single-lot site development projects where a sidewalk is the only required infrastructure construction. For such projects, a certificate of occupancy shall not be issued prior to City's final acceptance of the sidewalk.
 6. Generally, public and non-residential sidewalks shall have a width of not less than 5 feet. Along streets that do not have a corresponding street type cross-section in the Master Thoroughfare Plan (including streets with open ditches), sidewalks shall have a width of not less than 5 feet.
 7. Non-residential site development projects within City of Manvel ETJ shall include a sidewalk within the building setback area if a sidewalk is not permitted within the public right-of-way.
 8. The location of all proposed and existing sidewalks shall be shown on the construction drawings and plan and profile drawings.
- J. Requirements for Miscellaneous Items:
1. The type and amount of subgrade treatment shall be shown on the drawings.
 2. Paving headers shall be placed at the end of all concrete pavements.
 3. All concrete to be removed shall be saw cut before removal.
 4. Sight distance requirements based on the design speed the roadway shall be used for determining lengths of crest vertical curves for all pavements except boulevard sections which shall be designed for 45 mph.
 5. Standard City of Manvel barricades shall be placed at the end of all dead-end streets not terminating in a cul-de-sac.

6. Submit to the appropriate drainage agency before City approval.
7. A letter of agreement approving the construction plan crossing is required when paving is placed over a transmission pipeline.
8. When meeting existing concrete pavement, horizontal dowels shall be used if no exposed reinforcing steel for interconnection with new pavement exists. Horizontal dowels shall be Grade 60, #6 rebar, 24-inches long, drilled and embedded 12-inches into the center of the existing slab and epoxied. Dowels shall be 18 inches center to center, unless otherwise specified.
9. When concrete is removed for interconnections, the pavement shall be saw cut, and existing concrete removed, to expose a minimum of 15-inches of reinforcing steel. If no reinforcing steel exists, use horizontal dowels as previously described.
10. Dead-end streets or ends of concrete slabs designed to be extended in the future shall have paving headers and 15-inches of reinforcing steel exposed beyond the pavement, coated with asphalt and wrapped with burlap or paving headers and dowel type expansion joint for future pavement tie.
11. Pavement extensions shall connect to the existing pavement with a pavement undercut and a minimum steel overlap of 18-inches.
12. Concrete pavement thickness design is required for all pavement within industrial areas and on major thoroughfares. Concrete pavement thickness design shall be based on AASHTO design procedures for rigid pavements.
13. The pavement structure for each roadway shall be designed based on soil data from the site and based on the anticipated traffic volume, loading and service life of the proposed pavement structure. The design engineer is responsible for ensuring that the pavement structure is designed to withstand the anticipated loads that are expected on the roadway.
14. Adjust manhole frames and covers within the limits of the pavement to meet the proposed final top of slab.
15. Adjust manhole frames and covers outside the limits of the pavement to conform to the final grading plan.
16. No more than one (1) shrinkage crack shall be allowed in each header section. A shrinkage crack is defined as extending one half or more of the full depth of the concrete (i.e., 3" or more on 6" thick concrete) appearing within 2 years of the final concrete placement. If two (2) or more shrinkage cracks appear in a header, the entire section shall be removed and replaced at contractor's expense. No more than three (3) shrinkage cracks are allowed in each 20' section of curb. The contractor is allowed to seal cracks but may be required to remove sections near the end of warranty period.
17. If shrinkage cracks are less than one half of the depth of the concrete (i.e., less than 3" on 6" thickness) then a recommendation letter and data sheets are required from the testing laboratory as to the type of sealant which will be used to seal the shrinkage cracks. This recommendation shall be approved by the City Engineer before application of sealant.

18. Core samples for the sections will be taken no sooner than the twenty-eight (28) day break of the original concrete pour sample.
19. All medians must be sleeved for future irrigation lines.
20. Refer to MUTCD for pavement and curb markings near stopping points, crosswalks, etc.
21. All under-pavement utility crossings are to be sleeved.
22. Manholes, fire hydrants and water valves shall not be located within a driveway, sidewalk, or street.

K. Original Manvel Townsite

1. The Original Manvel Townsite (OMT) area is bounded by Cemetery Road on the east, Lewis Lane on the north, McCoy Road on the west, and Jordan Road on the south.
2. The special regulations in this section shall apply to lots in the OMT zoned Light Commercial or Planned Unit Development (PUD) allowing for commercial land use, where the lot is five (5) acres or less.
3. Roads in the OMT may be constructed with a minimum 26-foot wide asphalt (instead of concrete), with a minimum thickness of 8 inches of lime stabilized subgrade, 6 inches of hot-mix asphaltic concrete base, and 2 inches of hot-mix asphaltic (TY D) surfacing.
4. Roadside ditches (open ditches) are permitted in the OMT.

1.05 APPURTENANCES – Reserved

1.06 SUBMITTALS – Reserved

1.07 QUALITY ASSURANCE.

- A. All construction drawings and specifications shall be prepared by or under the supervision of a currently Registered Professional Engineer of the State of Texas, and all documents shall be sealed, dated, and signed by the engineer responsible for their preparation.
- B. All geotechnical work shall be performed by or under the supervision of a currently Registered Professional Engineer of the State of Texas disciplined in the science of soil analysis. All reports and documents shall be sealed, dated, and signed by the engineer responsible for their preparation.
- C. The designated laboratory technician must be on the jobsite at all times during the placement of concrete.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS – Reserved

2.02 DESIGN ANALYSIS

- A. All pavement design shall be supported by calculations to establish the required thickness and reinforcement.
- B. The current soils report shall be the basis for design considering the use, loading, and life span of the proposed pavement.
- C. Storm sewer inlets shall be established in such numbers and in such locations as to effectively drain storm water from paved sections. A graphical plot and calculations of the hydraulic gradient shall be furnished by the design engineer.
- D. Open-ditch drainage shall be designed to accommodate the anticipated storm runoff, and all culverts shall be designed to accommodate the expected ditch capacity. Construction drawings shall indicate the direction of flow in the ditches, and profiles of the ditches shall reflect this slope. Anticipated volumes of storm drainage shall be identified in each ditch to enable future culverts to be sized to accommodate anticipated runoff.

SECTION 5 DRAINAGE

1.0 GENERAL

1.01 CHAPTER INCLUDES:

Criteria for the design of storm drainage improvements.

- A. Design requirements - The drainage criteria administered by the City of Manvel and complemented by Brazoria County for newly designed areas provides protection from structural flooding from a 100-year storm event. 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 structural flooding from extreme events up to a 100-year storm.
- B. 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 capacity 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 storm sewer system, the additional run-off is intended to be stored or conveyed overland in a manner that reduces the threat of flooding to structures.
- C. Flood Control - The City of Manvel is a participant in the National Flood Insurance Program. The intent of the flood insurance program is to make insurance available at low cost by providing for measures that reduce the likelihood of structural flooding.
- D. Relationship to the Platting Process - Approval of storm drainage is a part of the review process for planning and platting of new development.

1.02 REFERENCES

- A. City of Manvel Flood Damage Prevention Ordinance subsequent revisions.
- B. Brazoria County Design Criteria Manual

1.03 DEFINITIONS

Conduit - any open or closed device for conveying flowing water.

Drainage Area Map - Area map of watershed, which is subdivided to show each area served by each subsystem.

FEMA - Federal Emergency Management Agency

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

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.

Public storm sewers - Defined as sewers and appurtenances that provide drainage for a public right-of-way, or more than one private tract, and are located in public right-of-way or easement. Private storm sewers provide internal drainage for a reserve or other tract. Private storm sewer connections to public storm sewers shall occur at a manhole or at the back of an inlet. All private storm sewers shall be constructed in conformance with these standards.

Rainfall frequency- Probability of a rainfall event of defined characteristics occurring in any given year. The National Weather Service publishes information on rainfall frequency. For the purpose of storm drainage design, the following frequencies are applicable:

1. 5-year frequency – a rainfall intensity having a 20 percent probability of occurrence in any given year, or nominally likely to occur once every 5 years.
2. 10-year frequency – a rainfall intensity having a 10 percent probability of occurrence in any given year, or nominally likely to occur once every 10 years.
3. 25-year frequency – a rainfall intensity having a 4 percent probability of occurrence in any given year, or nominally likely to occur every 25 years.
4. 100-year frequency - a rainfall intensity having a 1 percent probability of occurrence in any given year, or nominally likely to occur every 100 years.

Redevelopment - A change in land use that alters the impervious cover from one type of development of either the same type or another type and takes advantage of the existing infrastructure in place as a drainage outlet.

Sheet Flow - Overland storm run-off that is not conveyed in a defined conduit and is typically in excess of the capacity of the conduit.

1.04 DESIGN REQUIREMENTS

All designs of drainage facilities should meet the requirements of the City of Manvel Standard Specifications and Standard Drawings.

A. Determination of Run-off

1. Design Storm Events - All drainage improvements shall be designed for the following storm frequencies:

Roadside Ditch	5 years
Storm Sewers	5 years
Channels/Storm Sewers/Culverts draining 100 acres or less	25 years
Bridges	100 years
Creeks/Channels/Culverts draining 100 acres or more	100 years
2. The Rational Method shall be used for determining the peak flow rate in the sizing of all drainage improvements.

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

$$t_c = D/60V + 10 \text{ (minutes)}$$

$$D = \text{flow distance (ft)}$$

$$V = \text{flow velocity (ft/sec)}$$

For calculating t_c , use the following velocities:

$$V = 0.5 \text{ ft/sec for overland flow (undeveloped)}$$

$$V = 1.0 \text{ ft/sec for overland flow (developed)}$$

$$V = 1.5 \text{ ft/sec or flow across paved surfaces or along gutter flowlines.}$$

$$V = 2 \text{ ft/sec for flow in ditch or channel}$$

$$V = 3 \text{ ft/sec for flow in storm sewer}$$

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

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

Values to be used in Manvel are listed below:

Rainfall Frequency	b	d	e
5-year	58.019	9.236	0.712
10-year	57.515	7.777	0.676
25-year	52.780	5.022	0.618
100-year	46.316	1.555	0.533

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

b = the y-intercept of the straight line

d = a constant used to adjust the relationship to plot as a straight line

e = the slope of the straight line

Source: Brazoria County Drainage Criteria Manual May 2022

- c. The Rational Method is a method for calculating the peak run-off for a storm drain system. The formula for determining the peak flow rate is:

$$Q = C_f CIA$$

$$Q = \text{Flow rate (cubic feet per second (cfs))}$$

$$C_f = \text{Frequency factor, if the product of } C_f \text{ and } C \text{ exceeds 1.0, use 1.0}$$

$$C = \text{Runoff Coefficient}$$

$$I = \text{Rainfall intensity (inches/hour) for a given storm frequency}$$

$$A = \text{Area (acres)}$$

For the purposes of calculating C_f use the following values:

$C_f = 1.00$, for storm frequencies of 10 years or less

$C_f = 1.10$, for storm frequencies of 25 years

$C_f = 1.25$, for storm frequencies of 100 years

For the purposes of calculating C use the following values:

<u>Land Use Type</u>	<u>Run-off Coefficient</u>
Raw Undeveloped Acres	0.20
Improved Undeveloped Acres (i.e., mowed, filled, re-graded, etc.)	0.30
Park Land	0.40
Residential:	
Single Family Estates (≥ 2 acres)	0.45
Single Family Estates (≥ 1 acre)	0.50
Single Family (< 1 acre)	0.55
Garden Homes	0.65
Multi Family Low	0.75
Multi Family Medium	0.80
Multi Family High	0.85
Mobile Homes	0.85
Commercial	0.90
Industrial	0.95
Pond (detention and amenity)	1.00

Alternatively, the run-off coefficient “ C ” in the rational method formula can be calculated from the equation:

$$C = 0.6Ia + 0.2$$

C = watershed coefficient

Ia = impervious area/total area

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

B. Design of storm sewers

1. Design Frequency

a. Newly Developed Areas

The design storm event for sizing storm sewers in newly developing areas will be a 5-year rainfall. In the case where new development will interfere with the natural sheet flow of the land, the storm system must accommodate the runoff. Runoff should not be allowed to run over newly developed lots or streets. Stub out streets next to underdeveloped areas are to stub out storm lines to the limits of the streets.

b. Redevelopment or In-fill Development

The existing storm drain will be evaluated using a 5-year storm, assuming no development takes place. The storm drain will be evaluated with the development in place.

- (1) If the proposed redevelopment has a lower or equal impervious cover, no modifications to the existing storm drain are required.
- (2) If the hydraulic gradient of the existing storm drain is below the top of the curb, no improvements to the existing storm drain are required.
- c. Private Drainage Systems

Storm sewers for private drainage systems should conform to the City of Manvel Standards for public drainage systems.

 - (1) An approved development permit must be filed with the City of Manvel before any work shall be done on a private drainage system. Part of the development permit includes a plan and profile sheets detailing the scope of the work including elevations.
 - (2) Open ditch areas may be converted into storm sewer lines with the approval of a development permit. Guidelines for the process are available at the City of Manvel.

2. Velocity Considerations

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

Manning’s Equation: $V = (1.486/n) R^{2/3} S^{1/2}$

- V = velocity (ft/sec)
- R = hydraulic radius (area in square feet/wetted perimeter in feet)
- S = slope of energy line in feet
- n = coefficient of roughness
 - n = 0.013 for concrete pipes,
 - n = 0.024 for CMP
 - n = 0.011 for PVC
 - n = 0.012 for HDPE

Note: All public storm sewers must be constructed of RCP. Manning’s roughness coefficients for CMP, PVC, and HDPE are to be used for private storm sewers only. All storm sewer pipes entering City of Manvel ROW shall be RCP.

Continuity Equation: $Q = VA$

- Q = discharge (cfs)
- V = velocity (ft/sec)
- A = cross sectional area of conduit (ft²)

- b. Design velocities shall be 3 feet per second with the pipe flowing full.
- c. Maximum velocities shall not exceed 7 feet per second.
- d. Minimum Storm Sewer Pipe Slopes:

<u>Pipe Diameter</u>	<u>% Slope</u>
18	0.26
24	0.18
30	0.14
36	0.11
42	0.08
48	0.07
54	0.06
60	0.05

For pipe sizes not listed above, the minimum slope should be determined utilizing a design velocity of 3 fps.

3. Pipe Sizes and Placement

- a. Use the storm sewer and inlet leads with at least 24-inch inside diameter or equivalent cross section. Box culverts shall be at least 2 feet x 2 feet. Closed conduits: circular, elliptical, or box, shall be selected based on hydraulic principals and economy of size and shape.
- b. Larger pipes upstream should not flow into smaller pipes downstream unless construction constraints prohibit the use of a larger pipe downstream, or 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 severe depth constraints prohibit.
- d. Locate storm sewers in public street rights-of-way or in parallel and adjoining easements or in approved easements. Easements must be at least 20 feet wide, and the storm sewer must be centered in the easement. Side and back lot easements are discouraged.
- 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. Center culverts in side-lot storm sewer easements.
- h. Storm boxes may substitute for pipes when workable space is an issue.

4. Starting Water Surface and Hydraulic Gradient

- a. The hydraulic gradient shall be calculated by assuming the top of the outfall pipe as the starting water surface.
- b. At drops in pipe flowline, should the upstream pipe be higher than the hydraulic grade line, then the hydraulic grade line shall be recalculated assuming the starting water surface to be at the top of pipe at that point.
- c. For the design storm, the hydraulic gradient shall at all times be below the gutter line for all newly developed areas.
- d. Hydraulic grade lines shall be shown on all profile drawings.

5. Manhole Locations

Use manholes for precast conduits at the following locations:

- a. Size or cross section changes.
- b. Inlet lead and conduit intersections.
- c. Changes in pipe grade.
- d. Street intersections.
- e. A maximum spacing of 500 feet measured along the conduit run.
- f. Manholes shall be placed so as not to be located in the driveway area nor parking stalls.

6. Inlets

- a. Locate inlets at all low points in gutter.
- b. Valley gutters across intersections are not permitted.
- c. Inlet spacing is generally a function of gutter slope. For minimum gutter slopes, the maximum spacing of inlets shall result from a gutter run of 500 feet from high point in pavement or the adjacent inlet on a continuously graded street section, with a maximum of 1000 feet of pavement draining towards any one inlet location.
- d. Use only Standard Inlets:

Inlet	Application	Capacity
Type A	Parking Lots/Small Areas	2.5 cfs
Type B-B	Residential	5.0 cfs
Type D	Parking Lots	2.0 cfs
Type E	Roadside ditches	20.0 cfs
Type H-2	Residential / Commercial	5.0 cfs
- e. Do not use "Beehive" grate inlets or other "specialty" inlets.
- f. Do not use grate top inlets in unlined roadside ditch.
- g. Place inlets at the end of the 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. On-grade inlets shall be allowed.
- k. Avoid inlets in the areas designed for parking stalls, when possible.

C. Consideration of Overland Flow

- 1. Design Frequency. The design frequency for consideration of overland sheet flow shall consider extreme storm events, which exceed the capacity of the underground storm sewer system resulting in ponding and overland sheet flow through the development to the primary outlet.
- 2. Relationship of Structure to Street. All structures shall be constructed according to the Flood Damage Prevention Ordinance and should be higher than the highest level of ponding anticipated from the extreme event analysis.

3. Calculation of Flow
 - a. Streets will be designed so that consecutive high points in the street will provide for a gravity flow of drainage to the ultimate outlet.
 - b. The maximum depth of ponding at high points will be the top of curb or the centerline of roads without curb.
 - c. The maximum depth of ponding at low points will be 12-inches above the gutter on curb and gutter roads, or 6 inches above the centerline of roads without curb.
 - d. Sheet flow between lots can be provided only through a defined drainage easement.
 - e. 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.
 - f. In areas where ponding occurs and no sheet flow path exists, then a calculation showing that run-off from the 100-year event can be conveyed and remain in compliance with the other terms of this section must be provided.
 - g. The maximum ponding width along 2-lane roadway (1 lane in each direction) shall be $\frac{1}{2}$ half lane. The maximum ponding width along any roadway with 2 lanes or more in each direction shall not exceed one full lane per direction.
 4. Overland Flow shall enter outfall drainage facilities (channels or detention pond) through a storm sewer sized to convey the 100-year event. Calculations shall be submitted for sizing the structure and determining that adequate inlet capacity exists.
- D. Design of Open Channels
1. Design Frequency
 - a. Open channels shall be designed according to methods described in the corresponding Drainage District's Design Criteria Manual.
 - b. Design standards for channel construction should follow the requirements specified in the corresponding Drainage District's Design Criteria Manual.
 - c. Design standards for the outfalls into channels should conform to those in the corresponding Drainage District's Design Criteria Manual.
 2. Determination of Water Surface Elevation.
 - a. Water surface elevations shall be calculated using Manning's Equation and the Continuity equation.
 - b. For the design storm event, the water surface should be calculated to remain within banks and below freeboard.
 3. Design of Culverts
 - a. Head losses in culverts shall conform to TxDOT requirements.
 - b. Generally, only RCP will be approved for culverts in City right-of-way.
- E. Design of Roadside Ditches
1. Design Frequency
 - a. The design storm event for the roadside ditch shall be to 0.5 feet below the edge of pavement or the natural ground at the right-of-way line, whichever is lower.
 - b. Design capacity for a roadside ditch shall be to 0.5 feet below the edge of pavement or the natural ground at the right-of-way line, whichever is lower.
 - c. The design must include an extreme event analysis to indicate that structures will not be flooded.

2. Velocity Considerations
 - a. For grass-lined sections, the design velocity shall be 2.0 feet per second during the design event. The maximum velocity shall be 5 fps.
 - b. A grass-lined or unimproved roadside ditch shall have side slopes no steeper than three horizontal to one vertical.
 - c. Minimum grades for roadside ditches shall be 0.2-foot per 100-foot.
 - d. Calculation of velocity will use Manning's roughness coefficient of 0.040 for earthen sections and 0.025 for ditches with paved inverts.
 - e. Use erosion control methods acceptable to the City when design velocities are expected to be greater than 3 feet per second.
 3. Culverts
 - a. Culverts will be placed at all driveway and roadway crossings, and other locations where appropriate.
 - b. Culverts will be designed assuming inlet control.
 - c. Roadside culverts are to be sized based on drainage area. Calculations are to be provided for each block based on design criteria presented in this manual.
 - d. Cross open channels with roadside culverts no smaller than 18 inches in diameter or equivalent. The size of culvert used shall not create a head loss of more than 0.20 feet greater than the normal water surface profile without the culvert.
 - e. Use erosion control methods acceptable to the City when design velocities are expected to be greater than 3 feet per second.
 - f. Sloped end treatments (S.E.T.) must be placed at all driveways. If S.E.T.'s cannot be used due to space constraints, the culvert must be extended 12" on each side of the driveway. A head wall may be used to replace the extension of the culverts.
 - g. HDPE culverts may be used under residential driveways and between residential driveway culverts, but not under street crossings. All street culverts to be RCP or RCB.
 4. Depth and Size Limitations
 - a. Residential streets - maximum depth not to exceed 3 feet from edge of pavement.
 - b. Roadside ditch bottoms should be at least 2 feet wide.
 - c. Ditches in adjoining and parallel easements shall have the top of bank not less than 2 feet from the outside easement line.
 - d. Roadside ditch side slopes shall not exceed 3 horizontal to 1 vertical.
 5. Roadside open-ditch drainage systems will be permitted only within the Original Manvel Townsite, or with City Council approval.
 6. Existing roadside open-ditch drainage systems adjacent to new developments to be converted to underground storm sewer system by said developer.
- F. Design of Outfalls
1. Shall conform to the corresponding Drainage District's Design Criteria Manual.
 2. Detention pond and storm sewer outfalls shall be placed one foot above the flowline of the receiving channel.
 3. Outfalls shall be placed 6 inches above the flowline of the receiving roadside ditch.

4. Wet detention ponds may be connected by a submerged pipe.
 5. Outfalls must have a means to control erosion and washouts (i.e., concrete paving, interlocking blocks). Riprap is not acceptable.
- G. Detention and Mitigation

The purpose of storm water detention is to mitigate the effect of new development on an existing drainage system. As a one-time credit, if 20% or less of the entire property (single SFR lot, not subdivision) will be affected by new impervious cover, then a new or revised drainage plan will not be required outside of the floodplain.

1. Application of Detention.
 - a. As a normal consideration, storm water detention is required. The use of on-site detention is required in order to mitigate potential damage to existing structures unless the current infrastructure is improved, or the City has developed a plan for a detention facility to serve the overall area.
 - b. Design calculations for sizing the detention basin and related structures must be performed by the applicable method described in the following sections.
 - c. All calculations shall be sealed and signed by a Registered Professional Engineer.
 - d. A concrete parking lot may be used as part of the detention system, provided that the maximum depth of water over the inlet does not exceed nine (9") inches and the maximum depth in the parking stall does not exceed six (6") inches.
 - e. The Rational Method can be used for determining the peak release rate and the peak inflow rate for a detention pond.
2. Calculation of Detention Volume
 - a. The Modified Rational Method may be used to determine the detention storage volume for developments that are 5 acres or smaller.
 - b. A simplified method may be used for determining the amount of detention volume required based upon a rate of 0.65 acre-feet per gross acre. This method may only be used for developments of less than 100 acres.
(i.e., 5-acre site x 0.65 = 3.25 acre-feet)
 - c. The Triangular Hydrograph method may be used for determining the amount of detention volume required for development of 100 acres or less.
 - d. The Unit Hydrograph Method (Small Watershed Method), which calculates the required detention storage volume by determining the difference in volumes between the inflow and outflow hydrographs, may be used for developments less than 100 acres.
 - e. For developments with more than 100 acres, a detailed hydrologic analysis utilizing the HEC-HMS, HEC-RAS Flood Hydrograph method will be required.
3. Floodplain Mitigation
 - a. For properties located in AE Flood Zone, mitigation will be required at a 1:1 ratio for fill placed below the Base Flood Elevation.
 - b. For properties located in AO Flood Zone, mitigation will be required at a 1:1 ratio for fill placed below the Base Flood Depth.

4. Calculation of Outlet Size

- a. Outfalls, which utilize a restrictor to control outflow, shall use the orifice equation.
- b. Reducer or Restrictor Pipes shall be sized as follows:

- (1) Use the following equations to calculate the required outflow orifice:

$$\text{Area of pipe} = \pi d^2/4$$

$$Q = CA (2 gh)^{1/2}$$

$$D = Q^{1/2} / 2.25 h^{-1/4}$$

$$Q = \text{outflow discharge in cfs.}$$

$$C = 0.8$$

$$h = \text{water surface differential (ft)}$$

$$D = \text{orifice diameter (ft)}$$

$$A = \text{area of pipe (ft}^2\text{)}$$

$$g = \text{gravity (32.2 ft/s}^2\text{)}$$

- (2) For head differential in systems outfalling into a roadside ditch or storm sewer use actual head loss or 1-foot whichever is greater. For all other discharge conditions use 2 feet or difference of 100-year water surface elevation and elevation of 25-year storm in receiving channel, whichever is greater.
- (3) For detention systems outfalling into a public storm sewer, the restrictor shall be sized based upon the peak 5-year developed flow.
- (4) For detention systems outfalling into a public roadside ditch, the restrictor shall be sized based upon the peak 5-year undeveloped flow.
- (5) For detention systems outfalling into creeks, channels or storm sewers sized to carry the 25-year or 100-year storm, the restrictor shall be metered to release the 5-year, 25-year and 100-year undeveloped flows.
- (6) Restrictor shall be either the required diameter or the equivalent cross-sectional area. The orifice diameter "D" shall be a minimum of 6 inches.
- (7) Detention ponds less than one (1) acre in size shall have a minimum of 4 inches of freeboard. All ponds one (1) acre or larger in size shall have at least one (1') foot of freeboard. When a parking lot is used for detention per 1d. above, freeboard is not required within the parking lot. Freeboard shall be measured from the maximum 100-year water surface elevation and shall not be used in the calculation of storage or mitigation.

5. Detention Pond Structural Requirements

- a. Side slopes shall not exceed a slope of 4 horizontally to 1 vertically.
- b. Dry ponds with lengths over 50 feet shall have a concrete pilot channel.
- c. Concrete pilot channels shall have a minimum width of 4 feet and a minimum thickness of 4 inches with #3 rebar spaced at 12 inches on center each way. The concrete channels shall be constructed of 5-sack cement concrete with a compressive strength of 2500 psi at 28 days. Provide a 1-inch depression per every 1-foot of transverse slope with redwood headers spaced every 40 feet.
- d. Appropriate covering (grass, slope paving, etc.) shall be established on side slopes and pond bottom to prevent erosion during periods of maximum water velocity.
- e. A concrete gravity spillway, set at the maximum ponding elevation, shall be provided at the detention pond outfall structure.
- f. Wet detention ponds and ponds with vertical walls shall provide access for safety and maintenance purposes. Wet detention systems shall have a method in place to minimize stagnation, such as an aeration system.
- g. Dry detention ponds shall not be designed with less than two feet of depth.

6. Ownership and Easements
 - a. Maintenance responsibility of the detention facility must be indicated on the plat
 - b. Property owner is responsible for the operation and maintenance of the pond.
 - c. If property is sold, responsibility for operation and maintenance of the pond is transferred to the new owner.
 - d. All properties being served shall have drainage access to the pond.
 - e. A maintenance agreement must be provided when multiple tracts are being served.
 - f. A maintenance berm must be provided around all sides of detention and floodplain mitigation facilities.
 - (1) The minimum maintenance berm width for dry ponds is 15 feet.
 - (2) The minimum maintenance berm width for wet ponds is 20 feet.
 - g. All non-residential detention ponds shall have a perimeter fence.

7. Off-Site Detention

Off-site detention, such as regional or sub-regional detention, may be used provided:

 - a. The detention facility is in the same watershed or sub-watershed as the developer's site.
 - b. The drainage area is less than 100 acres.
 - c. Excess detention capacity may not be used for mitigation of fill in the flood plain.
 - d. The Developer provides conveyance to the detention facility without having a detrimental effect on any adjacent properties.
 - e. If conveyance is directed through properties not directly owned by the developer, an executed contract or recorded deed between the parties agreeing to the said conveyance must be presented.
 - f. This procedure is approved by both the City and the corresponding drainage entity during preliminary plan review.
 - g. It is the desire of the City of Manvel that regional detention be utilized when available. If new development is within the service area of a publicly owned or operated regional storm water detention facility, connection to such regional facility shall be as required by the drainage master plan applicable to such facility.

8. Redevelopment and Additions
 - a. Additional impervious cover may be added to an existing single-family residential lot (1-time allowance), provided that the cumulative increase does not exceed 20% of the original impervious cover for that lot.
 - b. A drainage plan and detention calculations will be required for any proposed improvements, additions, or redevelopment in excess of the 20% impervious cover allotment.
 - c. All commercial and non-residential new developments, additions, or redevelopment will require a new or revised drainage plan for additional impervious cover.

9. Pump Systems
 - a. Pumped floodplain mitigation facilities are not allowed.
 - b. Pumped detention facilities may be allowed by City Council on a case-by-case basis, but only with the following criteria:
 - 1) For Non-Residential Developments Only.
 - 2) No Residence is within 1,000 feet of the pump facility.
 - 3) A Backup Natural Gas Generator is provided for the entire pump facility.
 - 4) At least 50% of the required detention is achieved by a gravity system.
 - 5) The corresponding Drainage District has approved the pump facility.

1.05 RESERVED

1.06 SUBMITTALS

A. Preliminary Design - Submit for Review and Comment

One-line drawings are required as part of the platting process and include:

1. Approximate definition of lots and street patterns.
2. The approximate drainage areas for each system.
3. A definition of the proposed drainage system by single line.
4. The proposed pipe diameters.
5. Any proposed drainage easements.
6. Floodplain boundary, if any.

B. Final Design - Submit the Following for Approval

1. Copies of any documents which show approval of exceptions to the City design criteria.
2. Design calculations for storm line sizes and grades, and for detention facilities, if any.
3. Design calculations for the hydraulic grade line of each line or ditch, and for detention facilities, if any.
4. Contour map and drainage area map of the project.
5. Plan and profile sheets showing storm water design (public facilities only).
6. Projects located within a Flood Plain boundary or within a Flood Plain Management area shall show the Flood Plain boundary or Flood Plain area, as appropriate, on the one-line drawing or drainage area map.
7. Soil boring logs.
8. All drainage plans shall have a current FEMA flood zone determination statement.

C. Signature - Submit the Following for Approval

1. Review prints.
2. Original drawings.
3. Storm water detention maintenance agreement letters.

1.07 QUALITY ASSURANCE

A. Prepare calculations and construction drawings under the supervision of a Professional Engineer trained and licensed under the disciplines required by the drawings. The final construction drawings and all design calculations must be sealed, signed, and dated by the Professional Engineer responsible for the development of the drawings.

B. Prior to release of the maintenance bond (and in conjunction with the final walk-thru), the developer shall have all storm sewer lines (within the project boundary) inspected with television equipment. Any pipe settlement which causes excess ponding of water in pipeline, any misaligned joints, or other defects shall be cause for rejection. The developer shall provide the City with one copy of the TV videotape and one copy of the TV inspection report. For each segment, the video tape and corresponding written report shall clearly identify:

1. Each line segment being inspected.
2. The size and type of pipe being inspected.
3. Accurate footage of the line segment inspected.
4. Deficiencies in materials, alignment, pipe grade, or any other apparent deficiencies.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS – Reserved

2.02 DESIGN ANALYSIS

- A. All projects shall be tied to National Geodetic Survey (NGS) Datum adjustment, which matches the Federal Emergency Management Agency (FEMA) rate maps or the most current NGVD, which matches the FEMA rate maps. In the event GPS surveying is used to establish benchmarks, at least two references to benchmarks relating to the FEMA rate maps must be identified. Equations may be used to translate other datum adjustments to the required adjustment.
- B. Plan sets will include a drainage area map, which shall contain all storm sewer drainage calculations as determined by the Rational Method.
- C. All drainage systems for curb and gutter pavements shall be underground closed conduits; individual residential lot drainage is exempt. Drainage systems for pavements without curb and gutter shall be roadside open-ditch sections.
- D. Soil boring with logs shall be made along the alignment of all storm sewers having a cross section equal to or greater than 72 inches in diameter or equivalent cross section area. Boring should be taken at intervals not to exceed 500 linear feet and to a depth not less than 3 feet below the flow line of the sewer. The required bedding will be determined from the soil boring.
- E. Plan sets shall include the 5-year Hydraulic Grade Line for storm sewers and roadside ditches on the plan and profile sheets. They shall also include the 100-year ponding depth on the plan and profile sheets.
- F. Pumped floodplain mitigation facilities are not allowed.
- G. Pumped detention facilities may be allowed by City Council on a case-by-case basis with the following criteria:
 - 1. For Non-Residential Developments Only.
 - 2. No Residence is within 1,000 feet of the pump facility.
 - 3. A Backup Natural Gas Generator is provided for the entire pump facility.
 - 4. At least 50% of the required detention is achieved by a gravity system.
 - 5. The corresponding Drainage District approves the pump facility.

SECTION 6 SITE DEVELOPMENT

1.0 GENERAL

1.01 CHAPTER INCLUDES: Site Development

1.02 REFERENCES

- A. City of Manvel Zoning Ordinance.
- B. City of Manvel Subdivision Ordinance.

1.03 DEFINITIONS

Commission – Planning, Development and Zoning Commission

1.04 DESIGN REQUIREMENTS

A. Site Development Requirements

1. General Requirements

- a. Site development plans for all site developments within the City of Manvel and its ETJ shall be approved by the City prior to construction.
- b. Site developments, not including single family residential, shall include any project that affects public water, wastewater, storm drainage, or paving facilities.
- c. All site developments shall conform to the requirements of these Standards and applicable rules and regulations of the City of Manvel.
- d. All wastewater, drainage and paving site development improvements shall be privately owned, operated and maintained up to and including the connection to the public system.
- e. All water site development improvements shall be privately owned, operated and maintained up to, but not including, the meter and meter vault.
- f. Restore the City of Manvel ROW to existing or better condition.
- g. Private utilities and service lines shall be placed in an easement or on the property being served.
- h. Hours of Construction are 7:00 AM to 9:00 PM, Monday through Saturday.
- i. As-Built Construction Plans (Record Drawings) and a Two-Year Maintenance Bond (in the amount of 100% of the cost of the infrastructure improvements, valid two years from the date the infrastructure is accepted by City Council) shall be required for all public improvements being dedicated to the City.

2. Design Review Requirements for Site Development Plans.

- a. All site development plans for proposed developments shall be submitted to the City for approval prior to construction. Site development plans shall show all proposed water, wastewater, paving, parking, drainage, street signage, streetlight locations, flood protection facilities, and sidewalks with approved ADA ramps locations.

- b. A traffic impact study shall be required for any development proposal expected to generate traffic volumes that will significantly impact the capacity and/or safety of the street system. All proposed developments meeting the following criterion will be required to submit a Traffic Impact Analysis:
1. 1,000 trips per day
 2. 100 trips per peak hour
 3. 100-acre site or larger

The trip estimate shall be based on the latest version of the Institute of Transportation Engineers, Trip Generation Manual.

- c. A TIA Worksheet will be required to be completed and submitted for all new development within the City of Manvel to verify the need for a full traffic study.
- d. A City may require a full traffic study for any development.
- e. The developer should first schedule a Pre-Development Meeting (PDM) with the City of Manvel. At this meeting, the developer should be able to discuss infrastructure issues and the feasibility of developing the site.
- f. The next step is to prepare the Civil site plan submittal to be reviewed by staff. The submittal for the site plan requires electronic copy and 3 hard copies of:
1. Site Plan
 2. Landscaping Plan
 3. Elevation Plan
 4. Drainage Plan
 5. Utility Plan
 6. Grading Plan
 7. Storm Water Pollution Prevention Plan

To be provided to Permits Department staff with relevant application forms. The City will typically respond within 2 to 4 weeks of the initial submittal.

- g. Submittal to the appropriate drainage agency is required.
- h. Electronic copy of site development plans shall be submitted to the Permits Department with relevant application form for Building Official's review. The City will typically respond within 2 to 4 weeks of the initial submittal.

3. Building Slab Elevations - Minimum building slab elevations shall conform to the requirements of the City of Manvel Flood Damage Prevention Ordinance.
4. Water Service - Water service lines and meters shall be sized in accordance with requirements set out in Section 3 of the Design Criteria Manual.
5. Sanitary Sewer Service - Sanitary sewer service leads are normally installed during construction of the public sanitary sewer. When a sanitary sewer service lead is to be installed for site development, refer to the Wastewater Collection System Design Requirements. All lots, tracts, or reserves shall be connected directly to a public sanitary sewer by a single lead. The City shall be contacted for all sanitary sewer connections for commercial projects within the City.

6. Site Drainage Requirements - All commercial, industrial, office, recreational, and multi-family tracts shall have an internal drainage system. The internal drainage system shall connect all site runoff into a storm sewer system that shall connect to the public drainage facilities in the area, except with specific approval.
 - a. The internal site storm sewer shall be connected to a public storm sewer and a manhole or at an inlet adjoining the site. The site drainage outfall shall be connected to the nearest existing drainage system with adequate capacity to serve the drainage area. Where extension of the existing drainage system is required, all costs for extension shall be the responsibility of the development.
 - b. All internal facilities shall be designed by a Registered Professional Engineer and shall be sized to drain the site in accordance with these standards.
 - c. Drainage calculations shall be submitted with all site development plans. Other supporting data may be required by the City.
 - d. When the site drains directly into a Brazoria County facility and/or into a highway right-of-way, the appropriate governmental entity (entities) shall approve the site development connection to public facilities.

7. Driveways
 - a. It is desirable to minimize the number of driveways on all streets in order to reduce the number of conflict points and facilitate traffic flow. It is recognized, however, that certain existing tracts may not be able to fully comply with the following standards due to limited frontage or other constraints.
 - b. When compliance with these criteria is precluded 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.
 - c. If it can be demonstrated to the City that sufficient attempts to secure alternative access have been made and that such access is still not possible, the City may accept a Traffic Impact Analysis performed by a Registered Professional Engineer to permit a deviation to the driveway spacing requirements indicated herein.
 - d. Residential driveways shall be a minimum of 12 feet wide (and a maximum of 24 feet) at the right-of-way line and should be placed away from the property line.
 - e. Residential lots must have a minimum of 120 feet of frontage in order to be eligible for two driveways on the same lot and they shall have 50 feet of separation between them.
 - f. Residential lots should not front on collector streets, thoroughfares, or arterials. For residential lots that do front on collector streets, they must have an internal turnaround or circle drive to minimize conflict points.
 - g. Non-residential driveways shall be 25 feet to 35 feet wide of pavement.
 - h. Driveways shall be spaced with a minimum of 50 feet separation.
 - i. Islands may be allowed within non-residential driveways but must have a minimum of 12.5' travel lanes and be pre-approved by the Fire Marshal.
 - j. Driveways on major thoroughfares/boulevard streets shall be placed no closer than 125 feet from the ultimate curb line of an intersecting major thoroughfare or boulevard street.
 - k. Driveways on collector/ minor streets are to be placed no closer than 75 feet from the ultimate curb line of an intersecting major thoroughfare/boulevard street.
 - l. Driveways on major thoroughfares/boulevard streets are to be placed no closer than 75 feet from the ultimate curb line of an intersecting collector commercial/minor street.

- m. For purposes of determining the separation distance, the back of curb or edge of street shall be used in conjunction with the edge of driveway which is closest and parallel to the street.
 - n. Non-residential tracts with less than 150 feet of frontage on a public street shall have no more than 1 driveway. Non-residential tracts with between 150 and 320 feet of frontage on a public street shall have no more than 2 driveways. Non-residential tracts with between 321 feet and 600 feet of frontage on a public street shall have no more than 3 driveways. Non-residential tracts with over 600 feet of frontage on a public street shall have driveways specially designed and specifically approved by the City.
 - o. Non-residential driveway connections to the public street shall be approved and inspected by the City of Manvel.
 - p. Driveway radii shall not extend beyond the projection of a property corner to the back of the curb.
 - q. Non-Residential Driveways shall be concrete, installed according to the City of Manvel Construction Details.
 - r. On concrete streets, Residential Driveways shall be concrete, installed according to the City of Manvel Construction Details.
 - s. On asphalt streets, Residential Driveways shall be concrete or hot-mix asphalt, installed according to the City of Manvel Construction Details. Asphalt driveways shall have a minimum thickness of 8 inches of lime stabilized subgrade, 6 inches of hot-mix asphaltic concrete base with 2 inches of hot-mix asphaltic surfacing.
 - t. Driveways shall be evaluated with respect to signage, landscaping and structures for adequate sight distance.
 - u. A note stating, "Access to adjacent property and common driveways may be required," shall be placed on the site plan.
 - v. Curb return radius for driveways shall be, at a minimum:
 - (1) For residential driveways:
 - (a) 5 feet on local streets
 - (b) 10 feet on collector and arterial streets, parkways, major thoroughfares, and boulevards
 - (2) For non-residential driveways:
 - (a) 25 feet on local streets
 - (b) 35 feet on collector and arterials streets, parkways, major thoroughfares, boulevards and local streets less than 28 feet in width.
 - w. Per Section 59-53 of the Manvel City Code, manholes, fire hydrants, and water valves shall not be located within a driveway, sidewalk, or street.
 - x. Driveways within TxDOT or Brazoria County ROW shall be approved by the appropriate jurisdiction. City of Manvel shall be notified for reasoning of any deviation from the City of Manvel driveway design requirements.
8. Controlled Access Gate Requirements
- a. Plans for access control systems shall be submitted to the Fire Marshal's Office and approved prior to construction.
 - b. All access control gates shall have emergency means of operation in the event of power loss.
 - c. Access control gates shall provide a clear, passable width of at least twenty feet.
 - d. A Knox® key switch and Click2Enter-I.V4 scanner radio receiver shall be provided for all controlled access gates. The key switch shall operate all gates.

- e. A Knox® pad lock and Click2Enter-I.V4 scanner radio receiver shall be provided for all non-motorized gates.
- f. The location of the key switch shall be approved by the Fire Marshal’s Office.
- g. The owner shall maintain all parts of the access system and keep them in good working order.
- h. The Fire Marshal’s Office and Police Dispatch shall be notified immediately of any damage to the access system that hinders access including, but not limited to, damage to the key box, lock, or gates.

9. Pollution Prevention

A pollution prevention plan shall be provided for all site development projects.

- a. Filter fabric fence shall be installed at the perimeter of the site before construction is to begin.
- b. Once construction is completed, either filter fabric fence, 5 feet of hydro mulch or sod shall be installed at the back of all curbs, or other Best Management Practices shall be implemented.
- c. Refer to the storm water ordinance for additional requirements.

10. Parking Lot Guidelines

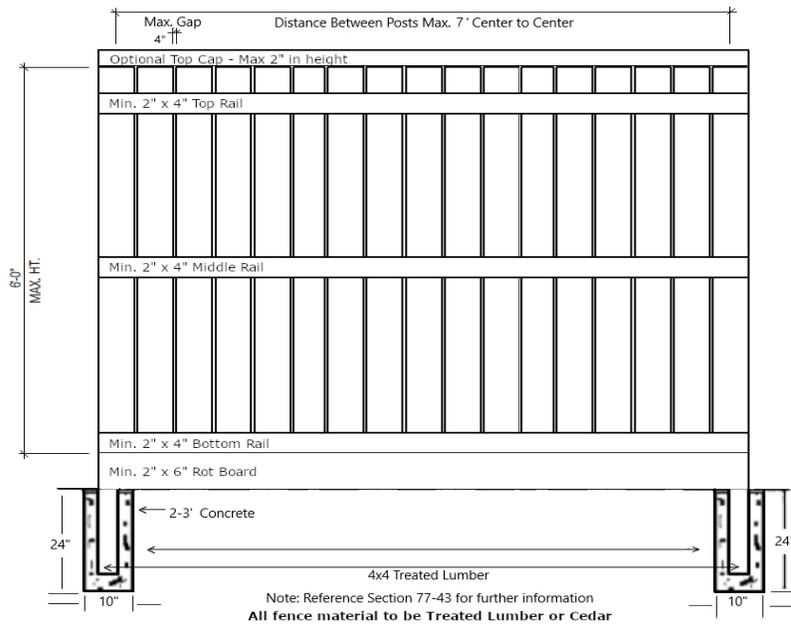
A parking lot layout is required to ensure that adequate off-street parking is provided with the construction, alteration, remodeling or change of use of any building or of land use.

- a. Off-street parking spaces shall be located on the same lot, tract, parcel, or premises as the use being served or on other property of the same or less restrictive zoning classification that the owner of the premises being served has a continuing right to use for parking. When the off-street parking spaces are not located on the same lot, tract, parcel, or premises being served, the distance from the center of the parking lot to an entrance to the building or use shall not exceed 300 feet in distance, measured along the shortest available pedestrian route with public access.
- b. Any existing building or use that is enlarged, structurally altered, or remodeled to the extent of increasing or changing the use by more than 50 percent as it existed shall be accompanied by off-street parking for the entire building or use. When the enlargement, structural alteration, or remodeling is to the extent that the use is not increased or changed by more than 50 percent, additional off-street parking shall only be required for the increased or changed floor area or use.
- c. Existing parking spaces may not be used to satisfy additional off-street parking requirements unless the existing spaces exceed the number recommended for the building or use for which the existing spaces are associated. Commercial areas may be phased. Parking from earlier phases may count for future uses.
- d. The Parking Group Table can be found in the Zoning Ordinance, Section 77-45.
- e. The design and dimensions of off-street parking areas shall be in accordance with the following table of minimum dimensions. The minimum size of parking spaces shall be 10 (ten) feet wide and twenty (20) feet long. All dimensions below are in feet:

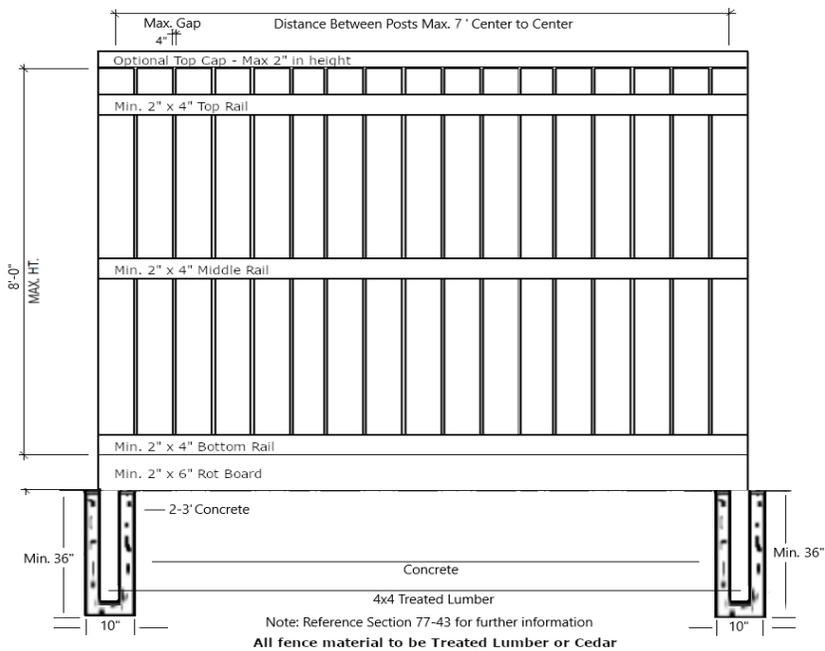
	<i>Angle</i>			
	<i>0°</i>	<i>45°</i>	<i>60°</i>	<i>90°</i>
Stall, parallel to aisle	25.0	10.0	10.0	10.0
Stall, perpendicular to aisle	10.0	20.0	20.0	20.0
Aisle width, one-way	25.0	15.0	18.0	25.0
Aisle width, two-way	25.0	25.0	25.0	25.0
Cross aisle, one-way	25.0	25.0	25.0	25.0
Cross aisle, two-way	25.0	25.0	25.0	25.0

- f. Off-street parking spaces shall be clearly marked. Parking spaces abutting an adjoining property line or street right-of-way shall be provided with wheel guards or bumper guards so located that no part of a normally parked vehicle will extend beyond the property line. When wheel guards are used, they shall be centered 2.5 feet from the property line for 90-degree parking, 2.3 feet for 60-degree parking, and 2.0 feet for 45-degree and 30-degree parking
 - g. Approval of the parking area layout and design of all off-street parking areas shall be made by the City. The City shall determine that spaces provided are usable, and that the circulation pattern of the area is adequate.
 - h. Mixed/Combination of Land Uses - Where a mixed or combination of land uses are proposed, parking shall be calculated based on the respective requirements of each land use. Shared parking is encouraged, if appropriate.
 - i. All new parking spaces shall be constructed with concrete, with a minimum slab thickness of 6 inches with $f_c = 3,500$ psi and reinforcement shall be Grade 60, $f_y = 60,000$ psi, #4 deformed reinforcing bars spaced at 18 inches center to center both ways and minimum lap lengths of 18 inches.
 - j. Existing asphalt parking lots can remain, be repaired, and be expanded as asphalt parking lots.
 - k. Minimum 12.5 drive aisle required for drop-off pickup lanes and drive-thru lanes.
11. Fences in any single-family residential district or subdivision may not exceed six feet in height except when located on a major thoroughfare where fences shall not exceed eight feet in height. Fences in districts other than single-family residential, may not exceed eight feet in height. Barbed wire fences are only allowed on property at least two acres in size and the barbed wire portion of the fence shall be no higher than 52 inches as measured from the natural ground.
- Residential and Commercial developments shall meet the following requirements:
- a. Perimeter fencing adjacent to Major Thoroughfares shall be masonry.
 - b. Perimeter fencing adjacent to Detention Ponds and Amenity Lakes shall be ornamental (wrought) iron.
 - c. Perimeter fencing to be installed prior to the release of the Maintenance Bond.

6' Fence Detail



8' Fence Detail



12. Driveway Culverts

a. *New Culverts*

- (1) Driveway culverts will be set by Public Works on city-maintained roads.
- (2) The Department will not set culverts in rights-of-way for State roads or on private roads.
- (3) Citizens requesting new culverts to be set are required to furnish reinforced concrete pipe (RCP) or HDPE of a suitable size as determined by Department personnel. Reasonable notice from citizen is required.
- (4) New culverts will be backfilled with soil or other material available on the site at the time culvert is set. Any material other than in-place soil must be purchased by the citizen from a vendor of their choosing. Clean out openings or grates must be supplied by the citizen if the culvert is longer than 48 feet.

b. *Existing Culverts*

- (1) When drainage projects are undertaken by the Department, culverts may be enlarged if necessary, and replaced with RCP or HDPE at Department's expense. Installation will be completed as follows:
 - (a) Culverts covered with base material will be re-covered with base material.
 - (b) Asphalt or concrete removed will be replaced with like material (asphalt for asphalt and concrete for concrete).
 - (c) When the Department undertakes projects to re-surface roads with asphalt, asphalt will be tapered outside edge of pavement at existing driveways to avoid abrupt drop off.

c. *Culvert Installation*

- (1) Stake and mark the ditch where you would like to have the culvert set. Call City of Manvel, Permits Department and have a work order prepared. We will send out our Public Works_Personnel to measure the ditch; and will call you with the correct size of reinforced concrete pipe you need to purchase.
- (2) Once the size is determined, order the reinforced concrete culvert pipe and have them delivered to the site. The only dirt we typically use to cover pipe is fill dirt (what we usually dig out of the ditch when we set the culverts). After your culverts are delivered to the site, give City Hall a call and we will put in another work order to install the culverts.

d. *Driveway Surface*

- (1) Contractor shall insure that alignment of culvert pipe is not altered during such operation.
- (2) If concrete surfacing is added by citizen's contractor: An expansion joint shall be provided two feet beyond outer edge of pipe on each side of culvert pipe, to facilitate removal of concrete as may be necessary to enlarge pipe during drainage improvement projects.
- (3) No concrete shall be placed within 11 feet of roadway centerline.

13. Streetlights
 - a. All new streetlights within a subdivision to be installed by the developer.
 - b. All monthly electrical charges and any maintenance and operation costs for streetlights within a subdivision to be paid for by the homeowners' association or MUD, as applicable.
 - c. All new streetlights to be LED Modules/Fixtures.
 - d. Refer to City Code 62-114.
 - e. Streetlights to be installed at all intersections, dead-ends, cul-de-sacs, and at a minimum spacing of 250 feet; or consistent with a photometric layout, as approved by the City.
 - f. Streetlights on Streets ($\leq 80'$ ROW) shall have minimum 60-watt LED. Streetlights on Thoroughfares ($> 80'$ ROW) shall have minimum 180-watt LED.

14. Fire Apparatus Access Roads and Fire Lanes
 - a. Approved fire apparatus access roads shall be provided for every facility, building or portion of a building hereafter constructed or moved into or within the jurisdiction. The fire apparatus access road shall comply with the requirements of this section and shall extend to within 150 feet (45,720 mm) of all portions of the facility and all portions of the exterior walls of the first story of the building as measured by an approved route around the exterior of the building or facility.
 - b. Fire apparatus access roads and fire lanes, shall have an unobstructed width of not less than 25 feet (7,620 mm), exclusive of shoulders, except for approved security gates in accordance with IFC 2021, Section 503.6, and an unobstructed vertical clearance of not less than 14 feet (4,267 mm). The required turning radius of a fire apparatus access road and fire lanes shall be 25'.
 - c. The fire code official is authorized to require more than one fire apparatus access road based on the potential for impairment of a single road by vehicle congestion, condition of terrain, climatic conditions or other factors that could limit access.
 - d. Dead-end fire apparatus access roads in excess of 150 feet (45,720 mm) in length shall be provided with an approved area for turning around fire apparatus.
 - e. Fire apparatus access roads shall be designed and maintained to support imposed loads of 80,000 lbs. for fire apparatus and shall be surfaced to provide all-weather driving capabilities.
 - f. Fire Lane Marking Striping, signs, or other markings, when approved by the fire code official, shall be provided for fire apparatus access roads to identify such roads or prohibit the obstruction thereof. Striping, signs and other markings shall be maintained in a clean and legible condition at all times and be replaced or repaired when necessary to provide adequate visibility.
 - (1) Striping – Fire apparatus access roads shall be continuously marked by painted lines of red traffic paint six inches (6") in width to show the boundaries of the lane. The words "NO PARKING FIRE LANE TOW-A-WAY ZONE" or "FIRE LANE NO PARKING TOW-A-WAY ZONE" shall appear in four inch (4") white letters at 25 feet intervals on the red border markings along both sides of the fire lanes. Where a curb is available, the striping shall be on the vertical face of the curb.

- (2) Signs – Signs shall read “NO PARKING FIRE LANE TOW-A-ZONE” or “FIRE LANE NO PARKING TOW-A-WAY ZONE” and shall be 12” wide and 18” high. Signs shall be painted on a white background with letters and borders in red, using not less than 2” lettering. Signs shall be permanently affixed to a stationary post and the bottom of the sign shall be six feet, six inches (6’6”) above finished grade. Signs shall be spaced not more than fifty feet (50’) apart along both sides of the fire lane. Signs may be installed on permanent buildings or walls or as approved by the Fire Marshal.
 - g. Where a portion of the facility or building hereafter is constructed or moved into or within the jurisdiction is more than 300 feet from a hydrant on a fire apparatus access road, as measured by an approved route around the exterior of the facility or building, on-site fire hydrants and mains shall be provided where required by the Fire Marshal.
15. Address Identification.
- a. New and existing buildings shall be provided with address identification. The address identification shall be legible and placed in a position that is visible from the street or road fronting the property. Address identification characters shall contrast with their background. Address numbers shall be Arabic numbers or alphabetical letters. Numbers shall not be spelled out. Each character shall be not less than 6 inches (152.4 mm) high with a minimum stroke width of 1/2 inch (12.7 mm). Where required by the fire code official, address identification shall be provided in additional approved locations to facilitate emergency response. Where access is by means of a private road, and the building cannot be viewed from the public way, a monument, or other approved sign shall be used to identify the structure or building. Address identification shall be maintained.
 - b. R-3 Single Family occupancies shall have approved numerals of a minimum 4 inches (88.9 mm) in height and a color contrasting with the background clearly visible and legible from the street fronting the property and rear alleyway where such alleyway exists.
16. 2” PVC Conduit shall be installed along Major Thoroughfares for future City of Manvel fiber optic network.
17. A Photometric Plan is required for all Non-Residential Site Plans. The Photometric Plan shall show lighting calculations in foot-candles along all property lines. The maximum allowable light level is 0.3 foot-candles along all property lines.
18. For all projects located within a MUD, a Water and Sewer Utility Availability Summary Table shall be provided with/within every plan and plat submittal. The Table will include a summary of currently platted lots and corresponding connections, along with reserved connections and planned future connections. It will also include the current capacity of the water and wastewater facilities (plant(s), lift stations, etc.) within the MUD.

2.0 EXECUTION

2.01 RESEARCH REQUIREMENTS

- A. Discuss project concepts outlining proposed features and usage with the City.
- B. Research existing utility and right-of-way information.
- C. Verify that no restrictions exist that will deny approval of the project concept.

2.02 DESIGN ANALYSIS – Reserved

2.03 DRAWINGS

- A. The plans shall include an overall drainage layout showing:
 - 1. Total area (in acres) of site to be drained.
 - 2. Area (in acres) drained to each inlet.
 - 3. Contours or an adequate number of spot elevations to indicate area drained to each inlet.
 - 4. Top elevation and flowline elevation at each inlet.
 - 5. Gradient and size on each private storm sewer.
 - 6. Computations to support pipe sizes and grades shown
 - 7. Design velocity for storm sewers shall be 3 feet per second.
 - 8. TX DOT permit shall be required for drainage affecting a state owned/maintained facility. Submit permit with site plan.
 - 9. The drawings shall be prepared and sealed by a Registered Professional Engineer.
 - 10. The size and location of the detention facility shall be indicated on the plans, along with the size and location of the outfall structure.
- B. All drainage plans shall be approved by the appropriate drainage entity prior to City approval.
- C. The site plan shall show all water and sewer service lines, sizes, grades and alignments with appropriate ties into existing public trunk lines.
- D. The site plan shall show all parking areas.
- E. The site plan shall indicate the types and location of all existing and proposed landscaping. Landscaping shall meet the minimum requirements of the Zoning Ordinance. A tree survey is required for first 20 feet of depth adjacent to all proposed streets. If no trees exist, a note to that affect shall be placed on the site plan.
- F. The site plan shall show all proposed and existing building setbacks, locations, heights and square footage of all proposed buildings.
- G. The land use for all adjacent property shall be shown on the site plan.
- H. All parking lot pavement for site plans shall be engineered to provide for regular use of vehicles expected to utilize the parking area and based upon the soil conditions underlying the parking area. A Registered Professional Engineer shall certify the design submitted for approval.

- I. Concrete sidewalks (a minimum of 5 feet wide and 4.5 inches thick with steel reinforcement) shall be required along all street frontages. The design and installation of such sidewalks shall comply with Texas Accessibility Standards Architectural Barriers requirements. The location of all proposed and existing sidewalks shall be shown on the construction drawings.
- J. Show location of signs, screening walls or fences and dumpsters (with appropriate screening).
- K. No improvements to the right-of-way shall be made without prior City approval. This includes planting trees in the right-of-way of residential and non-residential areas.
- L. In the event that there is a discrepancy in the drainage criteria requirements between the City and the applicable Drainage District, the City Engineer may determine which criteria will apply.

**CITY OF MANVEL
DESIGN CRITERIA MANUAL
SECTION 7 - MODIFICATION FORM**

Variations to technical standards identified in the Design Criteria Manual (DCM) may be allowed by the City of Manvel City Engineer. The modification proposal must be submitted by a registered Professional Engineer following generally accepted engineering standards and such proposal contains the following information and substantiates the findings in paragraph four (4) below. If an appeal to the City of Manvel City Engineer decision is requested, the Planning Development & Zoning (PD&Z) may review that appeal and make a recommendation to City Council. City Council will have final authority on the approval or denial of the Appeal.

Design Criteria Modification Approval will be valid for a period of 2 years. If work has not commenced within 2 years, the Modification will need to be resubmitted and reviewed, and new plan review fees paid.

This form must be completed in its entirety.

PROJECT NAME: _____
PROJECT ENGINEER: _____

SUBMITTAL DATE: _____
SUBDIVISION NAME: _____

MODIFICATION LOCATION:

1. Set forth the proposed deviation to the technical standard (including the page number and specific DCM reference).

2. Set forth the impact such deviation has, including 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.

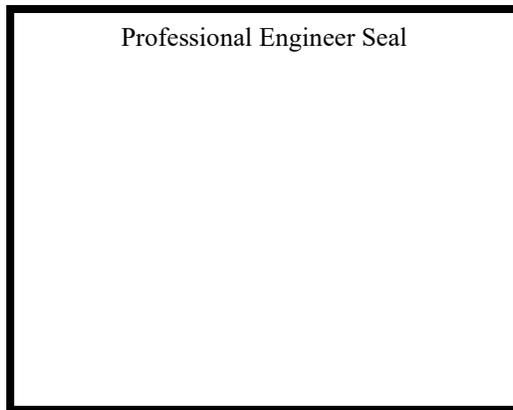
3. Show a comparison of the technical standard to the proposed deviation with respect to overall safety and quality, speed differential, street capacity, existing and projected accidents, long-term maintenance and operation, degree of functionality, degree of efficiency, technological advancements, and other relevant matters.

4. Describe all mitigating improvements that reduce the negative impact of the proposed deviation on overall safety and quality, speed differential, street capacity, accident occurrences, long-term maintenance and operation, degree of functionality, degree of efficiency and demonstrating the degree to which the proposed deviation detrimentally affects the foregoing. Other relevant factors, including technological advances, should be explained by describing how they will affect the proposed development. Mitigating improvements can include but are not limited to, traffic control devices, pavement improvements, added acceleration or deceleration lanes or reservoirs, and other on-site improvements.

SUMMARY & CONCLUSION/RECOMMENDATION FOR MODIFICATION:

List of Supporting Documentation Attached? Yes ___ No ___

Seal of Professional Engineer Required? Yes ___ No ___



<i>City of Manvel Use ONLY</i>			
1.	Modification Request:	Approved	Denied

	City Engineer	_____	Date
2.	Planning Development & Zoning:	Recommended	Not Recommended

	Chair	_____	Date
3.	City Council:	Approved	Denied

	Mayor	_____	Date