



MANUAL FOR THE DESIGN OF WATER AND SEWER LINES

SECTION I: GENERAL PROVISIONS

- 1.01 This manual is intended to aid and assist engineers in the layout and design of sanitary sewers and water lines to definite standards and to obtain uniformity in the plans. It is recognized that each project has its individual challenges and that no fixed rules will apply to all cases; therefore, final approval of all or any part of any plans rests with the City of Allen Director of Engineering.
- 1.02 The City of Allen must approve the location of all water and sanitary sewer main installations. Mains may be installed only in streets, alleys, public rights-of-way or utility easements dedicated to the City for its use and benefit thereof.
- 1.03 All infrastructure that is necessary to serve new development, including access roads, sanitary sewer force mains and lift stations, must be built on public property or within dedicated easements or rights-of-way. The required property or easement must be granted to the City of Allen by an appropriate written instrument filed with the county clerk.
- 1.04 All locations and sizes of water and sanitary sewer mains must be in accordance with this manual, the City of Allen Land Development Code and all applicable City Details.

SECTION II: WATER MAINS

- 2.01 Water Main Layout:
 - (a) In general, water mains are placed on the north and west sides of a street, at a distance of seven (7) feet from the R.O.W. line, or as otherwise directed by the Director of Engineering. See City of Allen Standard Construction Details for outline of locations.
 - (b) Where applicable, line sizes will comply with the most recent revision of the Water Distribution System Master Plan.
 - (c) Interconnections of water mains to form a grid system are preferred so that all individual water customers will have two or more potential sources and all lines are looped.
 - (d) Mains for future connections must be extended to the boundary of the tract.
- 2.02 Water Main Protection:
 - (a) All water mains shall have the following minimum cover or sufficient cover to clear other utilities:
 - (i) Six inch (6") and smaller diameter mains shall have forty two inches (42") cover.
 - (ii) Eight inch (8") diameter mains shall have forty eight inches (48") cover.



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- (iii) Mains greater than eight inches (8") in diameter shall have sixty inches (60") cover.
 - (b) All water mains must be protected at wastewater main crossings as required by the Texas Commission on Environmental Quality (TCEQ).
- 2.03 Water Main Sizing: (A computer model is not necessary to size water mains if the below minimum criteria are met provided they match the sizes illustrated and the development matches the type of development assumed in the Water Distribution System Master Plan.)
 - (a) Residential Districts: For mains over one thousand two hundred (1,200) feet in length or mains supplying more than one fire hydrant, an eight inch (8") pipe will be required. For mains less than one thousand two hundred (1,200) feet in length and supplying not more than one fire hydrant, a six inch (6") pipe will be allowed.
 - (b) Commercial and Manufacturing Districts: For mains over six hundred (600) feet in length, a twelve inch (12") pipe will be required. For mains less than six hundred (600) feet in length, a minimum of eight inch (8") mains will be required.
 - (c) Dead-end mains will not be allowed at any time unless otherwise approved by the Director of Engineering. If approved, dead-end mains shall not exceed five hundred (500) feet in length, and have at least one fire hydrant or automatic flushing device at or near the end of the main.
- 2.04 Water Main Material:
 - (a) All water mains six inches (6") in diameter and smaller shall be AWWA C900 / DR14 PVC, mechanical joint, or a joint of the type which provides a recession in the bell for the employment of a single rubber gasket to be placed before the insertion of the succeeding spigot. Joint material for PVC shall conform to ASTM F477.
 - (b) Water mains eight inches (8") to twelve inches (12") in diameter shall be AWWA C900 / DR18 PVC, mechanical joint or a joint of the type which provides a recession in the bell for the employment of a single rubber gasket to be placed before the insertion of the succeeding spigot. Joint material for PVC shall conform to ASTM F477.
 - (c) Water mains fourteen inches (14") to eighteen inches (18") in diameter shall be AWWA C905 / DR18 PVC, mechanical joint or a joint of the type which provides a recession in the bell for the employment of a single rubber gasket to be placed before the insertion of the succeeding spigot. Joint material for PVC shall conform to ASTM F477. Profile elevations shall be provided for mains twelve inches (12") in diameter and larger.
 - (d) All water mains larger than eighteen inches (18") in diameter shall be Concrete Pressure Pipe, Steel Cylinder Type complying with American Water Works Association Specifications C-301 and C-303. In addition, at the discretion of the City Engineer, eighteen inch (18") pipe may also be Concrete Pressure Pipe, Steel Cylinder Type.



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2.05 Water Valves:

- (a) Valves twelve inches (12”) and under shall be placed on or near street property lines not over eight hundred (800) feet apart in residential, duplex and apartment districts and not over five hundred (500) feet apart in all other districts; and in such a manner as to require preferably two, but not more than three valves to shut down each city block, or as may be required to prevent shutting off more than one fire hydrant. On cross-feed mains without services, a maximum of four (4) valves shall be used to shut down each block. The location of valves larger than twelve inches (12”) will be as approved by the Director of Engineering.
- (b) Valve Type:
 - (i) Valves twelve inch (12”) and under will be Resilient Seat Gate Valves (RSGV).
 - (ii) Valves over twelve inches (12”) will be Butterfly Valves.
- (c) If maximum static pressure exceeds eighty (80) psi at the proposed water meter location, a pressure reducing valve (PRV) must be installed on the customer side of the water meter. Minimum operating pressure is thirty five (35) psi at the highest elevation meter location.
- (d) At dead ends, gate valves must be located one pipe length or a minimum of twenty (20) feet from the end point of the main. Drawings must show complete restraint for all such valves, pipe extensions and end caps.
- (e) All valves shall be mechanically restrained.

2.06 Water Meters:

- (a) Each parcel, lot, tract or separate property to be served by City water shall have an individually metered service line connection from a public water main. Multi-dwelling lots must have a separate meter to each unit with separate meters for common areas, irrigation systems and any other outdoor uses of water.
- (b) Water meters must be located in areas with easy access and within public right-of-way or utility easements whenever possible. In addition, meters may not be located in areas enclosed by structures such as fences, walls, etc.
- (c) Meters shall be located outside of paved areas where at all possible. Where meters require location in residential driveways, they must be composed of a ductile iron traffic bearing meter box and lid.



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2.07 Fire Hydrants:

(a) Number and Locations

A sufficient number of fire hydrants shall be installed to provide hose stream protection for every exterior part of each building using the lengths of hose normally attached to the hydrants. There shall be sufficient hydrants to concentrate the required fire flow, as determined through application of the publication "Guide for Determination of Required Fire Flow (1974)," published by the Insurance Services Office, about any building with no hose line exceeding five hundred (500) feet.

- (i) All Residential or Duplex Zoned Property or Use: As the property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of four hundred (400) feet as measured along the length of the roadway. In fire sprinklered properties, this maximum spacing may be increased to six hundred (600) feet. No part of any structure shall be farther than five hundred (500) feet from two fire hydrants as measured along paved access routes.
- (ii) All Apartment Zoned Property or Use: As the property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of three hundred (300) feet as measured along the length of the roadway. In fire sprinklered properties, this maximum spacing may be increased to five hundred (500) feet. No part of any structure shall be farther than three hundred (300) feet from two fire hydrants as measured along paved access routes as fire hose would be laid.
- (iii) All Non-Residential Zoned Property or Use: As the property is developed, fire hydrants shall be located at all intersecting streets and at intermediate locations between intersections at a maximum spacing of three hundred (300) feet as measured along the length of the roadway. No part of the ground floor area of any structure shall be farther than three hundred (300) feet from two fire hydrants as measured by the route that a fire hose is laid.
- (iv) Fire hydrants shall be installed along all fire lanes as follows:
 - 1) Non-Residential Property or Use
 - a) Within one hundred fifty (150) feet of the main entrance.
 - b) Within one hundred (100) feet of any fire department connection.
 - c) At a maximum intermediate spacing of three hundred (300) feet as measured along the length of the fire lane.
 - 2) Apartment, Townhouse, or Cluster Residential Property or Use
 - a) Within one hundred (100) feet of any fire department connection.



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- b) At maximum intermediate spacing of three hundred (300) feet as measured along the length of the fire lane.
- (v) Generally, no fire hydrant shall be located closer than forty (40) feet to a non-residential building or structure unless approved by the Director of Engineering.
- (vi) In instances where access between the fire hydrant and the building which it is intended to serve may be blocked by a barrier, extra fire hydrants shall be provided to improve the fire protection. (Railroads, expressways, blocks which are subject to buildings restricting movement, and other man-made or natural obstacles are considered as barriers.)
- (b) Restrictions
 - (i) All hydrants shall be of the three-way type with National Standard threads, breakaway construction, a minimum 5¼" valve opening and shall comply with the latest AWWA specification C-502. The hydrant shall have a 4½" large connection with two 2½" side connections and shall be placed on water mains of no less than six inches (6") in size. Fire hydrants shall be Mueller "Centurion" or approved equal.
 - (ii) Valves shall be resilient seated gate valves placed on all fire hydrants leads and restrained to the main.
 - (iii) Required fire hydrants shall be installed so the break away point will be no less than two inches (2"), and no greater than six inches (6") above the grade surface.
 - (iv) Fire hydrants shall be located a minimum of two (2) feet and a maximum of four (4) feet behind the curb line, based on the location of the sidewalk. The fire hydrant shall not be located in the sidewalk. In addition, no fire hydrant shall be placed in a cul-de-sac or the turning radius of fire lanes.
 - (v) All required fire hydrants placed on private property shall be adequately protected by either curb stops, concrete posts or other methods as approved by the Director of Engineering and shall be in easements. Such stops or posts shall be the responsibility of the landowner on which the said fire hydrant is placed.
 - (vi) All fire hydrants shall be installed so that the 4 ½" connection will face the fire lane or street, or shall be installed as directed by the Fire Department.
 - (vii) Fire hydrants, when placed at intersections or access drives to parking lots, when practical, shall be placed so that no part of the fire truck will block the intersection or parking lot access when connections to the fire hydrant are made.
 - (viii) Fire hydrants, required by this article, and located on private property, shall be accessible to the Fire Department at all times.



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- (ix) All fire hydrants placed on private property shall be adequately protected by either curb stops of concrete post or other approved methods. Such stops shall be the responsibility of the landowner on which the fire hydrant is installed.
- (x) Fire hydrants shall be located at street or fire lane intersections, when feasible.
- (xi) An approved blue, two-sided reflector shall be utilized to identify each hydrant location. The reflector shall be affixed to the centerline of each roadway or fire access lane opposite fire hydrants.
- (xii) Fire hydrant caps and bonnet shall be painted according to the main size to which it is attached. (See chart below.) The remainder of the hydrant above ground shall be painted silver.

<u>Water Main Size</u>	<u>Color</u>
4"	Red
6"	Silver
8"	Blue
10" & larger	Yellow

- 2.08 Four-inch (4") mains used for hydrant supply shall be replaced and dead ends eliminated where practical. Six-inch (6") lines shall be connected so that not more than one hydrant will be between intersecting lines and not more than two hydrants on an eight inch (8") main between intersecting lines.
- 2.09 The minimum cover to the top of the pipe must vary with the valve stem. In general, the minimum cover below the street grade should be as follows: six inch (6") and smaller, three and one half (3.5) feet; eight inch (8"), four (4) feet; twelve inch (12"), four and one half (4.5) feet; sixteen inch (16"), five (5) feet. Lines larger than sixteen inch (16") shall have a minimum of six (6) feet of cover which is sufficient to allow water and sewer and other utilities to cross over the large main (follow TCEQ guidelines for crossings). For water lines to be constructed along county type roads commonly built with a high crown about the surrounding property, the cover shall be increased as required to allow for future paving grade changes.
- 2.10 Double strapped bronze saddles shall be used for making two inch (2") or smaller taps to mains twelve inc (12") in diameter or smaller. Tapping shall be performed with a pipe manufacturer's recommended/approved tapping machine and material-specific bit (i.e. no hole saws).
- 2.11 Large diameter water mains (over twelve inches (12") in diameter) may not be "tapped" by mains or services smaller or equal in size unless authorized by the Director of Engineering or Director of Community Services. Crosses or tees shall be provided for these types of connections. Private property mains shall not service from a water main over twelve inches (12") in diameter unless previously approved by the Director of Engineering or Director of Community Services.



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- 2.12 A service with a meter box is constructed from the main to a point just behind the curb line, usually in advance of paving. The location of the meter box is at or near the center of the front of the lot to be served. On multiple dwelling units and business properties, the desired size and location is usually specified by the owners or architect. Minimum requirements for water service sizes are:
- (a) Three quarter inch (3/4") polyethylene services are required to serve all residential lots including townhouse lots and patio homes unless otherwise required by lot size and use and approved by the Director of Engineering. Three quarter inch (3/4") polyethylene services are also required to serve lots zoned Duplex. Separate services shall be provided for each of dwelling unit. "Bull-head" taps and services are not permitted.
 - (b) The size of apartment, condominium, or multi-family services will depend on the number of units served with a minimum of one meter per building.
- 2.13 Use of water from a fire hydrant is prohibited except for the use of fire protection or as authorized by the Director of Community Services for construction with the rental of a fire-hydrant meter. A service connection shall not be allowed on fire hydrant leads except as authorized by the Director of Engineering.
- 2.14 If the City replaces or relocates a water main, or if street reconstruction requires replacement or relocation of a water main, the existing service lines shall be extended and reconnected to the new main.
- 2.15 All irrigation service lines must have a backflow prevention assembly on the customer side of the meter. No water may be returned to the City's potable water distribution system.

SECTION III: SANITARY SEWERS

- 3.01 Sizes and grades for sanitary sewers shall be as required by the Director of Engineering, and consideration shall be given as to possible extensions for future development. Sewers are usually located on the south and east side of the street a distance of 7' from the R.O.W. line. See City Standard Construction Details for details of locations.
- 3.02 Minimum Cover:
- (a) Minimum cover shall be three and a half (3.5) feet; exceptions authorized by the Director of Engineering shall have concrete protection.
 - (b) In general, the minimum depth required for sewer to serve given property with a 4-inch lateral shall be three (3) feet plus 2% times the length of the house lateral (the distance from the sewer to the center of the house). Thus, for a house 135 feet from the sewer, the depth would be 3 feet plus 2% x 135 feet = 3.0 plus 2.7 = 5.7 feet. For this example, the depth of the flow line of the sewer should then be at least 5.7 feet below the elevation of the ground at the point where the service enters the house. Profiles of the ground line twenty (20) feet past the building line will be required to verify that this criteria is met.



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- (c) On lines deeper than twelve (12) feet, a shallower parallel sewer line will be required when laterals are to be attached. This requirement should be discussed with the Director of Engineering.
- (d) Director of Engineering shall authorize any exceptions to minimum cover requirements.

3.03 Sewer Flows:

- (a) Sewage flow shall be computed in accordance with Exhibit A of this manual, with the exceptions, as required by the Director of Engineering. Pipes should be placed on such a grade that the velocity when flowing full is not less than two (2) or more than ten (10) feet per second (fps).
- (b) The minimum “n” factor for sanitary sewers shall be 0.013.

3.04 Sewer Pipe Grades:

- (a) Minimum and maximum grades for sanitary sewers shall be as follows:

<u>Pipe Size</u>	<u>Minimum Slope</u>	<u>Maximum Slope</u>
6"	0.64%	11.80%
8"	0.40%	8.40%
10"	0.30%	6.20%
12"	0.24%	4.80%
15"	0.17%	3.60%
18"	0.14%	2.80%

(Grades may be outside of the minimum and maximum slope range for short distances if approved by the Director of Engineering.)

- (b) All grades shall be shown to the nearest one tenth percent (0.01%). When the slope of a sewer changes, a manhole will be required. Gravity wastewater mains must be uniform in grade between manholes. No vertical curves will be allowed.

3.05 Sewer Plan Layout:

- (a) Horizontal curves to match change in street direction will be allowed as approved by the Director of Engineering. If allowed, minimum radii shall be as follows or as the pipe manufacturer recommends, whichever is larger:

<u>Pipe Size</u>	<u>Curve Radius</u>
6"	190'
8"	250'
10"	315'
12"	375'



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- (b) The sizes and locations of manholes, wyes, bends, tap connections, cleanouts, etc., shall be as designated by the Director of Engineering. In general, manholes shall be placed at all three and four-way connections, at the ends of mains, at all changes in horizontal alignment and at all changes in grade.

3.06 Sewer Manholes / Cleanouts:

- (a) In order to provide access for sewer lines for cleaning, manholes shall be so located that two hundred fifty (250) feet of sewer rod can reach any point in the line. This means that manhole spacing shall be limited to five hundred (500) feet.
- (b) Manholes placed on curved sewers shall only be located on PC and PT of the curves with a maximum manhole spacing of four hundred (400) feet.
- (c) The diameter of a manhole constructed over the center of a sewer should vary with the size of the sewer. The manhole diameter shall be a minimum of twenty four inches (24") wider than the largest pipe entering the manhole and shall be an even four feet (4'), five feet (5') or six feet (6') in diameter unless otherwise specified by the Director of Engineering.
- (d) Manholes may be either cast in place or precast, constructed of 4,000 psi concrete at twenty-eight (28) days.
- (e) In Flood Plains, sealed manholes "Type S" shall be used to prevent the entrance of storm water. If more than three "Type S" manholes are used sequentially, every third manhole shall have a vent that extends two (2) feet above the one hundred (100) year floodplain or ten (10) feet above the adjacent ground line, whichever is the higher elevation.
- (f) Clean-outs may not be used in the public right-of-way.
- (g) Drop manholes shall be required when the inflow elevation exceeds the outflow elevation by more than eighteen inches (18").
- (h) Wastewater mains with the same or approximately the same flow-line elevation should intersect each other at a ninety degree (90°) angle. However, where a true perpendicular intersection cannot be obtained, one or more manholes must be located so that a minimum angle of eighty degrees (80°) is achieved at the point of intersection of the wastewater mains.
- (i) A difference of one tenth (0.1) foot from the discharging wastewater main to the receiving wastewater main must be used for drops and head losses through manholes. When wastewater mains of different sizes intersect, the elevation of the crown of the receiving wastewater main must match the elevation of the crown of the entering wastewater main unless the City approves an exception due to special conditions.



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3.07 Sewer Laterals:

- (a) The sizes and locations of laterals shall be as designated by the Director of Engineering.
- (b) In general the minimum lateral size shall be four inches (4") for residential, six inches (6") for multi-family, retail and commercial and eight inches (8") for manufacturing and industrial or larger as required. Exceptions may only be used with prior approval from the Director of Engineering.
- (c) Residential laterals shall be located ten (10) feet downstream from the center of the lot, shall have a two percent (2%) minimum slope and shall have a ten (10) foot lateral separation from the water service.
- (d) Manholes will be required on six inch (6") and larger laterals where they connect to the main line.
- (e) At the end of a dead end line, the City may allow up to two wastewater laterals to be connected to a manhole. Consult the Director of Engineering prior to approval.
- (f) Laterals shall not be attached to sewer mains deeper than twelve (12) feet.
- (g) A minimum of one (1) lateral per building shall be required. Also, a minimum of one (1) lateral per residential lot shall be required.

3.08 Additional Crossings:

- (a) Railroad, State Highway and creek crossings, etc., shall be as approved by the Director of Engineering.

3.09 Construction Staking:

- (a) For private development, line and grade stakes for construction shall be furnished by the Developer's Engineer. The Contractor shall supply construction stakes for capital improvement projects. All property lines and corners must be properly staked to insure correct alignment.
- (b) The City will not be liable for improper alignment or delay of any kind caused by improper or inadequate surveys by the Developer, Developer's Engineer, Contractor or by interference of other utilities.

3.10 Materials for Sewer Lines:

- (a) All sewer pipe shall be PVC and shall conform to ASTM Designation D-3034, SDR 35. Sewer pipe joint materials shall have resilient properties, conforming to the specifications set forth in ASTM Designation D-3034.



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- (b) Pipe used for boring shall be rust-resistant steel casing a minimum of ¼” thick. Pipe placement within the steel casing shall use Raci spacers or approved equal.
- 3.11 If the City replaces or relocates a sewer main, or if street reconstruction requires replacement or relocation of a main, the existing service lines shall be extended and reconnected to the new main while maintaining positive drainage (min. 2.0%) to the main.

SECTION IV: FORM OF PLANS

- 4.01 Plans shall be clear, legible, and neatly drawn on bordered sheets, size 22” x 34.” Each sheet shall clearly display the Texas Professional Engineer’s seal of the engineer under whose direction the plans were designed. A title block in the lower right-hand corner shall be filled in to include, at a minimum: Project name and Engineer’s name, address, and telephone number.
- 4.02 The plan sheet should be drawn so that the north arrow points to the top or to the left side of the sheet. It is important that the plan show sufficient surrounding streets, lots, and property lines so that the existing water and sewer may be adequately shown, and so that proper consideration may be given to future extensions. Proposed water and sewer lines shall be stubbed out to the addition extremities in order that future extensions may be made with a minimum of expense and inconvenience. Unless it would make the plan very difficult to read, both water and sewer lines should be shown on the same sheet. The lines on the profile shall be drawn in the same direction as on the plan.
- 4.03 On large additions or layouts requiring the use of more than six sheets (total of plan and profile), key sheets may be required on a scale of 1” = 400’ or 1” = 1000’, as designated by the Director of Engineering. They shall show the overall layout with the specific project clearly indicated with reference to individual sheets.
- 4.04 The use of “off-standard” scales will not be permitted. A plan shall be drawn to scales of 1” = 100’, or 1” = 40.’ Plans for water and sewer that do not involve great detail should be drawn on a scale of 1” = 100.’ These may be on plan-profile sheets or the “plan” may be drawn with the profiles on full ruled profile sheets. (If required for clarity, a separate sheet on 1” = 40’ scale may be used to show details). Plans in and along creeks, heavily wooded sections, streets with numerous utilities, or as may be required to produce a clean and legible drawing, shall be drawn on plan-profile sheets or separate plan and profile sheets on a scale of 1” = 20’ may be necessary and will be permitted. All profiles shall be drawn on a vertical scale as required for clarity, and the horizontal scale shall be the same as for the plan unless otherwise directed by the Director of Engineering.
- 4.05 Data to be Included:
 - (a) Sewer Data to be Included Plan Sheets:
 - (i) The plan shall show the existing and proposed water and sewer lines and all appurtenances thereto.



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- (ii) All lines shall be numbered, lettered or otherwise designated on both plan and profile sheets.
 - (iii) All lines shall show sizes and direction of flow on both plan and profile sheets.
 - (iv) Stationing shall be shown to the nearest one (1) foot and each new line shall begin at 0+00 or 1+00 at the outlet and increase up the sewer. Station pluses at all junctions of sewers, horizontal P.C.'s, and P.T.'s, bends, angle points, wyes, manholes, the centerlines of all cross streets and railroads, and all crossing utilities, etc. shall be shown on both plan and profile.
 - (v) The degree of angles and horizontal curve data shall be shown on the plan only. Vertical curves will not be allowed.
 - (vi) Sewer laterals shall be shown on the plans.
- (b) Sewer Data to be Included on Profile Sheets:
- (i) The data for the profile sheet shall be obtained by running a line of levels along the actual route and by taking any other necessary observations.
 - (ii) Profiles shall show the elevations to the nearest one tenth (0.1) foot of the ground at the centerline of the sewer at the location of the approximate center of the proposed houses or buildings to be served, and the approved street or alley grade. Profiles shall also show the sewer pipe, manholes, etc.
 - (iii) The size of the sewer, the direction of flow, and the grade to the nearest one one-hundredth (0.01) foot shall be indicated just over the "pipe" and the total linear footage of line, size, kind of pipe, and type of embedment or encasement shown below the "pipe" between each manhole or structure.
 - (iv) All of the information pertaining to the horizontal data, station pluses, appurtenances to be built, manhole rims, etc., is usually shown just above the ground line, whereas, the flow line (invert) elevations are shown below the pipe.
 - (v) All existing water, sewer, gas, storm sewer, telephone, power, and other utilities parallel to or crossing the proposed sewer or water line shall be adequately designated as to size, type, and location. **Elevations of crossing and parallel utilities shall also be shown.**
 - (vi) All invert elevations shall be shown to the nearest one one-hundredth (0.01) foot. Invert elevations shall be recorded at all junctions (all lines-in and out), at grade breaks, the ends of lines, or other points as requested by the Director of Engineering.
 - (vii) Benchmarks used shall be clearly shown, giving the descriptive locations and elevations. Elevations must be from City of Allen datum, not assumed. Bench



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level circuits should begin at a USGS monument and benchmark of second order accuracy established at least every one-half mile through the project.

- (c) Data to be Included for Water Plan and Profile:
- (i) For water lines in new subdivisions, indicate the location of any existing valves required for shut-down purposes and of any tees, ends, etc.
 - (ii) Indicate clearly the sizes of the lines to be installed, and all proposed valves, fire hydrants, tees, crosses, bends, reducers, plugs, sleeves, blow-off valves, wet connections, tap connection, thrust blocking, creek, railroad or highway crossings, tunnels, meter boxes, valve vaults, and other appurtenances at each intersection or as required.
 - (iii) Where the pipe is to be laid around a curve, the curve data shall be provided in the plan view.
 - (iv) The size and type of services and the material, type of joint, and class of pipe may be indicated by adequate notation in the lower left or right hand corners of the plan sheet.
 - (v) Water services and meter boxes shall be indicated and shall be located at or near the center of the front of each lot.
 - (vi) If a water line requires a profile, then follow the general procedures as outlined for sewers, except that the grades and elevations of the proposed water line usually need not be shown closer than the nearest one tenth (0.1) foot.



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SECTION V: SANITARY SEWER DAILY FLOW CALCULATIONS (PEAK FLOW)

<u>Land Use</u>	<u>Design</u>	<u>Calculation</u>
Apartment	<ul style="list-style-type: none"> • 100 gal per person per day. • 20 units per acre. • 3 persons per unit. 	$(100*20*3*\text{daily peak factor})+\text{infiltration} =$ $(100*20*3*3)+650 = \underline{18,650}$ gal per acre per day.
Residential	<ul style="list-style-type: none"> • 100 gal per person per day. • 4.5 units per acre. • 3.5 persons per unit. 	$(100*4.5*3.5*\text{daily peak factor})+\text{infiltration} =$ $(100*4.5*3.5*3)+650 = \underline{5,375}$ gal per acre per day.
Patio Home	<ul style="list-style-type: none"> • 100 gal per person per day. • 5 units per acre. • 3.5 persons per unit. 	$(100*5*3.5*\text{daily peak factor})+\text{infiltration} =$ $(100*5*3.5*3)+650 = \underline{5,900}$ gal per acre per day.
Town Home	<ul style="list-style-type: none"> • 100 gal per person per day. • 10 units per acre. • 3.5 persons per unit. 	$(100*10*3.5*\text{daily peak factor})+\text{infiltration} =$ $(100*10*3.5*3)+650 = \underline{11,150}$ gal per acre per day.
Hospital	<ul style="list-style-type: none"> • 200 beds. • 200 gal per day per bed. 	$(200*200)+\text{infiltration} =$ $(200*200)+650 = \underline{40,650}$ gal per day.
Nursing Home	<ul style="list-style-type: none"> • 150 beds. • 90 gal per day per bed. 	$(150*90)+\text{infiltration} =$ $(150*90)+650 = \underline{14,150}$ gal per day.
Commercial/ Industrial/ Office	<ul style="list-style-type: none"> • 3,100 parking spaces per 34.7 Ac. • 1 person per parking space. • 35 gal per person per day. 	$3,100/34.7 \text{ acres} = 90 \text{ persons per acre}$ $(90*35)+\text{infiltration} =$ $(90*35)+650 = \underline{3,800}$ gal per acre per day.

Note: Infiltration shall be 650 gallons per acre per day (GPAD) and the daily peak factor shall be 3 or based on time of concentration calculations as approved by the Director of Engineering.

SANITARY SEWER DRAINAGE

DRAINAGE AREA IN ACRES	DOMESTIC FLOW	DOMESTIC DRAINAGE FACTOR	MAX. DOMESTIC FLOW (LESS INFILTRATION)	INFILTRATION (DOMESTIC ONLY) 750 GAL/AC.	DAILY MAX. DOMESTIC FLOW IN GAL/DAY	DAILY COMMERCIAL FLOW IN GAL/DAY	DAILY INDUSTRIAL FLOW IN GAL/DAY	MAX. APARTMENT FLOW IN GAL/DAY	DAILY APARTMENT FLOW IN GAL/DAY	MAX. PATIO HOME FLOW IN GAL/DAY	MAX. PATIO HOME FLOW IN GAL/DAY
0.1	133	5.00	665	75	740	500	250	2,350	2,425	1,662.5	1,737.5
0.2	286	5.00	1,330	150	1,480	1,000	500	4,700	4,850	3,325.0	3,475.0
0.3	399	5.00	1,995	225	2,220	1,500	750	7,050	7,275	4,987.5	5,212.5
0.4	532	5.00	2,660	300	2,960	2,000	1,000	9,400	9,700	6,650.0	6,950.0
0.5	665	5.00	3,325	375	3,700	2,500	1,250	11,750	12,125	8,312.5	8,687.5
0.6	798	5.00	3,990	450	4,440	3,000	1,500	14,100	14,550	9,975.0	10,425.0
0.7	931	5.00	4,655	525	5,180	3,500	1,750	16,450	16,975	11,637.5	12,162.5
0.8	1,064	5.00	5,320	600	5,920	4,000	2,000	18,800	19,400	13,300.0	13,900.0
0.9	1,197	5.00	5,985	675	6,660	4,500	2,250	21,150	21,825	14,962.5	15,637.5
1.0	1,330	5.00	6,650	750	7,400	5,000	2,500	23,500	24,250	16,625.0	17,375.0
1.5	1,995	5.00	9,975	1,125	11,100	7,500	3,750	35,250	36,375	24,937.5	26,062.5
2.0	2,660	5.00	13,300	1,500	14,800	10,000	5,000	47,000	48,500	33,250.0	34,750.0
2.5	3,325	5.00	16,625	1,875	18,500	12,500	6,250	58,750	60,625	41,562.5	43,437.5
3.0	3,990	5.00	19,950	2,250	22,200	15,000	7,500	70,500	72,750	49,875.0	52,125.0
3.5	4,655	5.00	23,275	2,625	25,900	17,500	8,750	82,250	84,875	58,187.5	60,812.5
4.0	5,320	5.00	26,600	3,000	29,600	20,000	10,000	94,000	97,000	66,500.0	69,500.0
4.5	5,985	5.00	29,925	3,375	33,300	22,500	11,250	105,750	109,125	74,812.5	78,187.5
5.0	6,650	5.00	33,250	3,750	37,000	25,000	12,500	117,500	121,250	83,125.0	86,875.0
5.5	7,315	5.00	36,575	4,125	40,700	27,500	13,750	129,250	133,375	91,437.5	95,562.5
6.0	7,980	5.00	39,900	4,500	44,400	30,000	15,000	141,000	145,500	99,750.0	104,250.0
6.5	8,645	5.00	43,225	4,875	48,100	32,500	16,250	152,750	157,625	108,062.5	112,937.5
7.0	9,310	5.00	46,550	5,250	51,800	35,000	17,500	164,500	169,750	116,375.0	121,625.0
7.5	9,975	5.00	49,875	5,625	55,500	37,500	18,750	176,250	181,875	124,687.5	130,312.5
8.0	10,640	5.00	53,200	6,000	59,200	40,000	20,000	188,000	194,000	133,000.0	139,000.0
8.5	11,305	5.00	56,525	6,375	62,900	42,500	21,250	199,750	206,125	141,312.5	147,687.5
9.0	11,970	5.00	59,850	6,750	66,600	45,000	22,500	211,500	218,250	149,625.0	156,375.0
9.5	12,635	5.00	63,175	7,125	70,300	47,500	23,750	223,250	230,375	157,937.5	165,062.5
10.0	13,300	5.00	66,500	7,500	74,000	50,000	25,000	235,000	242,500	166,250.0	173,750.0
15.0	19,950	5.00	99,750	11,250	111,000	75,000	37,500	352,500	363,750	249,375.0	260,625.0
20.0	26,600	5.00	133,000	15,000	148,000	100,000	50,000	470,000	485,000	332,500.0	347,500.0
25.0	33,250	5.00	166,250	18,750	185,000	125,000	62,500	587,500	606,250	415,625.0	434,375.0
30.0	39,900	5.00	199,500	22,500	222,000	150,000	75,000	705,000	727,500	498,750.0	521,250.0
35.0	46,550	5.00	232,750	26,250	259,000	175,000	87,500	822,500	848,750	581,875.0	608,125.0
40.0	53,200	5.00	266,000	30,000	296,000	200,000	100,000	940,000	970,000	665,000.0	695,000.0
45.0	59,850	5.00	299,250	33,750	333,000	225,000	112,500	1,057,500	1,081,250	748,125.0	781,875.0
50.0	66,500	5.00	332,500	37,500	370,000	250,000	125,000	1,175,000	1,212,500	831,250.0	868,750.0
55.0	73,150	5.00	365,750	41,250	407,000	275,000	137,500	1,292,500	1,333,750	914,375.0	955,625.0
60.0	79,800	5.00	399,000	45,000	444,000	300,000	150,000	1,410,000	1,455,000	997,500.0	1,042,500.0
65.0	86,450	5.00	432,250	48,750	481,000	325,000	162,500	1,527,500	1,576,250	1,080,625.0	1,129,375.0
70.0	93,100	4.90	456,190	52,500	508,690	350,000	175,000	1,644,500	1,694,000	1,140,475.0	1,192,975.0
75.0	99,750	4.80	478,800	56,250	535,050	375,000	187,500	1,692,000	1,748,250	1,197,000.0	1,253,250.0
80.0	106,400	4.76	506,464	60,000	566,464	400,000	200,000	1,789,760	1,849,760	1,266,160.0	1,326,160.0
85.0	113,050	4.72	533,596	63,750	597,346	425,000	212,500	1,885,640	1,949,390	1,333,990.0	1,397,740.0
90.0	119,700	4.66	557,802	67,500	625,302	450,000	225,000	1,971,180	2,038,680	1,394,505.0	1,462,005.0
95.0	126,350	4.62	583,737	71,250	654,987	475,000	237,500	2,062,830	2,134,080	1,459,342.5	1,530,592.5
100.0	133,000	4.57	607,810	75,000	682,810	500,000	250,000	2,147,900	2,222,900	1,519,525.0	1,594,525.0
110.0	146,300	4.49	656,887	82,500	739,387	550,000	275,000	2,321,330	2,403,830	1,642,217.5	1,724,717.5
120.0	159,600	4.40	702,240	90,000	792,240	600,000	300,000	2,481,600	2,571,600	1,755,600.0	1,845,600.0
130.0	172,900	4.34	750,386	97,500	847,886	650,000	325,000	2,641,740	2,749,240	1,875,965.0	1,973,465.0
140.0	186,200	4.25	791,350	105,000	896,350	700,000	350,000	2,796,500	2,901,500	1,978,375.0	2,083,375.0
150.0	199,500	4.20	837,900	112,500	950,400	750,000	375,000	2,961,000	3,073,500	2,094,750.0	2,207,250.0
160.0	212,800	4.14	880,992	120,000	1,000,992	800,000	400,000	3,113,280	3,233,280	2,202,480.0	2,322,480.0
170.0	226,100	4.09	924,749	127,500	1,052,249	850,000	425,000	3,267,910	3,395,410	2,311,872.5	2,439,372.5
180.0	239,400	4.04	967,176	135,000	1,102,176	900,000	450,000	3,417,840	3,552,840	2,417,940.0	2,552,940.0
190.0	252,700	4.00	1,010,800	142,500	1,153,300	950,000	475,000	3,572,000	3,714,500	2,527,000.0	2,669,500.0
200.0	266,000	3.96	1,053,360	150,000	1,203,360	1,000,000	500,000	3,722,400	3,872,400	2,633,400.0	2,783,400.0
250.0	332,500	3.79	1,260,175	187,500	1,447,675	1,250,000	625,000	4,453,250	4,640,750	3,150,437.5	3,337,937.5