
Chapter 9-2

WATER DISTRIBUTION SYSTEM STANDARDS

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9-2-1: General Provisions

- (A) **General.** A Registered Professional Engineer licensed to practice in the State of Colorado shall design public water mains. Designs shall be in accordance with the Latest Edition of Colorado’s Primary Drinking Water Regulations. All proposed construction shall follow recommendations provided within the City of Montrose Water Master Plan, as adopted and amended.

- (B) **Future Extensions.** Where it is determined that water lines are necessary to serve property beyond the subdivision or development in question, the developer will be required to design, properly size, and construct the system at an appropriate location to permit future extensions to be made at the limits of the subdivision or development in question. The system must terminate at all points within the new development to within one lot from the adjacent and/or downstream properties to be served by the system in the future. Public water systems must be designed and constructed along major roads and/or through the development to facilitate future extensions.

- (C) **Quality Control and Quality Assurance.** Quality Control shall be in accordance with Section 9-1-1 (B). Quality Assurance testing shall follow the general guidance of Section 9-1-1 (C) and specific requirements of Table 1 below.

Table 1 – Required Quality Assurance Testing

TEST REQUIRED	TEST PROCEDURE	REQUIRED ALLOWED RANGE	OR	MINIMUM TEST FREQUENCY
Compaction of bedding and haunching materials (except crushed rock)	AASHTO T 99 And T 265	90% minimum see notes		1 per 400 L.F. of trench (and each branch or section of trench less than 400 feet in length) for each two-foot vertical depth of backfill material.
Trench Compaction to subgrade 1. Within right of way. 2. In unimproved areas outside of right of way or within landscaped areas.	AASHTO T 180 And T 265	95% minimum see notes Match existing or 85% minimum		
Compaction of aggregate base course material	AASHTO T 180 And T 265	95% minimum see notes		1 per 200 S.Y.

TEST REQUIRED	TEST PROCEDURE	REQUIRED ALLOWED RANGE	OR	MINIMUM TEST FREQUENCY
Compaction within 24" of all structures (manholes, catch basins, vaults, etc.)	AASHTO T 180 And T 265	95% minimum see notes		1 per each two-foot vertical depth of backfill material or per 100 L.F. of structure perimeter

Notes:

Compaction of Clay soils – Compaction requirements per test procedure at optimum moisture to plus four percent (+ 4%)

Compaction of Non clay soils – Compaction requirements per test procedure near optimum moisture to plus or minus two percent (+/- 2%)

(D) Materials: All materials used shall be new and in conformance with the applicable standards.

- (1) **Contractor Requirements.** All materials to be furnished by the Contractor shall conform to the requirements of these specifications. The type, size and strength class of pipe, fittings and other materials shall be as shown on the Construction Drawings.
- (2) **City Furnished Materials.** When the City furnishes materials that are to be incorporated into the Work by the Contractor, the specific delivery, unloading, and storage requirements for both the City and the Contractor will be identified in the Special Conditions.
- (3) **Inspection and Testing.** All pipe shall be tested in conformance with the applicable standards. Testing may be witnessed by the Engineer's representative, or by an approved independent testing laboratory. Upon request of the Engineer, the Contractor shall provide a copy of certified test reports indicating that material does conform to the applicable standards or specifications.
- (4) **Handling.** All materials shall be handled with equipment and methods adequate to prevent shock or damage. Under no circumstances shall materials be dropped. Pipe handled on skids shall not be skidded or rolled against pipe already on the ground. If any part of the coating or lining is damaged, the Contractor shall repair or replace the material at his expense as directed by the Engineer. All pipe and appurtenances shall be handled in accordance with the appropriate AWWA and ASTM standards.
- (5) **Storage.** The Contractor will be held responsible for the safe storage and protection of all pipe and other materials delivered to the work site. The interiors of all pipe and fittings shall be kept free from dirt and foreign matter at

all times. Gaskets for pipe joints shall be stored in a cool location out of direct sunlight. If sunburned pipe is utilized, the City requires that the contractor provide a manufacturer's certification that all warranties are still valid. The City reserves the right to reject sunburned pipe depending on the severity of the apparent damage. Any material that has been damaged before actual incorporation in the Work shall be repaired or replaced at the Contractor's expense.

9-2-2: Water Distribution System Design Criteria

- (A) **Water Line Location.** Generally, water lines to be installed in proposed subdivisions and local streets shall be located within street rights-of-way and at least two (2) feet from the edge of pavement (within the pavement) where there is no curb and gutter and two (2) feet from the lip of gutter (within the pavement) where there is curb and gutter. However, within proposed curb and gutter streets, an alternate design may be considered if right-of-way is available and a design is feasible.

Where water lines are to be installed in roads expected to be widened in the future, they shall be located in easements unless the future road cross section is known and location of water line is designed to avoid future relocation. Water lines shall be designed so that changes in alignment are made with bends with approved thrust blocks or approved mechanical joint restraint systems wherever applicable. All mechanical joint thrust restraint system calculations shall be shown on plans with a detail sketch showing length of pipe and fittings to be restrained. Engineer is to verify existing field conditions to develop soil classifications for calculated bearing pressures.

- (1) **Within Subdivision Easements:** In subdivisions, water mains will be permitted in easements only when there is no other feasible alternative and prior approval is obtained from the City Engineer. Easements shall be at least two times the depth of the utility being installed or a minimum of twenty (20) feet wide.
 - (2) **Existing Systems and Structures:** The engineer shall identify the location of existing and proposed sanitary sewer and storm drainage systems and all other underground structures and utilities that could affect the location and type of materials for the pipeline. The selected location shall avoid conflicts and facilitate future maintenance. Where the possibility of conflicts with existing utilities and/or other structures exists, it shall be the engineer's responsibility to secure accurate horizontal and vertical locations of existing utilities through subsurface exploration and design proposed utilities to avoid conflicts.
 - (3) **Separation Standards:** Minimum separation requirements for water and sanitary sewer facilities identified in Section 9-3-2(C) shall be met.
- (B) **Water Line Depth.** All water lines shall be constructed with appropriate cover depth to provide adequate protection against freezing, to ensure adequate structural cover

over valves and other appurtenances, and to provide reasonable maintenance accessibility.

New installation of water lines adjacent to roadways shall have a minimum of forty-eight (48) inches of cover from existing/proposed edge of pavement. Greater depths shall be required where the street will be widened in the future, thereby reducing depth of cover. Clearance shall be provided for enlargement of undersized drainage structures.

In all cases, the maximum depth of cover above water lines shall be ten (10) feet. Where a proposal for importing fill above an existing water line will increase the depth of cover to greater than ten (10) feet, the water main shall be raised to the standard minimum depth of forty-eight (48) inches at the expense of the proposer.

(C) **Water Line Appurtenances.**

- (1) **Fire Hydrants.** The location of fire hydrants shall follow the currently adopted version of the International Fire Code. Generally, hydrants in residential areas should be located at street intersections, outside the clear sight zone, or in mid-block at lot lines as approved by the Montrose Fire Protection District. Maximum hydrant spacing within residential areas shall be five hundred (500) feet. No house shall be further than two hundred and fifty (250) feet from any hydrant. Maximum hydrant spacing within commercial and industrial areas shall be three hundred (300) feet. No commercial or industrial building shall be further than one hundred and eighty (180) feet from any hydrant. When cul-de-sacs are longer than two hundred and fifty (250), feet and the last fire hydrant shall be designed immediately before the bulb of the cul-de-sac, where practical. A fire hydrant shall be installed at the end of each dead-end line. The developer shall demonstrate that minimum fire flows and pressures identified in the currently adopted version of the International Fire Code shall be met or exceeded for all proposed fire hydrants, unless otherwise approved by the Montrose Fire Protection District. This requirement applies regardless whether the water is supplied by the City of Montrose or another water system.
- (2) **Valves.** Valves shall be located at maximum intervals of four hundred (400) feet and at all changes in pipe diameter unless otherwise approved. Valves shall also be provided at all pipe line intersections, outside of street intersections, in order to provide shut off for repairs of limited sections without interruption of service to large areas and to facilitate testing. A minimum of two (2) valves shall be provided at tees, three valves at crosses. The City may require additional valves where appropriate. All Valves are to be restrained to fittings by approved method.
- (3) **Tees and Tapping Sleeves.** When connecting to an existing water main, installing a tee as opposed to a tapping sleeve and valve may be desirable when there are long distances between main line valves (greater than one thousand (1000) feet) or even if the distance is less than one thousand (1000) feet where it

would be an advantage to add a main line valve for better system control. Therefore, it is important that each project be carefully evaluated by the developer's engineer with the City Engineer's assistance to determine if a main line valve is needed and/or cutting in a tee is practical, taking into consideration how many residences, businesses, hospitals, etc. may be without water.

(D) **Structural Design.** Structural requirements must be considered in the design of all water mains and appurtenances. This is a matter of detail design and is not subject to simple generalization. The design engineer shall consider the following criteria:

- (1) **Special Structures.** Structures shall be built as shown in the standard details. However, structures other than those shown in the standard details shall be considered special structures and shall be designed and detailed by the design engineer and submitted for review and approval to the City Engineer prior to plan submittal or brought to the Department's attention at the time of plan submittal.
- (2) **Pipe Foundation.** In all cases the proper strength water pipe shall be specified for the proposed depth, width of trench and bedding condition. Soil condition shall be considered with samples being obtained where necessary to verify pipe selection and foundation design.
- (3) **Thrust Protection.** Thrust protection as shown on plans in the standard details shall consist of concrete thrust blocks against undisturbed earth. Approved mechanical joint restraint systems may be required. Hydrant valves shall be installed with hydrant tees, and hydrants shall be protected from thrust by approved mechanical joint restraints and concrete thrust blocks.
- (4) **Mechanical Restraints.** Where valves are placed for future water line extensions, valves are to be rodded to the fitting and a minimum twenty (20) foot length of pipe shall be installed past the valve except where calculations or local conditions indicate more pipe is required to provide adequate restraint. Approved mechanical joint restraint systems are to be used as required to provide adequate retention of the pipe and valve when thrust blocks cannot be used.

(E) **Water Line Hydraulic Design.** Water distribution systems shall be designed to provide adequate flow and pressure for both domestic supply and fire flow based on sound hydraulic analysis, design criteria contained within this subsection, and the currently adopted version of the International Fire Code. Design shall be based on a maximum flow velocity at peak flows (excluding fire flow) of five (5) feet per second and a Hazen-Williams "C" Value of 150. The water distribution system and any extensions thereto shall be designed to supply the demands of all customers while maintaining thirty-five (35) psi at maximum day demand plus fire flow or peak hour domestic, whichever is greater; and to maintain forty (40) psi at maximum day demand. When forty (40) psi cannot be maintained, the engineer shall be responsible for coordinating with the City Engineer to investigate alternatives in order to provide

forty (40) psi. Designs providing less than forty (40) psi will be evaluated on an individual basis. Also, the design of the water line should be such that a velocity of two and one half (2.5) fps can be maintained at blow off devices and hydrants for proper flushing.

(1) The following criteria shall be used in estimating average daily demands:

Discharge Facility	Gallons per day/acre	Equivalent Persons/Acre
Residential		
Low Density (1.0-3.0 dwellings per acre)	500	5
Medium Density (3.1-7.0 dwelling units per acre)	1,000	10
High Density (7.1+ dwelling units per acre)	2,500	25
Commercial		
Business	2,000	20
Regional/Commercial	2,500	25
Industrial		
Light	2,500	25
General	3,500	35
Other		
Agriculture/Undeveloped Land	1,000	10

(2) Where site-specific determinations can be made, flows may be determined by using the following design information:

Discharge Facility	Design Units	Flow gpd
a) Single Family Units Includes Townhouses, Individual House Trailers	3.5 people/dwelling	350
(b) Apartments and Condominiums	4 people/3 bedroom apt	350
	3 people/2 bedroom apt	300
	2 people/1 bedroom apt	200
Schools with showers and cafeteria	Elementary	Per person 16
	High School	Per person 25
Motels and Hotels –rooms only	Per person	130
Churches:		
a) With Day Care/School Facilities	Per Person (based on max. Occupancy)	16
b) Without Day Care/School Facilities	Per Person (based on max. Occupancy)	25
Restaurants	Per seat	50

Discharge Facility	Design Units	Flow gpd
Service Stations	Per vehicle serviced	10
Factories	Per person/8 hr shift	25
Shopping Centers	Per 1000 sq ft of Ultimate Floor space	250
Hospitals	Per bed	300
Nursing Homes	Per bed	200
Homes for the Aged	Per bed	100
Doctors Office in Medical Center	Per 1000 sq ft	500
Laundromats, 9 to 12 machines	Per machine	500
Theaters, Auditorium Type	Per seat	5
Bowling Alleys	Per lane	75
Office Buildings	1000 sq ft ultimate floor space	200
RV Parks	Per parking space	100

- (3) To determine maximum daily demands and peak hourly demands the following multipliers shall be used:

$$\begin{aligned} \text{Maximum Daily Demand} &= 1.8 \text{ times Average Daily Demand} \\ \text{Peak Hourly Demand} &= 2.36 \text{ times Average Daily Demand} \end{aligned}$$

- (4) Fire flow requirements for residential and non-residential areas shall be in accordance with the currently adopted version of the International Fire Code and the applicable sections of UBC, and shall be coordinated with the Montrose Fire Protection District.
- (5) Minimum pipe size shall be eight (8) inches, except that terminal water lines may be six (6) inches in diameter unless a larger diameter line is needed to meet the peak domestic demand and/or fire flow requirements. Water extensions shall be designed to make continuous loops, connecting to the City water system in at least two points, approved by the City Engineer, to provide alternate sources of supply.
- (6) Services and meters shall be sized and locations designed in accordance with the Standard Details. Minimum service size shall be three-quarter ($\frac{3}{4}$) inch pipe with a three-quarter ($\frac{3}{4}$) inch meter. Services shall be designed and reflected on the plans for both residential and commercial developments.
- (7) Where design pressures exceed eighty (80) psi pressure reducing valves (PRV) shall be installed on the customer side of the meter (not inside the meter pit) by the builder or property owner. The PRV shall be operated and maintained by the customer. PRV's are recommended on all new construction because changes in the system may cause delivery pressures to change over time.

- (8) Engineer shall use the following guidelines, in regard to location of flush points, air release valves, blow offs, looping etc. during the design of public water systems:
- (a) Minimize the number of blow offs, and strategically place them so that proper flushing can be accomplished with minimal impact to users.
 - (b) Minimize number of air release valves, taking into consideration the depth that the water line is to be placed.
 - (c) Water main extensions shall be designed to make continuous loops. Two supply points shall be provided for alternate source of supply.
- (F) **Railroad Crossings.** All water line crossings of railroads shall be encased in a carrier pipe. Design of railroad crossings shall comply with the requirements of Union Pacific Railroad, Utilities Installation Procedures.
- (G) **Road Crossings.** Where required by the City Engineer, all water line crossings of roadways and other major structures shall be encased in a carrier pipe. When crossing CDOT highways, design must conform to current CDOT standards and construction must comply with CDOT utilities permit. When crossing City roadways, a City excavation permit is required.
- (H) **Stream Crossings.** Water mains entering or crossing streams shall be constructed by directional bore and installed in a casing pipe unless otherwise approved by the City Engineer. The top of the casing shall be a sufficient depth below the natural bottom of the streambed to protect the pipe. In general, three and one-half (3.5) feet of suitable cover is required. The pipe and joints shall be designed, constructed, and protected against anticipated hydraulic and physical, longitudinal, vertical, horizontal loads, erosion and impact.
- (1) Water mains constructed on piers will be permitted only when it can be demonstrated that no other practical alternative exists. The engineer shall submit a design for the piers, pier foundation and pipe that will demonstrate the structural integrity of the proposed system.
 - (2) Above ground pipe shall be adequately supported, protected from freezing, encased, accessible for repair or replacement, and above the one hundred (100) year flood elevation.
 - (3) The design shall provide valves at both ends of the crossing so that the section can be isolated for tests and repairs. The valves shall be easily accessible and not subject to flooding.
- (I) **Pipe and Fittings for Water Mains and Service Connections.** Pipe for water mains shall be PVC unless otherwise approved.

- (1) PVC Water Distribution Pipe. PVC pipe and fittings for the City's water distribution system shall conform to AWWA C-900 for sizes six (6) inch through twelve (12) inch and to AWWA C-905 for sizes fourteen (14) inch through thirty-six (36) inch. Unless otherwise specified, the minimum thickness class of C-900 PVC pipe shall be a Dimension Ratio (DR) of 18. Minimum thickness class of C-905 PVC is DR25.
 - (a) Joints. Joints shall be bell and spigot type sealed with elastomeric gaskets conforming to ASTM D-3139. Couplings shall be able to withstand the same internal pressure and external loading as the pipe.
 - (b) Fittings. PVC fittings for C-900 PVC pipe will not be allowed. Ductile iron fittings for use on PVC pipe shall conform to AWWA C-104 and C-153.

- (2) Water Service Pipe and Fittings:
 - (a) Copper Tubing. Copper tubing for water service lines three-quarter ($\frac{3}{4}$) inch through two (2) inches in diameter shall be Type K, soft temper copper tubing for underground service conforming to ASTM B-88 and ASTM B-251. The pipe shall be marked with the manufacturer's name or trademark and the type of pipe. The outside diameter of the pipe and minimum weight per foot shall not be less than that listed in ASTM B-251, Table II.
 - (b) PVC Water Service Pipe. PVC pipe and fitting for water services one and one-half ($1\frac{1}{2}$ ") inch and two (2) inches will be allowed. PVC pipe and fittings for water service lines three-quarter ($\frac{3}{4}$) inch to three (3) inches will be allowed after the meter or on services longer than sixty (60) feet in length. The pipe shall conform to ASTM D-1785 and unless otherwise specified, all pipe shall be CL 200 psi. All services four (4) inches and larger shall conform to AWWA C-900.
 - (c) Fittings. All fittings for copper water service lines shall be brass and have flared or Mueller 110 type compression copper connections.
 - (d) HDPE Water Service Tubing. HDPE tubing rated for a minimum of two hundred (200) psi, SDR 9 CTS, meeting ASTM D2737 (commonly referred to by brand names such as CenCore and PureCore), may be used for water service lines three-quarter ($\frac{3}{4}$) inches through two (2) inches in diameter in lieu of Type K copper tubing. When HDPE tubing is used, a tracer wire shall be buried with the tubing from the tap to the meter.

9-2-3: Water Distribution System Construction Specifications

- (A) **General.** All pipe, valves, hydrants, manholes and other pipeline appurtenances shall be installed and tested in accordance with these specifications and manufacturer's instructions. When installation instructions or procedures differ, the City Engineer will determine which will take precedence over the others.

Pressure pipelines covered by this specification include: water lines, force mains, siphons, pressurized irrigation lines and other lines that operate under a hydraulic head.

- (B) **Pipe Laying of Pressure Pipelines.** Pipe shall be laid on the alignment shown on the plans. Unless otherwise specified or approved, all pressure pipelines shall be laid to a minimum depth of forty-eight (48) inches measured from the proposed final ground surface to the top of the pipe.

The inside of the pipe and jointing surfaces shall be kept clean and free from mud, dirt, gravel, ground water, and other foreign material. When pipe laying is not in progress the open ends of the pipeline shall be kept closed with watertight plugs. Long radius horizontal or vertical curves may be laid with standard pipe by deflections at the joints of rigid pipe or by deflecting the entire length of flexible pipe. Maximum deflections at pipe joints shall be per the Manufacturer's recommendations or applicable AWWA Standard.

- (C) **Electrical Continuity.** All water mains and other pressure pipelines shall be buried with a continuous electrical tracing wire to enable future location of the pipe. Tracing wire shall be taped to the top of the pipe at ten (10) foot intervals to prevent dislocation of the wire during backfilling. The tracing wire shall be looped up to all valve boxes and to the base of all fire hydrants as shown on the *City Standard Drawings*. The wire shall be installed on the outside of the lower section of each valve box and the inside of the upper section to the lid. Tracing wire shall be terminated at the ends of all pressure pipelines as detailed on *City Standard Drawings Water System Detail W-09*.

- (D) **Polyethylene Encasement.** Prior to backfilling, all metal pipe (except copper service lines), fittings, valves and appurtenances shall be wrapped with polyethylene encasement material. Polyethylene film shall have a minimum thickness of 0.008 (8-mil) inches. Installation of the polyethylene encasement shall be in accordance with AWWA C-105 Method "A."

Ductile iron valves and fittings shall be fully encapsulated by the polyethylene encasement, except the valve-operating nut. The ends of the polyethylene shall be taped around the full circumference of the pipe. If the polyethylene is cut or more than one piece is used to wrap the valve or fitting, the pieces shall overlap a minimum of twelve (12) inches and the full length of the seam shall be taped.

- (E) **Thrust Restraint.** Thrust restraint shall be provided at all pipe bends, tees, caps, valves, hydrants, and at the end of all stub outs or dead end lines. Thrust restraint may be provided by concrete blocking or mechanical restraints. Any in-line valve that is at least twenty (20) feet from the nearest fitting need not be separately restrained.

- (1) Concrete Thrust Blocking. The size and location of concrete blocking shall be as shown on the plans or in accordance with the *Standard Waterline Details*. Thrust blocks shall be poured on firm, stable foundation material and all bearing surfaces shall be against undisturbed earth.

Concrete for thrust blocks shall be made with modified Type II Portland cement and shall reach a minimum compressive strength of three thousand (3000) psi in twenty-eight (28) days. All anchorage steel not embedded in concrete shall be factory epoxy coated or Cor-Ten steel.

Fire hydrants shall be dry blocked as well as mechanically restrained, as shown on the *Standard Waterline Details*.

- (2) Mechanical Restraint. Valves and fittings may be restrained by mechanically connecting them to the pipe or other fittings. Fitting to fitting connections may be made with a flange-by-flange connection or an integral ring anchoring fitting by mechanical joint connection. Pipe by fitting connections may be restrained with a Megalug®, JCM®, Uniflange Series 1500® or other approved joint restraint. Where a short piece of pipe is installed between a fitting and a valve or other fitting, the restraint may be provided by connecting the mechanical joints with five-eighth ($\frac{5}{8}$) inch stainless steel rod. The rod shall be connected to the mechanical joint fitting using tie-back bolts, not through the fitting's bolt holes. The rod shall be coated with an asphaltic sealant. All mechanical restraints shall be encased with polyethylene in accordance with Section 9-2-3(D) above.

- (F) **Installation of Water Service Pipe.** Where possible, underground water service pipes shall be laid not less than ten (10) feet horizontally from the building sewer service line. Where this separation is not possible, the water service line shall be at least eighteen (18) inches above the top of the sewer service line.

Tapping saddles shall be used for all water service lines. Taps shall be at forty-five degrees (45°) above the springline of the pipe. All water service connections shall include a corporation stop installed with the operating handle accessible from the top.

- (1) Service Stubouts. The service line shall be installed from the main to the meter pit location shown on the Construction Drawings. The meter pit shall be installed so the top of the pit is within one-half ($\frac{1}{2}$) inch of the proposed final ground surface elevation. The top of the pit shall be higher than the back of the adjacent sidewalk with a minimum slope of $\frac{1}{4}$ inch per foot from the pit to the back of the sidewalk. A meter setter shall be installed in each meter pit so the top of the setter will be twenty (20) inches (plus or minus two inches ($\pm 2''$)) below the top of the pit.
- (2) The service line shall extend to the back of the multipurpose or utility easement and marked either by a four by four (4"x 4") wood or steel fence post buried vertically. The post shall extend three (3) feet above the ground surface with the

exposed portion painted blue. The end of the service line shall be capped with a watertight plug.

Within the City limits, installation on non-City water systems shall conform, at a minimum, to the City standards, or those of that particular system, whichever is more stringent. The company or organization operating the water main shall install meters and coordinate all construction with the Public Works Department.

(G) **Sampling Stations.** Sampling stations are required for all new industrial/commercial or residential development. Sampling station installation is as follows: One sampling station shall be installed in each new subdivision of forty (40) acres or less. For subdivisions larger than forty (40) acres, one sampling station shall be installed for each forty (40) acres or portion thereof. The City Engineer shall approve sampling station locations. Sampling station shall be either Eclipse No. 88 Sampling Station (winterized) or a meter pit with Water Plus Corporation “All-in-One” Model 1500 Sampling Station installed in accordance with the manufacturer’s recommendations.

(H) **Backflow Prevention Devices.** A backflow prevention assembly shall be installed on all irrigation sprinkler systems, and any other connection to the service line that presents a backflow or siphon potential and contamination risk. All backflow prevention devices shall be installed in accordance with Chapter 3-8 of the Municipal Code, the Uniform Plumbing Code, and manufacturer’s recommendations. For water services with high-risk installations, as determined by the City, the assemblies shall be reviewed and approved prior to installation by the City Engineer.

All new or remodeled commercial buildings shall have an approved backflow prevention device installed on the building service line.

(I) **Service Line Replacements and Reconnections.** When discovered, existing lead and galvanized steel water service lines shall be replaced with approved water service line materials as specified in 9-2-2 (H) (2). Other service lines may be replaced as directed by the City. The new service lines shall be connected to the existing meter with the appropriate fittings. The existing meter pit shall be carefully excavated and re-used if serviceable.

The relocated meter shall be reconnected to the customer's service line with the appropriate fittings.

The City shall inspect the condition and configuration of the existing meter, fittings, and pit for all service line reconnections and relocations. The City may direct any or all of the components to be replaced or reconfigured to conform to current standards.

(J) **Connections to Existing Mains.** New water lines shall not be connected to existing mains in service until the new lines have been flushed, tested, disinfected, and accepted by the City. Where the connection of the new lines to old requires interruption of service, the City Engineer and Contractor shall mutually agree upon a

date and time for connections which will allow ample time to assemble labor and materials. The Contractor shall notify all impacted water users forty-eight (48) hours prior to any water service interruption.

(K) **Relationship Between Water Lines and Sanitary Sewers.** To reduce the possibility of contamination of the domestic water supply in the event of a water line break or repair, crossings of sewer and water lines shall not be at an angle less than forth-five degrees (45%) nor shall a sewer line or water line be installed within ten (10) feet of each other unless approved by the City Engineer. The following construction techniques shall be used when a water line and a sanitary sewer line are installed in close proximity to each other. These requirements shall apply to main lines and service lines.

- (1) If the sewer line is above and within ten (10) feet horizontally of the water line, the sewer line shall be installed through a PVC, steel, or ductile iron casing pipe or encased in reinforced concrete as shown on the *City Standard Details for General Utilities*. The casing pipe or concrete encasement shall extend a minimum of ten (10) feet on either side of the water line, measured perpendicular to the water line.
- (2) If the sewer line is eighteen (18) inches or less clear distance below and within ten (10) feet horizontally of the water line, the sewer line shall be installed through a PVC, steel, or ductile iron casing pipe or capped with concrete as shown on the *City Standard Details for General Utilities*. The casing pipe or concrete cap shall extend a minimum of ten (10) feet on either side of the water line, measured perpendicular to the water line.

In all cases, suitable backfill or other pre-approved structural protection shall be provided to preclude the settling or failure of both pipes.

9-2-4: Water Line Appurtenance Specifications

(A) **Installation of Fire Hydrants.** Hydrants shall be installed at the locations shown on the Construction Drawings.

- (1) A three (3) foot clear space, measured from the outside edge of the hydrant, shall be maintained around all fire hydrants. They shall be plumb and set so that the bottom of the pumper nozzle is no less than eighteen (18) inches and no more than twenty-two (22) inches above finished grade as shown in the *Standard Waterline Details*.
- (2) The depth of the water line shall be adjusted so the fire line, from the main to the hydrant, can be installed horizontally with a four (4) foot bury depth and the fire hydrant set with the ground line within one-half ($\frac{1}{2}$) inch of the finished ground level. If the depth of the water line cannot be adjusted because of conflicting utilities or other constraints, an offset shall be installed on the fire line and rotated to achieve the proper bury depth of the hydrant, or a fire hydrant with a different barrel height shall be used.

- (3) A minimum of one-quarter ($\frac{1}{4}$) cubic yard of washed gravel shall be placed around the base of the hydrant to insure proper drainage of the hydrant after use. All pipe and fittings between the water line and the fire hydrant shall be restrained with dry concrete thrust blocks behind the hydrant and mechanical restraints. The tee shall be restrained with an appropriately sized concrete thrust block. Weep holes, which drain the hydrant, shall not be covered with concrete.
 - (4) Fire hydrants shall be the dry barrel type and shall conform to AWWA C-502. Hydrants shall be Mueller A-423, Clow Medallion 2545, Kennedy K81 or approved equal, with a five and one-quarter ($5\frac{1}{4}$) inch main valve. Hydrants shall be of the "traffic" or "breakaway" design, having easily replaceable breaking devices for the grade line flange and operating stem that prevents damage to the barrel sections upon impact.
 - (5) The standard hydrant shall have two (2) and one-half ($2\frac{1}{2}$) inch hose nozzles and one four and one-half ($4\frac{1}{2}$) inch pumper nozzle with Storz hose connection (integral or adapter). The Storz connection shall have a locking, leak-tight cap, and the two and one-half ($2\frac{1}{2}$) in nozzles shall have nozzle caps securely chained to the upper barrel section.
 - (6) The hydrant barrel shall be marked with a circumferential rib to denote the intended ground line.
 - (7) Fire hydrants shall be painted bright red with an alkyd enamel paint or an approved substitute.
- (B) **Installation of Valves and Valve Boxes.** All valves shall be gate valves unless otherwise approved by the City Engineer. Each gate valve shall be installed in a vertical position and set on a concrete support block as shown on the *City Standard Drawings*. An adjustable slip type valve box shall be set into position prior to backfilling operations. The upper section of the unit shall be placed in proper alignment and adjusted so that its top will be at final grade. The completed valve box shall be vertically centered over the valve operating nut. Each valve shall be checked for proper access and operation prior to paving.
- (1) Gate valves shall be resilient seat or resilient wedge type gate valves conforming to AWWA C-509. Valves shall have cast iron or ductile iron bodies and bronze mounted non-rising stems with o-ring seals. The stem and all wearing surfaces shall be bronze or other approved non-corrosive material. Valves shall turn left to open.
 - (2) Valve boxes shall be five and one-quarter ($5\frac{1}{4}$) inch diameter, slip type, sized for the type of valve and depth of bury. The lid shall have the word "WATER" permanently cast on the top, as shown on *City Standard Water Details*. A cast iron valve box and lid with debris cap shall be provided for each underground valve.
- (C) **Installation of Butterfly Valves.** If approved for use, butterfly valves shall conform to AWWA C-504. The Contractor shall submit for approval by the City Engineer, drawings and literature showing the type, class, principal dimensions and materials

used for all parts of the valves and operator. All packing bolts shall be stainless steel. Each butterfly valve shall be installed in a vault. The diameter of the vault shall be as detailed on the plans.

- (C) **Vaults.** All valve vaults shall be made of reinforced concrete pipe or a manhole riser section. The cover shall be a precast concrete lid with a cast iron manhole ring and cover. The diameter of the vault will be as detailed on the plans. The cover for the air relief valve vault shall be perforated if a riser pipe is not to be installed, as shown on the *Standard Waterline Details*. The total area of perforations in the manhole cover shall be as detailed on the plans or specified by the Engineer.
- (D) **Bolts.** All packing bolts and valve bonnet bolts shall be stainless steel. All bolts for mechanical joints shall be Cor-Blue® bolts or approved equal. All bolts for flange connections shall be stainless steel bolts coated with anti-seize.
- (E) **Tapping Valves and Sleeves.** Connections for line extensions of four (4) inches and larger lines may be made with tapping sleeves and valves. Tapping valves shall be furnished with flanged inlet end connections having a machined projection on the flanges to mate with a machined recess on the outlet flanges of the tapping sleeves and crosses. The outlet ends shall conform in dimensions to the AWWA C-115 for the flange and AWWA C-111 for the hub or mechanical joint connection, except that the outside of the hub shall have a large flange for attaching a drilling machine. The seat opening of the valves shall be larger than normal size to permit full diameter cuts. The tapping sleeve or cross shall be of the same manufacture as the tapping valve. Either the tapping valve or the tapping sleeve shall have a test plug.
- (F) **Air relief valves.** Air relief valves shall be of the type, class and size specified on the Construction Drawings and shall be installed in a vault as shown on *Standard Waterline Details*. A separate isolation valve of the same size and pressure rating as the air relief valve shall be installed between the water main and the air relief valve. The isolation valve shall be a ball valve..
- (G) **Electrical Tracing Wire.** Electrical tracing wire shall be size No. 10 or No. 12, Type UF solid copper direct-bury wire. Splices shall be compression type designed for direct bury applications. Wire shall be taped to top of pipe at ten (10) foot intervals as a minimum.
- (H) **Corporation Stops.** Corporation stops shall be made of brass and shall be the same size as the service line. The outlet end of the stop shall be threaded in accordance with AWWA C-800, for use with Type K flared or Mueller compression copper service tubing. The inlet threads of the corporation stop shall be CC, not standard iron pipe threads.
- (I) **Tapping Saddles.** Tapping saddles for three-quarter ($\frac{3}{4}$) to two (2) inch service connections shall be wide-body brass saddles with flat neoprene seals (Mueller BR2B Series or approved equal). The inside diameter of the saddle shall be approximately

the same as the outside diameter of the pipe being tapped, so uniform pressure is applied to the full circumference of the pipe when the saddle is secured.

- (J) **Meter Setters.** Meter setters shall be brass and shall be the same size as the service line. The City standard meter setter is A.Y. McDonald – 4141-07731-2-WDQQ33, or approved equal. The inlet and outlet ends shall be threaded in accordance with AWWA C-800 for use with flared or Mueller compression fittings to the Type K copper or HDPE service tubing. All setters shall be equipped with a ball-type yoke stop valve with an approved locking device and a dual check valve. When HDPE is used for the service line, the meter setter shall be supported by nylon zip ties attached to a three-quarter ($\frac{3}{4}$) inch piece of PVC pipe inserted through two (2) holes drilled through the walls of the meter pit.
- (K) **Curb Stops.** Curb stops shall be brass ball valves with compression fittings and shall be located inside the meter pit with the operating nut accessible from the surface by valve key.
- (L) **Meter Pits.** Meter pits shall be installed within right-of-way, beyond the back of sidewalk as shown on *City Standard Water Details*. Meter pits shall be as manufactured by Mid-States Plastics, Inc., or approved equal, tapered type of a modified polyethylene material, thirty-six (36) inches in height. Pit diameter shall be twenty (20) inches unless otherwise approved by the City. Meter pits shall be furnished with an aluminum dome with an approved plastic outer lid and aluminum inner frost-proof lid.
- (M) **Reduced Pressure Backflow Prevention Devices.** Reduced pressure backflow prevention devices shall be the same size as the service line and shall be approved in the current edition of the Colorado Cross-Connection Control Manual.
- (N) **Sampling Stations.** Sampling stations shall be Eclipse #88 with lockable aluminum housing as manufactured by Kupferle Foundry, or approved equal. Sampling stations shall use standard three-quarter ($\frac{3}{4}$) inch service line pipe and fittings to connect to main, including curb stop and curb box.

9-2-5: Removals, Excavation, Backfilling, and Restoration Specifications

- (A) **Description.** For the purpose of this section, underground conduits shall be considered sanitary sewers, storm drains, water mains, irrigation lines or any other underground pipeline. Wherever the term "pipe" or "pipeline" is used it shall mean underground conduit.

This section covers surface removals, excavation, backfilling, compaction, disposal of surplus material, restoration of disturbed surfaces, and all other work required for the safe and proper construction of underground conduits.

- (B) **Survey Line and Grade.** All construction surveying and staking shall be performed by or under supervision of a professional engineer or land surveyor currently

registered in the State of Colorado. The Contractor shall use a laser instrument to maintain and control the line and grade of all gravity flow pipelines including sanitary sewers, storm drains and irrigation lines. Checkpoints shall be set at fifty (50) feet, one hundred (100) feet and two hundred (200) feet from the beginning of each reach of pipe.

- (C) **Excavation Permits.** For any construction within City street rights-of-way, an Excavation Permit must be obtained from the Public Works Department prior to commencing the work.
- (D) **Removal of Structures and Obstructions.** The removal of structures and obstructions shall be in accordance with Section 9-4-3 of the *Street System Standards*. The Contractor shall remove surface materials and obstructions only to the widths necessary for excavation of the trench. All trees, shrubbery, fences, plantings and structures not designated for removal shall be protected or, if moved, restored to their original condition after construction is complete.

Removal of concrete curbs, gutters, sidewalks, driveways, and asphalt pavement shall be along existing joints or neatly cut lines. All vegetation, concrete, asphalt, and other refuse removed from the construction limits shall be separated from suitable topsoil and backfill material, and hauled to a disposal site secured by the Contractor. Where the trench is in an unpaved area, clean topsoil suitable for final grading shall be stripped, stockpiled separately in approved locations, and restored to the original thickness after the trench is backfilled.

- (E) **Bracing and Sheeting of Trenches.** All trenches shall be properly braced, sheeted or otherwise supported to provide safe working conditions and protection of the work, workers and adjacent property. Bracing, trench shields and sheeting shall conform to the recommendations in the Occupational Safety and Health Administration (OSHA) Standards for Construction (29 CFR 1926). All trench support materials shall be removed in a manner that will prevent caving of the sides and movement or other damage to the pipe.
- (F) **Trenches with Sloping Sides.** Where working conditions and right-of-way width permit, trenches in unimproved areas may be excavated with sloping sides in accordance with OSHA requirements. All soils shall be assumed to be OSHA Type C Soil, unless otherwise classified by a qualified soils technician. Trenching and other excavations shall not extend beyond existing easements, rights-of-way or limits shown on the *Construction Drawings* unless otherwise approved by the property owner and the City Engineer.

In streets, alleys or narrow easements, trenches shall be excavated with vertical sides, properly braced and supported, unless otherwise approved by the City Engineer. Where trenches with sloping sides are permitted, the slopes shall not extend below a point twelve (12) inches above the top pipe. The trench shall be excavated with the vertical sides below this point.

- (G) **Open Excavation Limits.** The length of open trench shall be kept to a minimum and shall not exceed the length necessary to accommodate daily pipe laying and backfilling operations unless otherwise approved by the City Engineer. The Contractor shall be responsible for covering or barricading unattended trenches and excavations as necessary for protection of the public and the work. All trenches and excavations shall be backfilled at the end of each workday, unless otherwise shown on the plans or approved by the City Engineer. The end of a trench may be left open overnight if the entire perimeter of the excavation is fenced, lighted and barricaded with construction equipment and/or Jersey barriers. No excavation, equipment, materials, or other obstruction may impede the flow of traffic without a Traffic Control Plan that meets or exceeds current MUTCD standards and that is approved by the City Engineer.
- (H) **Unauthorized Excavation and Pavement Removal.** Unless authorized by the Engineer, all removed pavement and excavations made beyond the lines and grades shown on the *Construction Drawings* shall be replaced at the Contractor's expense.
- (I) **Unstable Trench Bottom.** Where the excavation is found to consist of muck, organic matter or any other material that is determined, by the Engineer, to be unsuitable for supporting and maintaining the line and grade of the pipe, the trench shall be excavated to an additional depth as agreed upon by the Contractor and Construction Inspector/Engineer, and replaced with an approved granular stabilization material. Should the Contractor and Inspector/Engineer fail to reach an agreement as to the depth and/or method of trench foundation stabilization, the City may require the services of a Geotechnical Engineer to assist in determination of an appropriate method for stabilization, at the developer's expense.
- (J) **Bedding and Shaping Trench Bottom.** Unless otherwise directed or specified in the Special Provisions, all trenches shall be excavated to at least six (6) inches below the pipe grade and backfilled to grade with approved granular bedding material. The bedding material shall be hand shaped and graded until the trench bottom is uniform and free from rocks, bumps, and depressions. A coupling or bell hole shall be dug at each pipe joint with sufficient length, width and depth to permit assembly of the joint and provide a minimum clearance of two (2) inches between the coupling and the trench bottom. After the pipe is joined, pipe-bedding material shall be placed and tamped under each pipe joint until all voids are filled. Care shall be taken not to displace the pipe from its line and grade.
- (K) **Cutoff Walls.** Cutoff walls shall be installed along every utility line to inhibit the movement of ground water through the screened rock bedding. Cutoff walls shall be five (5) to ten (10) feet long and consist of native material or imported material that has a permeability rate the same or less than that of the native material. Cutoff walls shall be constructed by discontinuing the installation of bedding and haunching material and installing approved native or imported material. Cutoff walls shall be installed at intervals not exceeding two hundred (200) feet on pressurized lines. On gravity flow lines, cutoff walls shall be installed on every line, ten (10) to twenty (20) feet upstream of every manhole or box.

(L) **Rock Excavation.** Rock excavation shall consist of the removal of boulders or concrete measuring one-half ($\frac{1}{2}$) cubic yard or more, hard shale, sandstone or other bed rock which, in the opinion of the City Engineer, requires for its removal the continuous use of pneumatic tools or drilling and blasting. Rock excavation shall be in accordance with Section 203 of the current *CDOT Standard Specifications for Road and Bridge Construction*.

(M) **Stockpiling Excavated Material.** Excavated material shall be piled in accordance with OSHA guidelines in locations that will not endanger the Work, create traffic hazards or obstruct sidewalks and driveways. Storm water runoff from stockpiled materials must be controlled in accordance with Section 9-6 of this manual. Fire hydrants, valve boxes, manholes and other utility access points shall be left unobstructed. Gutters and other watercourses shall not be obstructed unless other satisfactory provisions are made for runoff and street drainage.

All surplus material and excavated material unsuitable for backfilling shall be removed from the site and disposed of by the Contractor in approved areas.

(N) **Dewatering Trenches.** Trenches shall be kept free of water during pipe laying operations by draining, pumping or other approved methods. The water level shall be maintained at least six (6) inches below the trench bottom throughout the placement of bedding, pipe laying, joining and backfilling operations. The dewatering shall be carried out so that it does not destroy or weaken the strength of the soil under or along the side of the trench. The City Engineer or his representative shall approve the method of disposal of trench water. Watertight plugs shall be installed in the ends of all water and sewer lines when the trench is not being dewatered. The Contractor is responsible for securing a Construction Dewatering Permit from CDPHE. Surface water from any source shall be prevented from entering the trench excavation. No additional payment will be made to the Contractor due to an unstable trench or pipe foundation conditions caused by surface water entering the trench.

(O) **Backfilling Pipe and Structures.** Unless otherwise specified or approved by the Engineer, all backfill material shall be placed with moisture-density control in accordance with the typical trench detail shown in the *General Utility Details*. All backfill material shall be adjusted to near two percent ($\pm 2\%$) of the optimum moisture for non-clay soils, and at optimum moisture to plus four percent ($+4\%$) for clay soils, prior to its placement in the trench.

A minimum of twenty-four (24) inches of compacted backfill shall be placed over the top of all polyvinyl chloride (PVC) and polyethylene (PE) pipes before vehicles or heavy equipment are allowed to pass over the pipe. Less cover may be allowed only where *flow-fill* or other approved material is used for the pipe haunching and backfill material. Flow-fill shall meet the requirements of 9-5-10 of the *Concrete Standards*.

During initial backfilling, the Contractor shall take all necessary precautions to prevent movement or distortion of the pipe or structure being backfilled. Pipe

haunching material shall be placed and compacted in even lifts on both sides of the conduit to six (6) inches above the top of the pipe. Above the bedding and haunching material, earth backfill material shall be placed full width in uniform layers not more than twelve (12) inches thick, or eight (8) inches thick within two (2) feet of existing structures. Each layer shall be compacted to the required density with approved mechanical or hand tamping equipment. Hydro-hammers or other heavy compaction equipment shall not be used unless approved by the City Engineer. No hydro-hammer shall be used for compaction with less than forty-eight (48) inches of cover over the pipe.

It shall be the Contractor's responsibility to make necessary excavations and to provide safe access into the excavations in accordance with OSHA Standards in order to accommodate compaction tests at all locations designated by the City Engineer.

- (1) **Backfill Testing Requirements:** All backfill shall be frequently tested to insure that the required density is being attained. For every four hundred (400) lineal feet of trench and each branch or section of trench less than four hundred (400) feet in length, at least one (1) compaction test shall be performed for each two (2) foot vertical depth of backfill material placed. The first test shall be taken approximately two (2) feet above the top of pipe and the last test shall be at the pavement subgrade or six (6) inches below the ground surface in unpaved areas. Compaction tests shall be taken at random locations along the trench and wherever poor compaction is suspected. If any portion of the backfill placed fails to meet the minimum density specified, the failing area shall be defined by additional tests, if necessary, and the material in the designated area shall be recompacted to the required density or removed and replaced to the required density at the Contractor's expense.

The frequency of compaction testing may be reduced to one test for every one thousand (1000) feet of trench if full-time inspection is made during the backfilling operation by the Engineer or an independent testing laboratory and sufficient initial testing has been performed to demonstrate that the methodology being used achieves the required results. The methodology shall be verified for each soil type or trench condition encountered.

Failed compaction tests shall be immediately reported to the Inspector and the Contractor. A summary report of all compaction test results, including retests of failed tests and a test location map or other approved location format shall be submitted to the Project Engineer and to the Contractor. Compaction test results are required as a basis of acceptance of facilities by the City in accordance with Section 9-2-8.

- (2) **Backfilling Concrete Structures:** Concrete structures shall not be backfilled until the concrete and mortar therein has attained a minimum compressive strength of two thousand (2000) psi and can sufficiently support the loads imposed by the backfill. The Contractor is responsible for providing test results verifying that the concrete has reached two thousand (2000) psi compressive strength. Earth

backfill shall be placed simultaneously on all sides of the structure in layers approximately twelve (12) inches thick. Each layer shall be compacted in accordance with the requirements in Table 1, 9-2-1.

- (P) **Granular Stabilization, Bedding and Haunching Materials.** Granular materials required for stabilization of poor subgrade soils, bedding of pipe and structures, and haunching around pipe shall meet the following gradation requirements:

Sieve Size	Percent passing, by weight	
	Pipe bedding & haunching (crushed rock)	Granular Stabilization (screened or crushed rock)
2 inch	- - -	100%
1 inch	100%	- - -
No. 4	20% max.	15% max.

Crushed rock shall be the product of crushing rock and gravel. The portion of the material larger than will pass a three-eighth ($\frac{3}{8}$) inch sieve shall contain at least fifty percent (50%) of particles having three or more fractured faces. Not over five percent (5%) shall be pieces that show no fractured faces.

- (M) **Earth Backfill Material.** Earth backfill material shall consist of approved materials developed from project excavations or imported from another source. To be suitable for backfill, earth material shall be free from muck, frozen lumps, ashes, trash, vegetation and other debris. All excavated materials that, in the opinion of the Engineer, are unsuitable for use in the backfill shall be removed from the site and disposed of by the Contractor at his expense. The maximum size of rock or clod allowed within six (6) inches of any plastic pipe shall be one (1) inch.

- (1) *Proof Rolling.* The Engineer or Construction Inspector may require proof rolling of the compacted backfill material to test for deflection or additional consolidation. The Contractor shall furnish a rubber-tired, self-propelled vehicle for proof rolling. Acceptable proof rolling equipment includes a loaded water truck or loaded dump truck. If while proof rolling, any visible deflection or rutting is observed, additional compaction of the backfill will be required.

- (N) **Restoration of Grounds.** The cleanup and restoration of grounds shall be a continuous process from the beginning of construction to final completion of the Work. The Contractor shall keep the work site free from accumulation of debris and waste material caused by his operation. In the case of point-location work to be performed later in the construction process, such as water line tie-ins, the restoration (but not the clean up) of the area adjacent to the point-location may be delayed until the point-location work is performed.

- (1) After the pipeline is backfilled, the area shall be cleaned and restored to the original grade and condition. The cleaning and restoration shall be kept up to no greater than five hundred (500) feet behind the backfill operations.
 - (2) All fences, utilities, culverts, ditches, structures, grassed areas and plantings shall be replaced and restored to a condition equal to or better than that at the beginning of construction.
 - (3) The restoration of asphalt and concrete surfaces and structures may be performed at the completion of a segment of the project. A segment is defined as one contiguous length of pipe installed.
- (O) **Restoration of Concrete and Pavement Surfaces.** The Contractor shall replace all concrete and pavement surfaces removed or damaged by his operation. All paving, aggregate base course and concrete replacement work shall be in accordance with the *Street System Standards*. Paving and/or patching for an entire project may be performed as a single operation.

Prior to paving or patching, all edges that have been broken, raveled or otherwise damaged shall be recut to a neat line. Refer to section 9-4-3 of the *Street System Standards*.

9-2-6: Pipeline Testing

- (A) **General.** All pipelines shall be tested before final acceptance. The Contractor, under direct control and observation of the Engineer or an approved independent laboratory and a representative of the Public Works Department, shall witness all testing. The Contractor shall furnish all labor, equipment, tools, water and other incidental items required to conduct the tests.

If a pipeline fails to meet the test requirements, the leak or other deficiency shall be located and repaired at the Contractor's expense. After the repairs or corrections have been made, the pipeline shall be retested. Repairs and retesting shall continue until the test requirements have been met.

- (B) **Testing Pressure Pipelines.** Water mains, force mains, siphons, irrigation systems and all other pipelines that will operate under pressure shall be tested for pressure and leakage in accordance with these specifications and AWWA C-605, Section 7. Pavement or other permanent surfaces shall not be placed until all pressure and leakage tests are satisfactorily completed. If the section of pipe being tested includes components of an existing system or components installed by others, the testing shall be done at the Contractor's risk.
- (1) **Test Pressure.** Unless otherwise specified, the test pressure for all pipes shall be double the maximum operating pressure at the lowest elevation of the test section or the class designation of the pipe plus fifty (50) psi, whichever is less.

The minimum test pressure for water distribution lines shall be one hundred and fifty (150) psi.

- (2) Filling. The pipeline shall be filled with potable water at least twenty-four (24) hours before being subjected to the hydrostatic pressure test. Each section of pipeline shall be filled slowly and all air expelled by means of taps at points of highest elevation. If temporary taps are installed to fill the line or release the air, the corporation stop shall be removed and the tap plugged when the disinfection and testing have been completed.
- (3) Pressure Test Procedure. Pressure and leakage tests may be performed simultaneously or separately. The total time for the combined pressure and leakage tests shall be a minimum of two (2) hours for each section of pipeline. If separate tests are made, the pressure test shall be made first. The duration of the pressure test shall be a minimum of one (1) hour and the duration of the leakage test shall be a minimum of four (4) hours. The pressure of the leakage test may be reduced to one hundred and fifty percent (150%) of the maximum operating pressure that will occur on that portion of the line.

Leakage is defined as the quantity of water to be supplied to the section of pipeline being tested that is necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

The specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. No pipe installation will be accepted if the leakage for the section of the line being tested is more than the rate calculated using the following formula:

$$L=(N \times D \times \sqrt{P}) / 7400$$

- Where:
- L* = Allowable leakage in gallons per hour
 - N* = Number of joints in length pipeline tested
 - D* = Nominal diameter of pipe in inches
 - P* = Average test pressure in psi gauge

The allowable leakage rates for typical pipe sizes and pressures, based on twenty (20) foot joint lengths, within the City water distribution system are as follows:

Allowable Leakage (gallons per hour per 1000 feet)				
Test Pressure	6" pipe	8" pipe	10" pipe	12" pipe
150 psi	0.50	0.66	0.83	0.99
160 psi	0.51	0.68	0.85	1.03
170 psi	0.53	0.70	0.88	1.06
180 psi	0.54	0.73	0.91	1.09
190 psi	0.56	0.75	0.93	1.12
200 psi	0.57	0.76	0.96	1.15

- (C) **Tracing Wire Continuity Test.** Each valve box shall be visually inspected to verify that the tracing wire has been properly placed. The Contractor, in the presence of the City inspector, shall test the continuity of the tracing wire in each direction from each valve box or hydrant. An electronic pipe locator shall be connected to the tracing wire and a strong signal shall be received along the pipeline to the next valve box. This test shall be performed prior to paving, for example, during pressure testing and/or backfill work.

9-2-7: Disinfection of Water Lines

- (A) **Disinfection Standard.** All water mains shall be disinfected in accordance with AWWA Standard C651-99.

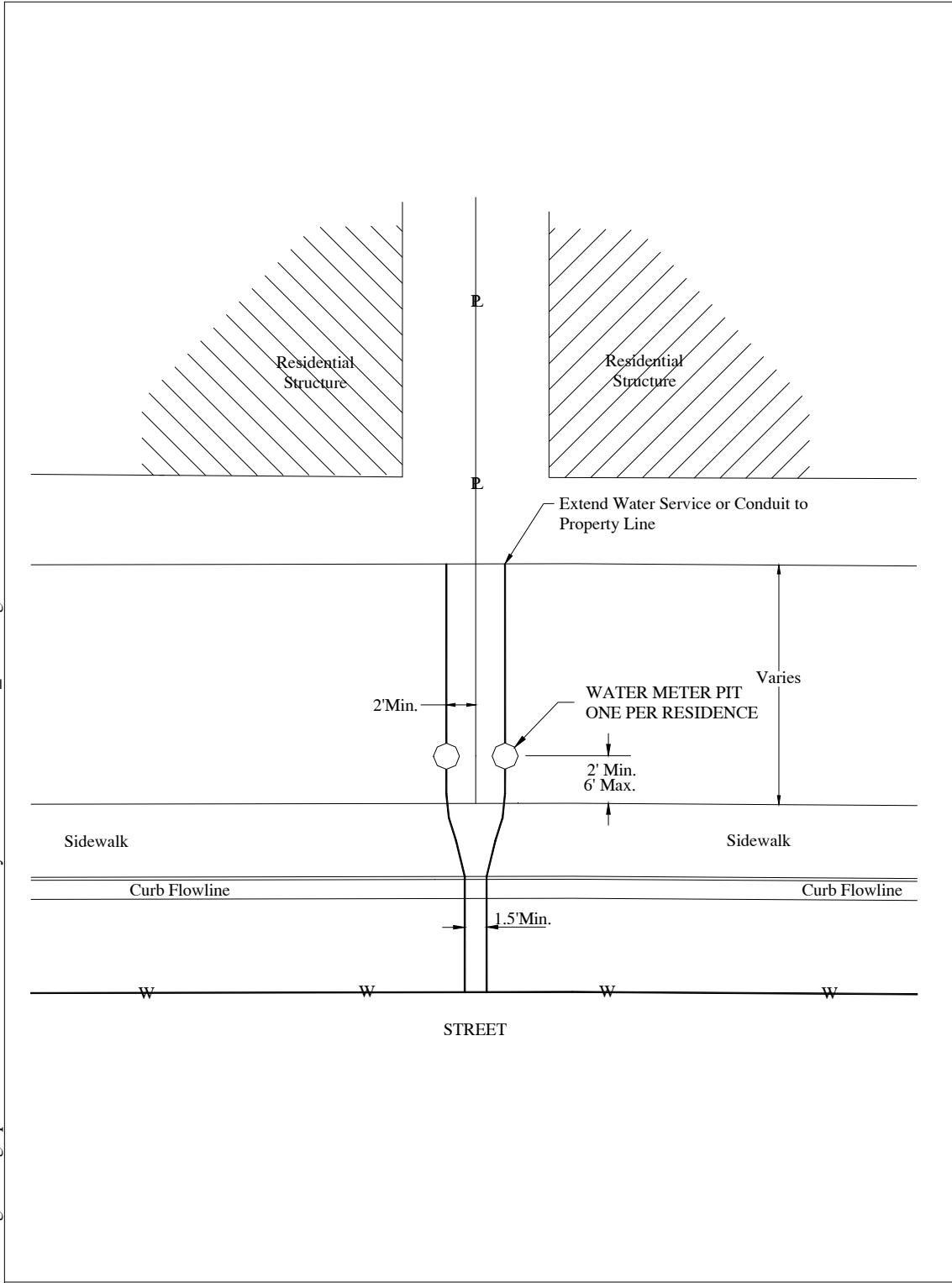
9-2-8: Final Inspection and Acceptance

- (A) **General.** City acceptance of all pipelines and “As-Built” drawings is required prior to paving.
- (B) **Contractor’s Warranty.** The Contractor shall guarantee his work to be free from defects in materials and workmanship for a period of not less than two (2) years, the initial Acceptance Period. At the end of the two (2) year initial Acceptance period, and at the request of the Contractor, the City Engineer and the Contractor shall jointly inspect all dedicated public improvements. The City Engineer may request tests and inspections as deemed necessary, and consistent with these specifications. Any defects in the system resulting from defective materials, poor workmanship or any other cause attributable to the contractors work shall be corrected by the contractor, to the satisfaction of the City Engineer at the Contractor’s expense.
- (C) **Inspection Results Submittal and Documentation.** City shall not accept the work until the Contractor has submitted results of all required tests (such as pipeline pressure test, leakage tests, disinfection tests, etc.). Test results shall be certified by the Engineer or an approved independent laboratory and shall comply with Table 1, Required Quality Assurance Testing—see section 9-2-1(C). The format of required submittals shall be coordinated with the City Engineer.
- (D) **As-Built Drawings.** As-Built construction drawings shall be submitted on twenty-four by thirty-six inch (24" x 36") paper and as an electronic AutoCAD file in accordance with the Montrose submittal standards. A Professional Engineer currently licensed by the State of Colorado shall certify all As-Built drawings. For water lines, both potable and irrigation, horizontal alignment information shall be required on all service lines and main line fittings. Water line as-builts shall also identify size and material type.

9-2-9: Water System Details

- W-01 Domestic Water Meter Location, Horizontal/Attached Walk
- W-02 Domestic Water Meter Location, Horizontal/Detached Walk
- W-03 Water Meter Location, Vertical
- W-04 Fire Line and Domestic Service Line
- W-05 1½” and 2” Meter and Vault
- W-06 4” and 6” Meter and Vault
- W-07 Typical Thrust Block Details
- W-08 Table for Concrete Thrust Blocking
- W-09 Fire Hydrant
- W-10 Valve Box Assembly
- W-11 Air Release Valve
- W-12 12” or Smaller Water Line, Lowering for Utility Crossing
- W-13 Field Installation Polyethylene AWWA C-105, Method “A”
- W-14 Valve Operation
- W-15 Standard Sprinkler Tap Detail
- W-16 Ditch Crossing Details

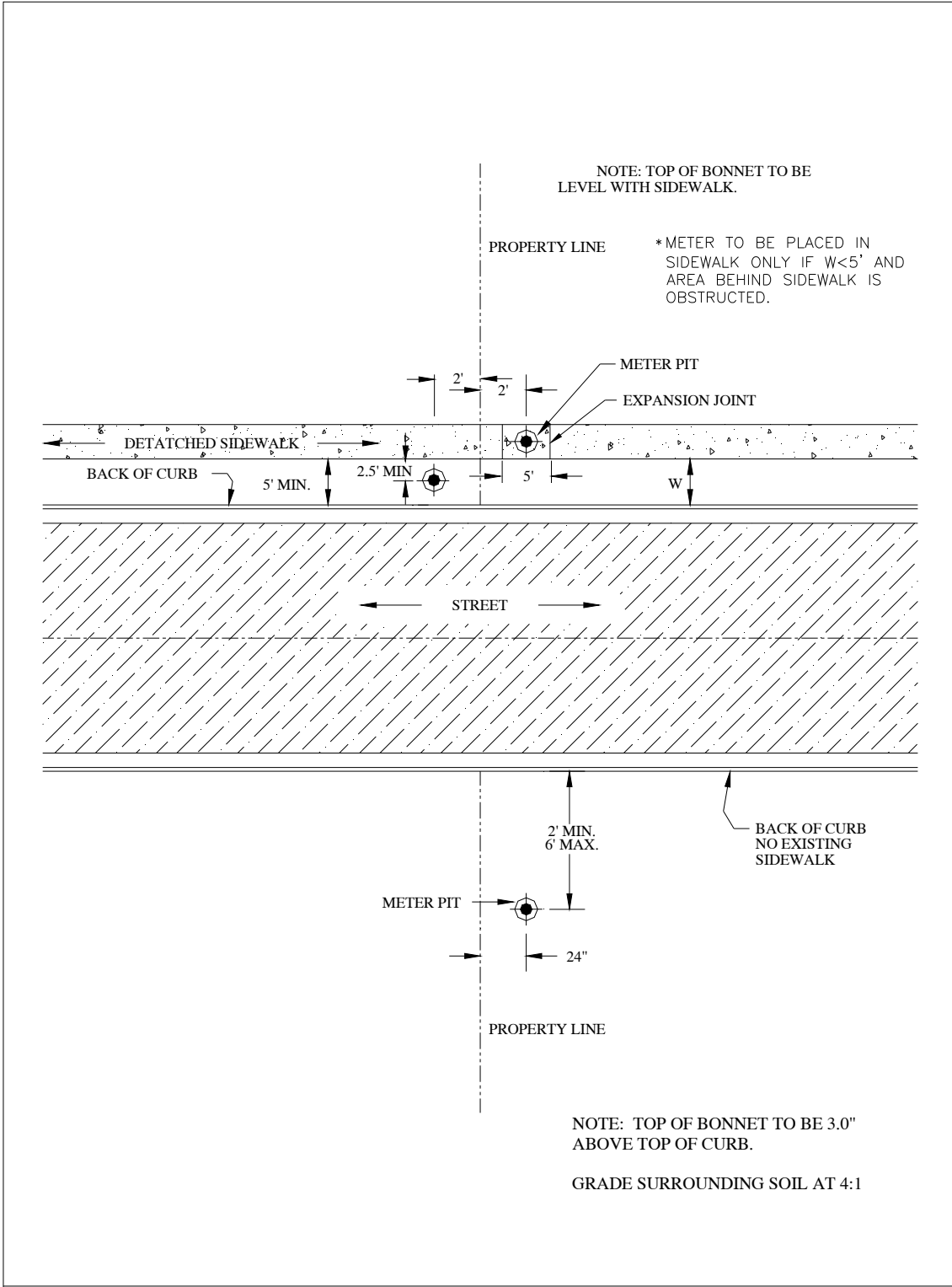
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DOMESTIC WATER METER LOCATION, HORIZONTAL / ATTACHED WALK

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <u>FRH</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u></p>	<p>PAGE W-01</p>
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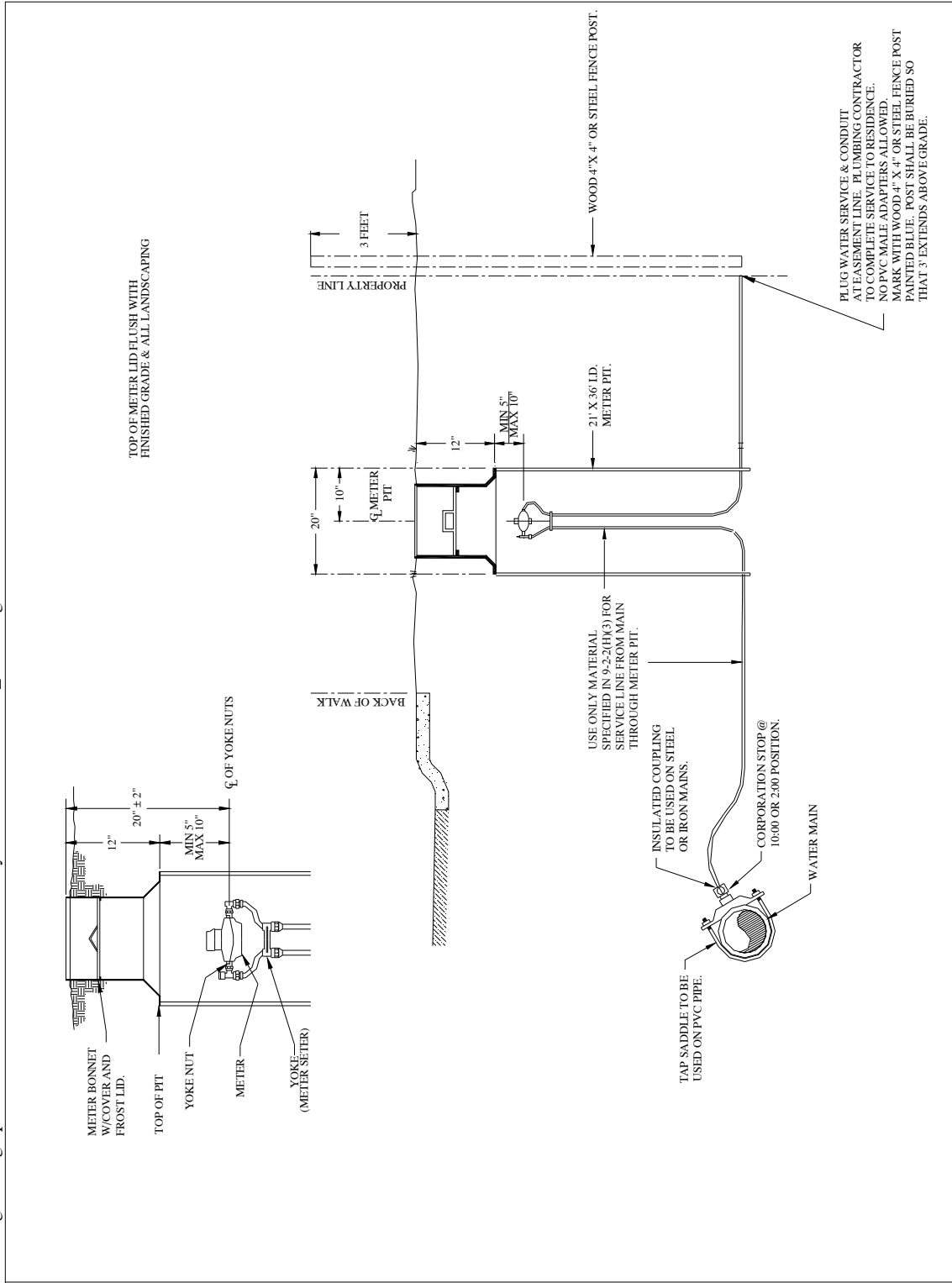
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DOMESTIC WATER METER LOCATION, HORIZONTAL / DETACHED WALK

	ENGINEERING DEPARTMENT	STANDARD WATERLINE DETAILS	APPROVED: <u>FRH</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u>	PAGE W-02
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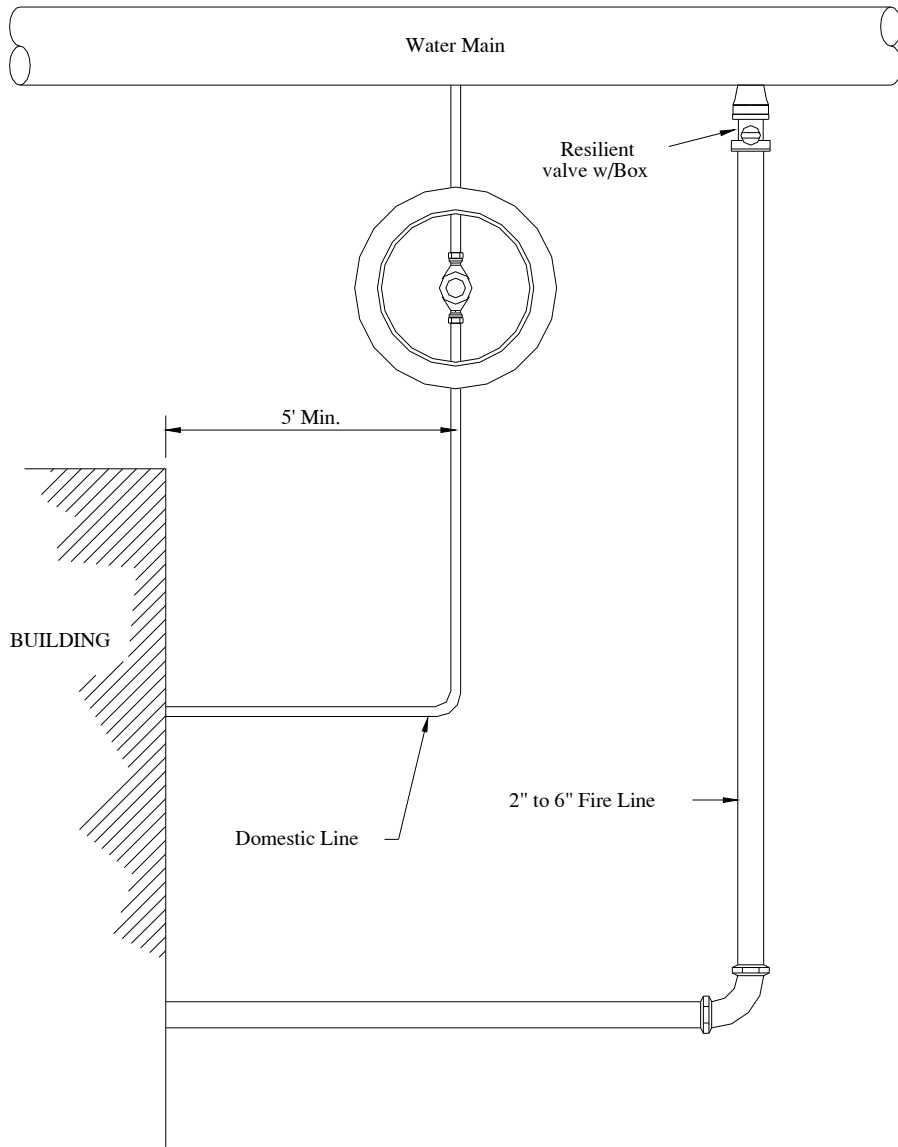
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WATER METER LOCATION / VERTICAL

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <u>FRH</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u></p>	<p>PAGE W-03</p>
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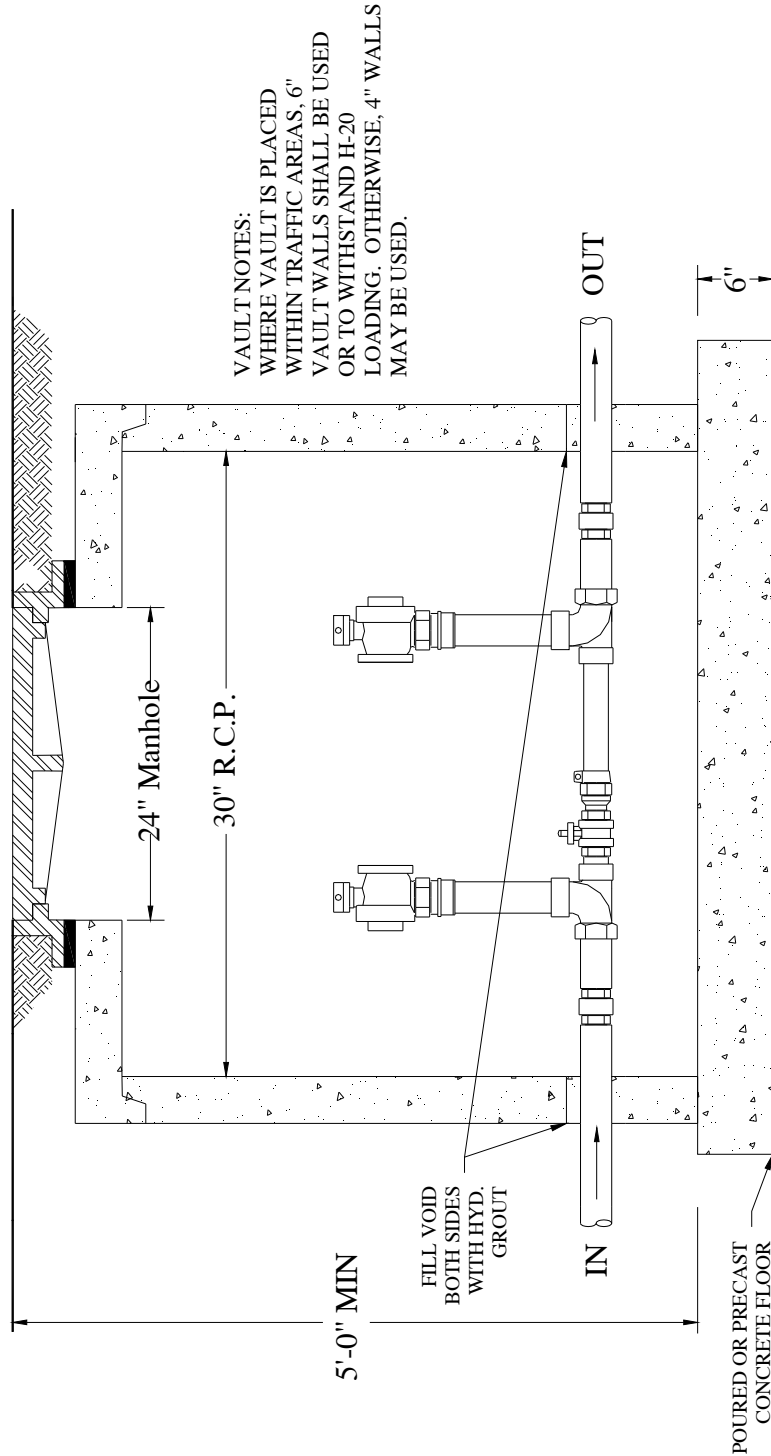
1. Service lines: All connections to be flared or Mueller compression.
2. Fire Lines: Backflow preventer on inside of building.
3. All services 3/4" to 2" shall be Type K copper or HDPE 200 psi CTS only per 9-2-2 (H)(3)
4. All 3" service lines shall be per 9-2-2 (H)(3)
5. All services 4" and larger shall be C-900.

FIRE LINE AND DOMESTIC SERVICE LINE

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <u>RLH</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u></p>	<p>PAGE W-04</p>
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PLUMBING MATERIALS SHALL BE PER 9-2-2 (H)(3)

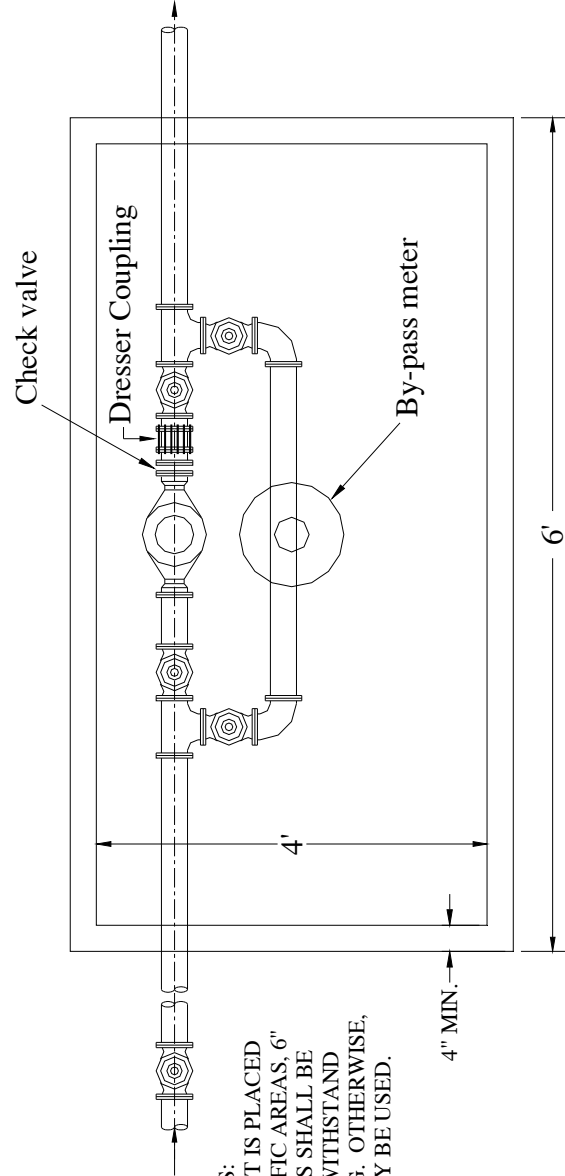


1 1/2" AND 2" METER AND VAULT

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <u>FRH</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u></p>	<p>PAGE W-05</p>
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1. For meters 4" and larger, meter support shall be an 8" x 8" x 12" concrete block set on a poured concrete floor. Vault cover may be sectional (3 piece) to facilitate installation and removal. Valves to be Resilient seated valves.
2. Vault must withstand H-20 loading for placement within traffic areas.



VAULT NOTES:
WHERE VAULT IS PLACED
WITHIN TRAFFIC AREAS, 6"
VAULT WALLS SHALL BE
USED OR TO WITHSTAND
H-20 LOADING. OTHERWISE,
4" WALLS MAY BE USED.

4" AND 6" METER AND VAULT



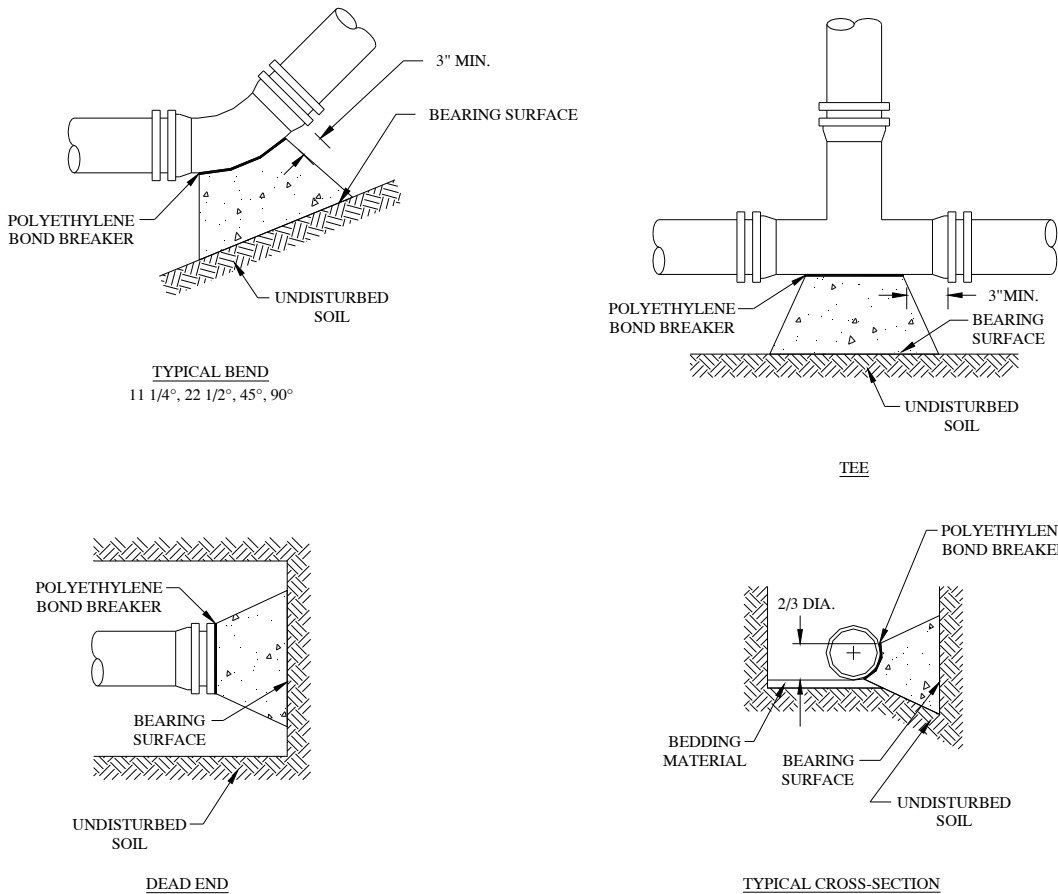
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DETAILS

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GENERAL NOTES:

1. All fittings to be wrapped with 8 mil polyethylene.
2. Pipe installed under conditions different from those normally encountered shall require thrust blocks designed for those particular conditions.
3. Thrust blocks on pipe larger than 12 inches diameter shall be designed for conditions existing at the installation site.
4. All thrust blocks to be 3000 p.s.i. concrete.
5. Mechanical restraints are to be installed in accordance with Water Distribution Standards section 9-2-3 (E)

TYPICAL THRUST BLOCK DETAILS

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <i>JRH</i> REV: <u>JAN 2011</u> DRAWN BY: <i>RLW</i></p>	<p>PAGE W-07</p>
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BEARING AREAS (IN SQ. FT.)					
SIZE	BENDS				TEES, DEAD ENDS, AND CROSS w DEAD END BRANCHES
	90°	45°	22 1/2°	11 1/2°	
3	1.0	0.6	0.3	0	0.7
4	1.8	1.0	0.5	0	1.3
6	4.0	2.2	1.1	0	2.8
8	7.1	3.8	2.0	1.0	5.0
10	11.1	6.0	3.0	1.5	7.8
12	16.0	8.6	4.4	2.2	11.3
14	21.7	11.8	6.0	3.0	15.4
15	25.0	13.5	7.0	3.5	17.6
16	28.4	15.3	8.0	4.0	20.0
18	36.0	19.4	10.0	5.0	25.4
20	44.2	24.0	12.2	6.1	31.4
21	49.0	26.5	13.5	6.8	34.6
22	54.0	29.0	14.8	7.4	38.0
24	64.0	34.5	17.7	8.8	45.0
30	100.0	54.0	27.6	13.8	71.0
36	144.0	78.0	40.0	20.0	102.0

NOTE: TEE SIZE IS BRANCH SIZE.

AREAS GIVEN IN TABLE ARE BASED UPON INTERNAL STATIC PRESSURE OF 100 P.S.I.
AND SOIL BEARING CAPACITY OF 1,000 lbs. PER SQ. FT.

BEARING AREAS FOR ANY PRESSURE AND SOIL BEARING CAPACITY MAY BE OBTAINED
BY MULTIPLYING TABULATED VALUES BY A CORRECTION FACTOR "F"

$$F = \frac{\text{ACTUAL SPECIFIED TEST PRESSURE IN HUNDREDS OF lbs.}}{\text{ACTUAL SOIL BEARING CAPACITY IN THOUSANDS OF lbs.}}$$

SOIL BEARING CAPACITIES SHALL BE DETERMINED BY THE ENGINEER

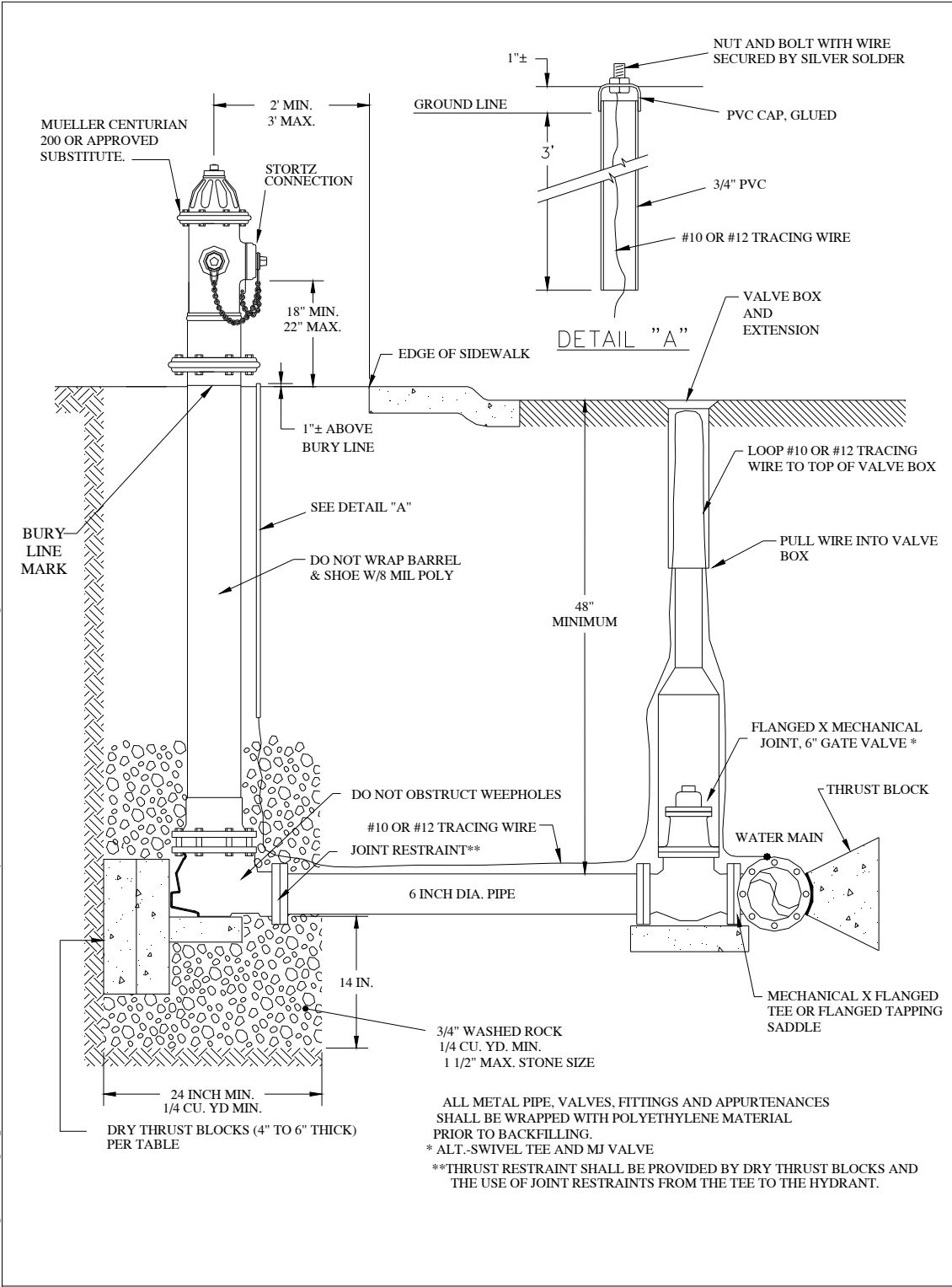
ALL WATER LINE PLANS SHALL CONTAIN THE FOLLOWING TABLE, WITH THE VALUES
FILLED IN BY THE ENGINEER:

SOIL BEARING CAPACITY - _____ LBS/SQ. FT.
TEST PRESSURE - _____ P.S.I.
BEARING AREA MULTIPLIER (F) - _____

TABLE FOR CONCRETE THRUST BLOCKING

	ENGINEERING DEPARTMENT	STANDARD WATERLINE DETAILS	APPROVED: <u>RLH</u>	PAGE W-08
			REV: <u>JAN 2011</u>	
			DRAWN BY: <u>RLW</u>	

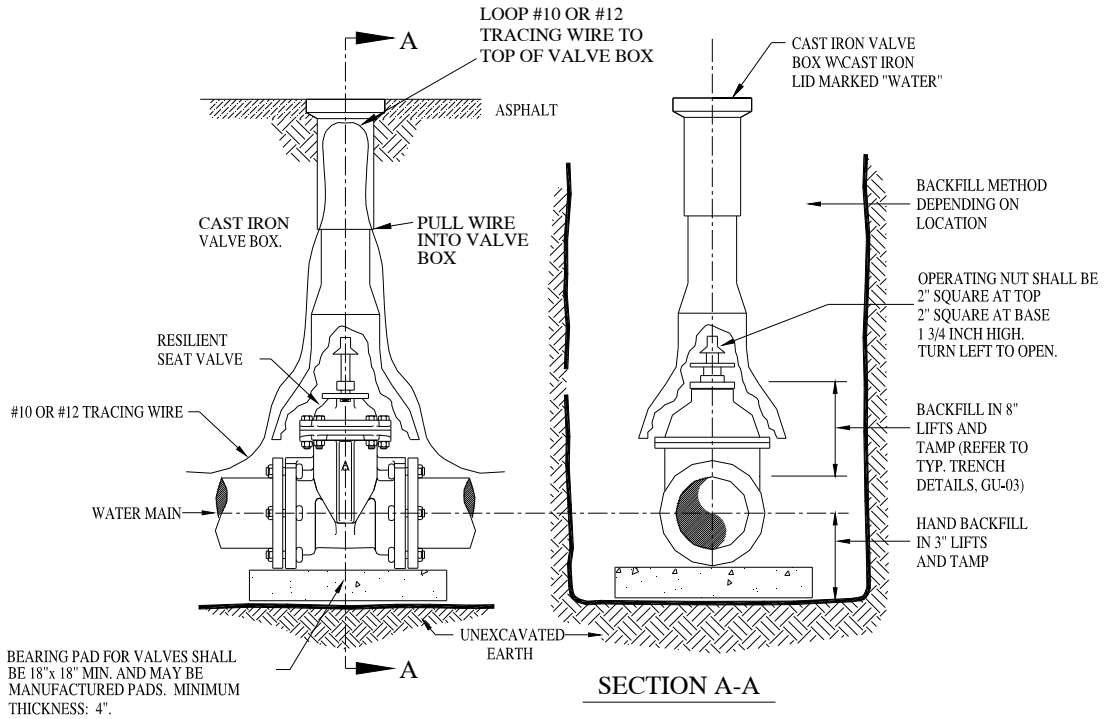
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FIRE HYDRANT

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <u>RLW</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u></p>	<p>PAGE W-09</p>
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BEARING PAD FOR VALVES SHALL BE 18" x 18" MIN. AND MAY BE MANUFACTURED PADS. MINIMUM THICKNESS: 4".

ALL VALVES TO BE RESILIENT SEAT, EPOXY COATED INSIDE AND OUT PER CITY OF MONTROSE AND AWWA SPECS.

ALL VALVE BOXES TO BE OF CAST IRON CONSTRUCTION, TWO PIECE SLIDE CASING ADJUSTABLE DESIGN PER CITY OF MONTROSE STANDARDS.

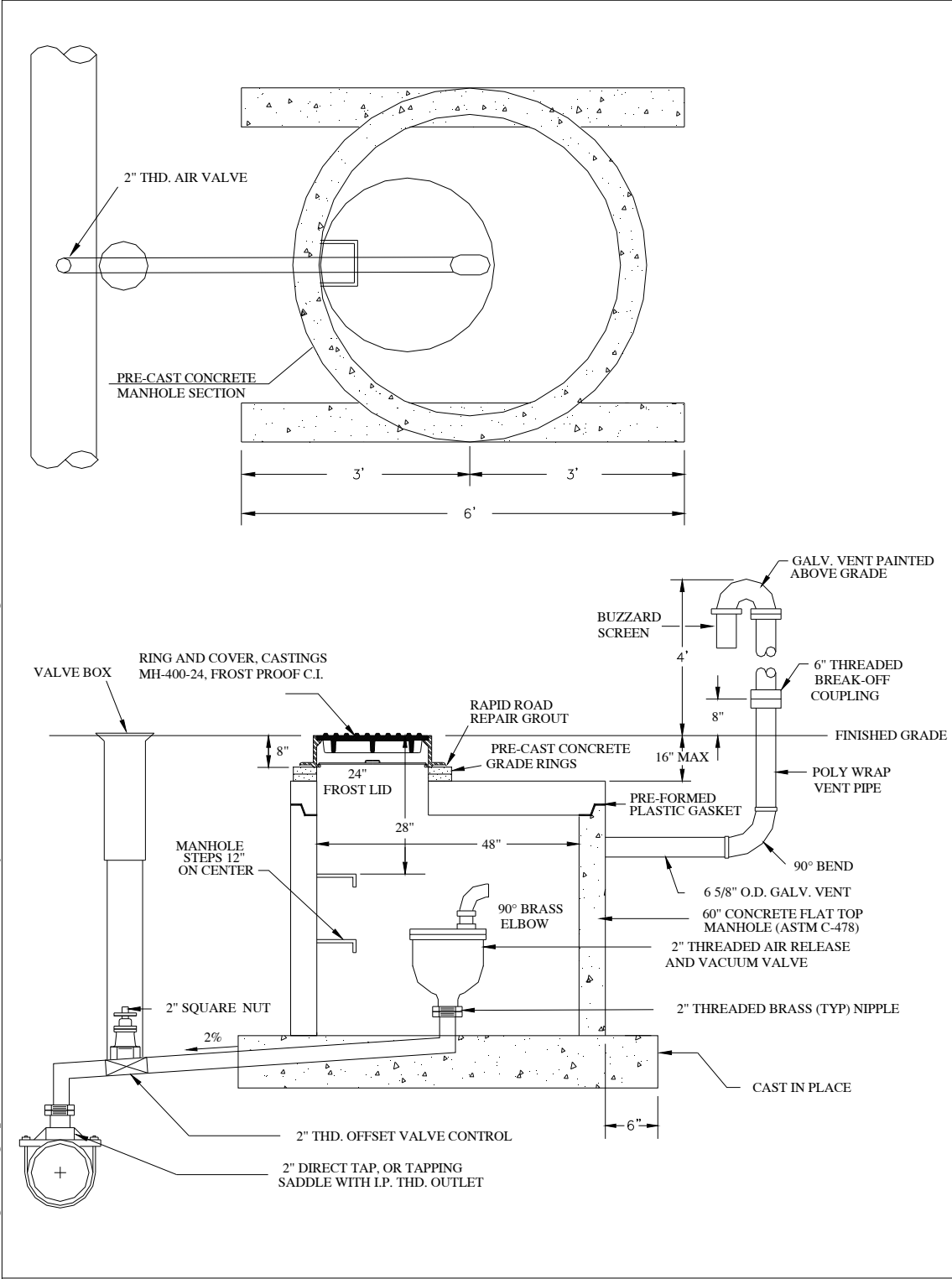
ALL VALVES TO BE 8 MIL POLY WRAPPED.

ALL PACKING BOLTS AND VALVE BONNET BOLTS SHALL BE STAINLESS STEEL. ALL BOLTS FOR MECHANICAL JOINTS SHALL BE COR-BLUE OR APPROVED EQUAL. ALL BOLTS FOR FLANGE CONNECTIONS SHALL BE STAINLESS STEEL BOLTS COATED WITH ANTI-SEIZE.

VALVE BOX ASSEMBLY

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <u>FRH</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u></p>	<p>PAGE W-10</p>
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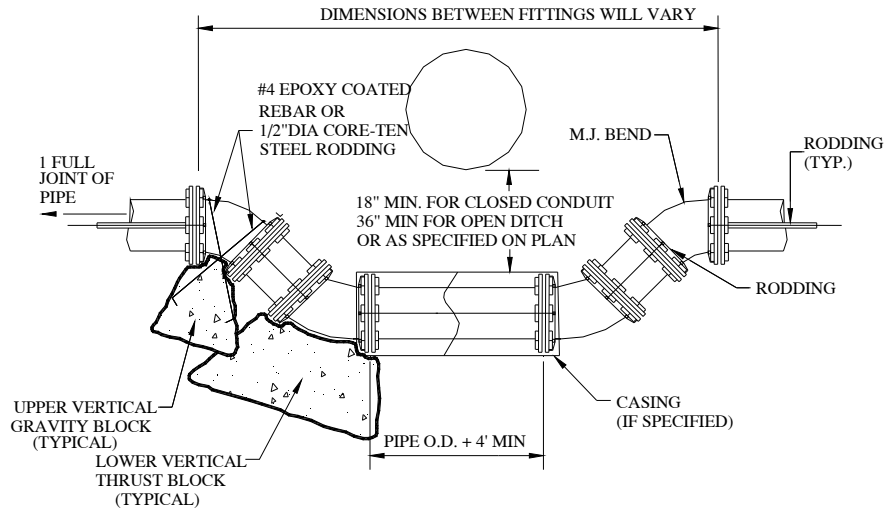
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AIR RELEASE VALVE

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <u>RLW</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u></p>	<p>PAGE W-11</p>
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NOTES:

- 1) SIZING OF VERTICAL THRUST BLOCKS BY DESIGN ENGINEER.
- 2) WHEN RESTRAINING PIPE BY MEANS OF RODDING JOINTS, 3/4" TIE RODS, NUTS, AND WASHERS WILL BE USED AND ARE TO BE MADE OF "COR-TEN" STEEL AS PER A.S.T.M. A242. SEE TABLE 1 FOR # OF RODS REQUIRED.
- 3) ALL METALIC PIPE, FITTINGS, AND APPURTENANCES WILL BE WRAPPED IN 8 MIL POLYETHYLENE.
- 4) REQUIREMENTS FOR LARGER THAN 12" DIAMETER PIPE WILL BE DETERMINED ON A CASE BY CASE BASIS.

TABLE 1

Pipe Size	Minimum number of Tie Rods
12" and less	2

12" OR SMALLER WATERLINE, LOWERING FOR UTILITY CROSSING



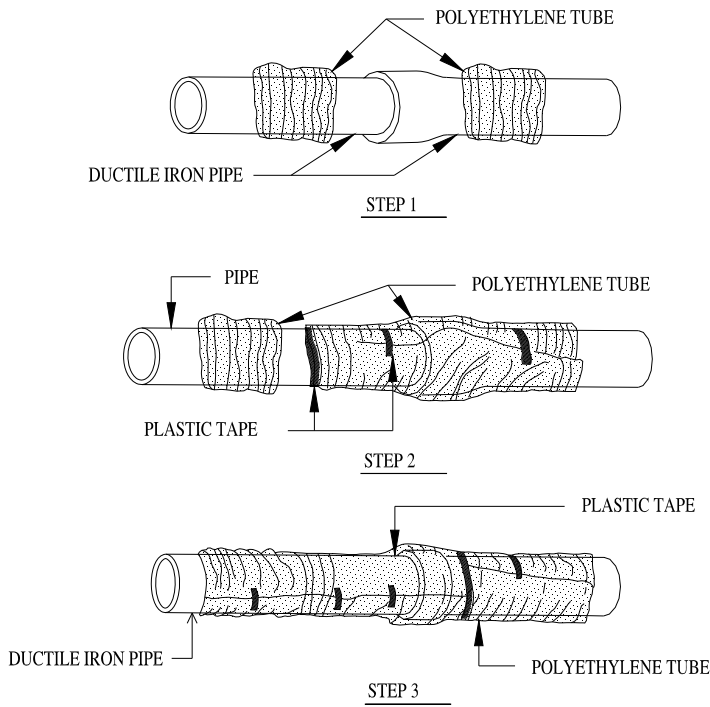
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DETAILS

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STEP 1- PLACE TUBE OF 8 MIL POLYETHYLENE MATERIAL ON PIPE PRIOR TO LOWERING IT INTO TRENCH.

STEP 2- PULL THE TUBE OVER THE LENGTH OF THE PIPE. TAPE TUBE TO PIPE AT JOINT. FOLD MATERIAL AROUND THE ADJACENT SPIGOT END AND WRAP WITH TAPE TO HOLD THE PLASTIC TUBE IN PLACE. EXCESS MATERIAL SHALL BE NEATLY DRAWN UP AROUND THE PIPE BARREL, FOLDED ON TOP OF PIPE AND TAPED IN PLACE.

TAPS: MAKE TAPS BY WRAPPING THREE LAYERS OF COMPATIBLE TAPE AROUND THE PIPE TO COVER THE TAPPING MACHINE AREA. INSTALL CORPORATION STOP THROUGH THE TAPE AND POLYETHYLENE.

STEP 3- OVERLAP FIRST TUBE WITH ADJACENT TUBE AND SECURE WITH PLASTIC ADHESIVE TAPE. THE POLYETHYLENE TUBE MATERIAL COVERING THE PIPE SHALL BE LOOSE. EXCESS MATERIAL SHALL BE NEATLY DRAWN UP AROUND THE PIPE BARREL, FOLDED ON TOP OF PIPE AND TAPED IN PLACE.

STEP 4- CAREFULLY BACKFILL WITH CLEAN MATERIAL THAT WILL NOT DAMAGE ENCASEMENT.

FIELD INSTALLATION POLYETHYLENE AWWA C-105 METHOD "A"



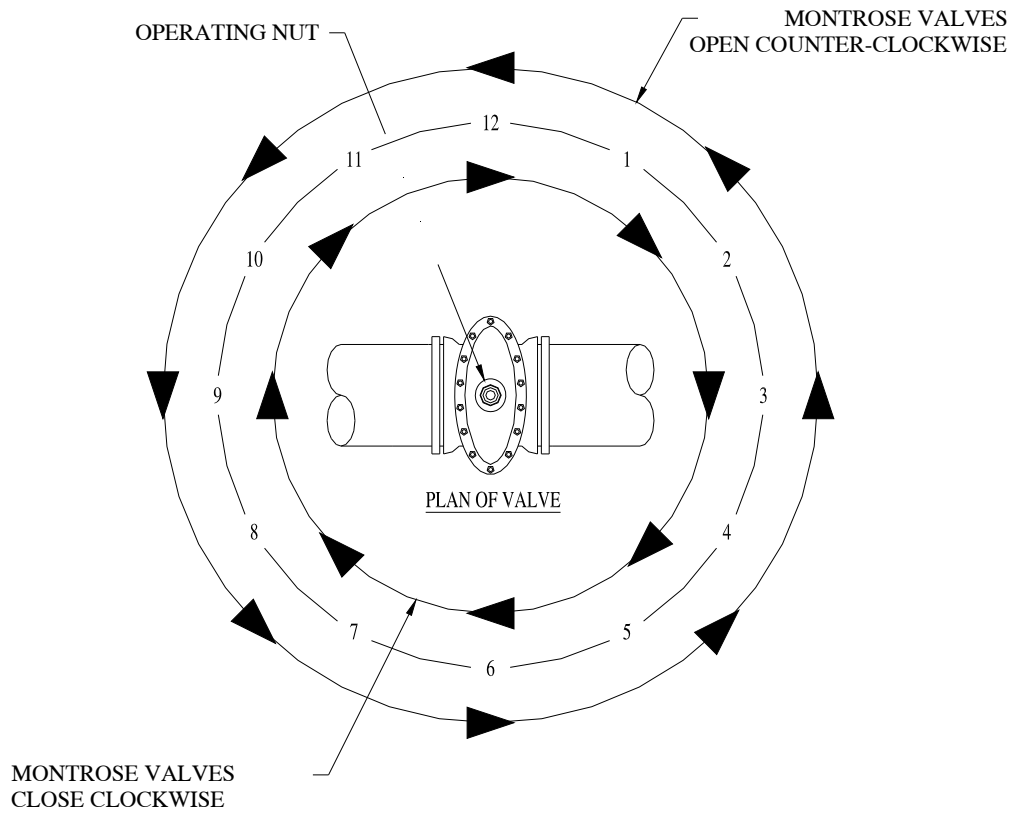
ENGINEERING DEPARTMENT

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DETAILS

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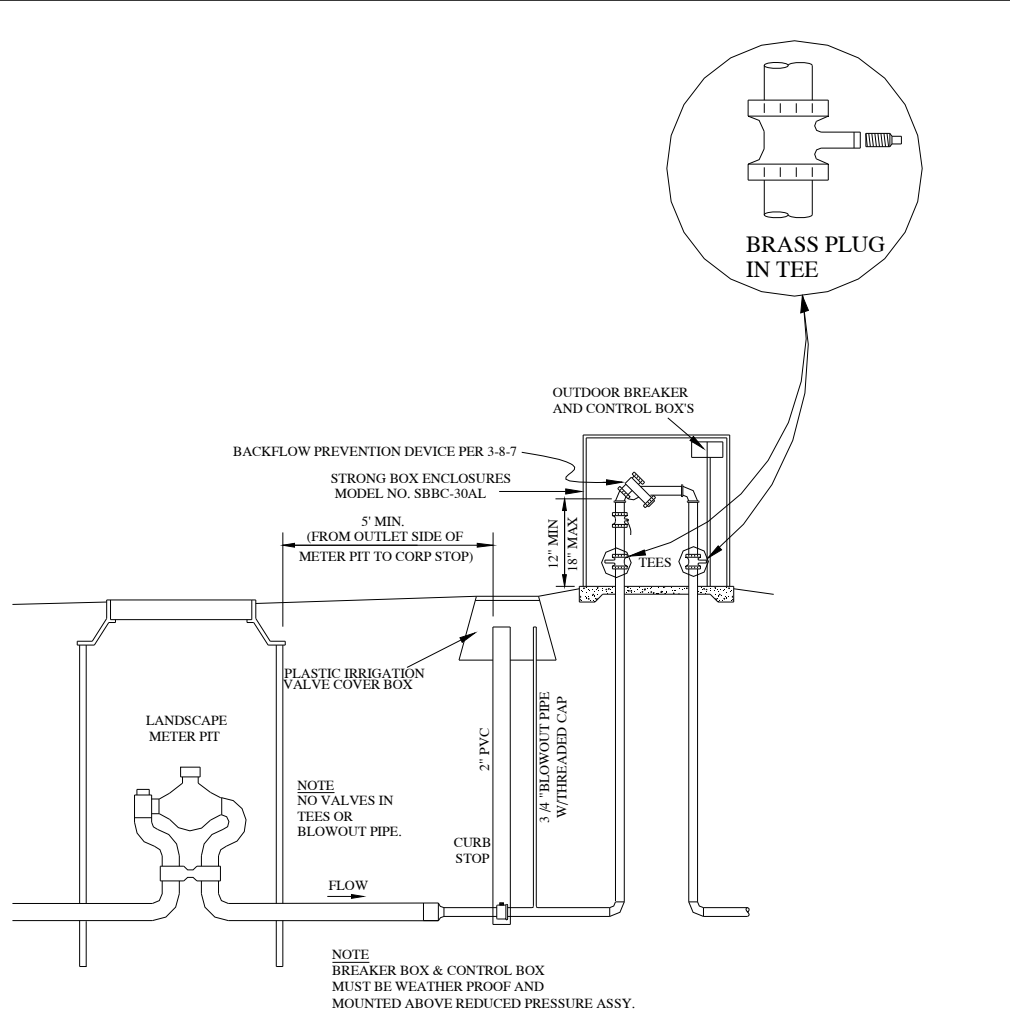
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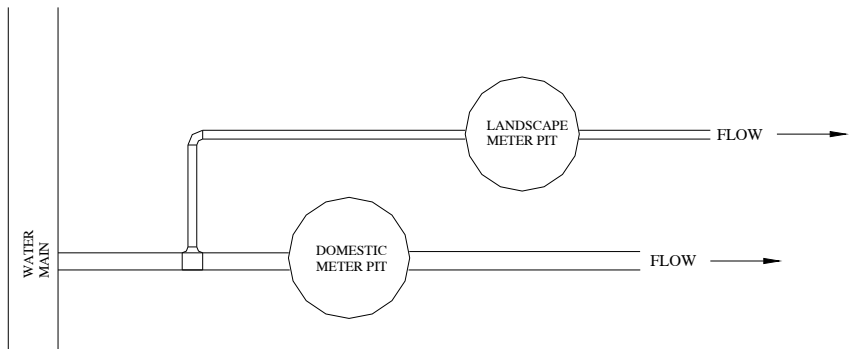
VALVE OPERATION

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <u>FRH</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u></p>	<p>PAGE W-14</p>
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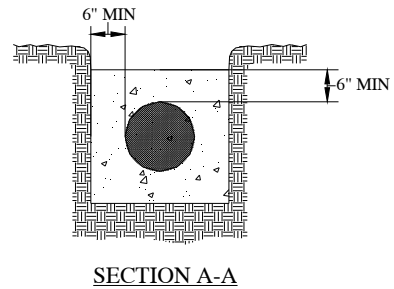
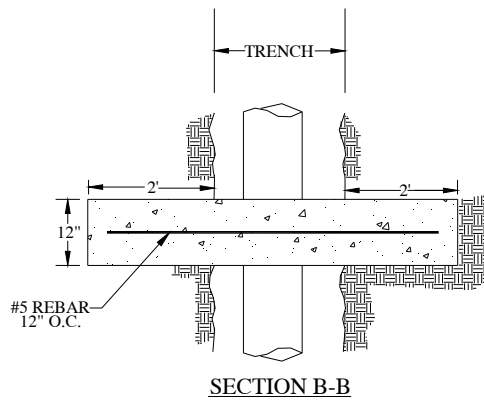
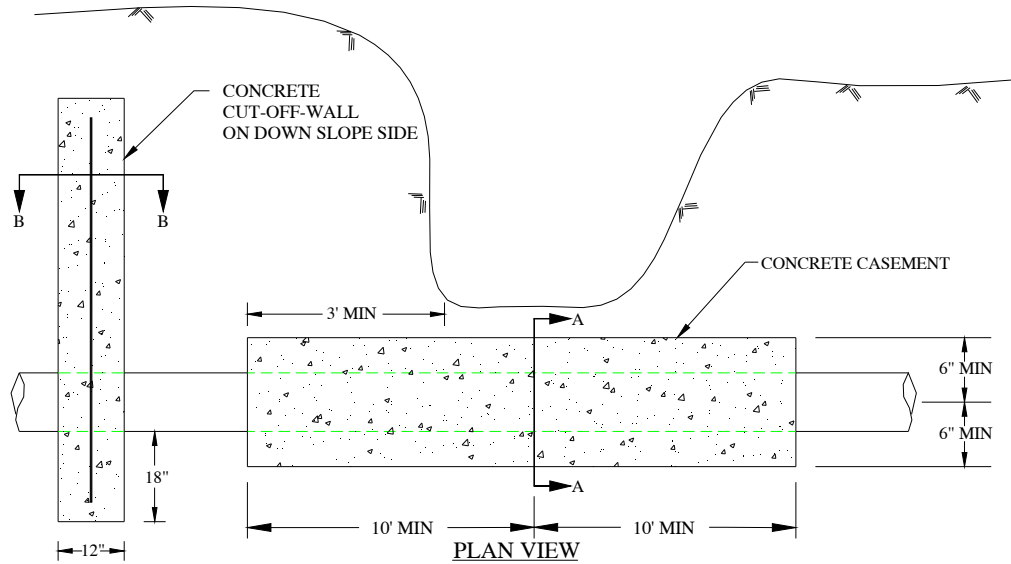
SPRINKLER TAP OFF DOMESTIC SERVICE
WITH REDUCED PRESSURE ASSEMBLY



STANDARD SPRINKLER TAP DETAIL

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <u>RLH</u> REV: <u>JAN 2011</u> DRAWN BY: <u>RLW</u></p>	<p>PAGE W-15</p>
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DITCH CROSSING DETAILS

	<p>ENGINEERING DEPARTMENT</p>	<p>STANDARD WATERLINE DETAILS</p>	<p>APPROVED: <i>JRH</i> REV: <u>JAN 2011</u> DRAWN BY: <i>RLW</i></p>	<p>PAGE W-16</p>
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