

**SPECIFICATIONS FOR WATER MAIN CONSTRUCTION
CITY OF COLUMBIA
WATER & LIGHT**

TABLE OF CONTENTS

- A. AUTHORITY**
- B. SPECIAL CONDITIONS**
- C. INTENT AND DEFINITIONS**
- D. RESPONSIBILITIES OF CONTRACTOR AND OWNER**
- E. MATERIALS**
- F. MATERIAL HANDLING**
- G. LOCATION**
- H. EXCAVATION AND PREPARATION OF THE TRENCH**
- I. PIPE LAYING**
- J. ANCHORAGE**
- K. BACKFILLING**
- L. TESTING**
- M. CLEANING AND DISINFECTION**
- N. SEEDING, SODDING, AND SITE RESTORATION**
- O. INSPECTION**
- P. MEASUREMENT AND PAYMENT**
- Q. DETAIL DRAWINGS**


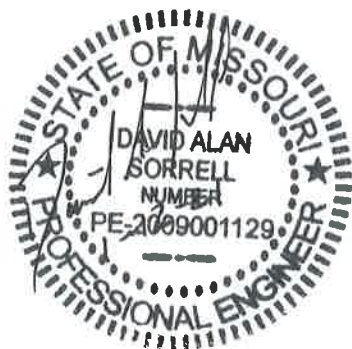

Specifications for Water Main Construction

SECTION A

January 8, 2021

A) AUTHORITY:

These specifications are drawn and approved by the Director of Utilities for the City of Columbia, Missouri, and shall be enforced, and no part thereof altered without approval of said Director.

 <p>The logo for the City of Columbia Water & Light department. It features a blue stylized 'X' or flower-like symbol to the left of the text 'city of Columbia' in a sans-serif font, with 'Water & Light' in a smaller blue font below 'Columbia'.</p>	 <p>A circular professional engineer seal for the State of Missouri. The outer ring contains the text 'STATE OF MISSOURI' at the top and 'PROFESSIONAL ENGINEER' at the bottom, separated by two stars. Inside the ring, the text reads 'DAVID ALAN SORRELL', 'NUMBER', and 'PE-2009001129'.</p>
<p>City of Columbia 701 East Broadway Columbia, Boone, Missouri Phone: 573-875-2555</p>	
<p>Approved By:</p>  <p>A handwritten signature in black ink, appearing to read 'David Alan Sorrell', written over a horizontal line.</p> <p>Director of Utilities</p>	<p>David Alan Sorrell Professional Engineer MO # PE-2009001129</p>

B) SPECIAL CONDITIONS:

- 1) These specifications shall apply to water mains extended under the provisions of the "Application to Extend Water Mains" (Developer extensions) within the City of Columbia's water service territory or projects bid through the Purchasing Division of the City of Columbia.
- 2) Any project special conditions for city contracted work will be included as part of the contract documents.

C) INTENT AND DEFINITIONS:

1. The intent of these specifications is to identify the type and quality of all water main materials, the method and procedure of construction, the inspection and testing methods, and the terms of acceptance by the City of Columbia of any water main work or extension on any main or mains, that are or will be an active part of the water system of the City of Columbia, Missouri.
2. These specifications are intended to guide the construction of water distribution infrastructure within the City of Columbia. In the event that any of these specifications do not conform to standing or enacted standards or requirements from governing bodies such as the Missouri Department of Natural Resources, or the American Water Works Association, the more stringent of the standards must be used. At no time shall any work be performed that is not in accordance with the relating standards of the work to be completed.

3. Definitions:

AWWA: American Water Works Association- National organization responsible for maintaining the foremost set of rules and specifications for potable water suppliers.

City: City of Columbia, Missouri.

City's Engineer: The Director of Water and Light of Columbia, Missouri, or his duly authorized designee.

Contractor: The individual or firm to which this contract is awarded or is otherwise completing work to which these specifications apply.

DI or DIP: Ductile Iron pipe or fittings to be used for water distribution.

DNR: Missouri Department of Natural Resources (State Water Distribution Governing Body).

FDC: Fire Department Connection- A fitting outside of a building where a pumper truck attaches to the inside sprinkler system and supplies water

from an outside source.

Inspector: The engineering or technical inspector or inspectors authorized by the director of Columbia Water and Light.

MoDOT: Missouri Department of Transportation (State Transportation Governing Body).

"Or Equal": Any part or fitting submitted to the Engineering Division of Columbia Water and Light for evaluation and determined by the director or his duly authorized designee to be equal in quality and performance to any manufacturer and series currently specified.

Owner: Applicant for the approved water main extension (generally the developer).

Owner's Engineer: An individual designated by the owner to fulfill the responsibilities and or duties of an engineer or architect.

Potable Water: Water that has been treated and tested as safe to drink.

Regular Work Week: 8:00 AM - 4:30 PM, Monday - Friday.

Rock excavation: Any excavation which requires the contractor to utilize equipment intended specifically for the removal of rock which encompasses a volume of 1/2 cubic yard or greater amount of rock measured in its original and undisturbed state.

PVC: Poly Vinyl Chloride- A synthetic resin commonly used in producing water distribution products.

Water Department: Water and Light of the City of Columbia, Missouri.

D. RESPONSIBILITIES OF CONTRACTOR AND OWNER:

1. The owner or city (whichever is applicable) or its engineer shall be responsible for the proper location and grade of the proposed extension. Property irons or accurately located and labeled laths shall be provided at key lot corners, particularly at intersections and curves. The main shall not be located solely from street centerline markers. The street pavement must be completed prior to installation of the water main extension. Possible problems with sanitary sewers, manholes, storm sewers, and drop inlets must be marked and sizes and depths indicated. Failure to provide the above requirements may result in suspension of the work.
2. The contractor shall employ skilled workmen under the supervision of a foreman experienced in water main construction to install the main. The inspector may suspend the work for the absence of an experienced foreman or until, in his opinion, skilled personnel are provided.
3. The owner or city's (whichever is applicable) contractor shall be responsible for any failure of the main extension that can be attributed to faulty workmanship or defective materials, and for maintenance of backfilled areas. The contractor will be responsible for a period of one year after final payment has been issued (for City Contract jobs) or for one year after the deed of dedication for the main has been accepted by the City Council (developer extension).
4. The owner shall be responsible for providing necessary easements and, after completion of the work, a deed of dedication transferring ownership of the installed water distribution infrastructure to the City. Failure to provide these documents will result in a refusal of the Water Department to make service connections to the mains concerned.
5. Contractor is responsible for obtaining a permit for work within public street rights-of-way from the agency having jurisdiction; the City of Columbia Public Works Department, Boone County Public Works, or the Missouri Department of Transportation, prior to any construction within the street right-of-way. The City will obtain a permit from the Missouri Department of Transportation for construction in state rights-of-way for city contracted jobs.

6. The Contractor shall ensure all construction complies with the City of Columbia's specifications for street and utility construction. Roadway construction and repair to improved streets shall comply with the requirements of the agency having jurisdiction; the City of Columbia Public Works Department, Boone County Public Works or the Missouri Department of Transportation. Unimproved streets shall be repaired, at a minimum, by backfilling with 1-inch clean rock and capping with asphalt the same thickness as the existing roadway but not less than 3 inches.
7. The contractor shall maintain traffic control devices in compliance with the Manual on Uniform Traffic Control Devices (MUTCD) and any additional requirements of the agency having jurisdiction.

E. MATERIALS:

1. Pipe: All pipe shall meet one of the following specifications:
 - a. Ductile-Iron Pipe: ANSI/AWWA C151/A21.51-09 or latest revision thereof, Thickness Class 50 or Pressure Class 350, push-on joint, cement-mortar lined, bituminous coated. Acceptable manufacturers are: Clow, American, and U.S. Pipe. For restrained joint pipe acceptable manufacturers are: U.S. Pipe TR-Flex™, Clow TR Flex, or approved equal.
 - b. PVC Pipe: 4"-12": Polyvinyl Chloride pipe, meeting AWWA Specification C900-07 or latest revision thereof, outside diameter equivalent to ductile iron pipe, DR (dimension ratio) series 18, gasket bell-end coupling. Installation requirements shall be the same as for ductile iron pipe. Acceptable manufacturers are: Pipe Life Jet Stream, Vinylplex, Northern Pipe Products, PW Eagle, JM Eagle, CertainTeed, Diamond, Ipex Blue Brute, and North American Pipe Company.
 - c. Polyethylene Pipe: Pipe shall meet AWWA C901 and ASTM D 2737 or the latest revision thereof. The pipe shall be copper tube size, DR9, 2.125 in OD, 1.653 in ID, and be rated for a max working pressure of at least 200psi. Acceptable manufacturers are Centennial Plastics, and Silver-Line Plastics, or an approved equal.
2. Fittings: All fittings shall meet one of the following specifications:
 - a. Ductile Iron Fittings: To meet ANSI/AWWA C110/A21.10-08 or ANSI/AWWA C153/A21.53-06, or latest revision thereof, mechanical joint, cement-mortar lined, bituminous coated; 12-inch to 24-inch fittings to be rated at 350 psi; 30-inch and larger fittings to be rated at 250 psi. Acceptable manufacturers are: Tyler Union, Star, U.S. Pipe, SIP, and Sigma.
 - b. PVC Fittings: 6"-8": To meet AWWA C907-04 or latest revision thereof. Acceptable manufacturers are Ipex, Blue Brute, and CertainTeed (for couplings only).
3. Valves: All valves shall meet one of the following specifications:

a. Gate Valves: NRS resilient wedge for buried service, conforming at a minimum to AWWA C509-09 or AWWA C515-09 or latest revisions thereof for 16" and larger; 2" square operating nut; open left; MJ X MJ; wedge rubber shall be molded and bonded in place to the wedge and shall not be mechanically attached with screws, rivets, or similar fasteners; wedge shall seat so the seating is equally effective regardless of direction of pressure unbalanced across the wedge; waterway shall be full diameter, smooth and shall have no depressions or cavities in the seat area where foreign material can lodge and hinder closure or sealing, the valve body and bonnet shall be fusion bonded epoxy coated, inside and out, and the valve shall be provided with stainless steel bonnet and packing bolts. Acceptable manufacturer and series for 16" and larger gate valves are U.S. Pipe 250, American Flow Control #2500, Clow RW, Mueller A-2361, and M & H Style 7000. For all other sizes less than 16", acceptable manufacturers are: American Flow Control Series 2500, M & H style 4067, Clow R/W, U.S. Pipe 250, Mueller 2361, Kennedy RW, EJ Flowmaster, or an approved equal.

b. Tapping Valves: Same as Gate Valves above.

c. Butterfly Valves: Rubber-seated for buried service, conforming as a minimum to AWWA C504-06 or latest revision thereof class 250; 2" square operating nut; open left; MJ X MJ; butterfly shall seat so the seating is equally effective regardless of direction of pressure unbalanced across it, the resilient seat shall be attached to the body of the valve and not the butterfly, the valve interior shall be epoxy coated and the exterior shall be epoxy or bituminous coated. Acceptable manufacturers are: Pratt, Kennedy, or an approved equal.

d. Valve Boxes: All valve boxes shall be 6" C900 PVC DR18 water pipe. During construction the valve boxes shall extend from 2 to 3 feet above grade to remain visible to other construction trades and traffic. Once final grade has been established, the valve boxes shall be cut to grade. It shall be the contractor's responsibility to ensure the valve boxes are cut to grade. All valve boxes shall be vertical, clear of mud and debris and capped with a Clay & Bailey #2195 valve box cover. Acceptable manufacturers shall be the same as those listed for PVC pipe, 4"-12" under the Materials Section of this set of specifications.

- e. Air Release Valves: All air release valves shall be single-body combination air valves designed to open automatically when air accumulates within the pipeline and if negative pressure occurs during draining activities. Valves shall be sized appropriately to exhaust large quantities of air during the filling of the pipeline. Valves should be operable while the main is under pressure and in use. Valve bodies shall be constructed of cast iron and all hardware shall be formed of Stainless Steel. Valves shall have full size NPT Inlets and Outlets equal to the nominal valve size. Valves shall be manufactured and tested in accordance with AWWA C512 or the latest revision thereof. Acceptable manufacturer and series are Val-Matic 200 series or an approved equal.
4. Gland Packs: All valves and mechanical joint manufacturers are to supply their domestic accessory gland pack with their fittings and/or valves. The manufacturers brand shall be clearly cast into the gland and also clearly printed onto any box or package in which the gland pack is shipped. If the gland pack and box are not so marked, a certification from the valve and/or fitting manufacturer will accompany each shipment certifying that the specific gland pack shipped is approved by the manufacturer for use with the valve and/or fitting. All glands must be ductile iron.
5. Tapping Sleeves: Manufactured from all stainless steel group 18-8, material 304 including sleeve, outlet neck, outlet flange, and all bolts and nuts; top of shell shall be a minimum of 11 Ga. plate and bottom of shell shall be a minimum of 14 Ga. plate; seal to be full circumferential gridded and approved for potable water; Mechanical Joint Tapping sleeve outlet shall be suitable for use with standard mechanical joint resilient wedge gate valves per ANSI/AWA C509-94 or latest revision thereof. Acceptable manufacturers and series are: Ford FTSS-MJ, JCM #439-MJ, Cascade CST-EX-MJ, Smith Blair #665-MJ, Power Seal Model #3490-MJ, and Mueller H304-MJ.
6. Fire Hydrants: Fire Hydrants shall be manufactured in accordance with the latest revision of AWWA standard C502. They shall be designed for 250 psi working pressure and tested to 500 psi. They shall be of self-draining design with a minimum of 2 straight weep holes within the seat ring. The seat ring should have a rubber o-ring seal above and below the installation threads. The hydrant shall not rely upon a spring for drain closure or flow

throttling during hydrant operation. They shall be a traffic model complete with safety flanges and a 360 degree rotating nozzle section. The hydrant rod shall be self-oiling within a sealed lubrication reservoir that can be refilled without hydrant disassembly. All working parts should be removable and serviceable without excavation. Hydrants shall be manufactured and supplied with a 5-1/4" valve opening, two 2-1/2" hose nozzles, and one 4-1/2" pumper nozzle. Acceptable manufacturers and series are Mueller Super Centurion 250-A-423 or Clow Medallion.

7. Reserved
8. Concrete: All concrete work shall meet A.S.T.M. Standards C150 (type 1), C260, and C33. Concrete shall be Class A, 6 bag mix, 5-inch slump, 3,000 psi minimum compressive strength in 28 days.
9. Anchors, Inserts, Reinforcements: All thread rod shall be 3/4" stainless steel, group 18-8, material 304, minimum yield of 70 ksi, minimum tensile 100 ksi. Nuts shall be hex head, 3/4" stainless steel, group 18-8, material 304. "DUC-LUGS" shall not be used on 12" or larger fittings and valves. Cor-Ten anchor eye-bolts may be used in lieu of "DUC LUGS" on 12" and larger valves and fittings, anchor eyes or rods shall tie directly into bolt holes on fittings and valves. Stainless steel washers shall be utilized with all tie rods and nuts. Stainless steel all-thread rod shall only be joined with stainless steel extension nuts. DUC-LUGS shall not be used to extend stainless steel all-thread rod. "T" bolts for use with MJ fittings shall be Cor-Ten, high strength, low alloy, corrosion resistant steel. Bolts should have a corrosion preventative coating utilizing baked on ceramic filled fluorocarbon such as Cor-Blue or an approved equal.
10. Casing Pipe:
 - a. Steel: Steel casing pipe wall thickness shall conform to the following schedule:

CASING DIAMETER	MINIMUM WALL THICKNESS
6, 8, 10, 12"	.188"
14, 16, 18"	.250"
20, 22, 24, 26, 28, 30"	.3125"

32 through 48"

.4375"

All pipe shall conform to all applicable requirements of AWWA C200-05 and AWWA M11 or latest revision thereof, and if fabricated shall be constructed of A36 steel with a minimum yield point of 36 ksi; or if manufactured shall conform to Grade B with a minimum yield point of 35 ksi. It may be shipped in random lengths between 18 and 22 feet and shall have one end cut square and one end beveled. All casing pipe to be joined with 360 degree welds. It shall be mill primed and coated with bituminous based coating before installation. Where coating is damaged during installation, it shall be repaired and replaced by thorough brushing or scraping to sound material and applying two coats of the coating material.

b. Concrete Pipe: Concrete pipe utilized for encasements shall be steel reinforced concrete pipe and shall conform in both material and installation specification to those of the Missouri Department of Transportation.

11. Casing Spacers: The casing spacers shall have a bolt on shell made in two sections. All metal components shall be Type 304 (18-8) Stainless Steel. It shall have an elastomeric liner to isolate the shell from the carrier pipe. It shall have runners attached to the shell and be designed to provide a minimum of .75 inches clearance between the carrier pipe's greatest outside diameter and the casing pipe's inside diameter. The chock runners shall be beveled with high abrasion resistance and a low friction coefficient. Acceptable manufacturers and models are: Pipe Seal & Insulator S8G-2 and S12G-2, Power Seal #4810, Cascade CCS series, Advance Products & Systems model SSI, and BWM Company model SS-8.
12. Pipe Restraints: All pipe restraints shall be ductile iron for use on ductile iron MJ fittings with ductile iron or C900 PVC pipe. All joint restraints shall have a minimum of 150 PSI pressure rating. Restraint systems that use set screws to hold the gland to the pipe are unacceptable. All T-bolts and studs shall be high strength, low alloy steel (Cor-Ten or equal).

Acceptable manufacturers and series are:

For DIP: EBAA Iron series 1100 Megalug, Tyler series 1000 TUF Grip, Sigma One-Lok SLDE Series, and Uni-Flange series 1400.

For PVC: EBAA Iron series 1500 and 2500 bell restraints, EBAA Iron series 2000PV Megalug, Tyler series 2000 TUF Grip, Sigma One-Lok SLCE Series, and Uni-Flange series 1500 Circle-Lock.

For DIP or PVC: Tyler MJ Field Lok; Romac Grip Ring, Uni-flange 1300 series 4" to 12", Uni-Flange 1360 Series 10" to 12", and JCM 610 and 620 Sur Grip for 4" - 12".

13. Pigs: All pigs shall be constructed from open cell polyurethane foam. They shall be of medium density ranging from 5 lb/ft³ to 8 lb/ft³ and be double dished. All pigs used shall be made for hand launching and specifically for the type and size of pipe being installed. Acceptable manufacturers and series are: Pipeline Pigging Products B-3 DD (Double Dish) 5 to 7 lb and the KNAAP Polly Pig 5A DD (Double Dish) 5 to 8 lbs.
14. Rubberized Spray-on Undercoating: All nuts, bolts, and threaded rod ends requiring additional corrosion protection shall be coated with an approved spray-on undercoating prior to backfilling. Approved Manufacturers are 3M Rubberized Underseal Undercoating 08883 or an approved equal.
15. Polyethylene Encasement: All poly wrap shall be 12 mil (min) polyethylene wrap in accordance with ANSI/AWWA C105/A21.5-05 or latest revision thereof.
16. Locator Wire: Locate wire and its appurtenances shall meet the following specifications.
 - a. For open trench installation locate wire shall be 12 AWG solid copper used in minimum 1000-foot rolls with as few splices as possible. Smaller roll lengths are acceptable if length of roll exceeds that needed to install without splices. Insulation shall be blue HDPE or HMWPE minimum thickness .030".
 - b. For trenchless installation the wire shall be 12 AWG copper clad steel with minimum break strength of 1,150 lb. Insulation shall be blue HDPE or HMWPE minimum thickness .045". No splices shall be allowed throughout trenchless installed sections.

- c. Direct bury wire connectors shall be specifically manufactured for use in underground trace wire installation, shall be dielectric silicon filled, and installed according to manufacturer specifications preventing any uninsulated wire exposure. Acceptable manufacturer and model are 3M DBR/Y connectors or an approved equal.
- d. Branch connections for service lines shall be specifically manufactured for use in underground trace wire installation, shall be dielectric silicon filled, and installed according to manufacturer specifications preventing any uninsulated wire exposure. Acceptable manufacturer and model are DryConn Direct Bury Lug Aqua or an approved equal.
- e. Grounding rods should be drive-in magnesium grounding anode rod, minimum 1.0 pound, supplied with and permanently connected to a minimum 20 feet of locate wire. Acceptable manufacturer and series are Copperhead ANO-12 or an approved equal.
- f. Tracer wire access stations shall be specifically manufactured for use in trace wire installation. Typical trace wire access points, when supplied at fire hydrants, shall include multiple binding posts with the ability to decouple the ground from trace wire. When installed in soil, the station shall be adjustable to grade. When installed in paved surfaces, the station should be traffic rated. Acceptable manufacturer and series are Copperhead Cobra and Copperhead Snakepit LD or RP or an approved equal.

F. MATERIAL HANDLING:

1. PVC pipe and fittings: Shall be handled according to guidelines set out in AWWA M23 or latest revision thereof. The pipe shall not be handled with individual chains or single cables, even if padded. They shall not be dropped to the ground or into the trench and shall not be dropped or rolled against other objects on the ground. Gaskets shall be protected from excessive exposure to direct sunlight, ozone, oil, and grease. If stored for extended periods the pipe and fittings shall be protected from direct sunlight and shall be laid so as not to become deformed or bent.
2. Ductile Iron Pipe and Accessories: The handling of pipe, fittings, valves, hydrants, and accessories shall conform as a minimum to the standards set out in AWWA C600-05 or latest revision thereof. They shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped or rolled against pipe or fittings already on the ground.

G. LOCATION:

1. Alignment and Grade: The water mains shall be laid, and valves, hydrants, and fittings shall be placed in accordance with the plans. Unless otherwise approved by the City's Engineer, all pipe shall be installed with the following minimum depths: All pipe smaller in diameter than 12" shall be installed a minimum of 42 inches below finished grade or when installed along streets, 42 inches below the existing street pavement centerline elevation, whichever is greater. All pipe 12" and larger in diameter shall be installed a minimum of 60 inches below finished grade or when installed along streets, 60 inches below the existing street pavement centerline elevation, whichever is greater.
2. Dead Ends: The dead end of a main shall have a fire hydrant or approved flush assembly for flushing purposes. Flush assemblies shall be a min 2" for 6" & 8" mains, a min 4" for 10" & 12" mains, and a fire hydrant assembly for 16" mains. Temporary flush out standpipes shall be installed on fire hydrant valves wherever possible. All 2" temporary flush outs shall be galvanized pipe with no weep-hole. The standpipe shall extend 2 feet minimum and not exceed 3 feet above ground level and be fitted with a plug. For permanent installation, flushing devices shall be below grade and completely enclosed within a valve box. Larger mains shall utilize a flushing assembly that provides a min of 4 ft/sec water velocity within the pipe at flushing. It will be the responsibility of the contractor to supply all required materials for temporary flush outs. Temporary flush outs shall be placed by the contractor as per the plans. Additional flush outs may be required by the Water & Light Inspector due to field conditions. These also shall be provided and placed by the contractor.
3. Ells, Tees, Plugs, and Hydrants: All fittings shall have thrust reinforcement, either in the form of approved manufactured restraint, stainless steel rods, or a properly designed thrust block of concrete.
4. Water Mains Near Sewers: All water mains installed near sanitary or combined sewers must be completed in accordance with "Minimum Design Standards for Missouri Community Water Systems".
 - a. Parallel Installation: A water main shall be laid at least 10 feet horizontally from any existing or proposed storm or sanitary sewer line. Should local

conditions prevent a lateral separation of 10 feet, water main may be laid closer than 10 feet to a storm or sanitary sewer line provided that the water main is laid in separate trench or on an undisturbed earth shelf located on one side of the sewer line and at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer line while maintaining minimum cover requirements. When it is impossible to obtain proper separation, either the water line or sewer line shall be constructed of manufactured restrained joint, or fusion welded pipe or installed within a continuous casing. If casing is used it must be a material approved for use as a water main and installed continuously until the required separation can be obtained. In no case shall the water main and the sewer main share the same granular fill bed.

b. Crossings: Where water mains must cross over storm drains or sanitary sewers, the water main must be laid at such an elevation that a vertical clear distance of 18 inches must be maintained between the outside of the water main and the outside of the sewer pipeline. At crossings, a full length of water main pipe must be centered over the sewer to be crossed so both of the joints will be equally distant from the sewer and as remote therefrom as possible and in no case less than 10 feet. This vertical separation must be maintained for that portion of the water main located within 10 feet horizontally of any storm drain or sanitary sewer that it crosses, said 10 feet to be measured as the shortest distance from the water main to the sewer at that point. When it is impossible to obtain proper separation, either the water line or sewer line shall be constructed of manufactured restrained joint, or fusion welded pipe or installed within a continuous casing. If casing is used it must be a material approved for use as a water main and installed continuously until the required separation can be obtained. Backfill shall be of compacted clay to a minimum of 18" above and below the outside dimension of the water main and for a horizontal distance of 10 feet from the sewer being crossed. In no case shall the water main and the sewer share the same granular fill bed.

c. Unusual Conditions: Where these conditions cannot be met the Missouri Department of Natural Resources shall be consulted as to the precautions to be taken to protect the public water supply.

H. EXCAVATION AND PREPARATION OF THE TRENCH:

1. Size and Alignment: The trench shall be dug such that the pipe can be laid to the proper grade and alignment as shown on the approved plans. Width of trench shall be so as to have a minimum width of 18 inches greater than the outside diameter of the pipe. Bell holes shall be provided at each joint. Bell holes shall be no larger than is necessary to permit proper jointing and ensure the pipe is supported evenly along the entire length of the barrel. This is especially important for PVC pipe. No voids shall be permissible under the pipe barrel. Hand excavation shall be employed in trenching when deemed necessary by the City's Engineer.
2. Tunneling: Tunneling may be permitted or required at the discretion of the City's Engineer.
3. Bracing and Shoring: It is the responsibility of the contractor to maintain all work in compliance with current Occupational Safety and Health Act (OSHA) standards. Inspectors, engineers or other City personnel shall not enter any trench or excavation not braced or shored in accordance with OSHA Standards.
4. Open Trench:
 - a. At no time shall there be more than 300 feet of trench opened in advance of the pipe laying operations provided that the trench is backfilled prior to the end of the day's work. This length of open trench may be shortened by order of the City's Engineer.
 - b. The contractor shall not allow a cut on any roadway which is open to traffic to remain overnight without capping the cut with a minimum of 3 inches cold mix patch.
5. Rock Excavations:
 - a. Definition: Rock excavation shall include any excavation which requires the contractor to utilize equipment intended specifically for the removal of rock which encompasses a volume of 1/2 cubic yard or greater amount of rock measured in its original and undisturbed state.

- b. Trench Width and Depth: Any trench of rock excavation shall be at least 18 inches wider than the outside diameter of the pipe and nine inches deeper than the average depth of the trench as required by existing topography or these specifications. In the event of any required undercut, the trench sub grade shall be restored to proper grade by filling and compacting, with an approved material, so as to insure a uniform bed along the full length of the pipe barrel. Approved materials are sand and crushed stone aggregate with 95% passing a 1/2 inch screen but not more than 10% passing a #200 sieve.
 - c. Rock Measurement: All rock measurement or estimates to be used for payment purposes shall be made, recorded, and signed in the field in the presence of the City's Engineer and contractor or their duly authorized designees. (SEE ALSO SECTION P)
- 6. Before starting work, the contractor shall be responsible for having located any utilities or services in the area which might be affected. Financial responsibility for damage to any utilities belongs to the contractor.

I. PIPE LAYING:

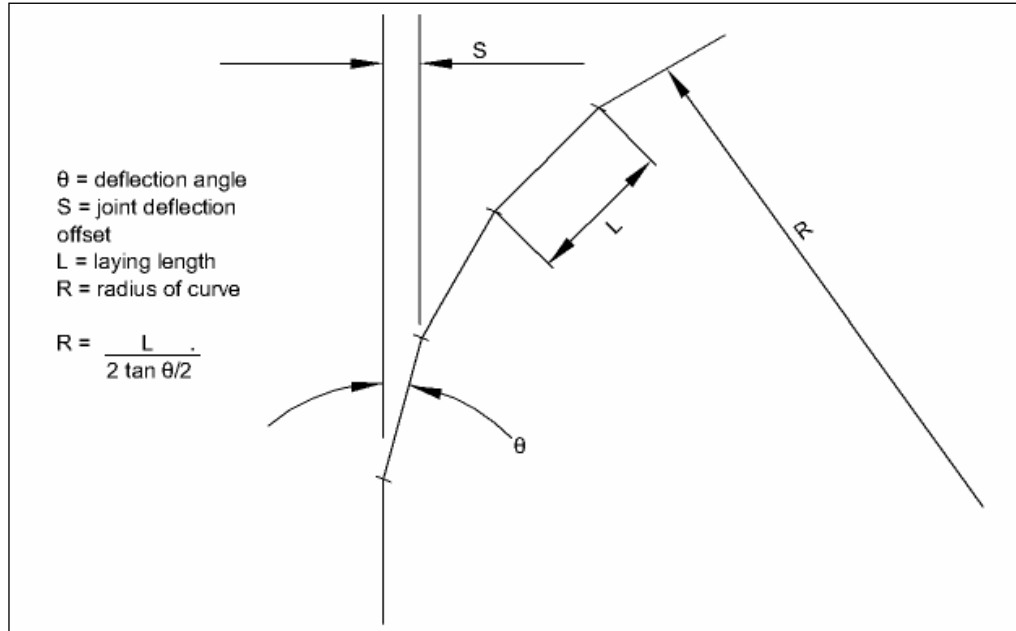
1. Laying: All pipe, fittings, valves, and hydrants shall be carefully lowered into the trench by means of ropes or mechanical equipment. Under no conditions may they be dropped or thrown. If he so desires, the inspector may hammer test all cast or ductile iron pipe before it is lowered into the trench. Ends of all pipe must be thoroughly cleaned.

After placing a length of pipe in the trench, the spigot end shall be centered in the bell; the pipe forced home and brought to the proper grade and alignment. The pipe shall be secured in place with proper backfill material tamped around and over it except at the bells. Bells shall be in the direction of the laying operations.

Precautions shall be taken to protect the interiors of pipes, fittings, and valves against contamination prior to and during installation in accordance with AWWA 651 or latest revision thereof. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks or meal periods. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry. The interior of each section of pipe shall be inspected immediately before and prior to installation in the trench to insure it is clean of critters, dirt, debris or other foreign matter.

All joint deflections must be within the pipe manufacturer's recommendations, and are hereby included in and made a part of these specifications. PVC pipe may be deflected around curves so long as deflection is in the joint only. No strain shall be placed on the pipe for the purpose of deflection. Manufacturers may vary in the amount of deflection which can be obtained in the pipe joint and their specifications should be consulted. In absence of the manufacturers published joint offset limits, one degree per joint shall be considered the maximum, or 4-1/4 inches per 20 foot pipe length.

Maximum Joint Deflection* Full-length DI pipe - push-on type joint pipe					
Nominal Pipe Size	Deflection Angle- θ	Maximum Offset - S		Approx. Radius of Curve - R Produced by Succession of Joints	
		inches		feet	
inches	degrees	L = 18 ft	L = 20 ft	L = 18 ft	L = 20 ft
6	5	19	21	205	230
8	5	19	21	205	230
12	5	19	21	205	230
16	3*	11	12	340	380
20	3*	11	12	340	380
24	3*	11	12	340	380
* For 16-in. and larger push-on joints, maximum deflection angle may be larger than shown above. Consult the manufacturer.					



Allowable bending for Gasket Jointed PVC Pressure Pipe*	
Nominal Pipe Size - Inches	Minimum Bending Radius - Feet
6	144
8	189
12	275
*ANSI/AWWA C900 PVC pipe with cast iron outside diameters (CIOD)	

2. Jointing: All joints must be made as per the manufacturers and AWWA Specifications.
3. Valves: Valves shall be located as designated by Water Department at street, bridge, railroad, waterway crossings, dead ends, and at all fire hydrants.

All valves shall be protected by a valve box (See Section E).
4. Polyethylene Encasement: All ductile iron pipe, valves and fittings shall be fully bagged with polyethylene wrap. Poly Wrap encasement shall be installed in accordance with the latest revision of AWWA C105.

5. Rubberized Spray-on Undercoating: All nuts, bolts, and threaded rod ends shall be protected from corrosion with an approved spray-on undercoating prior to backfilling. Bolts utilizing baked on ceramic filled fluorocarbon coatings meet the need for anti-corrosion protection without additional coating requirements.
6. Locator Wire: All water mains owned by the City of Columbia shall be installed with a locate wire attached. The wire shall be used in minimum 1000-foot rolls for open trench installation. The wire shall be installed with as few splices as possible utilizing an approved connector. No bare wire shall be exposed, and the ends of the wire shall be knotted to prevent strain on the splice. Branch connections for services shall be made without cutting the main wire, utilizing an approved branch connector. When extending an existing main with tracer wire available, the existing trace wire shall be connected to and extended with the new main.

The wire shall be securely attached to the top of the pipe in the center to retain its position during backfill. Access points shall be made available at all fire hydrant installations utilizing an approved trace wire access device. The wire length between surface points shall not exceed 1000'. If no fire hydrant is available to surface the wire, an approved tracer wire access box shall be used. CW&L engineering shall note the access point on all as-builts, and mapping records. When deemed necessary by the compliance inspector, the trace wire shall be made available within valve boxes by looping the wire and inserting it into the valve box through a hole just below the cap or lid with enough wire to extend 12" above final grade.

Tracer wire shall be grounded utilizing an approved grounding anode at all starting points, dead ends, fire hydrants, and other locations as determined by the Compliance Inspector. The wire length between grounding locations shall not exceed 1000 feet. The ground shall be bonded to the tracer wire within valve boxes or an approved tracer wire access box. Grounding anodes shall be installed in the bottom of the trench as the utility is installed in an orientation preventing parallel wire installation or signal cancellation. When installing grounds through long continuous stretches, the grounding anode shall be placed directly below the pipe at tracer wire access box. Tracer wire shall not be grounded to meter setters, yard lines, or other

locations that may contain stray electrical currents.

After construction is complete and final grading is done, a low frequency test shall be performed on the newly installed wire by city personnel. The low frequency test shall be performed using typical low frequency (512 Hz). A properly installed trace wire system should result in a uniform signal field in which the peak response and null response match or nearly match. Excessive signal distortion as determined by the test technician shall qualify as test failure. Any signal bleed off to another buried utility or any section of wire where the signal is not observed shall also constitute test failure. Failure of low frequency test shall be repaired by the Contractor and successfully pass retesting prior to acceptance of the water main by the City.

J. ANCHORAGE:

1. Plugs, Caps, Bends: All plugs, caps, tees, end valves, fire hydrant valves, and bends, unless otherwise indicated on approved plans, shall be anchored to prevent movement by providing suitable reaction backing in the form of concrete thrust blocks and approved manufactured restraints. Concrete thrust restraints shall bear on undisturbed earth as specified. Concrete shall be neatly formed to control size and shape of block. Tie rods shall be installed in accordance with the following schedule:

MINIMUM NUMBER OF TIE RODS REQUIRED FOR A CLOSED VALVE OR DEAD END						
	6-INCH	8-INCH	10-INCH	12-INCH	16-INCH	24-INCH
3/4" RODS	2	2	4	4	8	14

THRUST BLOCKS MINIMUM BEARING AREA IN SQUARE FEET					
PIPE SIZE	11 1/4	22 1/2	45	90	TEE
6-INCH	1	2	4	7	5
8-INCH	2	3	6	12	8
12-INCH	4	7	14	26	18
16-INCH	6	13	25	46	33
24-INCH	15	31	60	111	78
*SEE DETAIL DRAWING Q-5					

THRUST COLLARS MINIMUM BEARING AREA IN SQUARE FEET					
PIPE SIZE	6-INCH	8-INCH	12-INCH	16-INCH	24-INCH
AREA	5	8	18	33	74
*SEE DETAIL DRAWING Q-6					

K. BACKFILLING:

1. Under the Pipe: All backfill under the barrel of the pipe shall be free from debris, organic matter, and stones larger than one inch in greatest dimension, and shall be tamped into place. Sand or crushed stone aggregate (95% passing a 1/2" screen but not more than 10% passing a #200 sieve) are acceptable substitutes for soil.
2. Adjacent to Top of Pipe: The first one foot of backfill over the top of pipe shall be free from debris, organic material, and stones larger than three inches in greatest dimension, and shall be hand placed.

If excavated material is not suitable for backfill, the City's engineer may require imported material be used; including clean, finely divided soil or crushed stone aggregate (one inch and smaller). If the material in the banks of the trench is suitable, it may be used.

If the depth of the trench is over five feet, at least two feet of hand placed fill must be placed over the top of the pipe before a mechanical type fill may be used.

On completion of the specified hand fill, the balance of the trench shall be mechanically filled to at least three inches above the proposed finished grade of the surrounding terrain. Backfill shall be free of junk, debris, brush, roots thicker than two inches, and stones or rubble more than six inches in greatest dimension. Top six inches backfill shall be topsoil corresponding to that underlying original sod.

3. Improved Areas: Backfill of trenches through any improved area, such as streets, railroads, or improved drives shall be of one inch clean gravel. Check dams of compacted clay soil or flowable fill shall be constructed to the full depth of the trench on 100 foot intervals for the entire length of trench being backfilled with granular material. The restoration of these surfaces shall be sufficient to return the area essentially to its previous condition and shall be to the satisfaction of the City's Engineer.

Any backfill in or resurfacing of any portion of an existing street, shall be treated in the manner as directed by the governing agency. For streets Owned and maintained by the City of Columbia, these operations must

follow procedures prescribed in the City of Columbia, Missouri's latest revision of *Street, Storm Sewer and Sanitary Sewer Specifications and Standards* Backfill of trenches through developed areas such as grassed strips between streets and sidewalks or yards, shall be earth compacted to a minimum of 95% of standard proctor density (ASTM D698).

4. Maintenance of Backfilled Areas: The owner's or city's (whichever is applicable) contractor shall be responsible to maintain backfilled areas to the grade of the surrounding terrain for a period of one year after the main has passed final inspection by the City (for contract jobs) or for one year after the deed of dedication for the main has been accepted by the City Council (for developer extensions). Seeding and mulching or re-sodding shall be completed according to Section N of these specifications to the satisfaction of the City's engineer.
5. Cleaning Up: On completion of contract, contractor shall remove all excess materials or supplies and shall clean up the entire working area and dress the land so as to leave a neat, accessible work area. Any ditches, road, or street shoulders shall be restored to their original alignment and grade.

All cleared trees, brush, unearthed rock, excess dirt and trash shall be disposed of. Trees, brush and stumps that are cleared during construction may only be burned with a permit from the Columbia Fire Department. Waste from items that are allowed to be burned shall be free from embers prior to disposal by the contractor. The contractor shall exercise due care in his construction operations to prevent marring or scarring of trees that are to remain. Care should also be taken so as not to leave soil upon the surface of roads, walks, or other paved surface.

L. TESTING:

1. All piping, valves, and appurtenances installed shall be subjected to hydrostatic testing. No more than 1000 ft of continuous pipe shall be installed and tested without prior approval from the water department. The newly installed main shall be cleaned, disinfected, flushed, and pass bacteria sampling requirements according to Section M of these specifications prior to being subjected to hydrostatic test pressure.
2. The specified test pressure will be determined using the following criteria:
 - a. The minimum allowable test pressure shall be 1.5 times the maximum sustained working pressure the pipeline will be subjected to at the lowest elevation to be tested and 1.25 times the maximum sustained working pressure at the highest elevation to be tested. All mains must be subjected to a minimum of 150 psi at the lowest elevation in the test section.
 - b. The maximum allowable test pressure shall not exceed the rated working pressure for any fitting, joint, thrust restraint, valve, or other connected appurtenance of the test section.
 - c. If the pressure at the highest elevation does not reach 1.25 times the standard working pressure when the lowest elevation has reached 1.5 times the standard working pressure or, the pipeline shall be tested in multiple sections or the test pressure shall be increased until the highest elevation has reached a pressure of 1.25 times the standard working pressure. At no time shall the maximum allowable pressure for the pipeline or its appurtenances be exceeded.
3. The hydrostatic test shall be completed in accordance with the latest revision of AWWA C600, Section 5.2 for DI pipelines and AWWA C605, Section 10.3 for PVC pipelines.
 - a. The newly constructed pipeline shall be filled while taking necessary steps to remove all air from the pipeline. The pipeline shall be filled slowly in order to avoid excessive pressure surges. After filling, the pipeline should rest undisturbed for suitable time in order to allow pressures to stabilize and absorption to take effect. This resting period may occur concurrently with disinfection and sampling.

b. The newly installed and sampled pipeline and its appurtenances shall be subjected to a hydrostatic pressure test using a suitable pump. This test may not take place while the pipeline contains super-chlorinated water. The pressure gauge used to monitor the test will be provided by the water department. The appropriate reading on this gauge will be determined using the criteria in paragraph 2 of this section and corrected for the elevation at which the pressure is being read.

c. The pressure test must be of at least a 2 hour duration. The pressure must be held within ± 5 psi of the specified test pressure throughout the duration of the test using makeup water through a hydrostatic test pump. The makeup water used must be measured utilizing a flow meter. The makeup water utilized for maintaining the test pressure may not exceed the values in the following tables and said tables are hereby made a part of these specifications.

ALLOWABLE LEAKAGE FOR PIPELINES								
Hydrostatic test makeup allowance per 1000 ft of pipeline. (US gal/hr)								
Test Pressure (PSI)	Nominal Pipe Diameter (Inches)							
	4	6	8	10	12	16	24	36
250	0.43	0.64	0.85	1.07	1.28	1.71	2.56	3.85
225	0.41	0.61	0.81	1.01	1.22	1.62	2.43	3.65
200	0.38	0.57	0.76	0.96	1.15	1.53	2.29	3.44
175	0.36	0.54	0.72	0.89	1.07	1.43	2.15	3.22
150	0.33	0.50	0.66	0.83	0.99	1.32	1.99	2.98
125	0.30	0.45	0.60	0.76	0.91	1.21	1.81	2.72
100	0.27	0.41	0.54	0.68	0.81	1.08	1.62	2.43
<div> <div> This table has been generated from the formula: $L = \frac{SD\sqrt{P}}{148,000}$ </div> <div> Where: L is the allowable Leakage in gallons per hour S is the length of laid pipeline in feet D is the nominal pipe diameter in inches P is the average test pressure in psig </div> </div>								

d. Should any test fail to perform to these standards, the contractor shall, at the contractor's expense, locate and repair and/or replace the damaged or defective materials. Any materials used for repairs must be approved for use by the water department. Repairs and tests must be repeated until the allowable leakage is within the permitted allowance.

4. Operation of Existing Pressurized Valves: All valves under pressure in the mains owned by Columbia Water and Light shall be operated only by employees of the Water and Light Department except in cases of extreme emergency. All valves installed as a part of new construction shall be left fully closed by the contractor
5. Connection to Existing Mains:

Taps: It will be the contractor's responsibility to acquire locates, excavate the water main and install the tapping sleeve and valve to the water main for all taps. The valve shall be located a minimum of 36-inches from the nearest bell or fitting. The contractor will also contact the Water & Light Inspector to let them know that work has started. For a fee established by city ordinance, the Water Department will pressure test the valve and cut the coupon on the existing water main. Once the Water Department is finished, the contractor may begin to construct the water main out of the tapping valve.

Dead Ends: It will be the contractor's responsibility to acquire locates and excavate the water main. The contractor will also contact the Water and Light Inspector to let him know that work has started. The contractor will be responsible for tying into the existing dead end per the plans. This work shall take place only under direct supervision of the Water & Light Inspector.

M. CLEANING AND DISINFECTION

1. Pigging: When instructed by the engineer new water mains 4" and larger, installed with the intention of being dedicated to the City or being installed by contract for the City, shall be cleaned and flushed with a polyfoam pig prior to chlorination and sanitation. The contractor shall provide the excavation and backfilling required to establish any temporary pig flush assemblies. The contractor shall be responsible for requesting and coordinating all utility locations prior to excavation. A temporary flush for each pig shall be installed by the contractor and removed after pigging is complete. In its place the contractor shall install a standard D.E. cap and flush. The pit shall be constructed in such a manner, and the temporary flush removed, so as to prevent the backflow of dirty water into the new main. It shall be the responsibility of the contractor under the supervision of CW&L to flush the pig through. Any excavation, main removal and repair required to extricate a trapped pig shall be the responsibility of the contractor. During the time any excavation is left open, the contractor shall provide all required safety barriers and fencing. When unattended, the area shall be surrounded with poly fencing. Taping off the excavated area is not considered sufficient.
2. Disinfection: Unless otherwise specified by the City's Engineer water mains will be disinfected by the Water Department of the City of Columbia at its expense up to the first sampling. Any subsequent disinfection of new water mains shall be under the provisions of Section M of these specifications. All phases of disinfection and testing shall meet the requirements of AWWA Standard C651 or latest revision thereof and applicable requirements of the Department of Natural Resources. Unless otherwise specified, disinfecting will be by the injection method following the pigging and flushing.

Following the pigging process, at a point not more than 10 feet downstream from the beginning of the new main, water entering the new main for the purpose of disinfection shall receive a dose of chlorine fed at a constant rate such that the water will have 25 - 50 mg/L free chlorine. To assure that this concentration is provided, the inspector will measure the concentration at regular intervals. The concentration will not be allowed to fall below 25 mg/L. The chlorinated water shall remain in the main at least 24 hours.

Hypochlorite solutions may be applied to the water main with a gasoline or

electrically powered chemical-feed pump designed for feeding chlorine solutions. Feeds lines shall be of such material and strength as to safely withstand the corrosion caused by the concentrated chlorine solutions and the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the solution is applied to the main. Water to mix and inject chlorine into the pipes for disinfection shall be supplied through the taps provided for the purpose and not the main distribution line valves. The supply taps and connections are the responsibility of the contractor including excavation, backfill, safety and traffic barricades and the coordination for any utility locations prior to excavation. All connections must be in compliance with the Water Department's cross connection control standards and must be approved by its inspector prior to commencement of the disinfection process.

AMOUNT OF CHLORINE CONCENTRATE REQUIRED for a 25 mg/l chlorine solution in 100 ft. of pipe		
Pipe Diameter (In)	68% Chlorine Granules (lbs)	1% Chlorine Solution (gal)
4	.020	.16
6	.045	.36
8	.080	.65
10	.125	1.02
12	.180	1.44
16	.320	2.60
24	.360	5.76

The table above gives the amount of chlorine granules or solution necessary to reach the minimum required 25 mg/L concentration of chlorine solution in a 100 ft length of a given size pipe. A solution of 1-percent chlorine may be prepared with 1 lb of 68% concentration of sodium hypochlorite or calcium hypochlorite in approximately 12 gallons of water.

Should the engineer specify disinfection by utilizing granules, the contractor shall furnish and place disinfecting media, preferably calcium hypochlorite granules with 65% available chlorine, in the mains as pipe is laid. The granules will be added to each section of pipe as it is installed such that there will be a chlorine concentration of approximately 50 mg/L when the

pipe is filled. The following table will provide approximately 50 mg/L per 20' section of pipe:

PIPE SIZE	OUNCES OF GRANULES
4"	.13
6"	.3
8"	.5
12"	1.2
16"	2.2
24"	4.8

The granules shall not be allowed to remain in the pipe for an extended period. If the pipe will not be flushed and put in service within two weeks, disinfection shall be by Columbia Water & Light using the injection method. The owner will be responsible for any time and materials charges by CW&L. Should any section of main fail the required tests for disinfection by using the granules, then further disinfection will be by CW&L using the injection method and pigging (if deemed necessary by the City's Engineer). Again the owner will be responsible for time and materials charges by CW&L.

3. Flushing: Valves are to be operated only under the direct supervision of Columbia Water and Light personnel. Only Columbia Water and Light personnel shall operate valves on the existing water system. The super-chlorinated water shall be flushed from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the system. It shall be the contractors responsibility to ensure the super-chlorinated water is not discharged in such a way that it may affect the environment (fish life, plant life, physical installations, or other downstream water uses of any type). The contractor shall submit a written plan for the discharge and handling of the water to the department for approval. Upon review of the contractors plan the department may approve or deny it based upon a view of its assumed effectiveness and alignment with best management practices. If the contractors plan is denied, they may resubmit with changes or appeal to the governing bodies having jurisdiction over the downstream areas that may be affected by the discharge. Pumping of the super chlorinated water to a sanitary sewer system is an accepted method of disposal with permission to do so. The department may offer coordination in receiving

permission from the agency responsible for maintaining that sanitary sewer system and relaying any stipulations they may have. For the super-chlorinated water to be discharged to the ground surface, the chlorine residual remaining in the water must be thoroughly neutralized. The following neutralizing agents can be used: sulfur dioxide (SO₂), sodium bisulfate (NaHSO₃), sodium sulfite (Na₂SO₃), and sodium thiosulfate (Na₂S₂O₃*5H₂O).

CHLORINE RESIDUAL NEUTRALIZING TABLE UTILIZING SODIUM THIOSULFATE			
Residual Chlorine Concentration (mg/L)	Chlorine Discharge Flow Rate (gpm)	Concentration of Sodium Thiosulfate in water for neutralizing solution (Oz/gal)	Application rate of neutralizing solution to discharge stream (gpm)
25	50	2.8	.143
50	50	5.6	.143
25	100	2.8	.286
50	100	5.6	.286

The table above gives the ounces of Sodium Thiosulfate per gallon of water required to neutralize various residual chlorine concentrations at 50 and 100 gal / min of discharge with an application rate of .143 and .286 gal/min of the Sodium Thiosulfate solution. Recommended application of the neutralizing agent is with a pump sprayer.

4. Sampling: Bacteriological test samples will be collected by Columbia Water and Light personnel in accordance with AWWA C651 or the latest revision thereof. A set of samples shall be collected every 1200 feet along the newly installed water main plus one set from the end of the line and at least one set from each branch greater than one pipe length. For the purposes of bacteriological testing one set of samples includes all samples collected along the length of the pipeline.

Option A: An initial set of samples will be taken and a second set will be taken a minimum of 16 hours later. Both sets must pass bacteriological testing before the main is approved for service.

Option B: The main must sit static for a minimum of 16 hours without water

usage prior to samples being drawn. Two sets of samples will be drawn a minimum of 15 minutes apart while the sampling taps are left running. Both sets must pass bacteriological testing before the main is approved for service.

In the event that the main does not pass its first set of bacteriological tests, then the main will be pigged, flushed, chlorinated and sampled again at the contractor's expense. The contractor shall be responsible for digging up the main, reinserting a pig and reinstalling a pig flush assembly. Once the pig is flushed, the contractor will reinstall the temporary flush assembly for sampling purposes. The main will then be re-chlorinated, flushed, sampled and tested. The contractor will be responsible for any costs incurred by it's crews or city forces for second or subsequent disinfection and sampling.

N. SEEDING, SODDING, AND SITE RESTORATION

1. Topsoil: Topsoil shall be fertile, friable soil of loamy character, free of subsoil, stumps, refuse, roots, hard dirt, heavy or stiff clay, coarse sand, noxious weeds, noxious weed seeds, sticks, brush and other foreign material. It shall not be infested with nematodes nor with any other noxious animal life or toxic substances. Sandy loam of low fertility, even though mixed with leaf mold, manure, or other fertilizers, will not be accepted.
2. Seed Bed: The contractor shall be responsible for preparing the seed bed in order to provide a proper environment for reliable germination of the seed. This preparation may include but not be limited to rotary tilling, topsoil pulverization, topsoil replacement, and application of lime or fertilizer.
3. Grass seed: Grass seed shall be clean, dry, new crop seed and for established areas shall be a blend as specified below, unless otherwise specified on the plans or directed by the City's Engineer:
 - a. Kentucky Blue Grass 20% by weight.
 - b. Creeping Red Fescue 30% by weight.
 - c. Perennial Rye 30% by weight.
 - d. Annual Rye 20% by weight.
 - e. Purity 85%
 - f. Germination 80%
 - g. Maximum weed seed 1%

It shall comply with standards of the Official Seed Analysis of North America and be recommended for full sun exposure in Columbia, Missouri. Seed shall be free from Johnson grass, Canadian thistle, or field bind weed seed and be approved by the Inspector. If re-establishing pasture or cropland, seed used shall match existing crop cover.

4. Fertilizer: Fertilizer shall be a mixture containing 12 pounds each of soluble nitrogen, phosphate, and potash per 100 pounds.
5. Mulch for Broadcast Seeded Areas: Mulch for broadcast seeded areas shall be clean wheat straw.
6. Plants, Trees and Shrubs: Plants, trees and shrubs shall be same strain as

those removed. They shall be nursery grown.

7. Sod: Sod shall be the same type as removed or damaged, shall be best quality, not more than two years old and meeting the following standards:
 - a. Thickness of Cut: Sod shall be machine cut at a uniform soil thickness of 5/8 inch, plus or minus 1/4 inch, at the time of cutting. Measurement for thickness shall exclude top growth and thatch.
 - b. Pad Size: Individual pieces of sod shall be cut to the suppliers standard width and length. Maximum allowable deviation from standard widths and lengths shall be plus or minus 1/2 inch on width and plus or minus 5 percent on length. Broken pads and torn or uneven ends will not be acceptable.
 - c. Strength of Sod Sections: Standard size sections of sod shall be strong enough to support their own weight and should retain their size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.
 - d. Moisture Content: Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) will adversely affect its survival.
 - e. Mowing Height: Before stripping, sod shall be mowed uniformly at a height of 1 to 2-1/2 inches.
 - f. Thatch: Sod shall be relatively free of thatch, up to 1/2 inch allowable (uncompressed).
 - g. Diseases, Nematodes, and Insects: Sod shall be reasonably free of diseases, nematodes, and soil-borne insects. State nursery and/or plant materials? laws require that all sod entering interstate commerce be inspected and approved for sale. The same applies to sod being shipped intra-state. The inspections and approval must be made by the state agricultural department, office of the state entomologist.
 - h. Weeds: Sod shall be free of objectionable grassy and broad leaf weeds. Sod shall be considered free of such weeds if less than 5 such plants are found per 100 square feet of area. Sod will not be acceptable if it contains any of the following weeds: quack grass, Johnson grass, poison ivy, nut

sedge, nimble will, Canada thistle, bind weed, wild garlic, ground ivy, perennial sorrel, brome grass, bent grass, and Bermuda grass.

8. Preliminary Cleanup: Disturbed areas, including those disturbed by site grading, trenching, storing of dirt, pipe laying, pipe storage, movement of equipment, and other work shall be cleared of all rubbish, brush, rock, trash, and excess dirt as soon as is practical after the pipe is laid and backfilled. In established lawn and parkway area, surface shall be raked the same day backfill operations are performed in order to remove all above items, including all rock measuring two-inches or more in its greatest dimension. In pasture and cropland areas, all above items shall be removed in a timely fashion. Contractor may use tractor-drawn equipment, including rock rakes and steel roller drum.
9. Planting: Individual trees, plants and shrubs shall be replaced as necessary by the Contractor and as stipulated by the City's Engineer. Planting shall be in accordance with How to Plant a Tree by the University of Missouri - Columbia Extension Division (Publication G 6850). Where stipulated, replacement trees, plants, and shrubs shall be of the same size, type, strain, and value as those removed. Planting of replacement trees, plants, and shrubs shall be done as soon as possible after installation of mains, with due consideration given to optimal times of the year to plant the given species.
10. Application of Topsoil: For established lawn and parkway areas, after preliminary cleanup has been performed, topsoil meeting the requirements of paragraph 1 of this section shall be applied to a minimum depth of four inches to disturbed areas. Topsoil shall be pulverized and graded to match existing terrain, or as specified by the Inspector. Surface shall be raked smooth to provide a good seedbed.

For pasture and cropland areas, topsoil shall be stripped from the area and windrowed separately from the subsoil for replacement after preliminary cleanup.

11. Seeding: Initial seeding shall be performed as soon as practical after preliminary cleanup and application of topsoil. Seeding windows are specified as follows: Autumn seeding shall be performed between August 15 and October 15 and spring seeding shall be performed between March

15 and May 15. If initial seeding is performed within either of the specified seeding windows, the only additional work required of the Contractor shall be warranty work. If initial seeding falls outside either of the specified seeding windows, then re-seeding during the soonest seeding window shall be considered part of the work. The final determination as to need for re-seeding shall rest with the Inspector.

For hydraulic seeding, the seed, fertilizer, and mulch shall be mixed with water and constantly agitated so that a uniform mixture can be applied hydraulically to the specified areas. Seed shall not be added to the water more than four hours before application. Ratios of seed, fertilizer, mulch, and water shall be calculated so that seed will be applied at the rate of six pounds minimum per 1000 square feet of area, fertilizer will be applied at the rate of 12 pounds minimum per 1000 square feet of area, and mulch will be applied at the rate of 1000 pounds minimum dry weight per acre. Wet application rate of the mixture shall be 2000 pounds per acre minimum.

For Broadcast Seeding applicable to areas disturbed by service installation only, seed and fertilizer shall be broadcast at the rate of six and twelve pounds per 1,000 square feet, respectively. Seed and fertilizer shall be raked to a depth of approximately 1/4 inch. Mulch shall be applied to approximately 1/2 inch depth.

12. Sodding: Delivery of sod shall be timed so that sod will be transplanted within a period of 36 hours unless a suitable preservation method is approved prior to delivery. Sod not transplanted within this period shall be inspected and approved by the City's Engineer prior to its installation. During periods of higher than optimal temperature and after all unevenness in the soil surface has been corrected, the soil shall be lightly moistened immediately prior to laying the sod.

The first row of sod shall be laid in a straight line with subsequent rows placed parallel to and tightly against each other. Lateral joints shall be staggered to promote more uniform growth and strength. Care shall be exercised to ensure that the sod is not stretched or overlapped and that all joints are butted tight in order to prevent voids which would cause air drying of the roots. As sodding is completed in any one section, the sod shall be pressed into contact with the sod bed by tamping or rolling, so as to eliminate air pockets, provide a true and even surface, and assure knitting

without displacement of the sod or deformation of the surfaces of sodden areas. Following compaction, screened soil of good quality shall be used to fill all cracks. Excess soil shall be worked into the grass with rakes or other suitable equipment. The quantity of fill soil shall be such as will cause no smothering of the grass. It shall then be thoroughly watered to a depth sufficient that underside of the new sod pad and the soil immediately below the sod are thoroughly wet.

Staking of sod will not be required unless sod cannot be transplanted and maintained as specified herein. If required, sod shall be staked with six stakes per square yard or roll of sod. Stakes shall be of lath or similar materials and shall be driven six inches into the ground, leaving approximately one-half inch of the top above the sod line.

13. Protection: Seeded and sodden areas shall be protected against traffic. If necessary, barricades or warning signs shall be erected. Such protective devices shall be maintained until final acceptance of the project.
14. Maintenance: All seeded and sodden areas shall be maintained by the Contractor until acceptance, but in no case shall maintenance be for less than 30 days following completion of all seeding, mulching, and sodding operations. Maintenance shall include watering, mowing, reseeding, repair of erosion damage, maintenance of mulch, and removal of litter. The City will assume maintenance upon acceptance.
15. Replanting: Prior to the end of the maintenance period, seeded and sodden areas that show signs of substantial desiccation, as evident by a loss of color and a distinct yellowing or where no germination is evident, shall be considered as failed and shall be reseeded or resodded and continue to be reseeded or resodded until an acceptable cover is obtained. Replanting operations shall be as originally specified.
16. Maintenance of Grades: Original grades of grass areas shall be maintained after commencement of planting operations and during the maintenance period. Any damage to the finished surface from construction operations shall be repaired within a reasonable time. In the event erosion occurs from either watering operations or rainfall, such damage shall be repaired within a reasonable time. Ruts, ridges, tracks, and other surface irregularities shall be corrected, and reseeded where required.

17. Maintenance of Mulch: Mulched areas shall be maintained until covered with growing grass seedlings. Mulch material that has been removed from the site by wind or other causes shall be replaced and secured.
18. Mowing: All sodden areas shall be mowed at least once for acceptance. Not more than 1/3 of the grass lead shall be removed by the initial cutting or subsequent cuttings. Height shall be maintained by 2-1/2 inches.

Mowing equipment shall be rotary type in good operating condition, well adjusted, and with sharp blades. Extra care shall be taken when mowing around trees and shrubs to prevent bark damage. Any trees and shrubs with damaged bark as a result of maintenance operations shall be replaced by the Contractor at his expense. Clippings shall be blown off of private driveways and parking lots.

19. Removal of Litter: Prior to any mowing operations, all debris that would interfere with mowing shall be collected and removed. The debris includes, but shall not be limited to, paper and cardboard, cans, bottles, and any other wastes that detract from the general appearance of any area of the site.
20. Waiver: Some aspects of this Paragraph N may be waived by the City's Engineer if the property which is the subject of the waiver request is owned by the same party that is contracting to install the water main. Such request must be made in writing and state that the owner of the property is installing the main and will accept all responsibility for all of the requirements herein being requested to be waived. The request will also state that the owner will be solely responsible for and hold harmless the City of Columbia for any damage to the owners or any surrounding property due to the contractor's lack of compliance with those provisions being waived.

O. INSPECTION:

1. It shall be agreed to by all parties that Water and Light of the City of Columbia, Missouri shall have full authority of inspection at all times during the progress of any water main work. The inspector shall have full authority to inspect the materials and the work performed.
2. The contractor shall furnish all reasonable aid and assistance required by the City's Engineer or his aides, for the proper inspection and examination of the work and all parts thereof. The contractor shall regard and obey the directions and instructions of the City's Engineer or inspector so appointed, when the same are consistent to his contract or these specifications; however, should the contractor object to any order given by any inspector, he may object by written appeal to the Director of Water and Light of the City of Columbia, or his duly appointed designee.
3. Supervising engineers, inspectors, and other properly authorized representatives of the owner or City shall be free at all times to perform their duties, and intimidation or attempted intimidation of any one of them by the contractor or by any of his employees shall be sufficient reason, if the City so desires, for suspension of work.
4. Such inspections shall not relieve the contractor or owner from any obligation to perform his work in accordance with these specifications or any approved plans, and work not so constructed shall be removed and made good by the contractor or owner at his own expense, whenever ordered by the inspector without reference to any previous oversight or error in inspection.
5. The City's Engineer or inspector shall have full authority to immediately and "on the spot" suspend work on any job or site for any reason and/or direct changes or alter specifications as they dictate.
6. The contractor shall notify the City's Engineer for the availability of an inspector minimum of two working days before commencing work. Monday through Friday between the hours of 8:00 a.m. and 4:30 p.m. shall constitute a typical work week. Any work outside these hours requires approval of the City's Engineer or inspector. A Minimum of two days' notice will be required when requesting inspection services outside of normal working hours.

P. MEASUREMENT AND PAYMENT:

1. Scope: This section is not-applicable to water mains extended under the provisions of the "APPLICATION FOR PERMISSION TO EXTEND WATER MAIN" (Developer Extensions). This section covers methods of measurement and payment for items of Work under this Contract.
2. General: The total Contract Price shall cover all Work required by the Contract Documents. All costs in connection with the proper and successful completion of the Work, including furnishing all materials, equipment, supplies, and appurtenances; providing all construction plans, equipment, and tools; and performing all necessary labor and supervision to fully complete the Work, shall be included in the unit and lump sum prices bid. All Work not specifically set forth as a pay item in the Bid Form shall be considered a subsidiary obligation of Contractor and all costs in connection therewith shall be included in the prices bid.
3. Estimated Quantities: All estimated quantities stipulated in the Bid Response or other Contract Documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the Work and (b) for the purpose of comparing the bids submitted for the Work. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished. Contractor agrees that it will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished and the estimated amounts therefore.
4. Excavation and Trenching: Except where otherwise specified, the unit or lump sum price bid for each item of Work which involves excavation or trenching shall include all costs for such Work. No direct payment shall be made for excavation or trenching. All excavation and trenching except rock excavation shall be unclassified as to materials which may be encountered; in addition, trenches shall be unclassified as to depth.
- 4.01 Rock Excavation: Rock excavation shall include any excavation which requires the contractor to utilize equipment intended specifically for the removal of rock which encompasses a volume of 1/2 cubic yard or greater

amount of rock measured in its original and undisturbed state. The unit price bid for each item of rock excavation shall include the excess cost only of the removal and subsequent handling of such rock, over and above that of earth excavation.

Trench width and depth in rock shall meet the minimum requirements specified in Section H and rock excavation pay quantities shall be based on the volume of the excavated material in its original and undisturbed condition with the following maximum limits. For pipe with a 10-inch diameter or less the payment for rock excavation shall be based on a trench width of 2 feet. For pipe having a nominal diameter larger than 10-inches, payment for rock excavation shall be based on a trench width 18 inches wider than the outside diameter on the pipe. Payment for rock excavation at air release manholes or other structures shall be based on the outside diameter or dimensions of the structure plus 4 feet. Maximum trench depth shall be 9 inches deeper than the pipe depth required.

All rock measurement or estimates to be used for payment purposes shall be made, recorded, and signed in the field in the presence of the City's Engineer and contractor or their duly authorized designees.

When a contract unit price for rock excavation is not included in the contract, the payment for rock excavation shall be equivalent to the current rate for Class 3 Excavation in Rock included in the Missouri Department of Transportation's Specification Book for Highway Construction.

5. Pipelines: Pipelines which are to be paid for on a unit price basis shall be measured for payment on a horizontal plane after installation of the pipe. Where lines are laid to conform to stationed profiles, payment shall be made on linear quantities based on the pipeline stationing as determined by surveys made after installation.

The measurement of the length of each line or run of pipe of each size will begin and end at:

- a. The end of the pipe where connected to an existing pipe, fitting, or valve; or at the end of a dead-end run.
- b. The center line intersection of run and branch on tees, crosses, or laterals

where a branch line connecting therewith is constructed under this Contract. Where a branch fitting is installed under this Contract, and the branch or connecting line is to be constructed by others at some future date or under another contract, the pay measurement will include the entire laying length of the branch or branches of such fitting.

c. The measurement of each line of pipe of each size which is to be paid for on a unit price basis will be continuous through, and shall include the full laying lengths of, all fittings and valves installed between the ends of each line; except that the laying lengths of reducers and increasers will be divided equally between the connected pipe sizes.

d. Connected piping for fire hydrants in excess of 8 feet will be measured for payment from the center of the main to the end of the pipe at connection to fire hydrant less 8 feet included in the fire hydrant assembly pay item.

5.01 Connections to Existing Water Mains: Connections to existing water mains will be paid for at the lump sum prices bid. Each lump sum price named for a connection shall include all costs incurred for making the connection over and above the price of the connecting piping in place. Each lump sum price shall include furnishing and installing the tapping sleeve and valve; all excavation and backfilling work; tapping of existing main; all necessary thrust restraints and all other costs not included under other bid items. Tapping of existing main, and the costs associated with the tapping procedure, shall be the responsibility of Water and Light unless otherwise stipulated in the contract documents.

5.02 Gate Valves: Gate valves in water mains will be paid for at the unit price bid for each size. The unit price shall include all costs incurred in completing the gate valve installation over and above the amount paid for piping in place. The unit price shall include furnishing and installing the gate valve, valve box, and appurtenances; excavation and backfill not included under piping; and all other costs not included under other bid items.

No separate payment will be made for fire hydrant auxiliary gate valves or tapping valves.

5.03 Fire Hydrant Assemblies: Fire hydrants and air release fire hydrants will be paid for at the unit price bid. The unit price named for each fire hydrant

installation shall include all costs incurred in installing the fire hydrant; furnishing and installing hydrant, tee, auxiliary gate valve, accessories, and appurtenances; concrete blocking; drainage facilities; and all other costs not included under other bid items. Up to 8 feet of fire hydrant connection pipe is to be included in the fire hydrant assembly. Any connecting pipe in excess of 8 feet will be measured for payment as laid out in paragraph 5 of this section.

- 5.04 Fire Hydrant Assembly Relocation: Existing fire hydrants indicated on the drawings to be relocated will be paid for at the unit price bid. The unit price bid for each fire hydrant assembly relocation shall include removing the existing fire hydrant. The unit price bid shall also include furnishing and installing a mechanical joint end cap or plug at the main, new tee, auxiliary gate valve, accessories and appurtenances, concrete blocking, re-installation in accordance with paragraph 5.03 above and all other costs not included under other bid items. Up to 8 feet of fire hydrant connection pipe is to be included in the fire hydrant assembly. Any connecting pipe in excess of 8 feet will be measured for payment as laid out in paragraph 5 of this section.
- 5.05 Air Release Manhole Assembly: Air release manhole assemblies shall be paid for on a unit bid. The unit price shall include all labor and material including all excavation and backfilling not paid for as trenching for the water main, precast concrete manhole, concrete, reinforcing steel, manhole frame and cover, manhole steps, air release valve, corporation stop, miscellaneous valves and piping, and all other appurtenances required to complete the air release manhole assembly as indicated in the drawing as specified.
- 5.06 Fittings and Tees: The unit price bid for fittings and tees shall be the additional cost of such fitting or tee over and above that of an equivalent length of pipe and shall include all necessary thrust restraints.
- 5.07 Site Restoration, Seeding, and Sodding: No separate payment shall be made for site restoration seeding, or sodding as specified or required. All costs in connection with restoration, seeding, and sodding shall be included in the cost of the pipe.
- 6. Cased Bore: Where tunneling is required in connection with highway or

primary road crossings, each crossing shall be measured for payment horizontally along the longitudinal center line of the enclosing conduit or pipe installed there, from end to end of the enclosing conduit or from end to end of the tunnel excavation where an enclosing conduit is not required. Each designated type of crossing shall include the following:

a. Crossings in Conduit: The unit price bid for each crossing in pipe conduit or tunnel liner shall include all costs in connection with excavation and backfilling, pipe conduit or tunnel liner, the excess cost of installing pipe in pipe conduit or tunnel liner above the amount bid for the pipe laid in open trench, all skids, jointing materials, jacking pipe, jacking pits, sand backfill, end closures, and all other work for and in connection with the crossing, not paid for separately.

7. Pavement Removal and Replacement: Pavement removal and replacement shall be measured in place and the areas computed in square yards. The area measured shall be the actual areas required as indicated by the standard repair details Q17 & Q18 and trench details Q1 & Q2, or as ordered by the City's Engineer. If additional surface is removed or damaged due to the negligence on the part of the Contractor, the additional quantities shall not be measured for payment, but shall be repaired at the Contractor's expense.

The unit prices bid for pavement removal and replacement shall include all costs in connection therewith, including cutting, removal, and disposal of old pavement; construction of new pavement; and all extra compaction effort required for backfill beneath pavement.

8. Traffic Control: Signs and other traffic control devices required for traffic control during construction will be paid for at the lump sum price for traffic control. This item includes the submittal of a traffic control plan.
9. Miscellaneous Concrete: No separate payment shall be made for concrete for encasement or blocking of pipe and fittings or thrust collars at valves not included as parts of manholes and other structures.

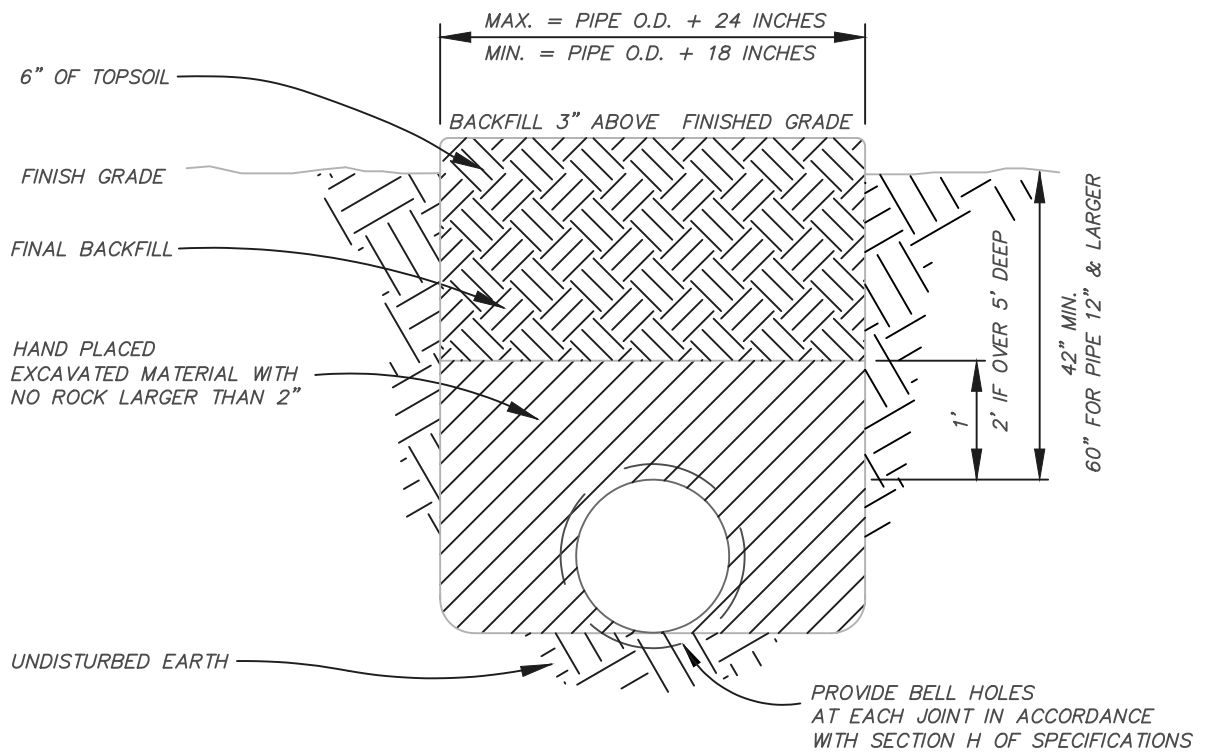
All concrete which is required in connection with manholes or structures, pavement or sidewalk replacement, and other pay items shall be included in the lump sum or unit price bid for the pay item.

10. Cleaning, Pressure and Leak Testing: Will be as specified and will be paid for at the unit price bid. The unit price bid shall include all materials and equipment needed to perform the specified functions including but not limited to pigs and pig assemblies, temporary water supply taps, pumps, gauges, and other testing equipment. It shall be the responsibility of the contractor to ensure the main is properly cleaned by pigging and flushing, that it is pressure and leak tested as required and any repairs made to ensure compliance with the listed allowable leak schedule.
11. Disinfection: If so specified by the City's Engineer, then disinfection will be done in accordance with Section M and will be paid for at the unit price bid. The unit price bid shall include all materials and equipment needed to perform the required functions but is not limited to temporary water supply taps, chlorine, neutralizer, pumps, gauges and other testing equipment. It shall be the responsibility of the contractor to ensure that the main is disinfected and flushed so as to pass the required bacteriological testing all for the unit price bid. No increase in allowances will be made for repeat of any function to ensure compliance with the specifications.
12. Mobilization: Will be specified and paid for at the unit price bid. Payment for mobilization will be released using the following disbursement schedule:
 - a. On the first progress estimate that shows work has been performed on at least one major contract item or after 5% of the original contract amount has been completed exclusive of the mobilization bid item and any payment for material on hand, 50% of the amount bid for mobilization will be paid.
 - b. On the progress estimate that shows 50% of original contract amount has been completed exclusive of the mobilization bid item and any payment for material on hand, the remaining 50% of the amount bid for mobilization will be paid.
13. Materials on Hand: Payment is available for materials on hand upon request of the contractor. Items eligible for payment are unit price bid items including: casing, pipe, fittings, valves, fire hydrant assemblies, and air release manhole assemblies. The contractor shall provide delivery tickets from the supplier depicting the price and quantity for materials delivered to the project site in order to receive payment for materials on hand. The

contractor will not be paid for any materials on hand delivered in excess of the bid quantity. Within 60 days of payment for materials, contractor shall provide paid invoices from supplier for materials previously compensated. Failure to provide paid invoices within 60 days will result in a cease in all payments until such invoices have been provided.

Q. Detail Drawings:

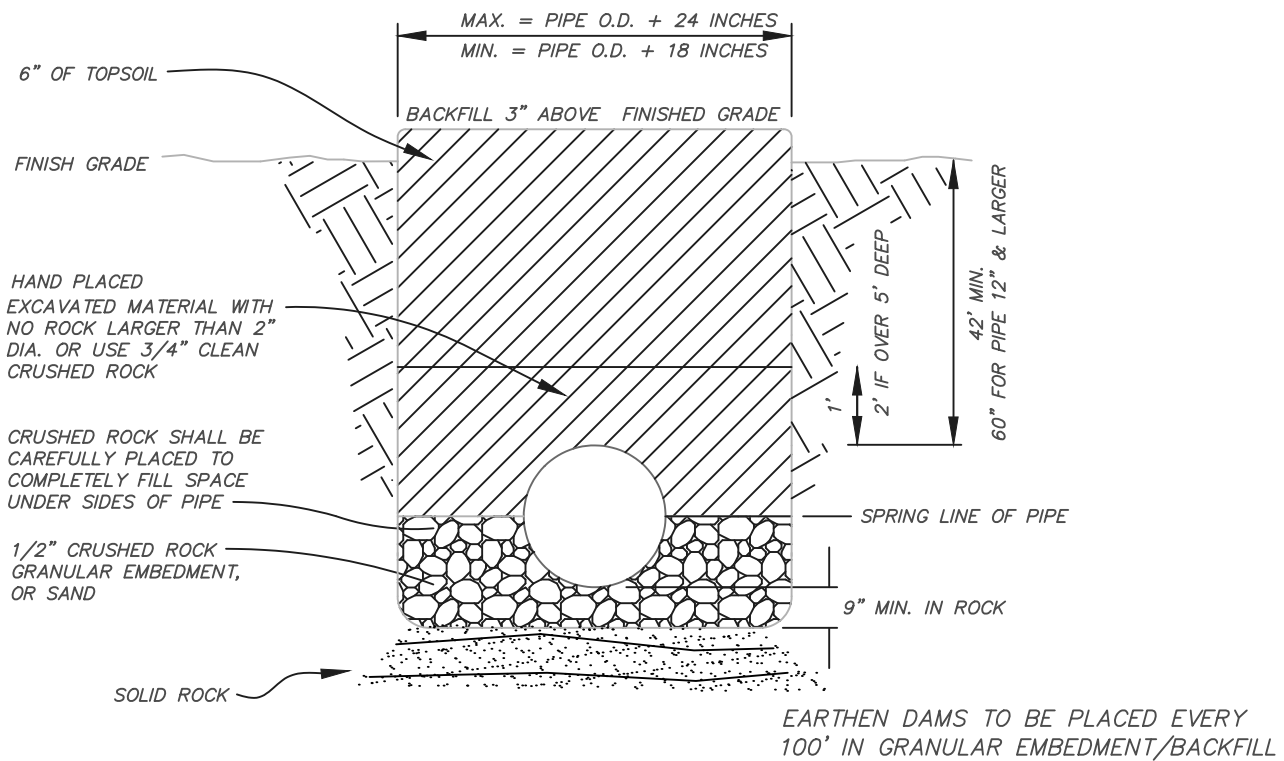
1. Pipe Embedment
2. Pipe Embedment (In Rock)
3. Locator Wire at Valve
4. Valves at Intersections & Branch Lines
5. Thrust Block Detail
6. Thrust Collar Detail
7. Thrust Block at Vertical Bend
8. Typical Installation at Cul-De-Sac
9. Flush Assembly at Dead End Valve
10. Flush Assembly w/ 2" Flush Valve
11. Fire Hydrant Assembly
12. Fire Hydrant Connection
13. Fire Hydrant Connection for Air Release
14. Air Release Manhole Detail
15. Casing Detail
16. Concrete Arch Encasement Detail
17. Concrete Pavement Repair
18. Asphalt Pavement Repair



City of Columbia, Missouri
Utilities Department - Water & Light

Pipe Embedment Detail

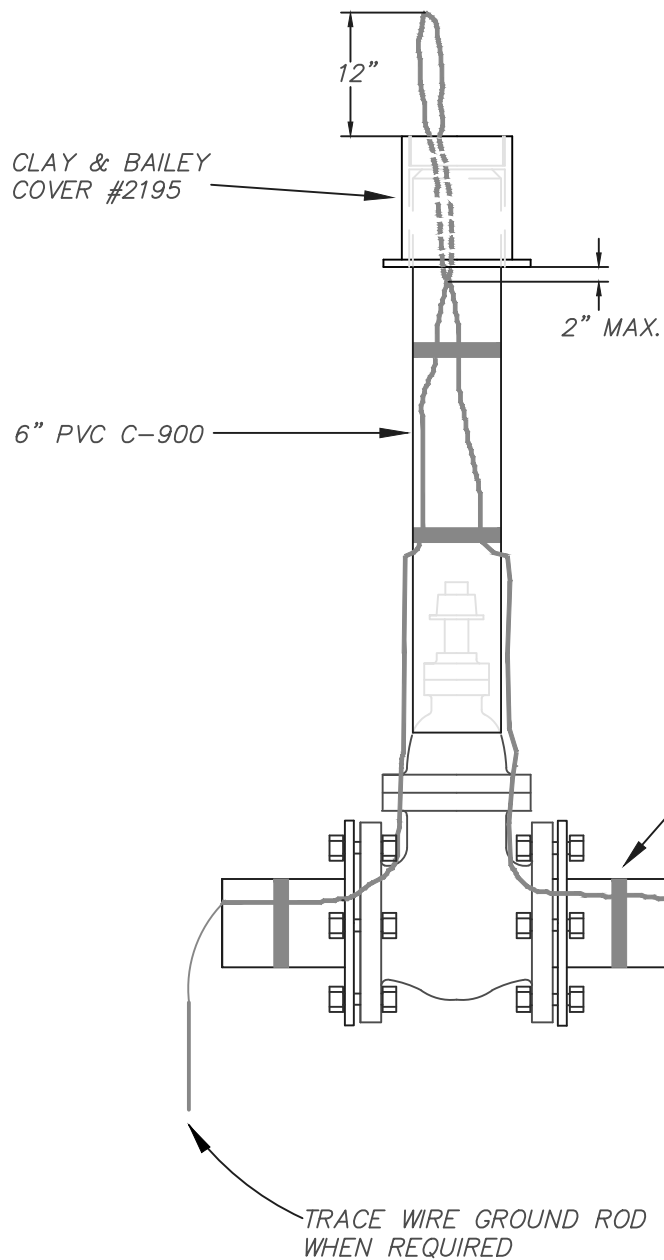
Detail Sheet- Q 01



City of Columbia, Missouri
Utilities Department - Water & Light

Pipe Embedment Detail In Rock

Detail Sheet- Q 02



WHEN CONNECTING TO EXISTING
MAINS WITHOUT TRACE WIRE
TRACE WIRE SHALL BE GROUNDED
AND LOOPED INTO VALVE BOX
THROUGH A HOLE JUST BELOW
THE COVER WITH ENOUGH WIRE TO
EXTEND 12" ABOVE FINAL GRADE

WHEN CONNECTING TO EXISTING
MAINS WITH TRACE WIRE
WIRES SHALL BE BONDED
UTILIZING A BRANCH CONNECTOR,
GROUNDED, AND INSTALLED PER
TRACE WIRE SPECIFICATION
PROVIDING ACCESS AS REQUIRED



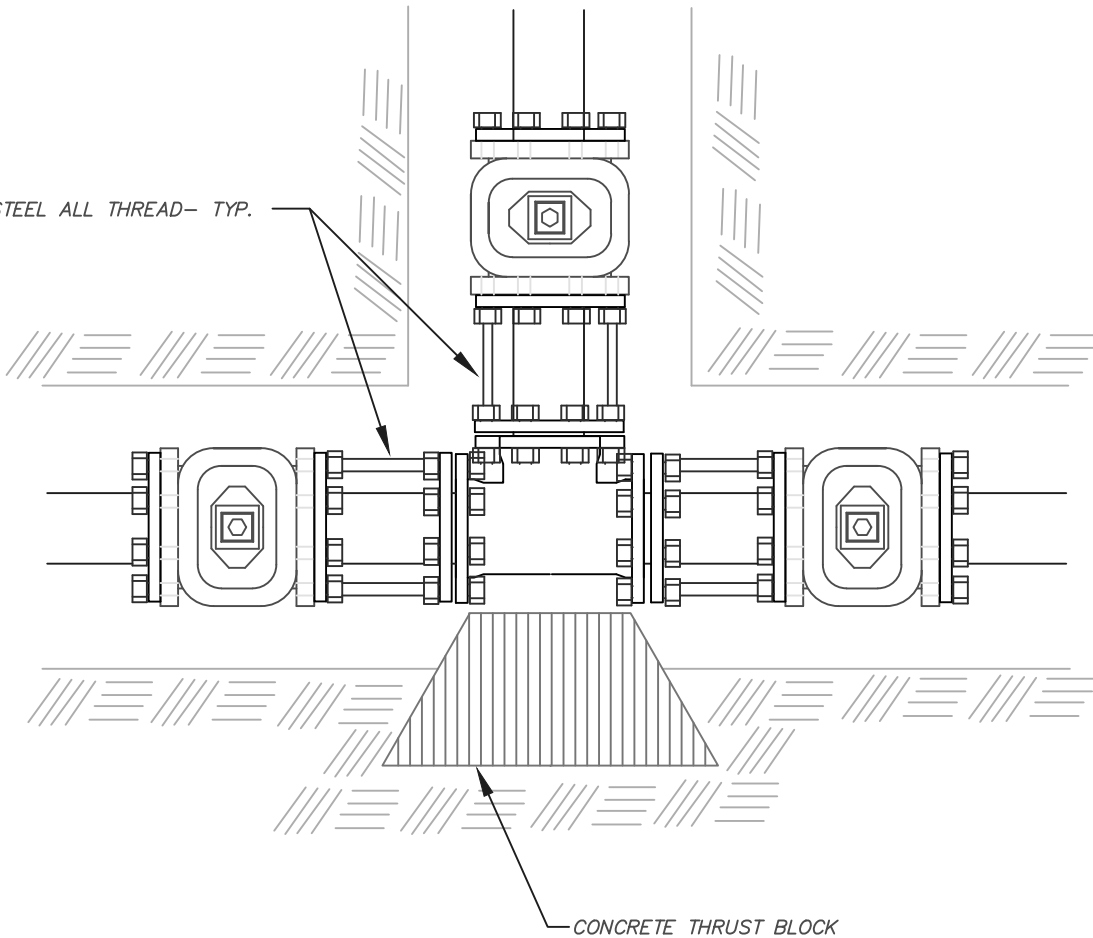
City of Columbia, Missouri
Utilities Department - Water & Light

Locate Wire At Valve

Detail Sheet- Q 03

RESTRAIN ALL VALVES TO TEES
ALL ANCHORAGE SHALL BE IN ACCORDANCE
WITH SECTION J OF SPECIFICATIONS

STAINLESS STEEL ALL THREAD— TYP.



City of Columbia, Missouri
Utilities Department - Water & Light

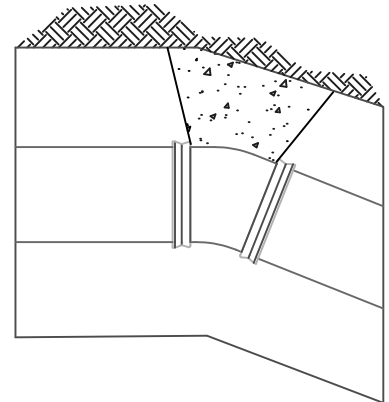
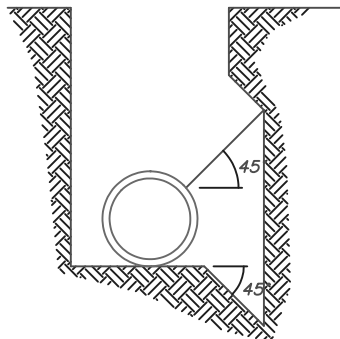
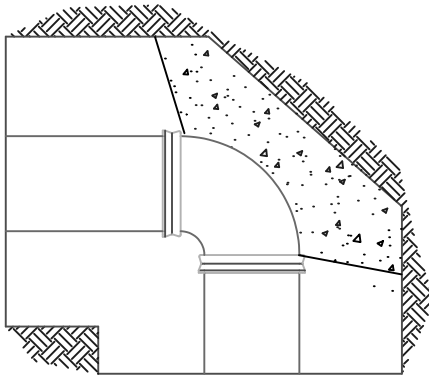
Valves at Intersections And Branches

Detail Sheet- Q 04

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555

MINIMUM BEARING AREA
ON UNDISTURBED EARTH
IN SQUARE FEET

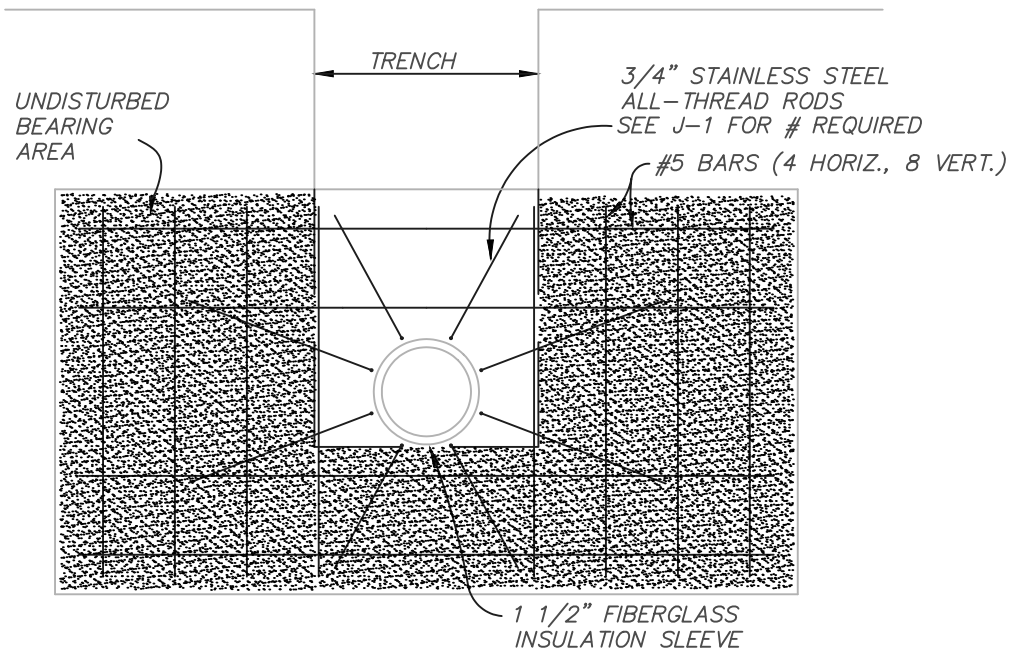
PIPE SIZE	11.25°	22.5°	45°	90°	TEE
6"	1	2	4	7	5
8"	2	3	6	12	8
12"	4	7	14	26	18
16"	6	13	25	46	33
24"	15	31	60	111	78



City of Columbia, Missouri
Utilities Department - Water & Light

Thrust Block Detail

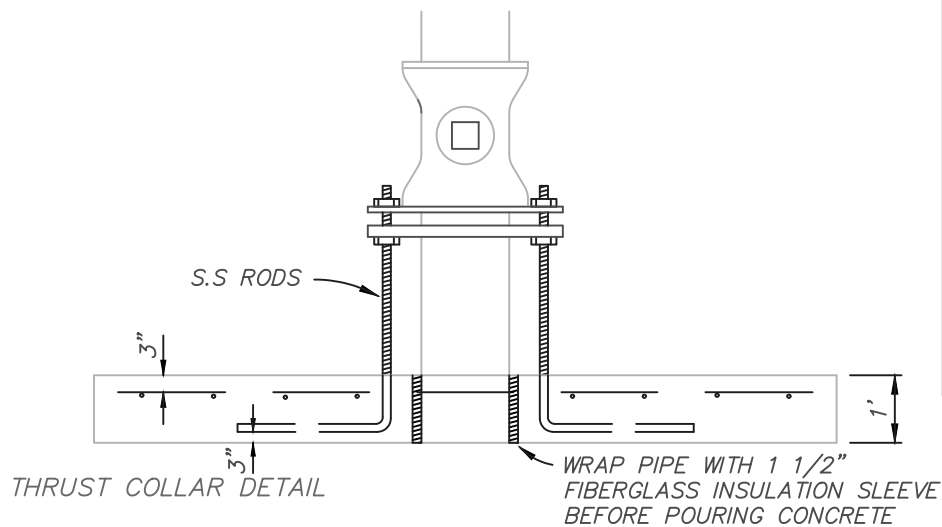
Detail Sheet- Q 05



SECTION

MINIMUM BEARING AREA
ON UNDISTURBED EARTH
IN SQUARE FEET

PIPE SIZE	AREA SQ. FT.
6"	5
8"	8
12"	18
16"	33
24"	74



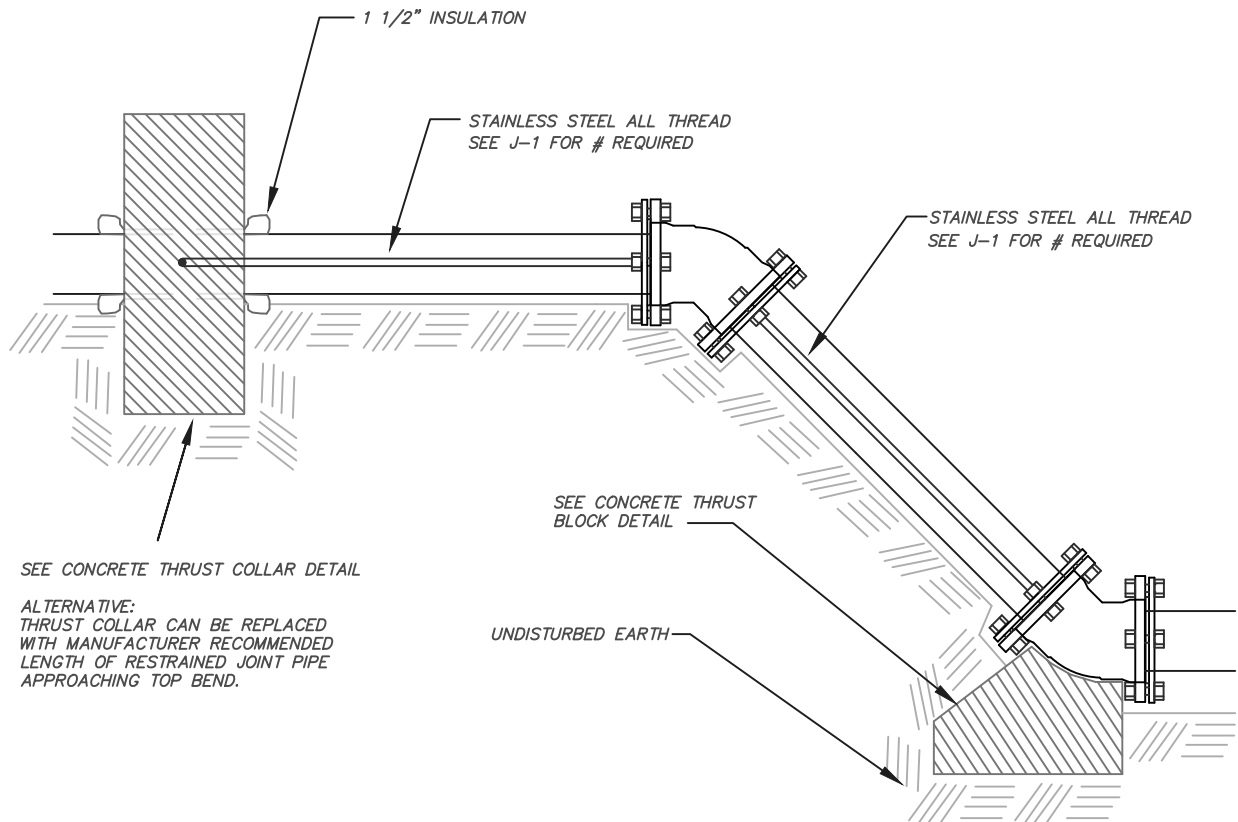
PLAN



City of Columbia, Missouri
Utilities Department - Water & Light

Thrust Collar Detail

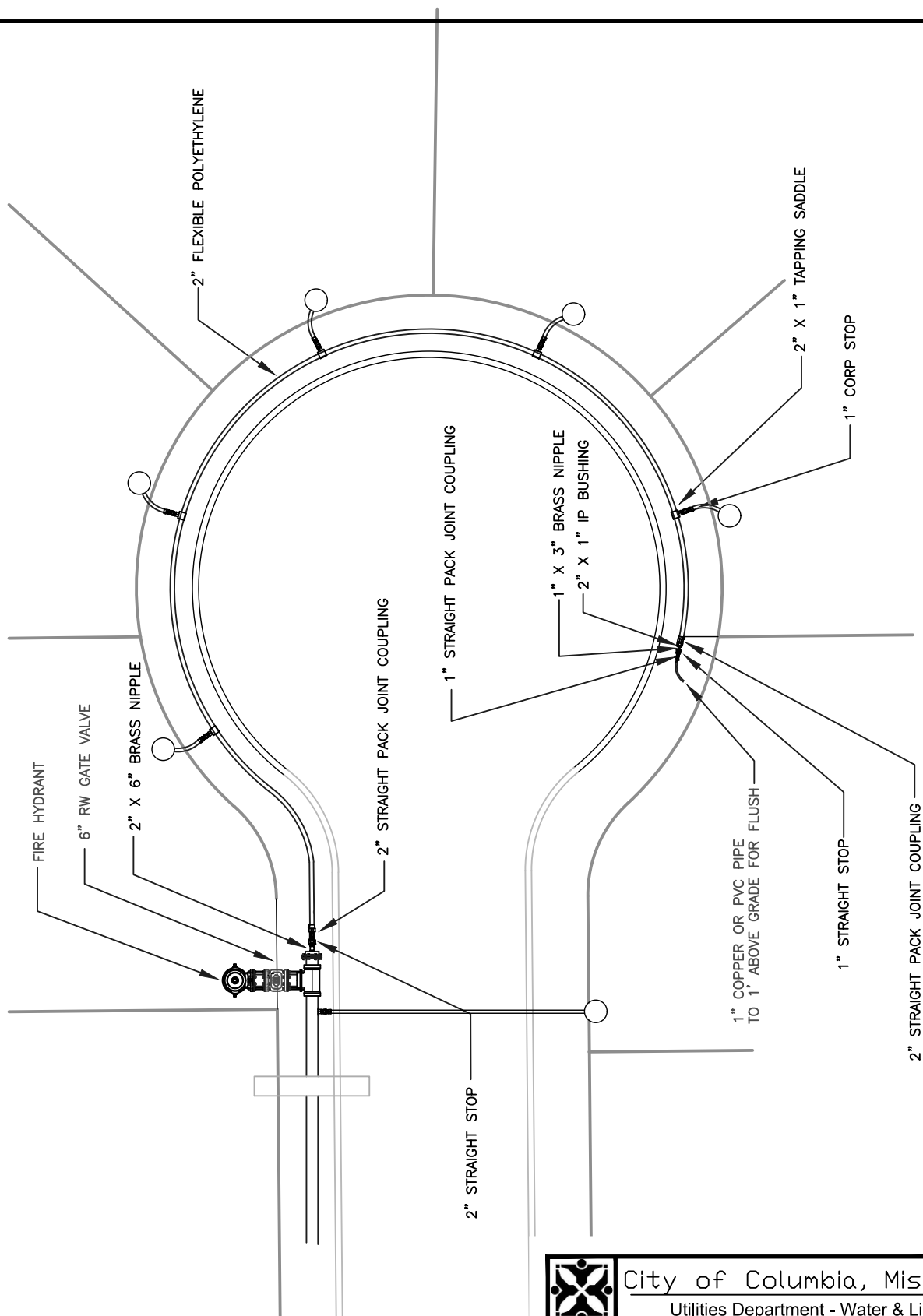
Detail Sheet- Q 06



City of Columbia, Missouri
Utilities Department - Water & Light

Thrust Block At Vertical Bend Detail Sheet- Q 07

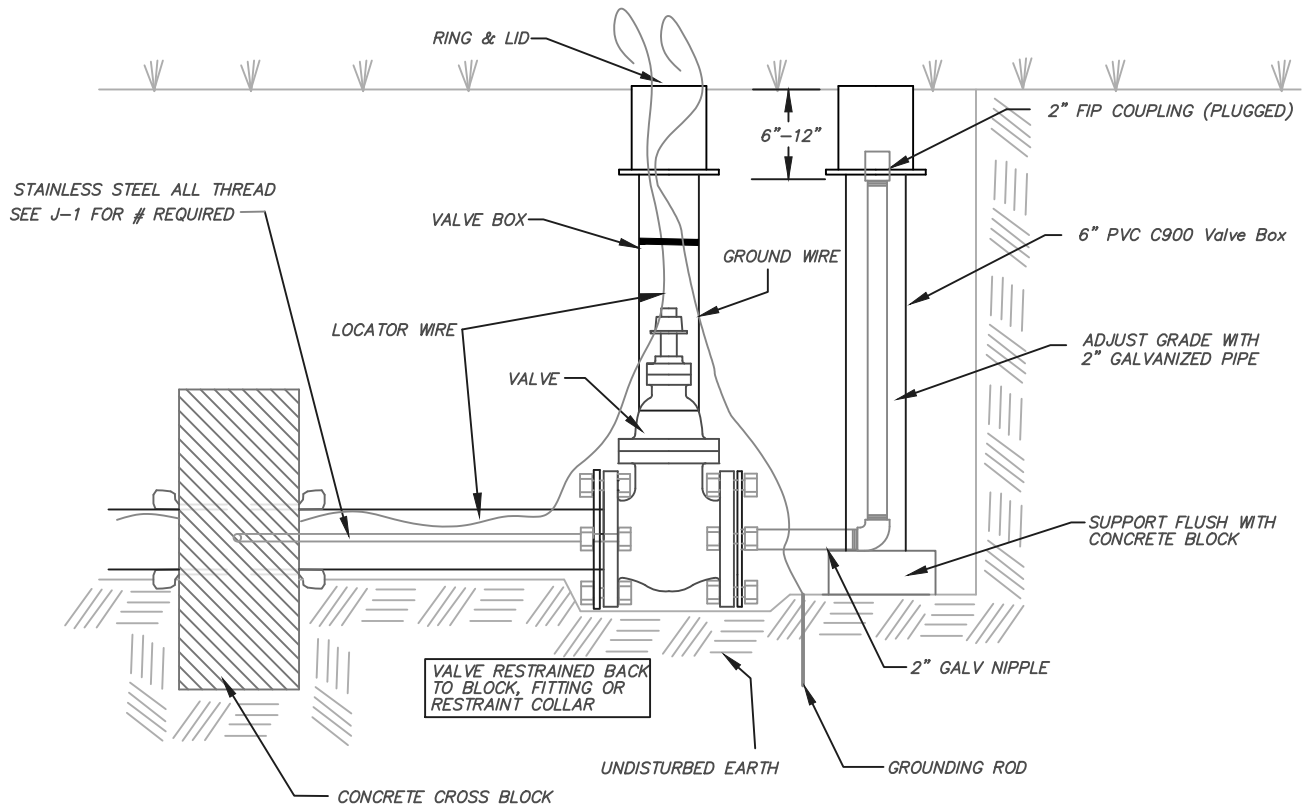
701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555



City of Columbia, Missouri
Utilities Department - Water & Light

Typical Installation At Culdesac Detail Sheet- Q 08

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555

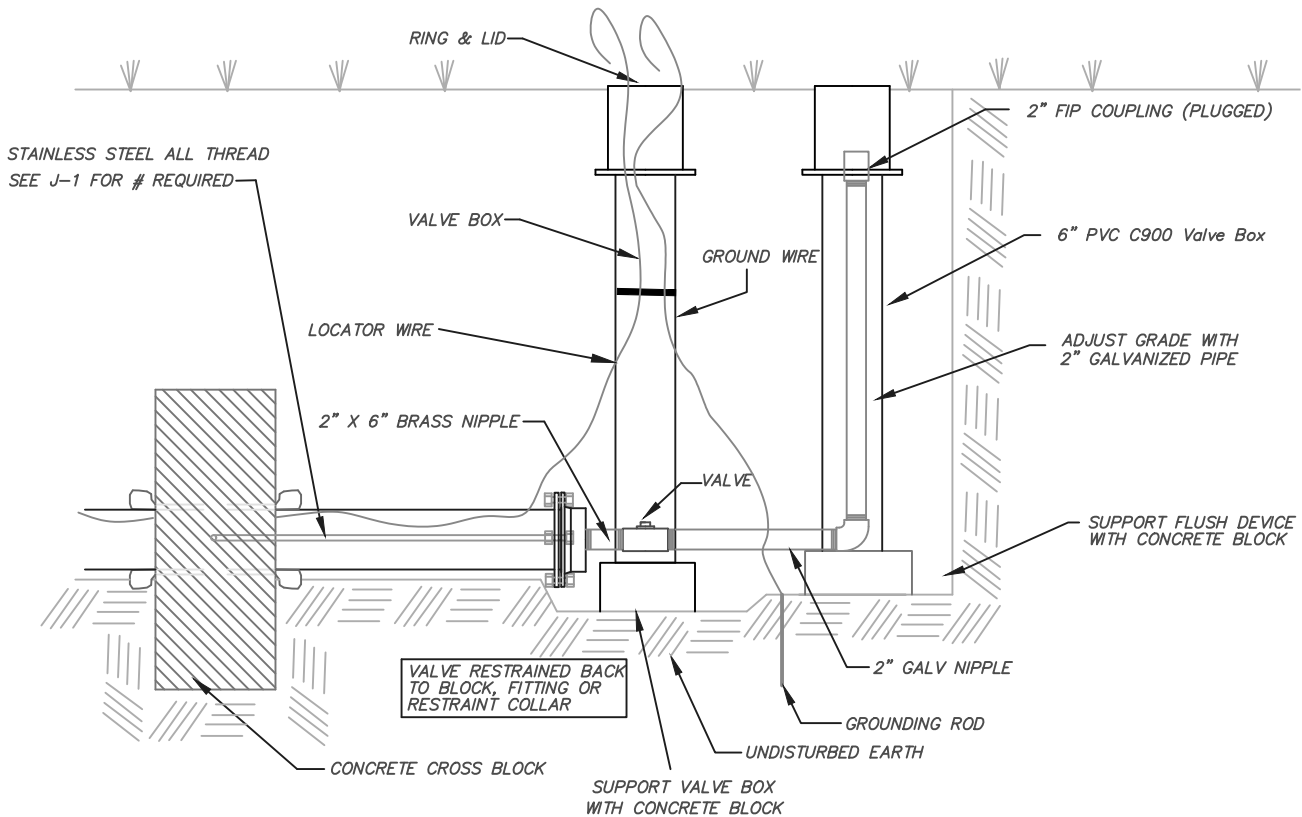


City of Columbia, Missouri
Utilities Department - Water & Light

Flush at Dead End Valve

Detail Sheet- Q 09

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555

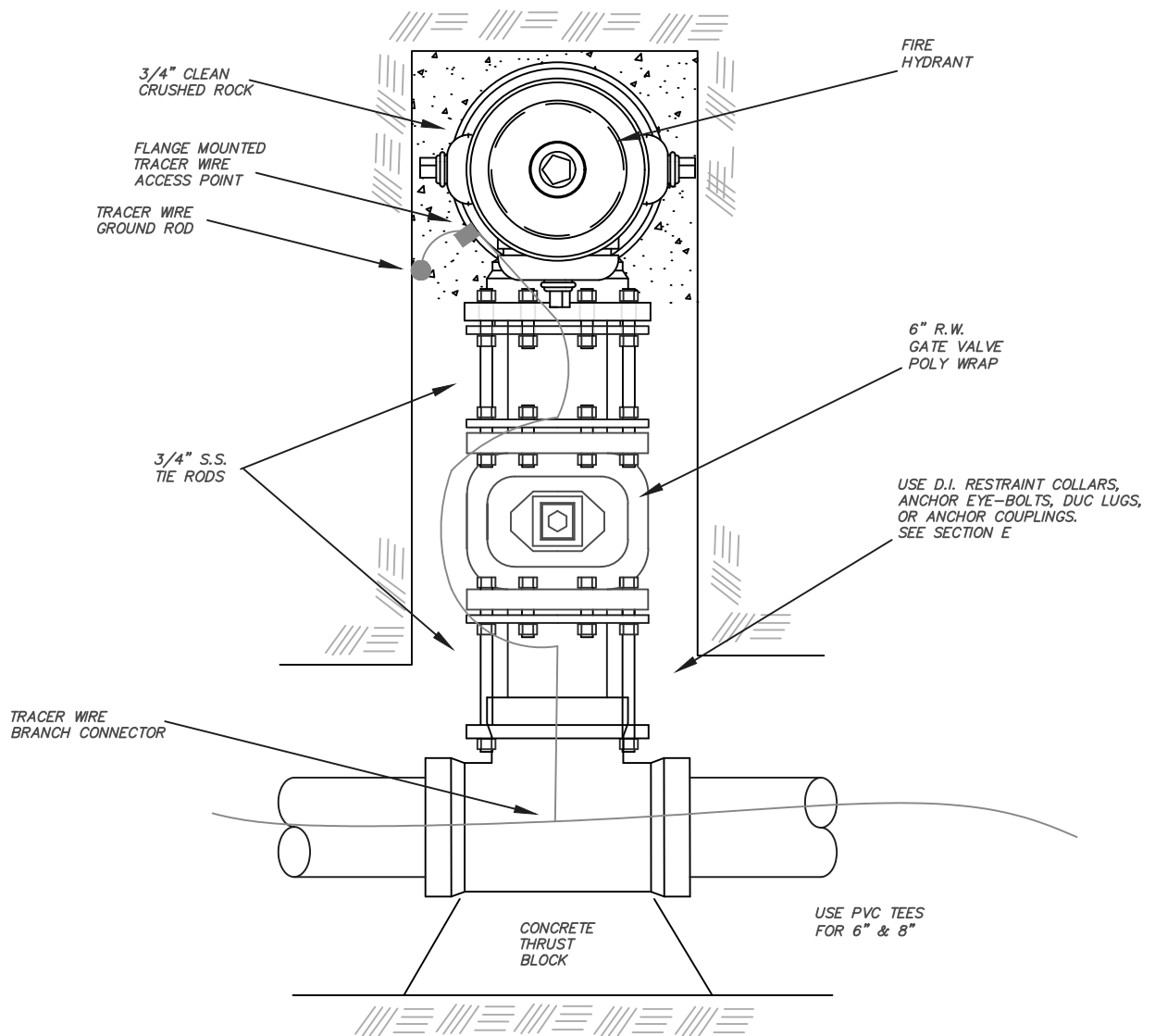


City of Columbia, Missouri
Utilities Department - Water & Light

Flush Assembly with 2" Valve

Detail Sheet- Q 10

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555



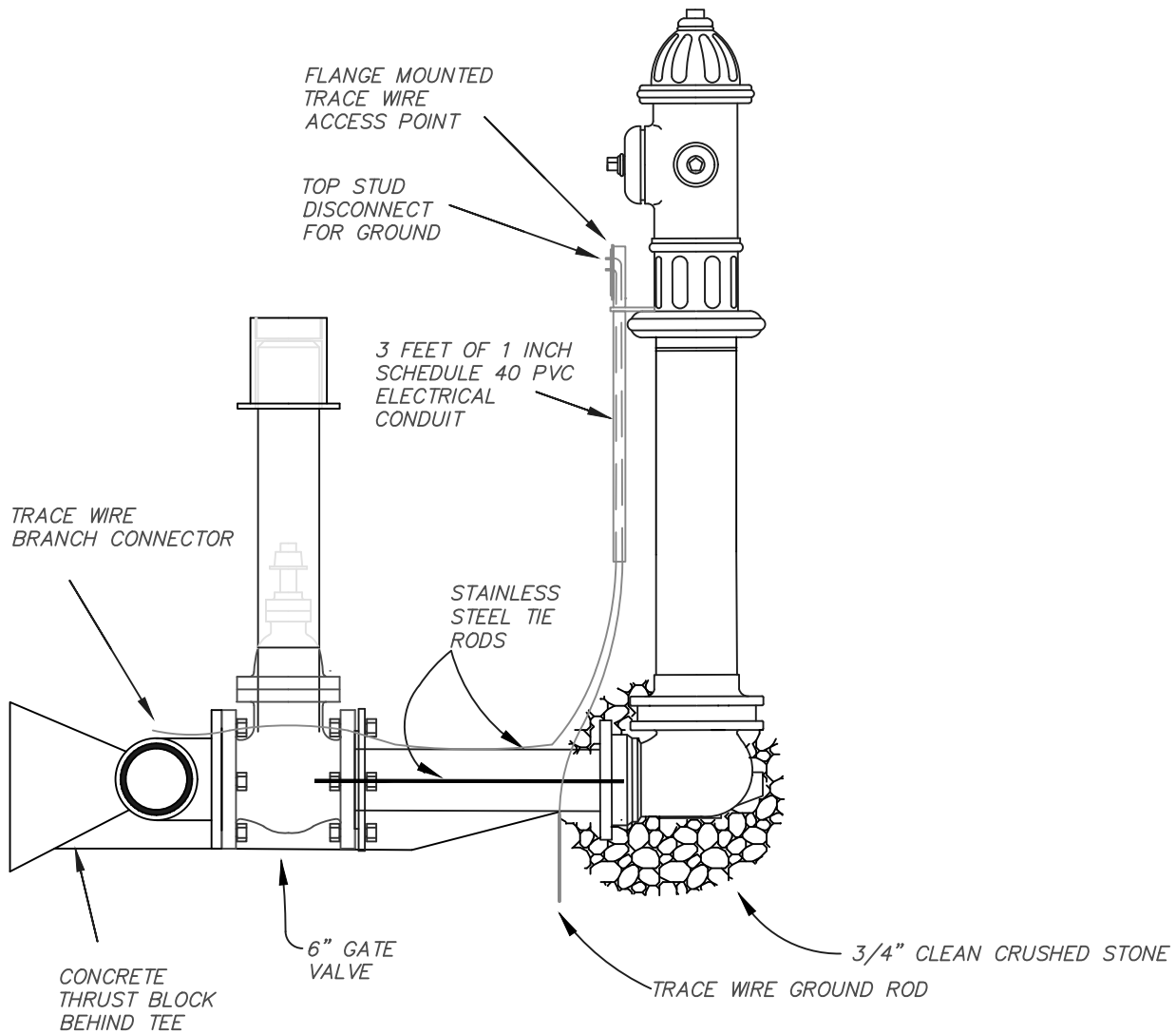
City of Columbia, Missouri
Utilities Department - Water & Light

Fire Hydrant Assembly

Detail Sheet- Q 11

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555

NOTE:
CONTRACTOR SHALL PROVIDE &
INSTALL 2" TEMPORARY FLUSH
POINTS AT ALL FIRE HYDRANT
VALVES FOR SAMPLING PRIOR
TO PLACING FIRE HYDRANTS.



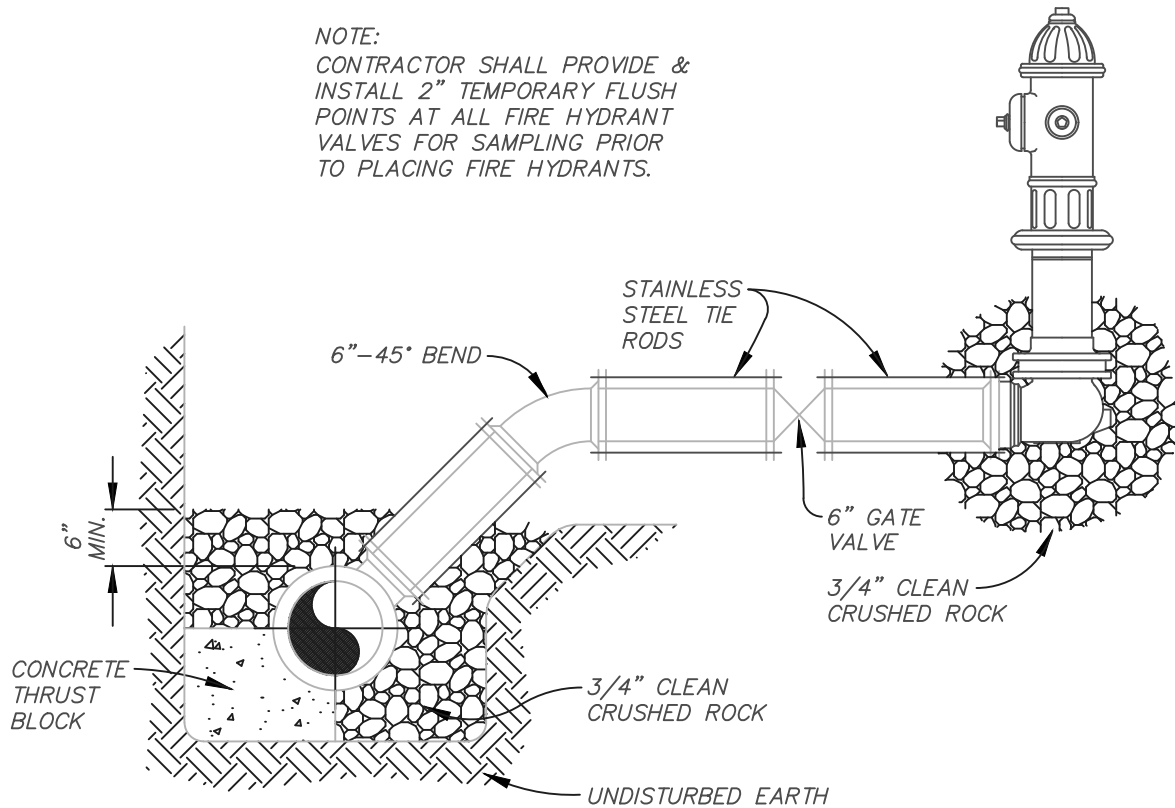
City of Columbia, Missouri
Utilities Department - Water & Light

Fire Hydrant Connection

Detail Sheet- Q 12

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555

NOTE:
CONTRACTOR SHALL PROVIDE &
INSTALL 2" TEMPORARY FLUSH
POINTS AT ALL FIRE HYDRANT
VALVES FOR SAMPLING PRIOR
TO PLACING FIRE HYDRANTS.



NOTES:

1. FIRE HYDRANT SHALL BE INSTALLED BY THE CONTRACTOR AFTER TESTING IS COMPLETE.
2. PROVIDE COMPACTED 3/4" CLEAN CRUSHED ROCK BETWEEN UNDISTURBED EARTH AND TEE. GRANULAR MATERIAL SHALL EXTEND A DISTANCE OF 5' EACH SIDE OF THE CENTERLINE OF THE TEE.

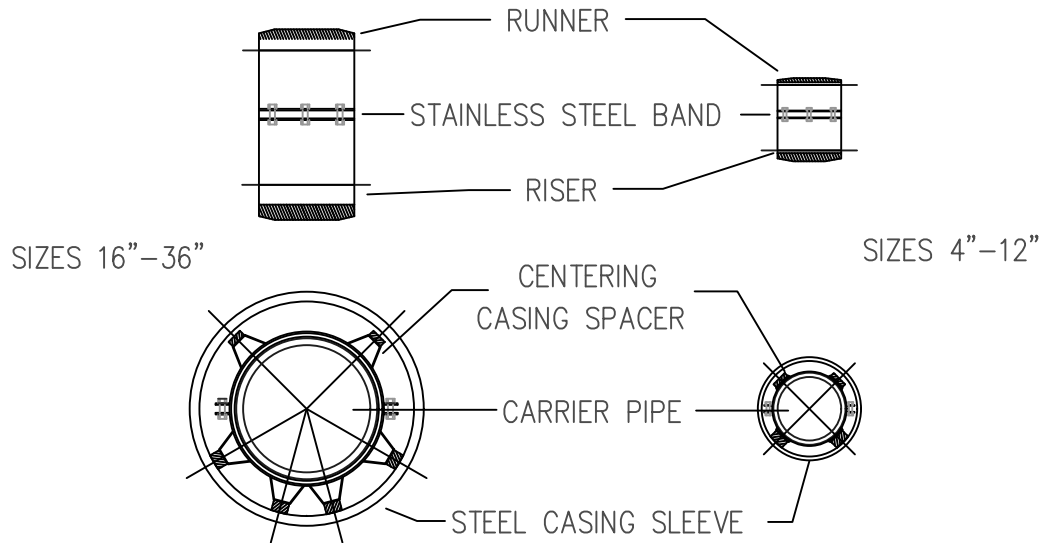


City of Columbia, Missouri
Utilities Department - Water & Light

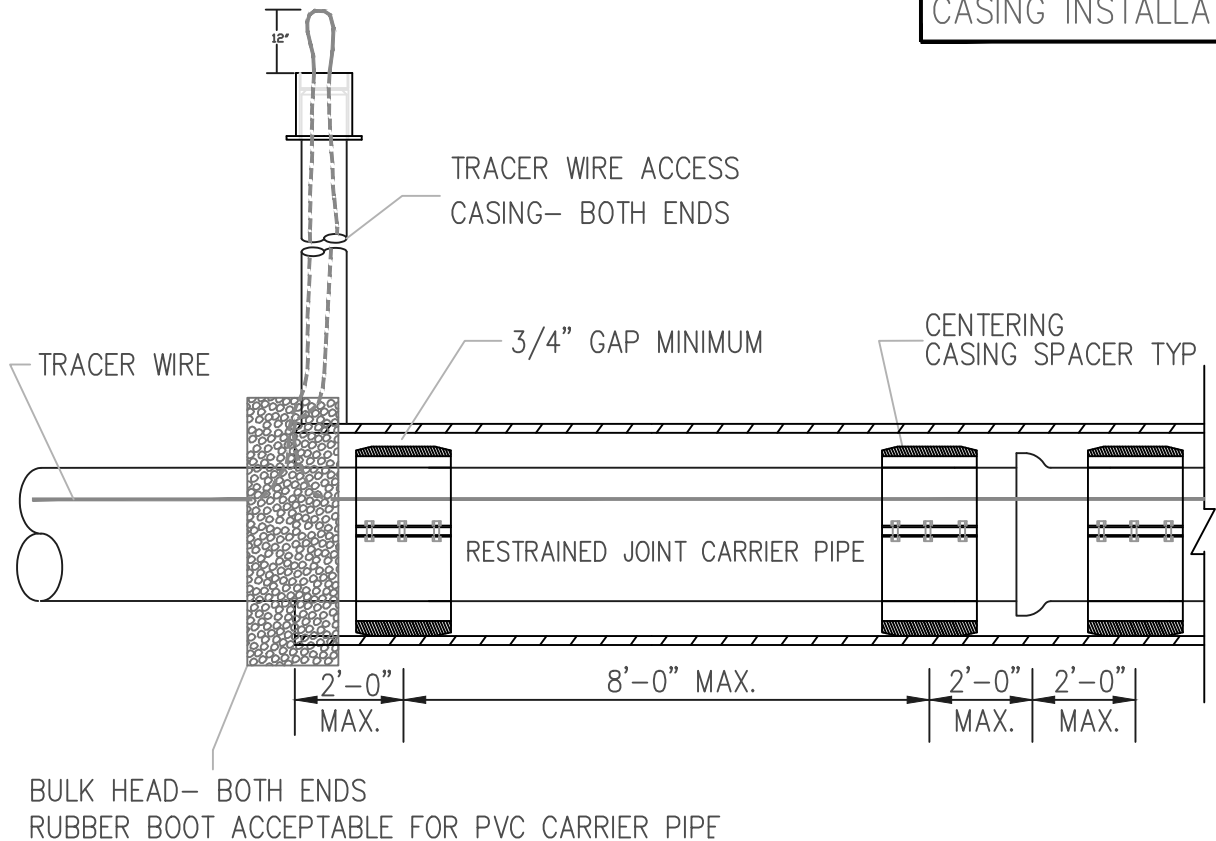
Fire Hydrant Connection For Air Release Detail Sheet- Q 13

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555

SPACER DETAIL



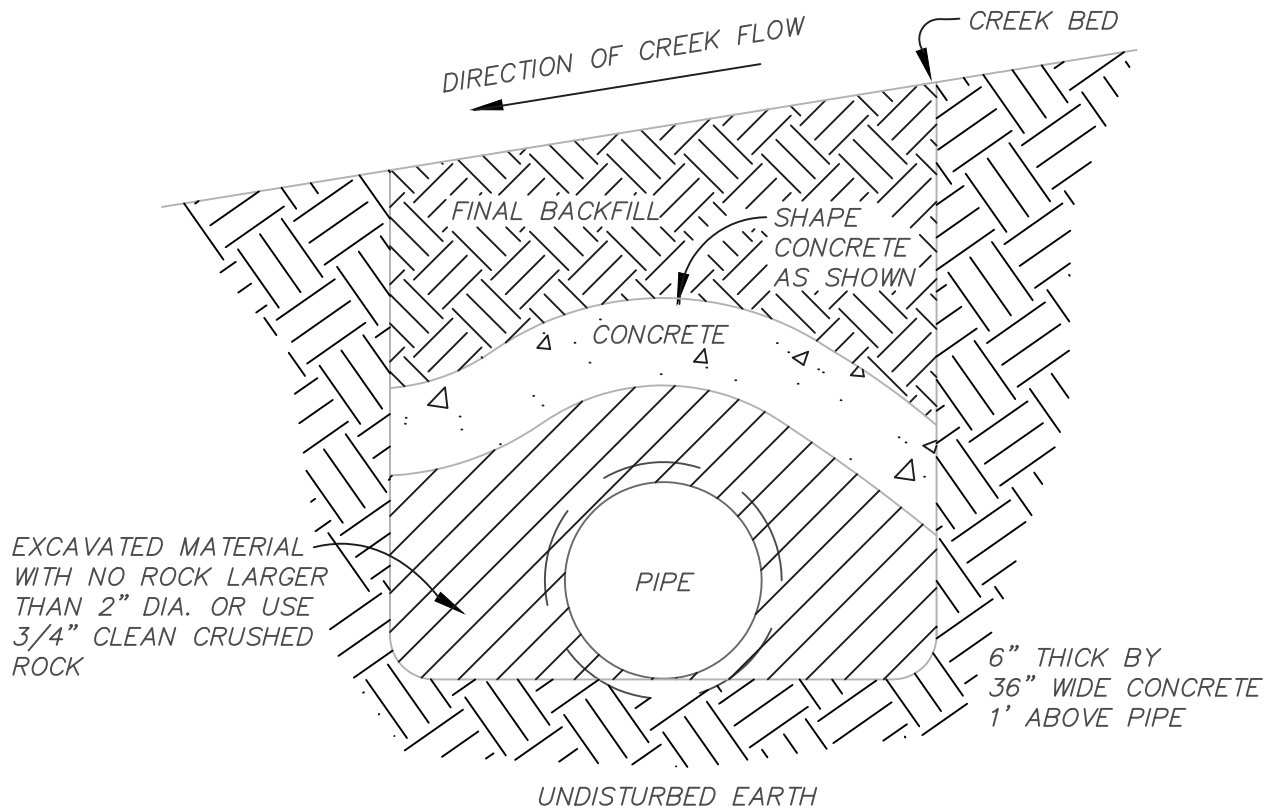
CASING INSTALLATION



City of Columbia, Missouri
Utilities Department - Water & Light

Casing Detail

Detail Sheet- Q 15



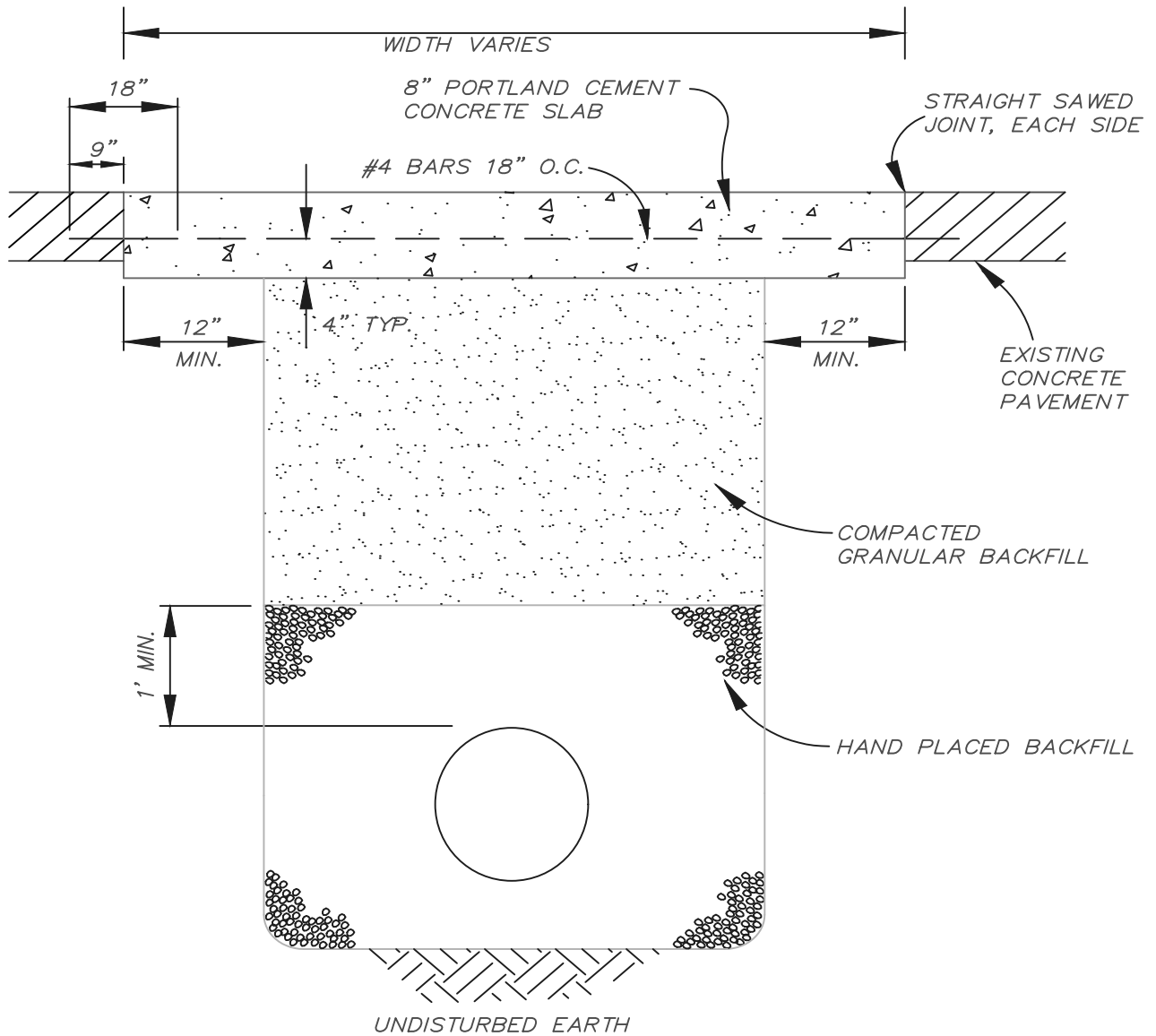
City of Columbia, Missouri
Utilities Department - Water & Light

Concrete Arch Encasement

Detail Sheet- Q 16

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555

REMOVE TO NEAREST JOINT OR AS REQUIRED BY STREET SPECIFICATIONS



- RESTORE ORIGINAL SAW JOINT PATTERN.
- ALL JOINTS SHALL BE SEALED. SEE CITY OF COLUMBIA STREET SPECIFICATIONS.

- EARTHEN DAMS TO BE PLACED EVERY 100' IN GRANULAR EMBEDMENT/BACKFILL

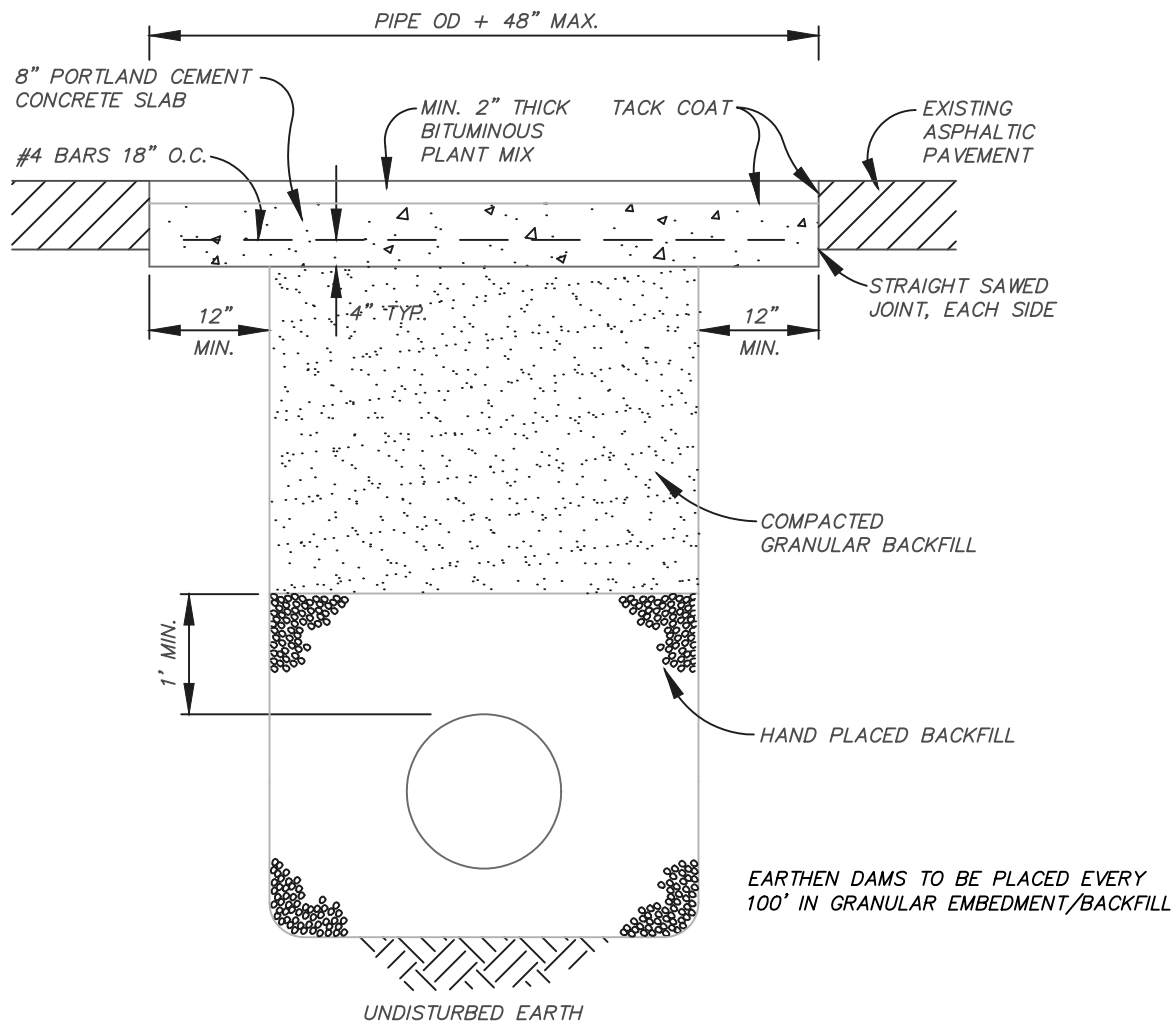


City of Columbia, Missouri
Utilities Department - Water & Light

Concrete Pavement Repair

Detail Sheet- Q 17

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555



City of Columbia, Missouri
Utilities Department - Water & Light

Asphalt Pavement Repair

Detail Sheet- Q 18

701 East Broadway - Columbia, Boone, Missouri - Phone: 573-875-2555