TECHNICAL SPECIFICATIONS AND STANDARD DETAILS

FOR

WATER & SEWER LINE EXPANSION FOR MODOT MAINTENANCE FACILITY

NEW FLORENCE, MISSOURI

MARCH, 2016

I HEREBY CERTIFY THAT THE SPECIFICATIONS LISTED BELOW WERE PREPARED BY ME, OR UNDER MY DIRECT SUPERVISION, AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER EXISTING UNDER THE LAWS OF THE STATE OF MISSOURI.

Philip Wilson, P.E.
Shafer, Kline & Warren, Inc.

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Contract Description.

B. Work by Owner.

C. Cash Allowances

D. Salvage of Materials and Equipment

E. Contractor use of site and premises.

F. Owner occupancy.

G. Lines and Grades.

H. Connections to Existing Facilities.

I. Cutting and Patching.

1.2 CONTRACT DESCRIPTION

A. Contract Type: Unit Price, as set forth in the Bid Form and Agreement

B. Description of Work under this Contract: Construction of the MoDOT Maintenance Facility water and sewer extensions will generally include the following:
   1. The project consists of the construction of 3,126 lf of 8” SDR-35 PVC gravity sewer line with 14 manholes, 290’ of 16” steel casing for the sewer I-70 highway bore, abandoning an existing lift station, 945 lf of 6” SDR-21 PVC water main, 280’ of 16” steel casing with an 8” carrier water pipe for the I-70 highway bore and 505 lf of 2” service line with a meter pit and connection to the existing service line for the MoDOT maintenance facility.

1.3 WORK BY OWNER

A. The Owner will not be performing any work on this project.

1.4 CONTRACTOR USE OF SITE AND PREMISES

A. Limit use of site and premises to allow:
   1. Owner occupancy, operations, and maintenance.
   2. Work by Owner.

B. Construction Operations:
   1. Limited to areas within general limits shown on the Drawings, inside Owners properties and, easements, except where specifically noted on the Drawings.
   2. Contractor may use the areas noted on the Drawings for storage and staging.

C. Time Restrictions: No work shall be done on Sunday, legal holidays, or at night, without the approval of Owner in each case, except such work as may be necessary for the proper care, maintenance and protection of work already done or of equipment and public property covered by the Contract, or to meet demanding time limitations on specific work activities called for under this contract. Approval of Owner shall be sought at least forty-eight (48) hours in advance of such work whenever practicable.

1. Before Contractor requests work to take place on Sundays, or legal holidays on a repeated basis to expedite the Work or make up for lost progress, Contractor shall first schedule and work five weekdays and Saturdays for at least two weeks prior.

D. Unfavorable Construction Conditions: During unfavorable weather, wet ground, or other unsuitable construction conditions, Contractor shall confine his operations to Work which will not be affected adversely by such conditions. No portion of the Work shall be constructed under conditions which would affect adversely the quality or efficiency thereof, unless special means or precautions are taken by Contractor to perform the Work in a proper and satisfactory manner.

E. Utility Outages and Shutdown: Brief shutdown of utilities, other than described herein, will be acceptable to Owner provided that the duration does not exceed one-half hour, and at least 48 hours prior notice has been given by Contractor.

1.5 OWNER OCCUPANCY

A. The Owner will periodically require access to the facility during the entire period of construction. To the extent possible, Owner's personnel will restrict activities to not interfere with construction.

B. Cooperate with Owner to minimize conflict, and to facilitate Owner's operations.

1.6 LINES AND GRADES

A. All Work shall be done to the lines, grades, and elevations indicated on the Drawings.

B. Basic horizontal and vertical control points will be established or designated by Engineer. Such control points shall be used as datum for the Work. All additional survey, layout, and measurement work shall be performed by Contractor as part of the Work.

C. Contractor shall provide an experienced instrument person, competent assistants, and such instruments, tools, stakes, and other materials required to complete the survey, layout, and measurement of the Work. In addition, Contractor shall furnish, without charge, competent persons from his force and other tools which Engineer may require in checking survey, layout, and measurement work performed by Contractor.

D. Contractor shall keep Engineer informed, a reasonable time in advance, of the times and places at which he wishes to do Work, so that horizontal and vertical control points may be established and any checking deemed necessary by Engineer may be done with minimum inconvenience to Engineer and minimum delay to Contractor.

1.7 CONNECTIONS TO EXISTING FACILITIES

A. Unless otherwise specified or indicated, Contractor shall make all necessary connections to existing facilities, including structures, drain lines, and utilities such as water, sewer, telephone, and electric. In each case, Contractor shall receive permission from Owner or the owning utility prior to undertaking connections. Contractor shall protect facilities against deleterious substances and damage.

B. Connections to existing facilities which are in service shall be thoroughly planned in advance, and all required equipment, materials, and labor shall be on hand at the time of undertaking the connections. Work shall proceed continuously (around the clock) if necessary to complete connections in the minimum time. Overtime work shall be scheduled with and approved by Owner in advance, as required within.

C. Operation of valves or other appurtenances on existing utilities, when required, shall be by or under the direct supervision of the owning utility.

1.8 CUTTING AND PATCHING

A. Contractor shall perform all cutting and patching required for the Work and as may be necessary in connection with uncovering Work for inspection or for the correction of defective Work.

B. Contractor shall perform all cutting and patching required for and in connection with the Work, including but not limited to the following:
1. Removal of improperly timed Work.
2. Removal of samples of installed materials for testing.
3. Alteration of existing facilities.
4. Installation of new Work in existing facilities.

C. Contractor shall provide all shoring, bracing, supports, and protective devices necessary to safeguard all Work and existing facilities during cutting and patching operations. Contractor shall not undertake any cutting or demolition which may affect the structural stability of the Work or existing facilities without Engineer's concurrence.

D. Materials shall be cut and removed to the extent indicated on the Drawings or as required to complete the Work. Materials shall be removed in a careful manner, with no damage to adjacent facilities or materials. Materials which are not salvageable shall be removed from the site by Contractor.

E. All Work and existing facilities affected by cutting operations shall be restored with new materials, or with salvaged materials acceptable to Engineer, to obtain a finished installation with the strength, appearance, and functional capacity required. If necessary, entire surfaces shall be patched and refinished.

F. Restoration of pavement and other surface construction shall be performed in accordance with the applicable specification section.

1.9 LAND DISTURBANCE

A. It shall be the Contractor’s responsibility to develop a Stormwater Water Pollution Prevention Plan (SWPPP) and obtain the appropriate permits from the Missouri Department of Natural Resources (MDNR) for land disturbance activities. The Contractor shall implement, maintain, and modify the SWPPP as appropriate through the duration of the Project. The Contractor shall furnish all labor, materials, equipment, and service to construct, maintain, and remove temporary erosion control measures necessary to comply with the requirements of the land disturbance permit and SWPPP. The Contractor shall be responsible for making all reports required by the land disturbance permit.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittal Procedures.

B. Proposed Products List.

C. Product Data.

D. Shop Drawings.

E. Certificates.

1.2 SUBMITTAL PROCEDURES

A. Transmit each submittal with submittal form acceptable to Engineer.

B. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix. For example, the first submittal under Section 15100 would be numbered "15100-01", and a re-submittal of the same item(s) would be numbered "15100-01a".

C. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate.

D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents. If Contractor affixes a stamp to the submittal which says "exceptions noted" or a clause to similar effect, Contractor shall specifically list all exceptions.

E. Submittal Checklist: Where specification sections list specific items to be included in the submittal, manufacturer or supplier shall make a copy of the list and include it as a checklist. Each item shall be checked that it is included. If an item is not included, an explanation as to why it was not included must be attached. If items are not included and/or an explanation why that item is not included is not attached, Engineer will return the submittal without review marked as "Revise and Resubmit". If no checklist is present, the submittal will not be reviewed until a manufacturer or supplier generated checklist is received.

F. Schedule submittals to expedite the Project, and deliver to Engineer at business address. Coordinate submission of related items.

G. Submittal Review Period by Engineer: For each submittal for review, allow fifteen (15) days excluding delivery time to and from Contractor, provided submittals are complete.

H. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed Work.

I. Provide space for Contractor and Engineer review stamps.

J. Conform with specific submittal requirements given in the individual sections of the specifications.

K. When revised for re-submission, identify all changes made since previous submission.

L. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

M. Submittals not requested will not be recognized or processed.

1.3 PROPOSED PRODUCTS LIST

A. Within fifteen (15) days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.4 PRODUCT DATA

A. Product Data for Review:
   1. Submitted to Engineer for review.
   2. After review, provide copies and distribute in accordance with submittal procedures article above and for record documents purposes described in Section 01700 - Contract Closeout.

B. Product Data for Information:
   1. Submitted for Engineer's knowledge as contract administrator or for Owner.

C. Product Data for Project Close-out:
   1. Submitted for Owner's benefit during and after project completion.

D. Submit the number of copies which Contractor requires, plus three (3) copies which will be retained by Engineer.
   1. In lieu of hardcopy submittals, Contractor may submit to Engineer electronically in Adobe PDF format. Submittals will be reviewed and returned to Contractor electronically in Adobe PDF format.

E. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

F. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

G. After review distribute in accordance with the Submittal Procedures article above and provide copies for record documents described in Section 01700 - Contract Closeout.

1.5 SHOP DRAWINGS

A. Shop Drawings for Review:
   1. Submitted to Engineer for review.
   2. After review, produce copies and distribute in accordance with submittal procedures article above and for record documents purposes described in Section 01700 - Contract Closeout.

B. Shop Drawings for Information:
   1. Submitted for Engineer's knowledge or for Owner.

C. Shop Drawings for Project Close-out:
1. Submitted for Owner's benefit during and after project completion.

D. Submit the number of opaque reproductions which Contractor requires, plus three (3) copies which will be retained by Engineer.

E. Upon agreement of both Owner and Engineer, Contractor may submit shop drawings electronically in Adobe Acrobat (.pdf) format in lieu of hard copies as specified in Paragraph D above.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality Assurance - Control of Installation.

B. Examination.

C. Preparation.

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work.

B. Section 01300 - Submittals: Submission of manufacturers' instructions and certificates.

1.3 QUALITY ASSURANCE - CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify that utility services are available, of the correct characteristics, and in the correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Temporary lighting and sanitary facilities.

B. Temporary Controls: Barriers, fencing, protection of the Work, damage to existing property, and water control.

C. Construction Facilities: Access roads, parking, progress cleaning, project signage, and temporary buildings.

1.2 RELATED SECTIONS

A. Section 01700 - Contract Closeout: Final cleaning.

1.3 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Temporary lighting, if required by Contractor, shall be provided by Contractor.

1.4 TEMPORARY SANITARY FACILITIES

A. Contractor shall furnish temporary sanitary facilities at each site, as provided herein, for the needs of all construction workers and others performing work or furnishing services on the Project.

B. Sanitary facilities shall be of reasonable capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent.

C. If toilets of the chemically treated type are used, at least one toilet will be furnished for each 20 men. Contractor shall enforce the use of such sanitary facilities by all personnel at the site.

1.5 BARRIERS

A. Provide barriers to prevent unauthorized entry to hazardous construction areas to allow for Owner's use of site, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.6 FENCING

A. All existing fences, affected by the Work, shall be maintained by Contractor until completion of the Work.

B. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the Engineer and alternative temporary fencing has been agreed upon.

C. Prior to final acceptance, Contractor shall restore all fences to their original or to a better condition, as specified in the fencing specifications, and to their original location, unless indicated otherwise on the Drawings.

1.7 WATER CONTROL

A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

1.8 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual specification sections.

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to prevent damage.

1.9 DAMAGE TO EXISTING PROPERTY

A. Contractor will be held responsible for any damage to existing structures, Work, materials or equipment, because of his operations, and shall repair or replace any damaged structures, Work, materials or equipment to the satisfaction of, and at no additional cost to Owner.

B. Contractor shall protect all existing structures and property from damage, and shall provide bracing, shoring or other work necessary for such protection.

C. Contractor shall be responsible for all damage to streets, roads, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by transporting equipment, materials, or men to or from the Work. Contractor shall make satisfactory and acceptable arrangements with the agency having jurisdiction over the damaged property concerning its repair or replacement.

1.10 PARKING

A. Arrange for temporary parking areas to accommodate construction personnel.

B. When site space is not adequate, provide additional off-site parking.

C. Parking on Right of Way is not allowed except for necessary equipment at the time of work. Storage of materials and equipment is not allowed on Right of Way.

1.11 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Collect and remove waste materials, debris, and rubbish from site periodically and dispose off-site.

1.12 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Final Application for Payment.

B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

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SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Transportation and handling.

B. Storage and protection.

C. Substitutions.

1.2 TRANSPORTATION AND HANDLING

A. Transport and handle Products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure that Products comply with requirements, quantities are correct, and Products are undamaged.

C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

1.3 STORAGE AND PROTECTION

A. Upon delivery, all materials shall immediately be stored and protected until installed in the Work.

B. Store and protect Products in accordance with manufacturers' instructions.

C. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

D. Arrange storage of Products to permit access for inspection. Periodically inspect to verify Products are undamaged and are maintained in acceptable condition.

1.4 SUBSTITUTIONS

A. The term "Substitutions", as discussed under this subpart, applies to any product which is not named in the specifications and which is proposed by Contractor as an "or-equal" item or a "substitute" item. Substitutions are discussed in Article 6.05 of the General Conditions.

B. Engineer will consider requests for Substitutions only within 45 days after date established in Notice to Proceed.

C. Substitutions may be considered at any time after Notice to Proceed when a Product becomes unavailable through no fault of the Contractor.

D. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents. Contractor shall indicate if his request is intended as an "or-equal" item or a "substitute" item.

E. A request constitutes a representation that the Contractor:

1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
2. Will provide the same warranty for the Substitution as for the specified Product.
3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension which may subsequently become apparent.
5. Will reimburse Owner and Engineer for review or redesign services associated with re-approval by authorities.

F. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request, or when acceptance will require revision to the Contract Documents.

G. Substitution Submittal Procedure: As set forth in Article 6.05 of the General Conditions, and as modified below:
1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
2. Submit shop drawings, product data and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
3. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures.

B. Final cleaning.

C. Project record documents.

D. Operation and Maintenance Data.

E. Spare Parts and Maintenance Products.

1.2 RELATED SECTIONS

A. Section 01500 - Construction Facilities and Temporary Controls.

1.3 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.

B. Submit final Application for Payment identifying total adjusted Contract Price, previous payments, and sum remaining due.

1.4 FINAL CLEANING

A. Execute final cleaning prior to final project assessment.

B. Clean site, remove waste and surplus materials, rubbish, and construction facilities from the site.

1.5 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed Shop Drawings, Product Data, and Samples.
   6. Manufacturer's Instructions for Assembly, Installation, and Adjustments.

B. Ensure entries are complete and accurate, enabling future reference by Owner and Engineer.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Details not on original Contract drawings.
   2. Record Drawings shall be maintained and updated throughout the Work, and presented at each progress meeting for review by Engineer.

G. Submit documents to Engineer with claim for final Application for Payment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02320

EARTHWORK & TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall perform all excavation, embankment, trenching, backfilling, cushioning, surface dressing, dewatering, shoring, surface restoration and disposal of waste as required for site grading, structures, piping, and appurtenances as shown on the Drawings.

1.2 SECTION INCLUDES

A. Pipe Embedment Material.

B. Crushed Rock.

C. Fill Materials.

D. Impervious Trench Check Material.

E. Classification of Materials

F. Site Clearing.

G. Subgrade Preparation.

H. Earthfills and Embankments.

I. Excavation.

J. Pipe Embedment Schedule.

K. Backfilling.

L. Surface Restoration.

M. Disposal of Materials.

1.3 RELATED SECTIONS

A. Section 02530 - Piping System Products.

B. Section 02535 - Piping Systems Installation.

C. Section 02922 - Seeding.

D. Section 03300 - Miscellaneous Concrete.

1.4 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the section requirements shall govern.

A. American Society for Testing Materials (ASTM):
   1. D-698 - Moisture-Density Relations Of Soils, Using 5.5 Pound (2.5 kg) Rammer And 12-Inch (304.8 mm) Drop.
   2. D-1140 - Test Method for Amount of Material in Soils Finer Than the No. 200 (75μm) Sieve.
   3. D-2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   4. D-3017 - Standard Test Methods for Water content of Soil and rock by Nuclear Methods.

1.5 SUBMITTALS: The Contractor shall submit the following items required by this division in accordance with Section 01300 - Submittals.

A. Product data for review: Soil test results as specified herein for soil testing.

1.6 DEFINITIONS

A. Earth excavation: Earth excavation is defined as the removal of all material whose removal is not defined as rock excavation.

B. Pipe embedment: Pipe embedment is defined as soil or stone aggregate material placed under, around, and in some cases over the pipe. The material type and extent of embedment is specified herein and shown on the Drawings.

C. Trench backfill: Trench backfill is defined as soil or stone aggregate material placed in a pipe or utility trench, above the pipe embedment and up to the existing ground surface, finished grade, or the bottom of pavement.

D. Structure backfill: Structure backfill is defined as soil or stone aggregate material placed around or above subsurface structures, such as manholes, vaults, foundations, and wetwells.

1.7 MAINTENANCE OF WORK: The Contractor shall be responsible for the satisfactory compaction and maintenance of all completed excavation, embankment, and backfill. If, prior to the expiration of the General Guaranty period stipulated in the Front End Documents, any grades or subgrades are found to have settled or eroded, they shall be reworked immediately by the Contractor and restored to the specified grades, and the surface restored.

PART 2 PRODUCTS

2.1 GENERAL

A. Materials shall conform to the respective references listed above and other requirements specified herein.

B. Topsoil, and material required for structural backfill and trench backfill in excess of suitable material excavated from trenching and structural excavation shall be furnished by the Contractor at no additional cost to the Owner.

2.2 PIPE EMBEDMENT MATERIAL: Granular Embedment Material: Granular embedment material for installation in pipe trenches and other locations indicated on the Drawings shall be crushed stone conforming to the 2007 MCIB Concrete Standards, Section 2.1.D for coarse aggregate meeting the gradation specified under Column IV, Table 2.1.D-1 for 2-inch aggregate with the modification that the maximum allowable percentage of material finer than No. 200 sieve shall be between 2.0% and 5.0% as determined by ASTM C-117. The gradation is repeated below for information:

Sieve Size	Percent Passing
3/4"	100
1/2"	80 - 100
3/8"	40 - 70
No. 4	0 - 15
No. 8	0 - 5
No. 200	0 - 3

2.3 CRUSHED ROCK: Crushed rock for use beneath concrete slabs and structures, and in other locations shown on the Drawings, shall be freely draining, siliceous gravel or crushed stone aggregate, conforming to 1999 Missouri Standard Specifications for Highway Construction, Section 1007, Type 1007.4.3. The gradation is repeated below for information:

Sieve Size	Percent Passing
1"	100
1/2"	55 - 90
No. 4	8 - 40
No. 10	0 - 15
No. 200	0 - 4

2.4 FILL MATERIALS

A. Random Fill Material: Random fill material for earthfills, embankments and other uses, shall be a soil material which is free from: rocks or stones larger than 6 inches in greatest dimension, brush, stumps, logs, roots, debris, top soil, and organic or harmful materials. The portion of fill material passing the No. 40 sieve shall have a liquid limit not exceeding 40 and a plastic limit not exceeding 25, when tested in accordance with ASTM D-4318. To the extent possible, site excavated material may be used. Random fill material shall be imported if suitable soil material is not available on site.

B. Select Fill Material: Select fill material shall be a sorted, job-excavated or imported soil material as specified for random backfill material, except no rocks, stones, or lumps larger than one inch in largest dimension shall be present. Select fill material, used for filling beneath or against structures, shall not contain weathered shale.

C. Granular Fill Material:

1. Granular fill material shall be a densely graded gravel of the following gradation:

Sieve Size (square opening)	Percent Passing (by weight)
1 inch	100
3/4 inch	85 - 100
3/8 inch	50 - 80
No. 4	35 - 60
No. 40	15 -25

2. Granular fill material shall be free from clay lumps or organic matter. The fraction passing the No. 4 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 5. The fraction passing the No. 200 sieve shall not exceed 3/4 of the fraction passing the No. 40 sieve.

2.5 IMPERVIOUS TRENCH CHECK MATERIAL

A. Material for impervious trench checks shall be naturally occurring clay or a soil and sodium bentonite mixture with the permeability of the material to be no greater than $10x10^{-6}$ cm/sec.

B. Material shall be free of any stones, bricks, concrete, etc., except gravel or crushed rock of 3/4 inch size or less.

PART 3 EXECUTION

3.1 PREPARATION

A. The Contractor shall verify that required lines, levels, contours and datum are as shown in the plans.

B. Grading, excavation and backfilling shall be made to the lines, grades and cross sections indicated in the plans.

C. The Contractor shall maintain the site and conduct earthwork operations to ensure that the property is well drained at all times. The Contractor shall protect adjacent and downstream properties from damage or pollution caused by erosion. The Contractor is responsible for erosion control measures and methods and shall conduct earthwork operations to ensure the protection of all downstream and adjacent properties. The Contractor shall implement any additional erosion control measures to prevent damage.

D. Existing Utilities:
1. The Contractor shall verify the location and depth of all utilities a minimum of 24 hours prior to construction. The Contractor may utilize the toll free number for the "Missouri One Call System" 1-800-344-7483. This number is applicable anywhere within the state of Missouri. Prior to commencement of work the Contractor shall notify all those companies which have facilities in the vicinity of the construction.
2. Coordinate removal or relocation of existing utilities with their Owner.
3. Locate, identify and protect utilities that remain from damage. The Contractor shall make every reasonable effort to protect all existing utilities from damage. If any utility is damaged through the carelessness or negligent actions of the Contractor, the utility shall be repaired by its owner at the Contractor's expense.
4. Abandoned pipes which the Drawings indicate shall be capped or filled do not need to be removed. All other abandoned pipe conduit within the limits of grading shall be removed by the Contractor

E. Existing fences: Fences within the construction grading area shall be removed and reconstructed to equal or better quality than that of the fence removed. It shall be the sole responsibility of the Contractor to maintain all gates, fences, cattle guards and the like encountered during construction, as required to prevent the straying of pets and livestock.

3.2 CLASSIFICATION OF MATERIALS: No classification of excavated materials, regardless of type or condition, will be made for purposes of payment. All excavation shall be unclassified unless designated

otherwise. Excavation and trenching work shall include the handling and removal of all materials, regardless of its nature, excavated or removed from the site in performance of the Work.

3.3 SITE CLEARING

A. Clearing and stripping: All stumps, roots, buried logs, foundations, drainage structures, or other miscellaneous debris occurring within the limits of the excavation and site grading shall be removed as part of the grubbing operations and disposed of by, and at the expense of, the Contractor. Like-wise, six inches of topsoil shall be stripped from the disturbed construction areas and stockpiled for later use in final grading.

B. Stumps and roots in excavated or fill areas where depth of fill does not exceed 3 feet shall be removed to a depth of 18 inches below subgrade. In fill areas where more than 3 feet of fill is required, roots and stumps shall be cut off at the face of the excavation.

3.4 SUBGRADE PREPARATION

A. Proof-roll subgrade below building slabs, tank slabs, and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
   1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
   3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.
   4. Subgrades under building slabs shall be compacted in place to ninety-five percent (95%) of maximum density as determined by ASTM D-698, at a moisture content within plus or minus two percent (±2%) of optimum.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.5 EARTHFILLS AND EMBANKMENTS

A. Material and Compaction Requirements:
   1. Fill areas which are below structures, concrete slabs, or paved areas, and within 5 horizontal feet of a structure or concrete slab shall be filled with select fill material, as specified herein, unless otherwise indicated on the Drawings. The select fill material shall be placed in lifts not exceeding 12 inches in compacted thickness, and shall be compacted to a minimum 95 percent of maximum density as determined by ASTM D-698. Fill shall be placed and compacted at a moisture content within ± 2 percent of optimum.
   2. Fill areas which are outside the envelope described above shall be filled with random fill material, as specified herein, unless otherwise indicated on the Drawings. The random fill material shall be placed in lifts not exceeding 12 inches in compacted thickness, and shall be compacted to a minimum 90 percent of maximum density as determined by ASTM D-698. Fill shall be placed and compacted at a moisture content within ± 3 percent of optimum.
      a. For areas which will be surfaced with gravel, the top two feet of random fill shall be compacted to a minimum of 95 percent of maximum density as determined by ASTM D-698. Fill shall be placed and compacted at a moisture content within ± 2 percent of optimum.

B. All vegetation and topsoil, and any loose, unstable or unsuitable material shall be removed from the existing surface to receive fill material. After stripping, the area shall be proof-rolled with a loaded

tandem axel dump truck, or other equipment acceptable to Engineer. Unstable materials located by proof-rolling, shall be removed and replaced with suitable compacted fill material.

C. Before placing any fill the existing surface shall be scarified, moisture conditioned as required and the top 6 inches compacted to 90 percent of the maximum density for that material in accordance with ASTM D-698.

D. When embankments, regardless of height, are placed against hillsides or existing embankments having a slope steeper than 1 vertical to 4 horizontal, the existing slope shall be benched or stepped in approximately 24 inch rises. The material shall be bladed out and the bottom area cut to form benches and the embankment material being placed shall be compacted to the specified density. Formation and compaction of benches shall not be measured and paid for directly but will be considered incidental work.

E. Where embankments of two feet or less are placed over existing pavement, the existing pavement shall be removed and the cleared surface compacted to the specified density. Where embankments greater than two feet are placed over existing pavement, the pavement shall be broken into pieces with a maximum dimension of 24 inches and the pieces left in place.

F. Do not place fill material over porous, wet, frozen or spongy surfaces. Embankment construction shall not be performed when fill material is frozen or contains frost or snow.

G. Placement: Place earth embankments in successive horizontal lifts uniformly distributed over the full width of the fill area. Each lift shall not exceed the specified thickness and shall be compacted to the specified density prior to placing any additional lifts. As compaction of each layer progresses, continuous blading and dozing will be required to level the surface and insure uniform compaction.

H. No rocks or stones shall be placed in the upper 18 inches of any fill or embankment. Rocks or stones within the size limit may be incorporated in the remainder of fills and embankments, provided they are distributed so they do not interfere with proper compaction, as determined by the Engineer.

3.6 EXCAVATION

A. General:
   1. Where necessary, satisfactory sheeting and bracing shall be used to hold the sides of the excavation at all points where damage might result from slides.
   2. All sheeting and bracing shall be removed as the backfill is placed, unless otherwise directed in writing by the Owner or shown on the Drawings. All voids left or caused by the withdrawal of sheeting shall be filled immediately with suitable material and tamped.
   3. Excavation below structure or trench subgrade:
      a. Over excavation of pipe trenches due to Contractor’s oversight, shall be backfilled with granular embedment material compacted in 8-inch lifts to 90 percent of the maximum density for that material in accordance with ASTM D-698, as required at no additional cost to the Owner.
      b. Over excavation of structure subgrades due to the Contractor's oversight, shall be replaced with concrete placed monolithic with the structure above at no additional cost to the Owner.
      c. When unstable or unsuitable material is encountered in the subgrade, such material shall be removed, replaced with crushed rock (for structures) or granular pipe embedment material (for trenches) and compacted to the density equal to or greater than required for subsequent backfill material. Such excavation and backfill shall be paid for at the contract unit price.
      d. When the subgrade bottom is soft and in the opinion of the Engineer cannot support the foundation, a further depth and/or width shall be excavated and refilled to the desired pipe or foundation grade with crushed rock, as required by

the Engineer to assure a firm foundation. Such excavation and backfill shall be paid for at the contract unit price.

4. Use of Explosives: The Contractor shall comply with all laws, ordinances, applicable safety code requirements, and regulations relative to the handling, storage, and use of explosives, and the protection of life and property. The Contractor shall be responsible for all damage caused by his blasting operations. Suitable methods shall be employed to confine all materials lifted by blasting within the limits of the excavation or trench. Pre and post-blast surveys and blast monitoring are required.
5. Dewatering: Each excavation shall be kept dry during subgrade or pipe embedment preparation, and continually thereafter until the structure or pipe is completely installed, to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
   a. All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level at least 12 inches below the bottom of the excavation.
   b. Trenches shall be drained so that workmen may work efficiently. The discharge of pumps used for draining the trenches shall be led to the construction BMP's prior to discharging to natural drainage courses or drains.

B. Structure Excavation:
1. Excavation for structures shall be performed to the limits indicated on the Drawings.
2. All suitable material removed by excavation shall be used as far as practicable for backfill and embankment as required to complete the work. The Contractor shall sort all excavated material and stockpile suitable material as necessary. Stockpile excavated material to be used as fill and backfill in area designated on site and remove excess material or unsuitable material not being reused, from site.

C. Trenching:
1. The Contractor shall not open more trench in advance of the pipe laying than is necessary. The length of open trenches shall be limited depending on the nature of the soil and safety considerations. All open trenches shall be adequately protected using fencing, barricades, etc. as required.
2. Trenches shall be excavated within the limits shown on the Drawings in conformance with the requirements herein. Trenches shall be excavated to the width and depth necessary to install pipelines to the lines, grades, and elevations shown on the Drawings.
3. In those areas designated to be landscaped, seeded or sodded, the top soil shall be excavated, stockpiled and replaced as specified herein.
4. The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. One city block or 300 feet, whichever is the shorter, shall be the maximum allowable length of open trench ahead of pipe laying.
5. Limiting trench widths: Trenches shall be excavated to a width which will provide adequate working space and pipe clearances for proper pipe installation, jointing, and placement and compaction of embedment. Unless otherwise noted on the drawings, the limiting trench widths below an elevation 12 inches above the top of the installed pipe shall be as follows:

Pipe Size (inches)	Minimum Trench Width (inches)	Min. Clearance on Each Side of Pipe (inches)	Maximum Trench Width (inches)
< 4	20	6	26
4 - 6	22	6	30
8	22	6	30
10	24	6	32
12	27	6	36
15	30	6	38
16	32	6	40
18	34	6	42

Pipe Size (inches)	Minimum Trench Width (inches)	Min. Clearance on Each Side of Pipe (inches)	Maximum Trench Width (inches)
20	36	6	44
36	50	6	60
48	62	6	72

6. Unauthorized trench widths: Where, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted in the foregoing table, either pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the expense of the Contractor.
7. Trench bottom in earth: The trench in earth shall have a flat bottom the full width of the trench and shall be excavated to the grade to which the embedment is to be laid. The surface shall be graded to provide a uniform bearing and continuous support. No part of the bell shall be in contact with the trench bottom.
8. The Contractor shall sort and stockpile excavated material so that suitable material is available for backfill. Excavated material shall be deposited on the side of the trenches and beyond the reach of slides. Excavated material not suitable for backfill shall be promptly removed from the site.
9. Where necessary to reduce earth load on trench banks to prevent sliding and caving, banks may be cut back on slopes, but sloping trench walls shall not extend lower than 1 foot above the top of the pipe.
10. Trench Shields: Where trench shields are used by the Contractor, no part of the shield shall exceed lower than 6 inches above the top of the pipe, nor shall the maximum allowable trench width be exceeded.

3.7 PIPE EMBEDMENT

A. Embedment Classes: Unless otherwise indicated on the drawings, embedment classes shall be as follows, and as detailed on the Drawings. All lifts are given in compacted thickness. All compaction percentages refer to maximum dry density as determined by ASTM D-698. Select fill material shall be compacted within 2% of optimum moisture content. Select fill material shall be replaced with granular fill material if granular fill material is required for trench fill to ground surface.
   1. Class A Embedments:
      a. Class A-1 embedment shall provide a cradle of concrete with a compressive strength of at least 3,000 psi, as specified in Division 3 - Concrete. After the initial set of the concrete, granular embedment material shall be placed in 6-inch lifts and compacted to a minimum of 90%, above the top of pipe.
      b. Class A-2 embedment shall provide an arch of concrete with a compressive strength of at least 3,000 psi, as specified in Division 3 - Concrete. Granular embedment material shall be placed in 6-inch lifts and compacted to a minimum of 90%, up to the centerline of the pipe. A concrete arch shall be placed on the granular embedment. After the concrete has set, one foot of select fill material shall be placed above the top of pipe, compacted in 8-inch lifts to a minimum of 85%.
   2. Class B Embedments:
      a. Class B-1 embedment shall provide an encasement of granular embedment material, extending below the pipe to above the top of pipe. Granular embedment material shall be placed in 6-inch lifts and compacted to a minimum of 90%.
      b. Class B-2 embedment shall provide a cradle of granular embedment material which shall be placed in 6-inch lifts and compacted to a minimum of 90%. Select fill material shall then extend above the top of the pipe, placed in 8-inch lifts and compacted to 85%.
   3. Class C Embedment: Materials and compaction requirements shall be as for Class B-2.

4. Class D Embedment: Shall allow the pipe to rest on a flat or restored trench bottom. Pipe embedment shall be select fill material extending from the bottom of the pipe to above the top of pipe, placed in 12-inch lifts and compacted to 85%.

B. Concrete Encasement: Where indicated on the Drawings, concrete encasement shall be provided instead of the pipe embedment classes specified herein. Requirements for concrete encasement are detailed on the Drawings. Concrete and reinforcement shall be as specified in Division 3 - Concrete, for 3,000 psi concrete.

C. Pipe Embedment Class Schedule: Unless otherwise noted on the Drawings, pipe embedment classes shall be provided according to the following schedule:

Pipe Material	Depth over pipe (feet)	Embedment class
SDR-35 PVC	All	B-1
Class 200 PVC in soil	All	D
Class 200 PVC in rock	All	C
SDR-PR PVC, SCH 40/80 PVC	All	B-1
C-900 PVC	All	B-1
HDPE (polyethylene)	All	B-2
DIP in soil up to 12-inch	minimum 3 ft	D
DIP in soil over 12-inch	minimum 3 ft	C
DIP in rock, all sizes	minimum 3 ft	C
Copper	All	C
Reinforced Concrete Pipe (RCP)	All	B-2
Other types not listed here	All	B-2

D. Placement of Embedment:
1. Place embedment material at the trench bottom with proper allowance for bell joints. Level materials in continuous layers not exceeding 6 inches in compacted depth. Shovel slicing of embedment shall be performed along the sides of the pipe as embedment is placed, to consolidate the bedding and haunching below the pipe.
2. Consolidate granular embedment by rodding, spading and compacting as necessary to provide uniform pipe support and meet the compaction requirement.

3.8 CRUSHED ROCK: Crushed rock shall be placed when shown on the Drawings or specified herein. Crushed rock shall be placed on suitably prepared subgrade and compacted by vibration. Crushed rock shall be kept free from dust, clay or trash. Crushed rock shall be compacted to not less than 90 percent of the maximum density for that material in accordance with ASTM D-1557.

3.9 BACKFILLING

A. General:
1. All trenches and excavations around structures shall be backfilled to finish grade according to the Drawings. Backfill with material as specified herein.
2. Large compaction equipment, including self-propelled compaction equipment, bulldozers, loaders, and boom-mounted vibratory plates, shall not be used within 3 feet above the top of pipe, or within 3 feet of new or existing structures.

3. If backfilling operations do not meet the specifications, the material shall be removed, replaced and re-compacted at the Contractor's expense.
4. Backfill shall not be placed when material is frozen, contains frost, snow, waste material, trees, organic matter and rubbish or when the surface to receive backfill is snow
5. No backfill shall be placed over or around any structure until the concrete or mortar has attained a minimum compressive strength of 2,000 psi and can support the loads imposed by backfilling and traffic.

B. Trench backfill: Backfill for all pipeline trench excavation shall be placed by the end of each working day around all pipe laid that day, leaving only the working end of the pipe uncovered. Any trenches excavated in advance of pipe laying shall also be backfilled at the end of each working day.
1. For trenches beneath proposed structures, slabs, or in areas which have or will have a paved or chip-and-seal surface, or where indicated on the Drawings to use granular fill material:
   a. Granular fill material shall be shall be placed on the compacted pipe embedment, in layers not to exceed 12 inches in compacted thickness.
   b. Granular fill material shall be compacted by vibratory means. Each lift of granular fill shall be compacted to a minimum 95 percent of maximum density as determined by ASTM D-698. Backfill shall be placed and compacted at a moisture content within plus 2 or minus 2 percent of optimum. Extreme care shall be used in compaction operations to prevent compacting equipment from contacting the pipe.
2. For trenches in graveled areas, or other vehicle traveled ways which are neither paved nor surfaced with chip-and-seal material:
   a. Select fill material shall be placed on the compacted pipe embedment, in layers not to exceed 12 inches in compacted thickness.
   b. Select fill material shall be compacted to a minimum of 90 percent of maximum density as determined by ASTM D-698. Backfill shall be placed and compacted at a moisture content within plus 3 or minus 3 percent of optimum. Select backfill may be compacted by vibratory plates, tracks or wheels of graders, tractors, high loaders or similar equipment, subject to the restrictions above. Extreme care shall be used in compaction operations to prevent compacting equipment from contacting the pipe.
3. For trenches in other areas, including grassed areas and parkways which are not in vehicle traveled ways:
   a. Random fill material shall be placed on the compacted pipe embedment, in layers not to exceed 18 inches in compacted thickness.
   b. Random fill material shall be compacted to a minimum of 85 percent of maximum density as determined by ASTM D-698. Backfill shall be placed and compacted at a moisture content within plus 3 or minus 3 percent of optimum. Backfill may be compacted by vibratory plates, tracks or wheels of graders, tractors, high loaders or similar equipment, subject to the restrictions above. Extreme care shall be used in compaction operations to prevent compacting equipment from contacting the pipe.

C. Structure backfill:
1. All structures shall be backfilled to the lines and grades shown on the Drawings. In no instance shall backfill be dumped, bulldozed or otherwise deposited in bulk upon the structure. Backfill shall be kept at approximately the same elevation on all sides of the structure as backfilling proceeds.
2. Structure backfill which will be beneath paved areas, slabs, or structures shall be granular fill material, compacted in place to 95% of maximum density as determined by ASTM D-698, at a moisture content within plus 2 or minus 2 percent of optimum. Granular fill shall be placed in lifts not to exceed 8 inches in compacted thickness, and compacted by careful pneumatic or vibratory tamping.
3. Backfill in all other areas shall be select fill material, placed in lifts not to exceed 12 inches in compacted thickness, and compacted in place to 90% of maximum density as

determined by ASTM D-698, at a moisture content within plus 3 or minus 3 percent of optimum.

3.10 SURFACE RESTORATION

A. All areas disturbed by construction operations shall be restored by paving, gravel surfacing, or seeding, as indicated on the Drawings and specified. For areas which are seeded, minimum depth of topsoil shall be six inches. Topsoil shall be a dark, friable, organic soil free of clay lumps and rocks larger than one and half inches in largest dimension.

3.11 IMPERVIOUS TRENCH CHECK

A. Trench checks shall be placed where indicated on the Drawings, or at a maximum interval of 400 feet. If a pipeline segment is at least 100 feet but less than 400 feet, one trench check shall be provided in a location acceptable to the Engineer.

B. Trench checks shall extend the full width of the trench, and the length and depth shall be as indicated on the Drawings. Trench check material shall be placed completely under, around and above pipe, and shall be placed in maximum compacted lifts of 8 inches in thickness and compacted to 95% of maximum density as determined by ASTM D-698. Extreme care shall be used in compaction operations to prevent compacting equipment from contacting the pipe.

3.12 DISPOSAL OF MATERIALS

A. All unused excess excavated material, together with all debris, removed pipe, stones, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by the Contractor, at the expense of the Contractor.

B. Material to be disposed of, including excess material, shall be promptly removed from the site by Contractor. If Contractor desires to set aside excess excavated material free from contamination by sewage or other hazardous substances, he shall do so only in an area approved by the Owner.

END OF SECTION

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SECTION 02530

PIPING SYSTEM PRODUCTS

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall furnish all required piping, fittings, and all accessories for complete and functional piping systems as shown on the Drawings and specified herein.

B. Section Includes:
1. Piping materials for water distribution piping, sanitary sewer piping, piping outside of buildings, and other services.
2. Pipe fitting and accessories.

C. This section does not cover piping installation. See Section 02535 - Piping Systems Installation

1.2 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching: For trenching, embedment, and backfill.

B. Section 02535 - Piping Systems Installation: For installation of products specified herein.

C. Section 02605 - Precast Manholes and Vaults

D. Section 02725 - Waterline Testing and Flushing

E. Section 02726 - Waterline Disinfection

1.3 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the requirements of this section shall govern.

A. American Society for Testing Materials (ASTM):
1. A-193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
2. A-194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
3. A-307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
4. A-746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.
5. B-88 - Specification for Seamless Copper Water Pipe.
6. D-1784 - Rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) Compounds.
7. D-1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, 120.
8. D-2241 - Poly (Vinyl Chloride) Pressure-Rated Pipe (SDR Series).
9. D-2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
10. D-2464 - Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
11. D-2467 - Socket-type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
12. D-2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
13. D-2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
14. D-2837 - Obtaining Hydrostatic Design Basis For Thermoplastic Pipe Materials.

15. D-3034 - Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
16. D-3139 - Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
17. D-3212 - Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals.
18. F-405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings
19. F-437 Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
20. F-439 Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
21. F-441/F-441M Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
22. F-493 Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
23. F-477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
24. F-606 - Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators and Rivets.
25. F-679 - Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
26. F-1970 Standard Specification for Special Engineered Fittings, Appurtenances or Valves for use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems.

B. American National Standards Institute (ANSI)/American Water Works Association (AWWA):
1. C104/A21.4 - Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
2. C105/A21.5 - Polyethylene Encasement for Ductile Iron Pipe Systems.
3. C110/A21.10 - Ductile-Iron and Gray-Iron Fittings 3 In. through 48 In.
4. C111/A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
5. C115/A21.15 - Flanged Ductile Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.
6. C150/A21.50 - Thickness Design of Ductile Iron Pipe.
7. C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
8. C153/A21.53 - Ductile Iron Compact Fittings 3 In. through 24 In. and 54 In. through 64 In. for Water Service.

C. American Water Works Association (AWWA):
1. C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. for Water Distribution.
2. C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. for Water Transmission and Distribution.

D. Uni-Bell PVC Pipe Association:
1. Uni-B-13-92 - Uni-Bell PVC Pipe Association Recommended Performance Specification for Joint Restraint Devices for Use With Polyvinyl Chloride (PVC) Pipe.

1.4 DEFINITIONS

A. Embedment: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.5 SUBMITTALS: The Contractor shall submit the following items required by this division in accordance with Section 01300 - Submittals.

A. Product Data for Review:
1. Pipe and joint materials and details.
2. Details and materials of fittings, pipe accessories, and specials.
3. Specifications, data sheets, and affidavits of compliance for protective shop coatings and linings.

4. Pressure gauge certification and calibration data.

B. Manufacturers Certificates: Contractor shall furnish the following prior to shipment:
1. Affidavit of compliance with applicable standard.
2. Test certificates.

C. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.

1.6 PROJECT RECORD DOCUMENTS

A. Requirements for project record documents are covered under section 02535 - Piping Systems Installation.

PART 2 PRODUCTS

2.1 PIPE MATERIALS

A. Notes on Materials: Each pipe material below is given an alphanumeric abbreviation shown in parentheses, which is shown on the Drawings to denote the applicable specified material for the given size and service.

B. Type PSM Polyvinyl Chloride Sewer Pipe and Fittings (SDR-35 PVC): Shall meet the requirements of ASTM D-1784 cell classification 12454-B for PVC compounds, and ASTM D-3034 for poly vinyl chloride (PVC) sewer pipe.
1. Minimum wall thickness shall conform to Standard Dimension Ratio 35 (SDR 35), except for 4-inch diameter pipe which shall conform to SDR 26.
2. The Contractor shall install the maximum pipe lengths manufactured by the supplier.
3. Joints: Flexible gasketed joints for PVC pipe and fittings shall be compression type joints with the gasket confined in either the spigot or the bell end of the pipe. Rubber gasket rings shall be neoprene or other synthetic material and conform to ASTM D-3212 and ASTM F-477. Natural rubber gaskets will not be acceptable.
4. Fittings: Fitting joints shall be bell and spigot with elastomeric gaskets conforming to ASTM D-3212, unless indicated on the Drawings to be solvent cemented joints, in which case the joint shall conform to ASTM D-2855. Fittings shall not be used unless directed by the Engineer or indicated on the Drawings.

C. Polyvinyl Chloride Plastic Pressure Pipe, Joints, and Fittings (SDR 21 PVC or Class 200): Shall meet the requirements of ASTM D-1784 cell classification 12454-A or 12454-B for PVC compounds, and ASTM D-2241 for (PVC) pressure pipe.
1. Minimum wall thickness shall conform to Dimension Ratio 21 for Class 200.
2. The Contractor shall install the maximum pipe lengths manufactured by the supplier.
3. Joints: Joints shall be push-on type with integral bell and spigot and elastomeric gaskets meeting the requirements of ASTM D-2122 and ASTM D-3139. An integral wall-thickened bell end or an integral sleeve-reinforced bell end will be acceptable. Rubber gasket rings shall be neoprene or other synthetic material and conform to ASTM F-477. Natural rubber gaskets will not be acceptable.
a. Bell restraint clamps: Clamps for restraining bell and spigot joints shall consist of clamping rings and rods, and shall meet the requirement of Uni-B-13-92. Restraint devices shall be of ductile iron, ASTM A536, Grade 65-45-12, with connecting bolts of high strength, low alloy metal in accordance with ANSI/AWWA C111-A21.11. All ferrous metal surfaces shall be shop coated with an epoxy coating for corrosion resistance. Bell restraint clamps shall be Ford Meter Box "Series 1350 Uni-Flange Block Buster", Romac "Series 611", or approved equal.

4. Joints for wastewater forcemain piping shall be groove& spline coupling with o-rings (flexible elastomeric seal). This piping shall be Certa-Lok Yelomine as manufactured by CertainTeed or Engineer approved equal.
5. Thrust restraints shall be concrete thrust blocks where possible. Where blocks are not possible, Contractor may use bell restraint clamps.

D. High Density Polyethylene Plastic Pipe (HDPE): The polyethylene pipe shall meet the requirements of ASTM D-3350 for cell classification 345464C and AWWA C906. The pipe material shall be listed and approved for potable water in accordance with NSF standard 61.
1. Water main 3-inch and smaller: Wall thickness shall conform to ASTM D-3035 and ASTM F-714, minimum working pressure of 200 psi, the pipe size shall be compatible with the existing water main. Pipe shall be Driscoplex “4000 PE 3408” or Engineer approved equal.
2. Joints: Joints in HDPE pipe, fittings, and adapters shall be thermally welded by butt fusion as recommended by the pipe manufacturer.
3. Fittings: HDPE fittings shall be fabricated of pipe with a wall thickness at least as thick as the adjacent pipe, or greater as required by AWWA C906. Mitred bends shall have a minimum of five segments for 90 degree bends, a minimum of three segments for 45 degree bends.
4. Flange Adapters: Flange adapters for connecting HDPE pipe to PVC pipe shall consist of a stub of polyethylene pipe which is integrally molded with a polyethylene flange. Minimum flange face thickness shall be 1.5 times the pipe wall thickness, and the flange diameter and drilling shall match that of the mated ductile iron flange. Bolts shall be evenly tighten according to the pattern and torque step recommendations of the manufacturer. A flange gasket shall be used. A flange backer ring of ductile iron or stainless steel shall be used. Flange bolts shall be stainless steel.
5. Mechanical Joint Adapters: Flange adapters for connecting HDPE pipe to ductile iron pipe shall consist of a stub of polyethylene pipe which is integrally molded with a polyethylene retaining ridge which is designed to fit against a ductile iron pipe mechanical joint bell and gasket. Bolts shall be evenly tighten according to the pattern and torque step recommendations of the manufacturer. A ductile iron follower gland shall be provided. Joint bolts shall be stainless steel.

E. Steel Casing Pipe
1. Casing pipe shall be installed as indicated on the Drawings to provide for repair, removal, and replacement of the carrier pipe without interference to traffic or disturbance of the feature being crossed by the carrier pipe.
2. Casing pipe and joints shall be made of metal and of leak proof construction. Casings shall be capable of withstanding E-80 loading (including impact).
3. Steel pipe shall have minimum yield strength of 35,000 pounds per square inch.
4. All metallic casing pipes are to be designed for effective corrosion control, long service life and relatively free from routine servicing and maintenance. Corrosion control measures must include cathodic protection.
5. Cast iron may be used for casing. It shall conform to ANSI A21. The pipe shall be connected with mechanical-type joints. Plain-end pipe shall be connected with compression-type couplings. The strength of the cast iron pipe to sustain external loads shall be computed in accordance with the most current ANSI A21.1 “Manual for the Computation of Strength and Thickness of Cast Iron Pipe.”
6. Wall thickness designated for steel casing pipe for E-80 loading shall be as follows:

Nominal Diameter (inches)	Min. Thickness for Coated (inches)	Min Thickness for Non-Coated (inches)
16 and Under	0.188	0.188

Nominal Diameter (inches)	Min. Thickness for Coated (inches)	Min Thickness for Non-Coated (inches)
18	0.250	0.312
20 and 22	0.281	0.344
24	0.312	0.375
26	0.344	0.406
28	0.375	0.438
30	0.406	0.469
32	0.438	0.500
34 and 36	0.469	0.531
38, 40 and 42	0.500	0.563
44 and 46	0.531	0.594
48	0.563	0.625
50	0.594	0.656
52	0.625	0.688
54	0.656	0.719
56 and 58	0.688	0.750
60	0.719	0.781
62	0.750	0.813
64	0.718	0.844
66 and 68	0.813	0.875
70	0.844	0.906
72	0.875	0.938

7. The inside diameter of the casing pipe shall be such that the carrier pipe can be removed without disturbing the casing. All joints or couplings, supports, insulators or centering devices for the carrier pipe shall be considered in the casing diameter.

F. Plastic Casing Pipe

1. Plastic casing pipe shall be used and installed as indicated on the Drawings to provide for repair, removal, and replacement of the carrier pipe without interference to traffic or disturbance of the feature being crossed by the carrier pipe.
2. Casing pipe and joints shall be of leak proof construction.
3. The inside diameter of the casing pipe shall be such that the carrier pipe can be removed without disturbing the casing. All joints or couplings, supports, insulators or centering devices for the carrier pipe shall be considered in the casing diameter.
4. Plastic casing pipe shall be of the same or better quality pipe as the carrier pipe.

2.2 PIPE ACCESSORIES

A. Banded Couplings: Banded couplings for gravity piping shall be synthetic rubber repair couplings with stainless steel clamping ring bands, BANDSEAL by Dickey, Fernco coupling or approved equal. Banded couplings shall be provided to transition between different materials and sizes as required.

B. Pipe grouting rings: Pipe grouting rings shall be synthetic rubber, with stainless steel take-up clamps. Ring and clamps shall meet or exceed the requirements of ASTM C-923. Grouting rings shall be matched to the outside diameter of the carrier pipe. Grouting rings shall be Press-Seal Gasket Corporation “WS Series WaterSTOP Grouting Rings” or approved equal.

C. Mechanical couplings: Mechanical couplings shall be gasketed, sleeve-type, sized to properly fit the pipes to joined, with steel or ductile iron middle ring, steel or ductile iron follower rings, and synthetic rubber gaskets. Gaskets shall be SBR, Buna-N, or EPDM. All ferrous metal surfaces shall be shop coated with an epoxy coating for corrosion resistance. All hardware shall be 300 series stainless steel. Mechanical couplings shall be Ford Meter Box "Style FC1, Style FC2A, Style FC3, or Style FC23", Dresser "Style 38, Style 153, or Style 162", Smith-Blair "441 or 411", or equal.

D. Dismantling Couplings: Dismantling couplings shall consist of ANSI flanged spigot which telescopes within an ANSI flanged adaptor to provide at least 1.5-inch of longitudinal adjustment. Spigot piece shall be ASTM A-283 Grade C steel. Flange adaptor shall be ASTM A-536 Grade 65-45-13 ductile iron. Tie bars shall be tensile steel. Gaskets shall be EPDM suitable for sewage. Tie bars, nuts, and washers shall be zinc coated. Flange adaptor and flange spigot shall be coated with a thermoplastic polymer coating, Rilsan "Nylon 11" to a thickness of 12 mils. Dismantling couplings shall be Viking-Johnson "Dismantling Joints" or approved equal.

E. Transition Couplings: Transition couplings shall be of ductile iron construction. Couplings shall be of the wide range type to fit Steel, Cast Iron, Ductile Iron, PVC, and HDPE with only a change of gaskets. Coupling sleeves shall be 5" in length on 2" - 2-1/2" nominal sizes, and 6" in length on nominal sizes 3" - 12". Ductile Iron couplings shall be JCM 210, 211, 212, Smith-Blair 461, 462, or approved equal.

1. Couplings shall be ANSI/NSF Standard 61 and Standard 61 Annex G Certified.
2. Couplings shall meet or exceed the ANSI/AWWA C-219 Standard as applicable.
3. Sleeve & Flanges: Ductile Iron Per ASTM A536 65-45-12.
4. Gaskets: Styrene-Butadiene Rubber (SBR), compounded for use with water, salt solutions, mild acids and bases, with excellent abrasion resistance. Per ASTM D-2000. Standard temperature range from -40° to 150° F (-40° to 65° C) constant, maximum intermittent 180° F (82° C).
5. Bolts: 5/8" Corrosion resistant, high strength low alloy oval neck track head bolts per ASTM A242/ANSI 21.11/AWWA C111 and heavy hex nuts per A563 or equal.
6. Coating: Corrosion resistant shop coat paint primer.
7. Working Pressure: Fittings shall be rated for 150 psi working pressure when installed per manufacturer's instructions.

F. Flange Adapters: Flange adapters shall be the cast iron slip-on type retained by set screws. Flange body shall be ductile iron, ASTM A-536, Grade 65-45-12. Set screws shall be manufactured form AISI 4140 steel, heat treated to Rockwell C 42-50 and zinc plated. Set screws shall have break away torque heads. Flange adaptors shall conform to ANSI B16.1 for machining and drilling. Gaskets shall be standard mechanical joint gaskets, EPDM or Buna-N. All non-plated ferrous metal parts shall be shop primed with an epoxy primer, for finish painting in the field. Flange adaptors shall be Ford Meter Box Corporation "UNI-Flange Series 200" or equal.

G. Wall Pipes: Wall pipes shall be ductile iron, cast as a single piece or fabricated. Ends shall be plain end, mechanical joint, or flanged as indicated on the Drawings. Where wall pipes are to be installed flush with the wall or slab, the flange or bell shall be tapped for studs. Where the flange or bell will project beyond the wall, the projection shall be sufficient to allow for installation of connecting bolts.

H. Wall/Floor Sleeve Assemblies:

1. Wall sleeves: Sleeves shall be either:
   a. HDPE thermoplastic with molded-in waterstop and reinforcing ribs. Nailer caps shall be provided for setting in forms. Thunderline Corp. "Model CS" or equal.
   b. Fabricated from heavy-wall welded or seamless carbon steel pipe, with full circle waterstop continuously welded to sleeve. Sleeve shall fabricated to proper wall thickness, and hot dip galvanized after fabrication. Thunderline "Model WS" or equal.
2. Floor Sleeves: Shall be as specified above for galvanized steel wall sleeves.

3. Modular casing seal: Shall have black EPDM seal elements, composite seal plates, and 18-8 stainless steel bolts and nuts. The sizing and number of seal links shall be accurately sized to accommodate the pipe outside diameter and the sleeve inside diameter. Modular casing seals shall be Thunderline “Link Seal Model S” or equal.
4. In lieu of wall sleeve assemblies specified above, Contractor may also provide Omni-Sleeve wall sleeve assemblies.
5. Where wall sleeves are to be installed flush with the wall or slab, the flange or bell shall be tapped for studs. Where the flange or bell will project beyond the wall, the projection shall be sufficient to allow for installation of connecting bolts.

I. Flexible Expansion Sleeves: Flexible expansion sleeves shall be synthetic butyl rubber. The body shall consist of fabric and various rubber compounds reinforced with steel rings. The cover shall be suitable for service conditions, formed from natural rubber or synthetics and coated with a Hypalon paint. All materials shall be suitable for temperatures up to 250° F for pressure and vacuum service. Flexible expansion sleeves shall be single arch configuration, Redflex “SL-50” or equal.

J. Arch Expansion Joints and Reducers: Arch expansion joints and reducers shall be Neoprene, Hypalon, or Buna-N. Joint shall allow 3/4-inch elongation. The tube shall be a leak-proof lining of natural rubber or synthetic. The body shall consist of fabric and various rubber compounds reinforced with steel rings. The cover shall be suitable for service conditions, suitable for 250°F, formed form natural rubber or synthetics and coated with a Hypalon paint. Flanges shall be made of duck and rubber construction and full-faced with 150 lb ANSI standard drilling. Standard or tapered reducing arch expansion joints shall be provided indicated on the Drawings.

2.3 GRANULAR EMBEDMENT MATERIAL

A. Granular embedment material shall be as specified in Section 02320 - Earthwork and Trenching.

2.4 BACKFILL MATERIALS

A. Backfill materials shall be as specified in Section 02320 - Earthwork and Trenching.

2.5 TRACER WIRE

A. Tracer wire shall be installed in the trench with all non-metallic pipe as detailed on the Drawings.

PART 3 EXECUTION

3.1 Refer to Section 02535 - Piping Systems Installation

END OF SECTION

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SECTION 02535

PIPING SYSTEM INSTALLATION

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall install all required piping, fittings, embedment materials, and all accessories for complete and functional piping systems as shown on the Drawings and specified herein.

1.2 SECTION INCLUDES

A. Installation of piping, fittings, and accessories.

B. Process piping/waterline acceptance testing.

1.3 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching: For trenching, embedment, and backfill.

B. Section 02530 - Piping System Products: For products installed herein.

C. Section 02605 - Precast Manholes and Vaults

D. Section 02725 - Waterline Testing and Flushing

E. Section 02726 - Waterline Disinfection

1.4 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the requirements of this section shall govern.

A. American Society for Testing and Materials (ASTM):
   1. D-2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
   2. D-2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping
   3. D-2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

B. American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):
   1. B1.20.1 - Pipe Threads, General Purpose, Inch
   2. B31.1 - Power Piping

C. American Public Works Association (APWA):
   1. Section 2500 Sanitary Sewers

D. American Water Works Association (AWWA):
   1. C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. for Water Distribution.
   2. C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. for Water Transmission and Distribution.

E. Uni-Bell PVC Pipe Association:
   1. Uni-B-13-92 - Uni-Bell PVC Pipe Association Recommended Performance Specification for Joint Restraint Devices for Use With Polyvinyl Chloride (PVC) Pipe.

1.5 DEFINITIONS

A. Embedment: Fill placed under, beside, and directly over pipe prior to subsequent backfill operations.

1.6 SUBMITTALS

A. Submittals for piping system products are covered under Section 02530 - Piping System Products.

1.7 PROJECT RECORD DOCUMENTS

A. Record location of pipe runs, connections, and invert elevations.

B. Record type of pipe material installed.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.8 REGULATORY REQUIREMENTS

A. Conform to applicable codes and ordinances for disposal of debris.

B. Contractor shall notify utility companies prior to commencement of construction and coordinate work with utilities as required.

1.9 FIELD MEASUREMENTS

A. Verify that field measurements and elevations are as indicated on the Drawings.

PART 2 PRODUCTS

2.1 Refer to Section 02530 - Piping System Products

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that the pipeline lines and grades are as shown on the Drawings.

3.2 PREPARATION

A. The Contractor shall verify the location and depth of all utilities prior to construction. Prior to commencement of work the Contractor shall notify all those companies which have facilities in the vicinity of the construction.

3.3 PROTECTION

A. Locate, identify, and protect utilities that remain, from damage. The Contractor shall make every reasonable effort to protect all existing utilities from damage. If any utility is damaged through the carelessness or neglectful actions of the Contractor, the utility shall be repaired by its owner at the Contractor's expense.

B. Relocation of an existing utility which is within the public right-of-way shall be performed by the respective utility owner at no cost to the Contractor. Relocation and protection of an existing utility which is within a utility easement shall be the responsibility of the Contractor.

C. Any private facilities damaged or disturbed by the Contractor's work shall be repaired by the Contractor prior to close of the working day. Repairs shall be made in a manner sufficient to restore utility service to that property.

D. Protect trees, plant growth, and features designated to remain as final landscaping.

E. Protect all property or lot corner pins and stakes from damage or displacement. If property or lot corner markers must be moved, they shall be properly referenced prior to removal and reset by the Contractor upon completion of the project.

F. Protect from damage or displacement all project benchmarks and existing structures within or adjacent to the construction limits that are not to be removed or demolished.

3.4 SEPARATION OF WATER AND SEWER UTILITIES

A. Gravity Sanitary Sewers: When potable water pipes (excluding service water pipes downstream of a backflow preventer) and gravity sanitary sewers are laid parallel to each other, the horizontal distance between them shall be not less than 10 ft. The distance shall be measured from edge to edge. The laying of water pipes and sanitary sewers shall be in separate trenches with undisturbed earth between them. In cases where it is not practical to maintain a 10 ft. separation, the Engineer will consult with MDNR to consider equivalent protection by other methods.
   1. When a water pipe and a sanitary sewer cross and the sewer is 18 inches for MDNR or more (clear space) below the water pipe, no special requirements or limitations are provided herein. At all other crossings, the Engineer will consult with MDNR to consider equivalent protection by other methods.
   2. Joints in the sewer pipe shall be located as far as practical from the intersected water main.

B. Sewer Manholes: No water pipe shall pass through or come in contact with any part of a sewer manhole.

C. Storm Sewers: The separation distance between a storm sewer (which is not a combined storm/sanitary sewer) and a water main, if encountered, shall be determined by the Engineer based on geotechnical considerations. Required separation distances between water mains and combined storm/sanitary sewers are equivalent to those for water mains and gravity sanitary sewers.

D. Drains: Underground drains from fire hydrants or valve pits should not be directly connected to sanitary or storm drains.

3.5 PIPE EMBEDMENT/ENCASEMENT

A. Material and installation for pipe embedment and concrete encasement shall be provided as indicated on the Drawings and specified in Section 02320 - Earthwork and Trenching.

3.6 PIPE INSTALLATION

A. All pipe shall be protected during transport, storage and installation from shock and free fall. Pipes shall be installed without cracking, chipping, breaking, bending or damaging the materials. Damaged pipe shall be replaced with new materials except when repairs are permitted by the Engineer. Use slings, lifting lugs, hooks and other protection devices during handling.

B. Install pipe of the size, material, strength class, and joint type as specified or indicated on the Drawings. Every pipe fitting is not called out on the Drawings. Contractor shall provide fittings required to connect piping as shown on piping plans, and plan and profile Drawings. Additional fittings required to make vertical changes in elevation to avoid utilities or to meet connections shall be provided at no additional cost to Owner.

C. The maximum fitting bend for force mains and pressurized process piping shall be 45 degrees. When multiple fittings are assembled adjacent to make deflections in alignment, adequate piping shall be provided between for thrust restraint.

D. Where cutting of pipe is allowed, pipe shall be cut from measurements taken at the site and not from the Drawings.

E. Install gravity pipelines beginning with the lowest point of the pipeline and install pipe with the spigot or tongue end downstream. Install pressure pipelines with the bell ends facing the direction of laying, except when reverse laying is specifically authorized by the Engineer.

F. Install pipe to the line and grades indicated on the drawings. Unless otherwise noted on the Drawings, minimum cover over top of pipe shall be 42 inches. Maximum slope variation from true slope shall be one inch between structures for gravity sewers. The maximum variation from alignment between structures shall be two inches. Joint deflection shall not exceed the maximum allowable deflection per joint according to the governing standard. The pipe manufacturers maximum recommended deflection limits, if more stringent, shall govern over the referenced standards.
   1. Only one correction for alignment and/or grade shall be made between structures.
   2. The Contractor shall establish such grade control devices necessary to maintain the specified tolerance. All pipe shall have a continuous slope free of depressions.

G. Pipe installation shall be in accordance with applicable standards, such as ASTM C-12, D-2321 and ANSI/AWWA C600, except where conflicts with this section occur, in which case this section shall govern.

H. Clean the interior of all pipe fittings and joints prior to installation. Protect pipe against the entrance of debris and foreign matter during discontinuance of installation and at the close of the working day by installing a close fitting plug at the open end. Plugs shall be water tight against heads up to 20 feet of water.

I. The Contractor shall take whatever means necessary to keep the trenches free of water and as dry as possible during pipe installation, bedding and jointing operations.

J. After each pipe has been brought to grade, aligned and placed in final position, place sufficient embedment material under the haunches and on each side of the pipe to hold the pipe in proper position during subsequent pipe jointing, bedding and backfilling operations. Place embedment material uniformly and simultaneously on each side of the pipe to prevent lateral displacement. Embedment material shall be compacted as specified in Section 02320 - Earthwork and Trenching.

K. Pipe Jointing: Locate joints to provide for differential movement at changes in type of embedment, concrete collars and encasement and structures. Pipe jointing shall be according to the following specifications:
   1. Clean and lubricate all joint and gasket surfaces as recommended by the manufacturer.
   2. Examine all materials prior to installation for soundness and compliance with specifications.
   3. Check joint position and condition after assembly prior to installing additional pipe sections.
   4. Check joint opening and deflection for specification limits.

L. Pipe cutting shall be performed in a neat and workmanlike manner without damage to the pipe. Main taps for service saddle tees shall be made with a tapping tool specifically designed for that purpose. Cut edges shall be smoothed by power grinding to remove burrs and shape edges.

M. Pipe connection to structures: Pipe connection to new structures shall be as shown on the Drawings.

3.7 REQUIREMENTS FOR PIPE JOINTS: Pipe joints shall be carefully and neatly made, in accordance with the requirements which follow.

A. Flanged: Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but not so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly. Connecting flanges shall have similar facings, i.e., flat or raised face.

B. Push-on: Gasket installation and other jointing operations shall be in accordance with the recommendations on the manufacturer. Each spigot end shall be suitable beveled to facilitate assembly. All joint surfaces shall be lubricated with a heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean.

C. Rubber Gasketed: When rubber-gasketed joints are used for hub and spigot type cast iron soil pipe, spigot ends shall be plain, without beads. Cut ends of all pipe shall be cut square and all burrs removed. Spigot ends shall be coated with a lubricant recommended by the gasket manufacturer and fully seated in the gasket. Clamps for hubless cast-iron soil pipe shall be installed in accordance with the manufacturer's recommendations.

3.8 PLASTIC PRESSURE PIPE (PVC)

A. Pipe joints shall be assembled according to manufacturer's instructions. Joints shall be restrained with bell restrained clamps in locations where restrained joints are required, as specified herein.

B. Mechanical joint fittings shall be assembled as specified herein for ductile iron pipe.

3.9 JOINT RESTRAINT FOR PRESSURE PIPING: Joint restraint shall be provided for portions of buried piping which will serve in a pressure flow application, including: water lines and pump discharge lines.

A. Joint restraint for all pressure pipe shall be accomplished by means of thrust blocks, as shown and detailed on the Drawings.
   1. All plugs, caps, tees, bends and hydrants shall be provided with thrust blocks according to the details in the plans, and using 3,000 psi concrete.
   2. The concrete shall extend from the fitting or hydrant to undisturbed soil and poured or formed so that joints are accessible. If adequate soil support cannot be obtained, a mechanical restraining assembly shall be installed.

B. Where specifically indicated on the Drawings, mechanical restraint shall be provided in place of concrete thrust blocks.

C. Mechanical joint restraint for pressure pipe shall be accomplished using bell restraint clamps for joints between pipes, and fitting restraint devices at joints with fittings, as specified herein. Joints shall be restrained for a minimum distance as recommended by the manufacturer of the joint restraint device being used and for the conditions in which the pipe is installed.

3.10 DIRECTIONALLY DRILLED CROSSINGS

A. Directionally drilled crossings shall be performed in accordance with industry practice, and shall include all labor, equipment and consumables necessary to accomplish the following:
   1. Clearing, grading, and general site/access preparation necessary for construction operations;
   2. Transportation of all equipment, labor, consumables, and Owner supplied materials to and from the jobsite;
   3. Erection of horizontal drilling equipment at the drill site;
   4. Reaming the pilot holes to a diameter suitable for installation of the prefabricated pull sections;
   5. Installation of the prefabricated pull sections along the reamed holes;
   6. Fabrication of the pull sections; and
   7. Clean-up and restoration of all work areas.

B. Horizontal directional drilling type machines shall be used when a minimum bend radius is specified on the project "Drawings". Contractor shall not bore a radius smaller than specified on the project "Drawings". Wash boring is not permitted.

C. Sodium Bentonite and/or gel type drilling muds are permitted for cuttings removal, borehole stabilization and carrier pipe lubrication on pullback.
   1. No fluid shall be approved or used that does not comply with permit requirements and environmental regulations. Drilling fluid shall not contain any additives that impart taste, odor, or contain hazardous materials.
   2. Disposal of drilling fluids shall be the responsibility of the Contractor and shall be conducted in compliance with all relative environmental regulations, right-of-way and workspace agreements, and permit requirements.
   3. Mud pits shall be suitably lined and bermed to prevent leakage to the surrounding area. All barrels, tanks, connections, valves, lines, etc. shall be maintained in good condition so that leaks do not occur. Should a leak occur, any spillage shall be cleaned up immediately and the cause of the leak remedied.
   4. The drilling Contractor shall be responsible for mud containment/disposal.
   5. The Contractor is responsible for securing permits and transporting all excess fluids to an approved disposal site.

D. Pulling:
   1. Before inserting a plastic pipe through a bored hole, ensure that the size of the bore is of sufficient diameter to prevent stress during insertion.
   2. The pull section shall be supported during pull back so that it moves freely.
   3. A swivel shall be used to connect the pipeline pull section to the reaming assembly to minimize torsional stress on the pipeline pull section.
   4. A leader or fuse link approximately four feet long of the next smaller size PE pipe shall be added to the pulling hitch.
   5. The pull section shall be installed in 1 continuous length with no tie-in welds, if possible. If this is not possible, tie-in welds shall be minimized.
   6. The leading end of the inserted pipe shall be closed to prevent entrance of dirt and water.
   7. After insertion, the leading end shall be examined in the exit bell hole to see if there are any scratches or gouges which would indicate contact with sharp objects.
   8. If the pipe is damaged or distorted, remove the pipe and pull a plug through the bore to clean the hole. Repeat this process as many times as necessary until the leader passes through the bore undamaged.
   9. The maximum allowable pulling force on the pipeline pull section shall not exceed 5,500 pounds.
   10. The Contractor shall at all times provide and maintain instrumentation which will accurately locate the pilot hole and measure drilling fluid flow discharge rate and pressure. The Owner shall have access to these instruments and their readings at all times.
   11. Polyethylene has elastic properties, and if the pulling load on the pipe does not exceed the Safe Pull Strength, the pipe will relax back to its original pre-pull length. After the pull is

complete, a relaxation period of several hours is necessary before final tie-in. The pipe shall be pulled slightly past the tie-in point to accommodate pipe contraction and facilitate final tie-in.

E. Tracer Wire: In an "uncased" insertion of plastic pipe through a bored hole, a 12-gage copper clad steel core tracer wire shall be attached to the leading pipe and inserted along with the pipe. Care shall be used to try and minimize the twisting of the wire around the pipe.

F. The contractor shall be responsible for any and all damages to the highway and or Outer road caused by the boring operations.

3.11 CASING PIPE INSTALLATION

A. Casing and pipeline installations should be accomplished by directional boring, jack-and-bore, tunneling or other approved methods. Tunneling construction under railroad tracks will be permitted only under direct supervision of the owner of the railroad. Generally, tunneling shall not be considered where less than six (6) feet of cover exists, or where excessively sandy, loose or rocky soils are anticipated.

1. For cased crossings of railroads:
    a. Tunneling procedures and equipment, as well as structural design, must have the railroad owners approval prior to starting any work on railroad property.
    b. Rail elevations over the work must be monitored at intervals prescribed by the railroad to detect any track movement. Movements of over one-quarter (1/4) inch vertically shall be immediately reported to the Railroads designated representative. Due to the danger to rail traffic that is caused by only small amounts of track movements, the Railroad may have to be called to surface the track several times.
2. The following requirements shall apply to the above construction methods:
    a. The use of water under pressure jetting or puddling will not be permitted to facilitate boring, pushing or jacking operations. Some boring may require water to lubricate cutter and pipe, under such conditions, is considered dry boring.
    b. Where unstable soil conditions exist, boring or tunneling operations shall be conducted in such a manner as not to be detrimental to the roadway or railroad being crossed.
    c. If excessive voids or too large a bored hole is produced during casing or pipeline installations, or if it is necessary to abandon a bored or tunneled hole, prompt remedial action should be taken by the Contractor.
    d. All voids or abandoned holes caused by boring or jacking are to be filled by pressure grouting. The grout material should be sand cement slurry with a minimum of two (2) sacks of cement per cubic yard and a minimum of water to assure satisfactory placement.
    e. The hole diameter resulting from bored or tunneled installations shall not exceed the outside diameter of the utility pipe, cable casing (including coating) by more than one and one-half (1-1/2) inches for pipes with an inside diameter of twelve (12) inches or less, or two (2) inches on pipes with an inside diameter greater than twelve (12) inches.

B. Vents. In casing pipe installations, vents are appurtenances by which fluids or gases between carrier and casing may be inspected, sampled, exhausted or evacuated.

1. Vents shall be located at the high end of short casings and at both ends of casing longer than one hundred fifty (150) feet.
2. Vent standpipes shall be located and constructed so as not to interfere with maintenance of the roadway or railroad, or to be concealed by vegetation. Where possible, they shall be marked and located at the property line. The markers shall give the name and address of the owner, and a phone number to contact in case of emergency.

3. Casing pipe, when sealed, shall be properly vented. Vent pipes shall be of sufficient diameter, but in no case less than two (2) inches in diameter and shall be attached near each end of casing, projecting through ground surface at property lines.
4. Vent pipes shall extend not less than four (4) feet above ground surface. Top of vent pipes shall be fitted with a down-turned elbow, properly screened; or a relief valve.
5. For pipelines carrying flammable materials, vent pipes on casings shall be at least 16 feet (vertically) from aerial electric wires. Casings shall be suitably insulated from underground conduits carrying electric wires on roadway or railroad right-of-way.

3.12 PIPE ACCESSORIES

A. Mechanical couplings: Mechanical couplings shall be carefully installed in accordance with the manufacturer's recommendations. Pipe ends shall be separated by a space of at least 1/4 inch but not more than 1 inch. Pipe and coupling surfaces which contact gaskets shall be clean and free from dirt during assembly. Following installation of the coupling, damaged areas of shop coatings on the pipe and couplings shall be repaired.

B. Flange Adapters: Flange adapters shall be carefully installed in accordance with the manufacturer’s recommendations. Following installation of the adapter, damaged areas of shop coatings on the pipe and couplings shall be repaired.

C. Wall Pipes: Where wall pipes with flanged or mechanical joint ends are installed, the bolt holes in the bell of the wall pipe shall straddle the top centerline of the casting. The top centerline shall be marked on the wall pipe at the foundry.

3.13 GRAVITY PIPING ACCEPTANCE TESTING

A. All new segments of sewer or other gravity piping between manholes or structures will be subject to acceptance testing under this subpart. Segments of piping which are shorter than 100 feet will not be subject to testing.

B. Visual Inspection:
1. Clean pipe of excess mortar, joint sealant, dirt and debris prior to inspection.
2. Inspect the sewer by lamping the pipeline between manholes to determine the location of any misaligned, displaced or broken pipe and any visible infiltration or defects. In large pipes where space permits, the visual inspection may be made by physical passage.
3. Correct defects as required prior to conducting leakage tests.

C. Air Leakage Test:
1. Contractor shall perform air leakage tests for all pipe sizes.
2. Notification: Contractor shall notify Owner at least 48 hours in advance the scheduled time for testing. Resident Project Representative shall be present for acceptance testing and approval.
3. Contractor shall provide all necessary equipment for performance of the air leakage test, including but not limited to piping connections, pipe plugs with taps, test pumping equipment, pressure gauges, bulkheads and regulators to avoid over pressurization. The equipment and gauges shall meet the minimum specifications set forth in ASTM F-1417. The air equipment shall consist of necessary valves and pressure gauges to control an oil-free air source and the rate at which air flows into the test section to enable monitoring of the air pressure within the test section.
4. Gauge certification from the manufacturer and calibration data shall be required for all pressure test gauges, a copy of which will be made available to the Engineer at the time the air tests are performed.
5. Test each reach of pipe between manholes after completion of pipe and appurtenance installation and trench backfill.

6. Plug ends of sewer line at manholes and cap or plug all lateral connections to withstand internal pressure. One plug shall have two taps for connecting equipment. After connecting air control equipment to the air hose, begin increasing the air supply within the pipe section, monitoring the air pressure so that the internal pressure does not exceed 6.0 psig.
7. After the internal pressure reaches 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least two minutes in order to reach equilibrium between air temperature and pipe walls. During this time, check all plugs for leaks. If leaks are found, bleed off air, tighten plugs and begin increasing the air supply again.
8. Air testing shall take place by the Time-Pressure Drop Method. Decrease the pressure to 3.5 psig and begin timing to determine the time required to achieve a pressure drop from 3.5 to 2.5 psig. If the time, in seconds, to achieve the 1.0 psig pressure drop is greater than that shown in the following table, the line is presumed free of defects. For pipe sizes and lengths other than those shown in the table below, refer to ASTM F-1417.

Required Time for Length up to Length Indicated, min:sec

Pipe Size	up to 100 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
8"	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10"	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12"	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15"	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18"	17:00	25:38	32:03	38:37	44:52	51:16	57:41
21"	19:50	34:54	43:37	52:21	61:00	69:48	78:31
24"	22:47	45:34	56:38	68:22	79:46	91:10	102:23
27"	28:51	57:41	72:07	86:32	100:57	115:22	129:48

9. If the air test fails to meet the requirements, repair the defects and retest the line. All constructed sewer lines shall pass the low pressure air test prior to acceptance.
10. In areas where ground water is known to exist, a 2-inch diameter, 10 inch long, capped pipe nipple shall be installed at the top of the pipe through the manhole wall during installation. Immediately prior to performing the acceptance test, the ground water level shall be determined by connecting a clear plastic tube into the nipple and holding vertically until the water level stops rising. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to the test readings.
11. Reinforced Concrete Pipe shall be air tested in accordance with ASTM C924 - Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.

D. Deflection Test for Flexible Sewer Pipe:
1. Prior to final acceptance, the Contractor shall perform a diametral deflection test on all flexible and semi-flexible pipe (such as PVC plastic pipe). Tests shall be conducted between manholes or structures. Deflection testing of a segment of sewer shall occur at least 30 days after the pipe has been installed and completely backfilled.
2. The maximum allowable deflection shall be five percent of the inside pipe diameter. A mandrel with a diameter equal to 95 percent of the inside diameter of the pipe to be tested shall be used. Any section of sewer failing the diametral deflection test shall be repaired or replaced by the Contractor at no cost to the Owner, and retested.

3.14 PRESSURE PIPING ACCEPTANCE TESTING

A. All new pressure piping will be subject to hydrostatic pressure testing under this subpart. Force mains and pressure sewers shall be tested from the point of discharge to the isolation valves in the

corresponding lift station(s). New segments of pipelines which will be connected to existing lines shall be pressure tested prior to connection.

B. Water lines, including potable water and service water, shall be tested in accordance with Section 02725 - Water Line Testing and Flushing, and shall be disinfected after hydrostatic testing in accordance with AWWA C651 and Section 02726 - Water Line Disinfection.

C. Notification: Contractor shall notify Ownerr at least 48 hours in advance of the scheduled time for testing. Resident Project Representative shall be present for acceptance testing and approval.

D. Test Conditions:
1. Test pressure shall be 100 psi (gauge) for the sewage forcemain, for process piping and for other pressure pipes. This pressure will not exceed the thrust-restraint design pressure.
2. The hydrostatic test shall be of at least a 2 hour duration. Test pressure shall not vary by more than ∀5 psi for the duration of the test.
3. Contractor shall pressure test new forcemain in segments or increments not to exceed 3,000 feet.
4. If Contractor chooses to test in segments, provide AWWA resilient seated gate valves or temporary valves.

E. Test materials: Contractor shall supply all of the necessary plugs, hose, riser pipe, pumps, gauges, and other equipment as required for the testing. The Contractor shall obtain permission from the Owner for use of Owner's water supply from an existing fire hydrant.

F. Pressurization: After the pipe has been laid and backfilled, the section of pipe shall be isolated. The pipe shall be slowly filled with water. Before applying the specified test pressure, air shall be expelled completely from the section of piping under test. If permanent air vents are not located at all high points, corporation cocks shall be installed at such points so that the air can be expelled as the line if filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged or left in place as directed by the Engineer. The specified test pressure (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) shall be applied by means of a pump connected to the pipe. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure. The system will be allowed to stabilize at the test pressure before the leakage test is conducted.

G. Examination: All exposed pipe, fittings, valves, and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until satisfactory results are obtained.

H. Leakage: Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time. Allowable leakage shall be as follows:

Pipe Size (inches)	Allowable Loss 50 psig test pressure (gallons per hour per 1,000 feet)	Allowable Loss 100 psig test pressure (gallons per hour per 1,000 feet)
1.5	0.080	-
2	0.106	-
4	0.212	0.30
6	0.319	0.45
8	0.425	0.60

10	0.531	0.75
12	0.637	0.90
14	0.743	1.05
16	0.849	1.20
18	0.956	1.35
20	1.063	1.50

I. Acceptance of Installation: Acceptance shall be determined on the basis of allowable leakage. If any test of pipe discloses leakage greater than that specified above, repairs or replacements shall be accomplished in accordance with the specifications. All visible leaks shall be repaired regardless of the amount of leakage.

3.15 AIR PIPE ACCEPTANCE TESTING

A. All new air piping shall be subject to testing under this subpart. Air piping shall be tested from the point of discharge to the isolation valves at the corresponding blowers.

B. Notification: Contractor shall notify Engineer at least 48 hours in advance of the scheduled time for testing. Resident Project Representative shall be present for acceptance testing and approval.

C. Test Conditions:
1. High Pressure (above 15 psi): High pressure air piping shall be tested at a pressure of 150 psi for a duration of at least 2 hours.
2. Low Pressure (below 15 psi): Low pressure air piping shall be tested at a pressure of 25 psi for a duration of at least 2 hours.

3.16 FIELD QUALITY CONTROL

A. Perform field inspection and testing.

B. Compaction and soil testing will be performed in accordance with Section 02320 - Earthwork and Trenching.

END OF SECTION

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SECTION 02605

PRECAST MANHOLES AND VAULTS

PART 1 GENERAL

1.1 The Contractor shall furnish and install all manholes, covers, and accessories, and perform all repairs to existing manholes, as shown on the Drawings and specified herein, and tested by Contractor for approval by the Engineer.

1.2 SECTION INCLUDES

A. Aggregate and Backfill Materials.

B. Manhole and Vault Materials.

C. Manhole and Vault Accessories.

D. New Sanitary Sewer Manholes and Appurtenances.

E. Manhole Wall Reconstruction.

F. Pipe Connections to Manholes.

G. Manhole Testing.

1.3 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching

B. Section 02530 - Piping System Products

C. Division 3 - Concrete

1.4 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the requirements of this section shall govern.

A. Midwest Concrete Industry Board (MCIB) Standard Specification for Concrete Work.

B. American Society for Testing Materials (ASTM):
1. A-48 - Gray Iron Castings
2. A-615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
3. C-32 - Sewer and Manhole Brick (Made From Clay or Shale)
4. C-139 - Concrete Masonry Units for Construction of Catch Basins and Manholes
5. C-270 - Mortar for Unit Masonry
6. C-478 - Precast Reinforced Concrete Manhole Sections, except for the modifications herein.
7. C-923 - Specification for Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes
8. C-1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure Test

1.5 SUBMITTALS: The Contractor shall submit the following items required by this division in accordance with Division 1.

A. Product Data for Review:
   1. Manholes, castings, manhole appurtenances.
   2. Manhole repair products
   3. Repair mortar

B. Manufacturer's Installation Instructions: Indicate special procedures required to install products specified.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.6 FIELD MEASUREMENTS

A. Verify that field measurements and elevations are as indicated on the Drawings.

PART 2 PRODUCTS

2.1 AGGREGATE AND BACKFILL MATERIALS

A. Crushed rock: Crushed rock material used as a foundation and for leveling of manholes, shall be as specified in Section 02320 - Earthwork and Trenching. Granular pipe embedment material may also be used.

B. Backfill materials shall be as specified in Section 02320 - Earthwork and Trenching.

2.2 MANHOLE AND VAULT MATERIALS: Manhole materials shall conform to the details on the Drawings, and to the following:

A. Precast manholes and vaults: New manholes and vaults shall be constructed of precast concrete with developed base (DB) or precast concrete with cast-in-place (CIP) base.
   1. Precast concrete manholes with CIP base: The precast concrete manholes shall conform to ASTM C-478. All precast concrete shall be 4,000 psi with ASTM C-150, Type II cement. Concrete poured on site shall be 4,000 psi, as specified in Section 03300 - Cast-in-Place Concrete. Joints between the riser sections shall be a double gasketed joint of joint sealant material. Where possible, pipe openings for pipe connections shall be furnished with cast-in-place flexible entrance seals. Otherwise, pipe connections for pipes grouted in place shall be made using pipe grouting rings. Boxouts for grouting shall have surfaces grooved or roughened to improve grout bond.
   2. Precast concrete manholes with developed base: The precast concrete manhole shall conform to ASTM C-478. All concrete shall be 4,000 psi with ASTM C-150, Type II cement. The developed base shall be cast monolithic with the bottom riser section. The base reinforcement shall be continuous with the reinforcement of the bottom riser section. Manhole supplier shall verify that barrel reinforcement is sufficient for the depth of installation. Joints between the riser sections shall be a double gasketed joint of joint sealant material. Pipe openings shall be furnished with cast-in-place flexible entrance seals.
   3. The minimum shell thickness for precast reinforced manholes shall be:
      a. At a depth of 0 to 16 feet: One-twelfth internal shell diameter or 4 inches, whichever is greater.
      b. At a depth of 16 feet or greater: One-twelfth internal shell diameter plus one inch, or 5 inches, whichever is greater.

B. Adjusting rings: Adjusting rings shall be precast concrete, with circumferential reinforcement per ASTM C-478. The use of two or three grade adjustment rings under the manhole frame and cover is recommended in undeveloped areas where grade adjustment may be necessary.

C. Lifting notches: Precast sections may be provided with lifting notches on the inside faces of walls to facilitate handling. Lifting notches shall be not more than 3 inches deep. Holes extending through a wall will not be acceptable.

D. Castings: Manhole rings and lids shall be constructed of gray cast iron conforming to ASTM A-48. Castings for standard manholes shall be Neenah R-1726-A or approved equal with "Sanitary" cast on the lid. Castings for standard shallow manholes shall be Neenah R-1726-A or approved equal with "Sanitary" cast on lid. Castings for "bolt-down lid" manholes and lids, as indicated on the Drawings, shall be Neenah R-1916-F or approved equal.

E. Protective coating: The protective coating for the exterior of manholes shall be Koppers Company, Inc. Bitumastic No. 50 or Tnemec Company, Inc. "Series 46-465 H.B. Tnemecol" or approved equal. Pre-cast manholes shall be shop coated.

F. Joint sealant: Joint sealant material used for sealing the joint between the manhole frame and chimney or corbel/cone section shall be pre-formed butyl rubber mastic joint sealant, BIDCO C-56 or equal.

G. Clay brick (for repairs to existing manholes): Clay or shale brick shall conform to the requirements for ASTM C-32, Grade MS or SM. Brick may be either solid or cored.

H. Mortar/Grout: Mortar/grout for brick work and other uses as required shall be a general construction grade grout prepared to a stiff, trowelable consistency. Grout product shall be a non-shrink, non-catalyzed grout containing mineral aggregate, and having a minimum compressive strength of 8,500 psi at 28 days in a plastic consistency. Grout shall be Master Builders "Construction Grout", W.R. Meadows "Sealtight CG-86", or equal.

1. Preparation of grout mortar: Grout shall be prepared according to the recommended proportions of the manufacturer. Grout mortar may be extended with clean aggregate as recommended by the manufacturer. Grout mortar shall be mixed only in such quantities as needed for immediate use. The retempering of grout mortar will not be permitted.

I. Repair Mortar: Repair mortar shall be a one-component, shrinkage-compensated, cement based product. Repair mortar shall have a low permeability and be freeze/thaw durable and resistant to chlorides and sulfates. Repair mortar shall be a single-component product requiring only the addition of potable water for mixing. Repair mortar shall have a minimum compressive strength of 3,800 psi at 1 day and 11,000 psi at 28 days.

1. For hand application: Master Builders "Emaco S88-CI" or approved equal.
2. Pourable or pumpable: Master Builders "Emaco S77-CR" or approved equal.

2.3 MANHOLE AND VAULT ACCESSORIES

A. Pipe grouting rings: Pipe grouting rings shall be synthetic rubber, with stainless steel take-up clamps. Ring and clamps shall meet or exceed the requirements of ASTM C-923. Grouting rings shall be matched to the outside diameter of the carrier pipe. Grouting rings shall be Press-Seal Gasket Corporation "WS Series WaterSTOP Grouting Rings" or approved equal.

B. Flexible entrance seals: Cast-in-place flexible entrance seals shall be "A-LOK" flexible seals manufactured by A-LOK Products Incorporated or "Press Wedge II" manufactured by Press-Seal Gasket Corporation or approved equal.

C. Manhole steps shall be Neenah R-1980-J, Clay & Bailey 2102-01-620 and 2102-01-6300, GCI MS 1114B or Engineer approved equal.

PART 3 EXECUTION

3.1 SEPARATION OF WATER AND SEWER UTILITIES

A. SEWER MANHOLES: No water pipe shall pass through or come in contact with any part of a sewer manhole.

3.2 NEW MANHOLES: New manholes shall be constructed of precast concrete sections, with cast iron frames and covers in accordance with the Drawings and as specified herein.

A. Handling: Precast concrete sections shall be handled carefully and shall be protected during transport, storage and installation from shock and free fall. Hooks shall not be permitted to come into contact with joint surfaces. Per ASTM C-478, damaged sections adversely affecting the watertightness of the sections shall be replaced with new sections, except when repairs are permitted by the Engineer.

B. Inspection: Precast concrete sections shall be inspected when delivered and all cracked or otherwise visibly defective units rejected.

C. Manhole construction:

1. Precast concrete manholes with cast-in-place base: Construct manhole with precast concrete section on a cast-in-place concrete foundation slab as shown on the Drawings. Concrete base shall be poured over a base of crushed stone. Joint seals between each riser section shall be installed in strict conformance with manufacturer's recommendations. Damaged exterior coating shall be touched up and allowed to dry prior to backfilling.
2. Precast concrete manholes with a developed base: Precast manholes with a developed base shall be placed on a base of crushed stone as detailed on the Drawings. The crushed stone base shall be graded smooth, level and to the correct grade. The bottom riser section shall be placed upon the crushed stone base and checked for alignment, elevation and plumbness. If not correct, the bottom riser section shall be completely removed from the excavation and the crushed stone base reshaped. Pipe connections to the manholes shall be in strict conformance with manufacturer's instructions for installation of the flexible entrance seals. Joint seals between each riser section shall be installed in strict conformance to manufacturer's recommendations. Damage to exterior coating shall be touched up in the field prior to backfilling.

D. Inverts: The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section.

1. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly.
2. The floor of the manhole outside the channels (the bench) shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot.
3. Invert channels shall be formed in the field using either concrete readi-mix, or clay brick and mortar as specified herein. Where brick and mortar used, mortar shall be placed completely around each brick to a minimum thickness of 3/8 inch. Manhole inverts formed directly in the concrete of the manhole base of developed-base manholes will not be acceptable.

E. Flexible entrance seals: Where cast-in-place flexible entrance seals are used to seal pipe connections to new manholes, the concrete or mortar of the field-installed invert shall extend exactly half-way up

the pipe, to the springline. No concrete or mortar shall be placed around the pipe on the exterior of the manhole.

F. Frames and covers: Unless shown otherwise on the Drawings, all castings shall be set flush with finish grade in all roadways and lawns, and at least 12 inches above finish grade in all other areas.

G. Manhole steps: Steps shall be set in expanding grout and in a vertical row 16-inches on center. Locate steps 45 deg from centerline of outlet pipe or on largest clear wall equal distance from pipes to avoid locating steps over pipe.

3.3 MANHOLE WALL RECONSTRUCTION

A. Where damaged by the Contractor's operations, required by other sections, or indicated on the Drawings, the walls of existing manholes shall be rebuilt using clay brick and mortar. If repair of the manhole wall is adjacent to the sewer pipe wall penetration, repair mortar shall be used in place of mortar.

B. Where joining new work or repair work to existing surfaces, the existing surfaces shall be solid, clean, and sufficiently rough to create a good bond. If surfaces of existing materials are not solid or are prone to crumbling, Contractor shall remove existing materials as required to reach a clean, hard surface.

C. Brick units shall be laid in such a manner that the courses are true to line and the joints fully bonded.
1. In a structure of circular cross section, the bricks shall be laid with the long dimension radially in the structure.
2. In a structure of rectangular design, the bricks shall be laid in alternate courses of headers and stretchers.

D. Exterior faces of masonry shall be plastered at least ½-inch thick with mortar.

3.4 PIPE CONNECTIONS TO MANHOLES

A. Pipe connection to new manholes shall be as shown on the Drawings.

B. Pipe connection to new manholes shall be made with cast-in-place flexible entrance seals wherever possible, following the entrance seal manufacturer's instructions.

C. Pipe connection to existing manholes, and to new manholes where boxouts are used shall be made with approximately two inches clearance surrounding the pipe or fitting. A pipe grouting ring shall be placed around the outside of the pipe where the pipe enters the manhole. The opening between the pipe and structure shall be filled with repair mortar to form a water tight seal.

D. Pipe connections to existing manholes shall be made in such manner that the finish work will conform to the essential applicable requirements specified for new manholes, including all necessary concrete work, cutting and shaping. When new sewer piping is connected to an existing manhole, manhole benches and invert shall be repaired using repair mortar.

E. Repair Mortar: Repair mortar used to fill voids around pipes or to repair walls and benches of manholes shall be mixed, applied, and cured according to the manufacturer's recommendations.
1. Preparation: Surfaces to receive repair mortar shall be solid and free of oil and grease. The concrete surfaces to receive repair mortar shall be saturated or in a saturated, surface-dry condition as recommended by the manufacturer. The mix may be extended with pea gravel or other suitable aggregate, as limited by the manufacturer's recommendations.
2. Mixing shall be accomplished with a slow speed drill equipped with a paddle or an appropriate size mortar mixer.

3. Placement: Repair mortar used to fill voids and holes shall be hand-placed in plastic form or poured in flyable form, as required by the manufacturer's recommendations for the product used.
4. Application of repair mortar in vertical and horizontal layers shall conform to the thickness limitations of the manufacturer.
5. Curing: Repair mortar shall be protected against rapid loss of moisture by covering with wet rags or polyethylene sheets. The repair mortar shall be wet cured for at least 7 days. As an alternative to moisture curing, a two-coat application of a curing compound recommended by the manufacturer may be used.

3.5 MANHOLE TESTING

A. Manhole leakage test: All new precast manholes and existing manholes which have been rehabilitated shall pass a vacuum leakage test. Contractor shall conduct vacuum tests.

B. Notification: Contractor shall notify Owner at least 48 hours in advance the scheduled time for testing. Resident Project Representative shall be present for acceptance testing and approval.

C. Pre-Test Inspection: All precast concrete manholes shall be visually inspected to determine the presence of misaligned, displaced, broken manhole sections or other physical defects. All defects shall be satisfactorily corrected prior to conducting vacuum leakage tests.

D. Each manhole shall be tested immediately after assembly and prior to backfilling. All lifting holes shall be plugged with repair mortar. No standing water shall be allowed in the excavation during testing.

E. Vacuum testing procedure: All pipes entering the manhole shall be plugged, taking care to securely brace the plugs from being drawn into the manhole. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturer's recommendation. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to nine inches. The manhole shall pass if the time is greater than 60 seconds for a 48-inch diameter manhole, 75 seconds for 60 inches, and 90 seconds for 72 inches. If the manhole fails the initial test, necessary repairs shall be made by replacing the joint seals and/or pipe seals. Retesting shall proceed until a satisfactory test is obtained. If the joint mastic or gasket is displaced during the vacuum testing, the manhole shall be disassembled, the seal replaced and the manhole retested. Manholes which cannot be made to pass in this manner shall be replaced.

3.6 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01400 - Quality Control.

END OF SECTION

SECTION 02725

WATERLINE TESTING AND FLUSHING

PART 1 GENERAL

1.1 This section applies to all work associated with pressure testing and flushing of newly installed water lines throughout the distribution system. The work shall consist of all labor and equipment necessary to perform the testing and flushing as outlined below.

1.2 SECTION INCLUDES

A. Disinfection sequence

B. Filling of potable water mains.

C. Testing of pressure lines

D. Flushing of potable water mains.

1.3 RELATED SECTIONS

A. Section 02535 - Piping Systems Installation

B. Section 02726 - Water Line Disinfection

PART 2 MATERIALS

2.1 CORPORATION STOPS

A. The Contractor shall provide corporation stops and saddles, at intervals no greater than 6 miles, to facilitate planned testing and disinfection sequences and procedures. After use is complete, the corporation stop will be replaced with a brass plug.

2.2 WATER

A. Water for filling and flushing lines shall be furnished by Owner at no cost to the Contractor

2.3 ACCESSORIES

A. Contractor shall furnish all equipment and material including temporary flanges, plugs, valves, fittings, etc., for testing. All materials are subject to approval by the Engineer.

PART 3 EXECUTION

3.1 DISINFECTION SEQUENCE

A. When timing and direction of filling and flushing are governed by the Owners water supply and operational limitations or abilities, the basic sequences will be described in Division 1 - General Requirements. The Contractor must observe these requirements unless changes are granted by prior written approval from the Owner and Engineer.

B. For disinfection sequence and procedures, refer to Section 02726 - Water Line Disinfection.

3.2 FILLING OF WATER MAINS

A. The water mains shall be constructed, backfilled, thrust blocking completed, and all necessary associated work completed before the water mains are filled.

B. Resident project representative shall review the details, sequence, and schedule of filling prior to beginning operation.
   1. The filling shall consider the City's system and water demands, and be done in such a manner and time so as to provide as little disruption of normal service as possible.
   2. Filling shall normally begin at low points in the main and be at such rate as to allow air to escape without entrapment through blowoffs or cleanouts.
   3. The rate of fill shall not be greater than that tolerable to the suppliers system.

C. Fill water mains with potable water only.

D. Where additional air releases are needed, the Contractor shall provide the necessary 3/4-inch corporation stops and saddles on the top of the pipe at high elevations to allow for the removal of air. Such taps shall be plugged with properly threaded brass plugs subsequent to the pressure and leakage test.

E. Some flushing may be done during the filling operation to ensure that all air is removed.

3.3 TESTING OF PRESSURE LINES

A. It has been observed that allowing the mains to be under some pressure for a few days after filling, and bleeding off at high points several times during this period, reduces the amount of entrapped air and aids testing.

B. It is the intent of this specification that all joints be watertight and free from leaks, and each leak which may be discovered, at any time prior to the expiration of one year after the date of final acceptance by the Owner, shall be repaired by and at the expense of the Contractor.

C. The Contractor may, at his convenience, make tests upon the system in addition to those listed above.

D. Allowing a lapse of at least 5 days after the placing of thrust or backing blocks, all newly-laid pipe and its appurtenances or any valved section thereof shall be subjected to pressure and leakage tests.

E. Tests to be observed by the Engineer are intended to be demonstrations of satisfactory performance. The Contractor shall satisfy himself that the section to be demonstrated will pass a test before requesting an observed test.

F. Cross-connection control. When existing water mains are used to supply test water, they should be protected from backflow contamination by temporarily installing a double check-valve assembly between the test and supply main or by other means approved by the purchaser. Prior to pressure and leakage testing, the temporary backflow protection should be removed and the main under test isolated from the supply main.

G. Procedure. The following procedure is based on the assumption that the pressure and leakage tests will be performed at the same time. Separate tests may be made if desired. If separate tests are made, the pressure test shall be performed first. Tests shall be performed only after the pipeline has been properly filled, flushed, and purged of all air. The specified test pressure shall be applied by means of an approved pumping assembly connected to the pipe in a manner satisfactory to the purchaser. The test pressure shall not exceed pipe or thrust-restraint design pressures. If necessary, the test pressure shall be maintained by additional pumping for the specified time during which the system

and all exposed pipe, fittings, valves, and hydrants shall be carefully examined for leakage. All visible leaks shall be stopped. All defective elements shall be repaired or removed and replaced and the test repeated until the allowable leakage requirements have been met.

H. Test Method. The constructor may perform simultaneous pressure and leakage tests or perform separate pressure and leakage tests on the installed system at test durations and pressures specified in Table 1. Test shall be witnessed by the purchaser or the purchaser's agent, and the equipment used for the test shall be subject to the approval of the purchaser or the purchaser's agent.

I. Allowable leakage. The constructor shall furnish the gauges and measuring device for the leakage tests, pump, pipe, connections, and all other necessary apparatus, unless otherwise specified, and shall furnish the necessary assistance to conduct the test. The duration of each leakage test shall be 2 hours, unless otherwise specified. During the test, the pipeline shall be subjected to the pressure listed in Table 1. Leakage shall be defined as the quantity of water that must be supplied into the pipe section being tested to maintain a pressure within 5 psi (34 kPa) of the specified leakage test-pressure after the pipe has been filled with water and the air in the pipeline has been expelled. No installation will be accepted if the leakage is greater than that determined by the formula:

$$L = \frac{SD\sqrt{P}}{148{,}000} \qquad \text{(Eq. 1)}$$

Where,

L = allowable leakage, in gallons per hour
S = length of pipeline tested
D = nominal diameter of the pipe, in inches
P = average test pressure during the leakage test, in pounds per square inch (gauge)

Table No. 1: System Test Methods

Procedure	Pressure	Duration of Test
Simultaneous Pressure and Leakage Tests	150% of working pressure* at point of test, but not less than 125% of normal working pressure at highest elevation. H	2 hrs
Separate Pressure Tests	150% of working pressure* at point of test, but not less than 125% of normal working pressure at highest elevation. H	1 hr
Separate Leakage Tests	150% of working pressure* of segment tested. H	2 hrs

* Working pressure is defined as maximum anticipated sustained operating pressure.

H In no case shall the test pressure be allowed to exceed the design pressure for pipe, appurtenances, or thrust restrains.

Table No. 2: Allowable Leakage per 1,000-ft of Pipe* - gph[H]

Avg. Test Pressure		Nominal Pipe Diameter, in. (mm)											
psi	(kPa)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	14 (350)	16 (400)	18 (450)	20 (500)	24 (610)	30 (760)	36 (915)
300	(2,070)	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81	3.51	4.21
275	(1,900)	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69	3.36	4.03
250	(1,720)	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56	3.21	3.85
225	(1,550)	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43	3.04	3.65
200	(1,380)	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29	2.87	3.44
175	(1,210)	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15	2.68	3.22
150	(1,030)	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99	2.48	2.98
125	(860)	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81	2.27	2.72
100	(690)	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62	2.03	2.43
75	(520)	0.23	0.35	0.47	0.59	0.70	0.82	0.94	1.05	1.17	1.40	1.76	2.11
50	(340)	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.96	1.15	1.43	1.72

* If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

H To obtain leakage in liters per hour, multiply the values in the table by 3.72

These formulas are based on an allowable leakage of 10.5 gpd/mi/in. (0.978 L/day/km/mm) of nominal diameter at a pressure of 150 psi (1,030 kPa).

1. Leakage values determined by the above formulas are presented in Table 2.
2. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.078 gph/in. (0.0012 L/h/mm) of nominal valve size shall be allowed.
3. When hydrants are in the test section, the test shall be made against closed hydrant valves.
4. All visible leaks shall be repaired, regardless of the amount of leakage.
5. Alternative allowable-leakage criteria may be used if specified by the purchaser.

3.4 FLUSHING OF POTABLE WATER MAINS

A. Thoroughly flush mains after successful completion of testing requirements. Flushing is no substitute for preventive measures taken before and during pipe installation of potable water mains. Certain contaminants resist flushing at any velocity.

B. Govern maximum rates and duration by the availability of potable water for flushing.

C. A minimum flushing velocity is 2.5 feet per second.
   1. Rate of flow to produce this velocity in various diameters is as follows:

Pipe Size	G.P.M.
2-inch	25
4-inch	100
6-inch	220
8-inch	370
12-inch	880
14-inch	1,132
16-inch	1,565

D. Flush through cleanouts and fire hydrants.

E. Progress from points near the supply connection to the end of the main.

F. Take precautions so as not to damage property or drainage courses.

END OF SECTION

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SECTION 02726

WATERLINE DISINFECTION

PART 1 GENERAL

1.1 This section applies to all work associated with the disinfection of newly installed water lines throughout the distribution system. The work shall consist of all labor and equipment necessary to perform the disinfection as outlined below.

1.2 SECTION INCLUDES

A. Disinfection Sequence

B. Disinfection of water mains

C. Disinfection of tie-ins to existing system

1.3 RELATED SECTIONS

A. Section 02530 - Piping System Products

B. Section 02535 - Piping System Installation

C. Section 02725 - Water Line Testing and Flushing

1.4 RELATED DOCUMENTATION

A. Disinfection Procedures - (Included)

1.5 SUBMITTALS

A. The Contractor shall submit the following items, in accordance with Section 01300:
   1. Product data for review: Product information and Material Safety Data Sheet for disinfection chemical.
   2. Contractor to provide lab tests of water samples from new pipeline to verify successful disinfection.

PART 2 WATER MAIN DISINFECTION PROCEDURES

2.1 All new or repaired potable water lines in the public water supply system must be disinfected before they are put into service. These disinfection procedures are based on the AWWA Standard for Disinfecting Water Mains, C651.

2.2 NONEMERGENCY WATER MAIN DISINFECTION PROCEDURES

A. The basic steps in nonemergency disinfection of water mains are the following:
   1. Prevent the introduction of contaminated material into the main during the installation process.
   2. Flush the main or otherwise utilize methods to remove any contaminants that have entered the main.
   3. Chlorinate the main by use of the tablet, continuous, or slug method and maintain the specified chlorine residual for the minimum required contact time.

4. Flush the heavily chlorinated water from the main. Dispose of the chlorinated water in a manner that will not adversely impact the environment.
5. Confirm the effectiveness of the disinfection procedure through bacteriological testing.

B. Step 1 - Preventive Measures During Construction

1. During construction, the interior as well as all sealing surfaces of pipe, fittings, and other accessories should be kept clean as possible. Inspect the interior of all pipes prior to installation. If dirt enters the pipe, it should be removed and the affected interior of the pipe swabbed with a 1 percent chlorine solution. All openings in pipelines should be closed with watertight plugs whenever the trench is unattended. Sealing, lubricating, or gasket materials used in pipe installation should be stored and handled in a manner that avoids contamination and be suitable for use with potable water.

C. Step 2 - Preliminary Flushing of Mains

1. Before being chlorinated, the main should be completely filled with water to eliminate air pockets and then flushed to purge the line of dirt and debris. This is typically conducted after the completion of the leakage and pressure tests. Ineffective removal of dirt and debris from lines prior to disinfection often leads to failed bacterial tests, requiring repeated disinfection. Preliminary flushing should be accomplished at a rate of at least 2.5 ft/sec. See Section 02725.
2. Water needed to flush and disinfect after the initial procedure shall be purchased at the current residential rate, contractor to verify cost with the City of New Florence.
3. Fittings and valves should be thoroughly cleaned before applying chlorine to a main. Special attention should be given to mechanical joints, fittings, and valves which may contain spaces that are difficult to chlorinate once they become filled with water.
4. Table 1 shows the required flow rate to obtain a velocity of 2.5 ft/sec in commonly used sizes of pipe. Flushing can be enhanced by the use of soft pigs to remove dirt, debris, and air from the main prior to disinfection. The use of pigs can also conserve water and are particularly useful when there is insufficient water supply to attain a 2.5 ft/sec minimum flushing velocity.

Table 1: Flows Required for Various Flushing Velocities

Pipe Size (in)	Pipe Area (sq. ft.)	Flow Required for Given Velocity (gpm)		
		1 ft/s	2.5 ft/s	5 ft/s
2	0.02	10	25	50
4	0.09	40	100	200
6	0.20	90	220	440
8	0.35	155	390	780
10	0.55	245	610	1,220
12	0.79	350	880	1,760
14	1.07	480	1,200	1,400
16	1.40	625	1,570	3,140

D. Step 3 - Chlorination of Mains

1. Chlorine is available in three chemical forms: one of which is approved for this project.
   a. Sodium Hypochlorite - Available in liquid form in 1 qt to 5 gal containers and contains approximately 5 to 15 percent-available chlorine. It includes common household bleaches such as Chlorox or Purex which typically contain approximately 5 to 6 percent-available chlorine. Special precautions must be taken to minimize deterioration of sodium hypochlorite solution in storage.
2. AWWA Standard C651 provides for three methods of chlorination for water mains: tablet, continuous, and "slug". The continuous method is the only preapproved method accepted in this specification. The chlorine dose and minimum contact time for each AWWA

method are summarized in Table 2. Recommendations for disinfection of small sections of mains under emergency repair are also included in Table 2. Methods for measurement of free chlorine residual are summarized in attachment A. Before any disinfection method is utilized, valves must be positioned so that the highly chlorinated water in the main being treated does not flow into water mains in active service.

Table 2: Chlorination Methods for Disinfecting Water Mains

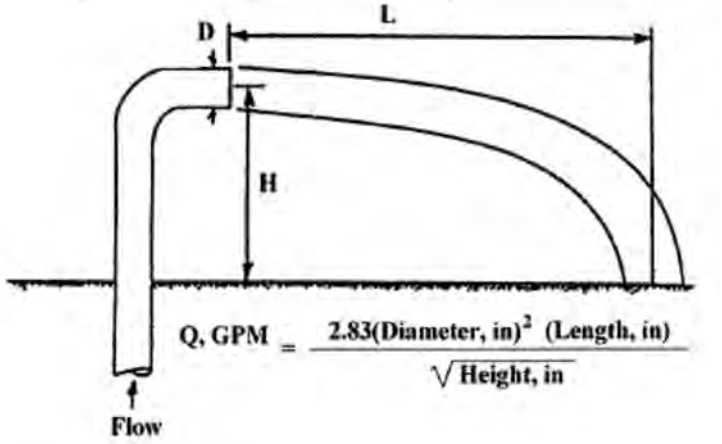
Chlorination Method Used	Initial Chlorine Dose (mg/L)	Minimum Contact Time (hours)	Minimum Chlorine Residual (mg/L)
Non-Emergency Procedures			
Continuous	25	24	10
Slug	100	3	50
Emergency Procedures			
Premixed Solution or Hypochlorite Injection	300	0.25	100
Swabbing	10.00 (1% solution)	---	Swab thoroughly the interior of pipes and fittings used in repairs

3. Factors to consider when choosing a method of chlorination include length and diameter of the main, type of joints present, equipment and materials necessary for disinfection, skills and training of personnel, safety concerns, and whether the main must be put into service on a rapid basis. The continuous and "slug" methods require the use of appropriate chlorine feed equipment and the determination of the necessary chlorine feed rate for the chlorine solution. In long, large-diameter mains, the slug method has the potential for reduction in water and chemicals as compared to the continuous method.
4. Continuous Method
   a. Though this method is referred to as "continuous", it does not require continuous feeding of chlorine into the main over a 24-hour period. The key feature is that the main is "continuously" in contact with at least 10 mg/L free chlorine concentration over 24 hours with an initial dose of 25 mg/L.
   b. Procedure 1 - Injection of Concentrated Chlorine Solution
      1) An alternate approach is to inject a concentrated chlorine solution into the main while filling. The contractor or operator maintains a desired flow rate of water filling the main through an inlet valve on a temporary connection from the existing distribution system or other approved source. At a point no more than 10 ft downstream from the inlet to the main, the concentrated chlorine solution is pumped into the main at a uniform feed rate until the desired chlorine residual (at least 25 mg/L) is measured in the flushed water at the terminal outlet. The main is then shut down and the chlorinated water allowed to stand in the pipe for a 24 hr period. At the end of this time period, the treated water in all portions of the main should have a chlorine residual of not less than 10 mg/L free chlorine as confirmed by measurement of the chlorine residual (see Attachment A).
      2) The concentrated chlorine solution may be prepared from sodium hypochlorite and injected into the main with a chemical-feed pump designed for chlorine solutions. Feed lines and connections should be of

such material and strength as to safely withstand the corrosive effect of the concentrated chlorine solution and the pressure of the pump. The flows of water filling the main and the concentrated chlorine solution must be proportioned so that the resulting chlorine concentration in the main is uniform and at least 25 mg/L. (See Figure 2)

3) In most cases, the chlorine solution injection rate, $Q_{cl\text{-}sol}$, will be significantly less than the rate of filling the main, Q_{fill}. When this is true, Q_{fill} may be considered essentially equivalent to the rate of water exiting the main, Q_{flush}. After startup of the clorine solution injection, the chlorine residual should be checked at the first available outlet, and the hypochlorite injection rate adjusted to obtain at least a 25 mg/L residual.

4) This approach, the injection of a concentrated chlorine solution into a flowing main is consistent with the typical chlorination procedure used by operators in disinfecting a continuous flow of water from a well using a hypochlorite feed system. It does, however, require the maintenance of a specific main filling rate (or flushing rate from the outlet of the pipe) as well as a uniform chlorine solution injection rate. Flow rates may be difficult to measure accurately under field conditions which typically involve temporary connections. In addition to the use of flow meters, methods for estimating flow rates include measuring the time to fill a container of known volume or measuring the trajectory of the discharge from a hydrant and using the formula in Figure 1 below.



The chlorine feed rate into the main, Cl_{feed}, for a 25 mg/L dose (assuming 100%-available chlorine such as supplied by chlorine gas) may be calculated with the following equation:

$$Cl_{feed} = Q_{fill} \text{ x } 1440\frac{\text{min}}{\text{day}} \text{ x } \frac{1 \text{ day}}{24 \text{ hrs}} \text{ x } \frac{1 \text{ mgal}}{1 \text{ x } 10^6 \text{ gal}} \text{ x } 8.34\frac{\text{lb}}{\text{gal}} \text{ x } 24\frac{\text{mg}}{\text{L}} \quad \text{(Eq 1)}$$

where,

Q_{fill} = flow rate of water filling main (gpm)
Cl_{feed} = chlorine feed rate into main (lb of Cl as 100%-avail./hr)

In chlorine feed rate problems, the chlorine solution injection rate, $Q_{cl\text{-}sol}$, and the filling rate of the main, Q_{fill}, are typically assumed and fixed. Where the chlorine solution is applied uniformly to the main during its filling, the time of filling of the main, T_{fill}, is essentially equivalent to the time of chlorine solution injection, $T_{injection}$:

$$\frac{Vol_{main}}{Q_{fill}} = T_{fill} - T_{injection} \quad \text{(Eq 2)}$$

where,

Vol_{main} = volume of main (gal)
Q_{fill} = main filling rate (gpm)
T_{fill} = time to fill main (min)
$T_{injection}$ = time of chlorine solution injection (min)

The minimum volume of chlorine solution, prepared from sodium hypoclorite, may be determined by multiplying the chlorine solution injection rate by the time of chlorine solution injection:

$$Vol_{Cl-sol} = Q_{Cl-sol} \times T_{injection} \quad \text{(Eq 3)}$$

where,

$Q_{cl\text{-}sol}$ = rate of chlorine solution injection (gpm)
$T_{injection}$ = time of chlorine solution injection (min)
$Vol_{cl\text{-}sol}$ = volume of chlorine solution (gal)

c. Procedure 2 - Use of Sodium Hypochlorite

1) Sodium hypochlorite is available in liquid form as a concentrated chlorine solution expressed typically in percent-available chlorine, where 1-percent available chlorine is approximately equivalent to 10,000 mg/L chlorine. Strong solutions of sodium hypochlorite, such as 15 percent, may be injected directly into a flowing main with a chemical feed pump without the necessity of dilution. In such cases the concentration of chlorine in the injected solution is known. For an assumed sodium hypochlorite solution injection rate, $Q_{cl\text{-}sol}$, the filling rate of the main, Q_{fill}, can be determined from the following equation:

$$Q_{fill} = \frac{Q_{Cl-sol} \times Conc_{Cl-sol}}{25 \frac{mg}{L}} - Q_{Cl-sol} \quad \text{(Eq 4)}$$

where,

$Q_{cl\text{-}sol}$= rate of sodium hypochlorite solution injection (gpm)
$Conc_{cl\text{-}sol}$ = chlorine concentration in injected solution (mg/L)
Q_{fill} = main filling rate (gpm)

The following equation determines the necessary amount of sodium hypochlorite to achieve a 25 mg/L chlorine dose in a given main:

$$Vol_{Cl-sol} = \frac{Vol_{main} \times 25 \frac{mg}{L}}{Conc_{Cl-soln}} \quad \text{(Eq 5)}$$

where,

Vol_{main} = volume of main, gal
$Conc_{cl\text{-}sol}$ = concentration of chlorine in sodium hypochlorite solution, mg/L
$Vol_{cl\text{-}sol}$ = volume of sodium hypochlorite, gal

2) The quantities of 15-percent available sodium hypochlorite or 65-percent available calcium hypochlorite (HTH) required to produce a 25 mg/L concentration in water filling a section of main with a length of 100 ft in common diameters are shown in Table 3.

3) Table 3 includes the minimum volume of various sodium hypochlorite solutions (1%, 5%, 10%, and 15%) for direct injection into a 100-ft main to prepare a 25 mg/L chlorine dose. Eq. 2 above may also be used to calculate the required volume of chlorine solution as sodium hypochlorite for a given Vol_{main}, Q_{fill}, and $Q_{cl\text{-}sol}$. For a given Q_{fill}, Eq. 1 above may be utilized to calculate the necessary chlorine feed rate into the main, which is converted to a sodium hypochlorite feed rate by the following equation:

$$\text{Sodium Hypochlorite}_{\text{feed}} = \frac{\text{Cl}_{\text{feed}}}{\frac{\%\ \text{available Cl}}{100}} \quad \text{(Eq 6)}$$

Table 3: Hypochlorite Required to Produce 25-mg/L Dose in 100-ft of Pipe

Pipe Size (in)	Total Pipe Volume (gal)	Hypochlorite Solution (Granules)				
		Percent Available Chlorine				
		1 Percent (gal)	5 Percent (gal)	10 Percent (gal)	15 Percent (gal)	65 Percent (ounces)
2	16.3	0.34	0.0082	0.0041	0.0027	0.084
4	65.3	1.4	0.033	0.016	0.011	0.34
6	147	3.1	0.073	0.037	0.024	0.75
8	261	5.4	0.13	0.065	0.044	1.3
10	408	8.5	0.20	0.10	0.068	2.1
12	587	12.2	0.29	0.15	0.098	3.0
16	1,044	21.8	0.52	0.26	0.17	5.4

Note: 1 percent chlorine solution = 10,000 ppm or mg/L free chlorine.

4) If a sodium hypochlorite solution just be diluted with water to prepare a given volume of less concentrated chlorine solution for injection into the main (e.g., diluting a 15 percent strength solution to form a 5-percent solution), the following equation may be used to determine the necessary volume of concentrated sodium hypochlorite:

$$\text{gallons concentrated solution} = \frac{(\text{gallons diluted solution})\text{x}\ (\%\ \text{diluted solution})}{\%\ \text{concentrated solution}} \quad \text{(Eq 7)}$$

5. Slug Method (This method is not pre-approved)

a. The slug method consists of the formation of a solid column or "slug" of chlorinated water in the main with a free chlorine concentration of at least 100 mg/L. This "slug" of highly chlorinated water must flow through the main at a slow enough rate so that all parts of the main and its appurtenances will be exposed to the highly chlorinated water for a period of at least 3 hr. As the "slug" passes tees, crosses, etc. valves must be operated to ensure their disinfection. This method would be appropriate for very large and long mains where continuous feed is impractical. This method could also be used with smaller mains of limited length where due to time constraints, a 24 hour contact time is not available to comply with the continuous method. By application of the higher initial chlorine dose of 100 mg/L, the required minimum contact time is reduced from 24 hr to 3 hr.

b. The free chlorine residual must be regularly measured in the "slug" during the required 3-hr minimum contact time. If at any time, the free chlorine residual

drops below 50 mg/L, additional chlorine must be applied to the head of the "slug" to restore the free chlorine in the "slug" to not less than 100 mg/L.

E. Step 4 - Final Flushing of Mains

1. After the applicable minimum retention period, highly chlorinated water should be flushed from the main until chlorine residual measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system. Care must be exercised when disposing of water with high free chlorine residuals. Chlorine is toxic to fish and other aquatic life. Disposal of highly chlorinated water to storm sewers should be avoided without neutralization of the chlorine residual where the sewer discharges directly to a creek, river, or lake.
2. Neutralization of the chlorine residual remaining in the water can be accomplished by application of a neutralizing chemical such as sulfur dioxide (SO_2), sodium bisulfite ($NaHSO_3$), sodium sulfite (Na_2SO_3) or sodium thiosulfate ($Na_2S_2O_3$\$5H_2O) in a temporary retention pond, container, or tanker truck. The amount of these chemicals to neutralize various residual chlorine concentrations in 100,000 gallons of water is listed in Table 4. There is also significant reduction of free available chlorine in open ponds or containers primarily due to destruction by sunlight.

Table 4: Amounts of Chemicals Required to Neutralize Various Residual Chlorine Concentrations in 100,000 Gallons of Water

Residual Chlorine Concentration (mg/L)	Chemical Required			
	Sulfur Dioxide (lb)	Sodium Bisulfate (lb)	Sodium Sulfate (lb)	Sodium Thiosulfate (lb)
1	0.8	1.2	1.4	1.2
10	8.3	12.5	14.6	12.0
25	20.9	31.3	36.5	30.0
50	41.7	62.6	73.0	60.0

Adapted from AWWA Standard C651

F. Step 5 - Bacteriological Tests

1. AWWA Standard C651 requires that after final flushing two consecutive sets of acceptable bacteriological samples shall be collected from the new main at least 24 hours apart. At least one set of samples shall be collected at all test sections of the new main at length no greater than 6 miles, plus one set from the end of the line and at least one set from each branch. The bacteriological test required is for the presence of coliform organisms in accordance with *Standard Methods for the Examination of Water and Wastewater.*
2. A brief summary of bacteriological sampling procedures and analytical methods is provided as Attachment B.

2.3 Emergency Water Main Disinfection Procedures

A. When repairs require that mains be opened and depressurized under emergency conditions such as a break or other physical failure of the pipeline, the necessity to restore water service as soon as possible prevents complete compliance with the routine main disinfection procedures of AWWA Standard C651. Alternate disinfection procedures under such conditions were described in detail in an article by R. Scott Yoo, "Procedures for Emergency Disinfection of Mains," *Opflow*, Vol 12, No. 1, (January 1986). The following recommended procedures are based in part on this article:

1. Minimize the entry of contaminants into the repaired main. If possible, repair the break without depressurizing the main by use of clamps, sleeves, or other devices. If the main must be shut down and depressurized during repair, excavated areas should be dewatered to the extent practical to prevent dirty water from contacting the pipe. If a pipe is cut and a

section removed, examine the inside of the remaining pipe ends and remove pieces of pipe, scale, or other debris. Provide temporary plugs to open ends of pipes.

2. If the main has been depressurized and opened, disinfect the pipe by swabbing with a concentrated chlorine solution or by maintaining a high chlorine residual in the repaired section of main for a brief contact period. The swabbing method is quick and is generally effective under repair conditions which do not pose a threat of significant contamination. The swabbing method, however, should not be utilized where there is a potential for significant contamination of the main (for example, sewage is detected in the trench during repairs).
   a. Swabbing Method. All new pieces of pipe, couplings, clamps, sleeves, and other materials used in repair are thoroughly swabbed with a concentrated (1-percent available) chlorine solution to disinfect all surfaces which will come in contact with potable water. The 1-percent chlorine solution may be prepared by adding 2 oz of calcium hypochlorite (65-percent available chlorine) or 26 fl oz of household bleach (5-percent available chlorine) to 1 gal of water. The chlorine solution is typically applied using clean rags or a sprayer. Longer pieces of pipe may be disinfected using a clean mop. When working with hypochlorite compounds, proper personal protection should be worn such as rubber gloves, goggles, and respiratory protection under conditions of inadequate ventilation.
   b. Hypochlorite Injection or Addition of Premixed Solution. In these methods of disinfection, a high chlorine residual is maintained in the repaired section of main for a brief contact period.
3. Preliminary Steps - Both methods require the repaired section of main be isolated from the distribution system. This will require the shut off of all service connections along the section of main to be disinfected. Temporary connections for filling the main with water as well as a method of flushing the main through a hydrant or other temporary outlet must be provided. The isolated section of main must be initially flushed to remove dirty water, debris, and air.
4. Hypochlorite Injection - In the hypochlorite injection method, liquid sodium hypochlorite is injected into the flowing main by means of a chemical-feed pump to achieve a high chlorine residual. The initial required chlorine dose is 300 mg/L, verified by measuring chlorine residuals in the flushed water through an outlet in the end of the section. The minimum amount of hypochlorite solution, which is required to treat one pipe volume with an initial chlorine dose of 300 mg/L, can be calculated using the following equation:
5.

$$\mathrm{Vol}_{\mathrm{Cl-sol}} = \frac{300\,\frac{\mathrm{mg}}{\mathrm{L}}}{\mathrm{Conc}_{\mathrm{Cl-sol}}} \times \mathrm{Vol}_{\mathrm{main}} \quad \text{(Eq 8)}$$

Where,

$\mathrm{Conc}_{\mathrm{cl\text{-}sol}}$ = concentration of chlorine in sodium hypochlorite solution in mg/L, where 1-percent CL solution is approximately equal to 10,000 mg/L.

$\mathrm{Vol}_{\mathrm{main}}$ = volume of main, gal

$\mathrm{Vol}_{\mathrm{cl\text{-}sol}}$ = volume of sodium hypochlorite as a chlorine solution, gal

Table 5 includes the minimum volumes of sodium hypochlorite solution (5- and 12.5-percent available chlorine) necessary to achieve an initial chlorine dosage of 300 mg/L in 100 ft of main. Volumes in excess of the table values will be necessary because pumping must continue until the minimum chlorine dose is verified at the flushing outlet.

Table 5: Hypochlorite Required per 100-ft of Main

Pipe Size (in)	Total Pipe Volume (gal)	Hypochlorite Solution Gallons of 5%		Hypochlorite Solution Gallons of 12.5%		Hypochlorite Granules Ounces of 65%	
		100 mg/L Dose	300 mg/L Dose	100 mg/L Dose	300 mg/L Dose	100 mg/L Dose	300 mg/L Dose
2	16.3	0.03	0.1	0.013	0.039	0.33	1.0
4	65.3	0.13	0.39	0.052	0.16	1.3	4.0
6	147	0.29	0.88	0.12	0.35	3.0	9.0
8	261	0.52	1.6	0.21	0.63	5.4	16.1
10	408	0.82	2.4	0.33	0.98	8.4	25.1
12	587	1.2	3.5	0.47	1.4	12.1	36.2
16	1,044	2.1	6.3	0.84	2.5	21.4	64.3

Note: 5-percent chlorine solution = 50,000 ppm or mg/L free chlorine.

6. Addition of Premixed Solution - An Alternate method is the preparation of a premixed chlorine-water solution in sufficient volume to completely fill the repaired section of main. A hypochlorite compound is added to potable water in a tanker truck or other large container to form a solution with at least 300 mg/L free chlorine (see Table 5). The solution from the tanker truck or large container is pumped into the repaired section of main until the main is full as indicated by a discharge through a hydrant or other outlet at the other end of the section.
7. Minimum Contact Period - The minimum contact period for an initial chlorine dose of 300 mg/L is 15 minutes. After the minimum 15-minute contact period, a chlorine residual of at least 100 mg/L should be verified. Lower initial chlorine doses may be used for longer contact periods (e.g., 100 mg/L initial chlorine dose with a 3-hr contact time).
8. Final Steps - The heavily chlorinated water is flushed from the main until the chlorine residual is reduced to the level normally present in water supplied to the area. Consideration should be given to the collection of bacteriological samples after disinfection is completed to provide a record of the effectiveness of the procedures where repairs were conducted under conditions which posed a threat of significant contamination.

END OF SECTION

(ATTACHMENTS FOLLOW)

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ATTACHMENT A

METHODS FOR TOTAL CHLORINE RESIDUAL MEASUREMENT

Methods for determining total chlorine include amperometric titration, colorimetric DPD, titrimetric DPD, and Iodimetric titration. The most widely used method for field test dsituations is colorimetric DPD. In this method DPD (N,N-diethyl-p-phenylenediamine) is oxidized by chlorine causing a magenta (red) color. The intensity of the color is directly proportional to the chlorine concentration in the sample. Colorimetric DPD field test kits are available from several suppliers. The basic procedure for the DPD Colorimetric method include the following steps:

1) Collect a water sample in the sample tube of the DPD test kit.

2) Add DPD color reagent to the water sample.

3) Match color sample with a color on the comparator to estimate the chlorine residual in mg/L.

Each chlorine test kit is designed to measure total residual chlorine only within a certain range of concentration. The low range instruments typically measure total residual chlorine in concentrations no higher than 3.5 to 5 mg/L. Some manufacturers have produced high range test kits which are capable of measuring chlorine at the level of doses required for disinfection of water mains, e.g. 25 mg/L. However, a low range test kit can be used to measure a chlorine concentration higher than the kit=s range by dilution. This dilution method can be performed in two ways:

1) Graduated Cylinder Method

   a) Collect a 2 mL sample of highly chlorinated water and pour the sample into an empty graduated cylinder (50 mL or greater). Add chlorine free water (distilled) for a total of 50 mL and shake gently. Distilled water can be purchased in most grocery and convenience stores in gallon containers.

Figure A-1. Dilution of Sample

   b) From the graduated cylinder, collect a sample for total residual chlorine analysis using the DPD test kit in the quantity required for the particular kit. Add DPD reagent and estimate chlorine residual based on a colorimetric comparison with the standard according tot he instructions for the particular kit.

   c) Multiply the estimated chlorine concentration by the dilution factor, which is calculated as follows:

$$\text{Dilution Factor} = \frac{\text{Vol. of distilled water} + \text{Vol. of chlorinated sample}}{\text{Vol. of chlorinated sample}} \quad \text{(Eq A1)}$$

Where 2 mL of sample is combined with 48 mL of distilled water in a graduated cylinder, the dilution factor is 24 as determined below:

$$\text{Dilution Factor of 24} = \frac{48\text{ mL of distilled water} + 2\text{ mL of sample}}{2\text{ mL of chlorinated sample}} \quad \text{(Eq A2)}$$

For example, if it is determined that the diluted sample from the graduated cylinder has a chlorine residual of 1 mg/L, the undiluted sample from the disinfected main would have a residual of 25 X 1 mg/L or 25 mg/L. If it is not possible to accurately determine the chlorine residual of the undiluted sample, it may be necessary to provide a different dilution to the sample. For example, if it is anticipated that the chlorine residual is around 100 mg/L (slug method), a more appropriate dilution factor would be 50. This could be obtained by diluting 1 ml of sample with 49 ml of chlorine free water.

2) DPD Drop Dilution Method

a) Add 10 mL of distilled water and one premeasured packet or powder pillow of DPD reagent (or 0.5 mL of DPD solution) to the sample tube of the DPD test kit.

b) Using an eye dropper, add a sample of the highly chlorinated water being tested on a drop-by-drop basis to the sample tube until a color is produced.

c) Record the number of drops added to the sample tube. Assume one drop equals 0.05 mL.

d) Determine the chlorine residual in the sample tube containing the drops of sample, 10 mL of distilled water, and DPD reagent by means of a colorimetric comparison with the standard according to the specific instructions on the DPD test kit.

e) Estimate the chlorine residual in the chlorinated sample from the disinfected main by use of the following equation:

$$\text{Cl Residual}_{\text{sample}}, \text{mg/L} = \frac{(\text{Cl Residual}_{\text{sample tube}}, \text{mg/L})\text{x } (\text{Vol}_{\text{distilled water}}, \text{mL})}{(\text{Vol}_{\text{sample}}, \text{drops})\text{x } (0.05\text{ mL/drop})} \quad \text{(Eq A3)}$$

For example, assume three drops of chlorinated water from the disinfected main produced a chlorine residual of 0.2 mg/L in 10 mL of distilled water in the sample DPD tube. The chlorine residual in the sample of chlorinated water from the disinfected main is determined by use of Eq. A2 as follows:

$$\frac{(0.2\text{ mg/L})\text{x } (10\text{ mL})}{(3\text{ drops})\text{x } (0.05\text{ mL/drop})} = 13.3\text{ mg/L} \quad \text{(Eq A4)}$$

END OF ATTACHMENT A

ATTACHMENT B

BACTERIOLOGICAL SAMPLING AND ANALYSIS

AWWA C651 provides that two consecutive sets of samples, taken at least 24 hours apart, shall be collected from the main and analyzed for bacteriological contamination. If initial bacteriological samples are unsatisfactory, the new main shall be reflushed and additional samples collected and analyzed. According to AWWA C651, if any of the check samples are also unsatisfactory, results are achieved.

Analysis Methods

AWWA Standard C651 provides that bacteriological test of the disinfected main should be conducted in accordance with Standard Methods for the Examination of Water and Wastewater and show the absence of coliform organisms. Total coliform is the indicator group of bacteria for use in monitoring drinking water. The Maximum Contaminant Level for total coliforms as determined by the Safe drinking Water Act is now based on the presence or absence of the indicator bacteria, not on density or direct count. There are four standard laboratory techniques that are approved for coliform analysis:

- MMO-MUG
- multiple tube fermentation (MTF)
- presence-absence (PA)
- membrane filtration (MF)

Number of Samples

AWWA Standard C651 provides that at least one set of samples for bacteriological analysis should be collected from every test section of the new water main, one set from the end of the line, and at least one set from each branch. If trench water or excessive quantities of dirt has entered the new main during construction, AWWA Standard C651 specifies that samples should be taken at intervals of approximately 200 ft and shall be identified by location.

Sample Collection Procedures

2. Use only sterile bottles furnished by the laboratory. Keep the bottles sealed until used. Each sample bottle should contain a dechlorinating agent (typically, sodium thiosulfate) in sufficient amount to neutralize any residual chlorine in the water sample. Do not rinse the bottle prior to taking the sample as such rinsing will remove the dechlorinating agent and render the subsequent sample invalid.

3. Try to avoid collecting your sample from a hose or fire hydrant. Such outlets will often contaminate the sample leading to unsatisfactory results. AWWA Standard C651 recommends the use of a specially installed sampling tap consisting of a smooth, unthreaded, 2-inch hose bib. A corporation stop installed in the main equipped with a copper-tube gooseneck assembly can also function as a sampling tap.

4. Be sure that the heavily chlorinated water has been thoroughly flushed from the main before sampling. Run water through the sampling tap at a steady rate 3 to 5 minutes before beginning sampling procedure.

5. Wash hands thoroughly. Remove the bottle lid just before filling, holding the lid with your free hand. Do not contaminate the inner surface of the cap of the bottle with your hands. Fill the bottle to the shoulder or fill line. Do not overflow the bottle or splash water on the outside of the bottle. Replace the lid and tighten securely.

6. Complete the appropriate sample documentation provided by the laboratory. This will typically include a sample label and chain of custody form.

7. Deliver the samples to the laboratory promptly after collection. There are strict time limits on the amount of time that may elapse between sample collection and analysis before the sample is considered too old to analyze. Check with your laboratory on sample holding time requirements. Unless special arrangements are made, avoid having the sample arrive at the laboratory on weekends or holidays.

8. Samples should be held at a temperature of 41C. If practicable, place samples in an iced cooler for storage during transport if transport time will exceed 1 hour. At no time, however, should the sample container be allowed to become immersed or submerged in the ice or melted ice water. Check with your laboratory for specific packaging and transport recommendations.

END OF ATTACHMENT B

SECTION 02730

AGGREGATE SURFACING

PART 1 GENERAL

1.1 SUMMARY

A. This section of the specifications contains the requirements for construction of the aggregate surfacing for roadway, parking area and pavement replacement in conformity with the dimensions, typical sections, and lines and grades shown on the Drawings.

1.2 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching

1.3 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the section requirements shall govern.

A. Missouri Department of Transportation (MODOT):
   1. Missouri Standard Specifications for Highway Construction
      a. Section 1006 - Aggregate for Surfacing

B. American Society for Testing Materials (ASTM):
   1. C-131 - Test for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine

1.4 SUBMITTALS

A. The Contractor shall submit for approval the following items required by this Division:
   1. Certifications that all materials supplied are in compliance with these specifications.
   2. Aggregate Gradations.

PART 2 PRODUCTS

2.1 SURFACING AGGREGATE

A. Gradation: All materials shall conform to the following gradation: 2011 Missouri Standard Specifications for Highway Construction, Section 1006.3, Grade A:

Sieve Size	% Passing
1 inch	100
3/4 inch	80 - 100
3/8 inch	----
No. 4	60
No. 10	10 - 35
No. 200	0 - 10

B. Percentage of wear: The percentage of wear of surfacing aggregate shall not exceed 55% when tested by ASTM C131.

C. Deleterious material: The percentage of deleterious material shall not exceed the following:

Deleterious rock and shale	12.0
Mud Balls	5.0
Other Foreign Material	2.0

The sum of the percentages of all deleterious substances shall not exceed twelve (12) percent.

PART 3 EXECUTION

3.1 SURFACING CONSTRUCTION

A. Aggregate surfacing shall be placed in one lift on the roadway and parking areas to the lines and dimensions as shown on the Drawings. Where a depth of aggregate is not shown on the Drawings, 6 inches shall be provided.

B. The subgrade shall first be prepared as specified in Section 02320 – Earthwork & Trenching.

C. Aggregate shall be distributed and spread uniformly over the prepared subgrade and then incorporated into the upper two (2) to four (4) inches of the paving bed by the use of a blade, tiller, scarifier or disk until a uniform mixture of aggregate and soil is obtained.

D. The mixture shall then be shaped and compacted until a true uniform surface of proper cross section is obtained and until there is no visible evidence of further consolidation.

END OF SECTION

SECTION 02922

SEEDING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes: This section covers the operations necessary to establish and maintain a grass cover for stabilizing soils on new slopes and swales, and in areas damaged by trenching and construction operations.

B. Contractor shall perform all clearing, grading, fertilizing, preparing of seedbed, seeding, covering and firming of seed into the soil, application of mulch, and maintenance.

1.2 RELATED SECTIONS

A. Section 02320 - Earthwork and Trenching

1.3 SUBMITTALS: The Contractor shall submit the following items required by this division in accordance with the Submittals Section.

A. Product data for review:
1. Representative label bearing the composition of seed mixtures.
2. Label indicating the composition of the fertilizer.

B. Product data for information:
1. Copies of supplier's invoices for all seed, mulch, and fertilizer showing the weight purchased for the project.

1.4 GUARANTEE

A. The Contractor shall unconditionally guarantee a stand of grass that is reasonably uniform in density and reasonably free of weeds, and otherwise acceptable to the Owner for eight weeks after seed has been planted.

PART 2 PRODUCTS

2.1 SEED

A. Seed: All seed shall be labeled in accordance with U.S. Department of Agriculture Federal Seed Act. Seeds shall be free of prohibited weed seeds and shall contain no more than one percent of noxious weed seeds.
1. Seeds shall be delivered to the site in convenient, fully labeled containers bearing the name, trade name or trademark and warranty of the manufacturer with a certificate of the purity and germination of each kind of seed.

2. Type "A" seed mixture shall be used for established yards, shoulders and slopes in street right-of-way and other areas designated on the Drawings. Type "A" seed mixture shall be as follows:

Table 1: Type "A" Seed Mixture

Kind of Seed	Minimum Pure Live Seed (%)	Rate of Pure Live Seed (lb/acre)
Turf Type Tall Fescue	80	105
Perennial Rye Grass	80	65
Kentucky Blue Grass	75	50
Creeping Red Fescue	85	30
Total		250 lb/acre

3. Type "B" seed mixture shall be used for areas outside of the street right-of-way which are not maintained and other areas designated on the Drawings. Type "B" seed mixture shall be as follows:

Table 2: Type "B" Seed Mixture

Kind of Seeds	Minimum Pure Live Seed (%)	Rate (Lbs. per Acre)
Alta Fescue or Kentucky 31 Fescue (Festuca Elatior Var. Arundinces)	75	90
Rye Grass (Lolium Perenne or L. Multiflorum)	80	50
Total		140 lb/acre

2.2 FERTILIZER: Fertilizer shall be a complete commercial grade, minimum 12-12-12 water soluble, fertilizer.

2.3 MULCH: Mulch shall be hay or straw with no viable seeds of noxious weeds.

PART 3 EXECUTION

3.1 PREPARATION

A. Clearing and stripping, earthwork, grading, and placement of topsoil shall be performed as specified in Section 02320 - Earthwork and Trenching.

B. Areas to be seeded containing excess weeds shall be sprayed with a non-selective herbicide, such as Roundup or equal. Follow herbicide manufacturer's instructions for application rates and time after application before seeding can be completed.

3.2 SEEDING

A. Seeding: Seeding shall be performed on all areas disturbed by construction that are not reestablished by sodding, pavement, gravel, driveways and other methods of reestablishment. Included shall be seeding, fertilizing, mulching, preparation of seed bed, and maintenance.
   1. Fertilizer shall be evenly distributed before tilling, at a rate of six hundred (600) pounds per acre (7 pounds per 500 square feet) and incorporated into the soil to a depth of at least two inches by discing or harrowing.
   2. Those areas designated to be seeded shall be cleared and graded prior to tilling. The surface shall be tilled to a depth of at least two inches by discing or other approved methods until

the surface is suitable for seeding. The prepared surface shall be maintained until seeding and mulching is completed to prevent excessive weeds, gullies, and depressions.

3. Seeding and fertilizing shall be performed between February 15 and April 15 or between August 15 and October 15. The specified seed shall be sowed using a mechanical spreader or drill at the application rate. Successive seeding strips shall be overlapped to provide uniform coverage. Seed sown by broadcast type seeders shall be raked in or otherwise covered with soil to a depth at least one-quarter inch and rolled to obtain a firm seed bed.
4. Seed that is wet, moldy or otherwise damaged in transit or storage shall not be used. Seeding shall not take place when wind velocity exceeds five (5) miles per hour.
5. Immediately following completion of seeding, if in the Engineer's judgment the seed bed is too loose or contains clods, the entire area shall be compacted using a roller weighing at least sixty (60) but not more than ninety (90) pounds per lineal foot of roller.
6. Within 24 hours of seeding, mulch shall be spread over all seeded areas. Mulch shall be spread uniformly with a mechanical spreader or other approved methods at a rate of 2 tons per acre. Mulch shall be spread in a loosened condition with no lumps of compacted material. Mulch shall be anchored into the soil a minimum of 2 inches using a heavy disc harrow by not more than two passes of the harrow. Discs of the anchoring tool shall be set approximately nine inches apart. Mulch shall be anchored not cut.
7. Seeded areas shall be watered immediately following application of mulch, to a depth of at least two (2) inches. Care shall be taken not to cause erosion. Watering shall be repeated daily until a flourishing grass coverage is achieved.
8. The seeded area shall be protected against damage by vehicle and pedestrian traffic by use of barriers and warning signs. If at any time before completion and acceptance of the seeding work any portion becomes gullied, damaged or destroyed shall be repaired or re-established to the specified condition at the Contractor's expense prior to acceptance by the Owner.
9. Maintenance: Maintenance shall include watering, as required of the seed bed and resulting growth, and replacement of any areas eroded by any causes.

END OF SECTION

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SECTION 03300

MISCELLANEOUS CONCRETE

PART 1 GENERAL

1.1 GENERAL

A. The Contractor shall provide all concrete work as required to complete the concrete construction as specified herein and as shown on the Drawings.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

1.3 REFERENCES: The following publications form a part of these specifications to the extent indicated by references thereto. The revision in effect at the time of the Bid Opening shall be applicable. If these publications conflict with the requirements of this section, the section requirements shall govern.

A. American Concrete Institute (ACI):
1. 302 - Guide for Concrete Floor and Slab Construction.
2. 304 - Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.
3. 305 - Committee Report on Hot-Weather Concreting.
4. 306 - Committee Report on Cold-Weather Concreting.
5. 309 - Recommended Practice for Consolidation of Concrete.
6. 318 - Building Code Requirements for Reinforced Concrete.
7. 347 - Recommended Practice for Concrete Formwork.

B. American Society for Testing and Materials (ASTM):
1. A-615 Deformed and Plain Billet Steel Bars for Concrete Reinforcement
2. C-31 Making and Curing Concrete Test Specimens in the Field.
3. C-33 Concrete Aggregates.
4. C-39 Compressive Strength of Cylindrical Concrete Specimens.
5. C-94 Ready-Mixed Concrete.
6. C-143 Slump of Portland Cement Concrete.
7. C-150 Portland Cement.
8. C-185 Test Method for Air Content of Hydraulic Cement Mortar

C. Midwest Concrete Industry Board (MCIB).

1.4 SUBMITTALS

A. Contractor shall submit product data for review on the following items required by this Division:
1. Laboratory name.
2. Aggregate testing and gradation.
3. Design mix.

B. Product data shall be submitted in accordance with Section 1300 - Submittals.

PART 2 PRODUCTS

2.1 CEMENT: Cement shall conform to ASTM C-150, Type I. Cement may be bagged or bulk. Cement shall be used from only one mill throughout the entire project.

2.2 FINE AGGREGATE: Fine aggregate shall conform to ASTM C-33 and have the following gradation:

Sieve	% Passing	% Retained
3/8"	100	0
No. 4	95-100	0-5
No. 8	80-100	0-20
No. 16	50-85	15-50
No. 30	25-60	40-75
No. 50	5-30	70-95
No. 100	0-10	90-100

2.3 COARSE AGGREGATE

A. Coarse aggregate shall conform to ASTM C-33 and have the following gradation:

Sq. Sieve	% Passing	% Retained
1"	100	0
3/4"	90-100	0-10
3/8"	20-55	45-80
No. 4	0-10	90-100
No. 8	0-5	95-100

2.4 WATER

A. Treated and filtered water from a municipal or other public water supply district shall be used.

2.5 REINFORCING STEEL

A. All bars shall conform to ASTM A-615, Grade 60. Bending details shall conform to ACI 318.

2.6 FORMS

A. The forms shall be true and rigid and conform to shape, line and dimensions as shown on the Drawings. All forms shall be rigidly constructed, braced and tied to prevent any deflection or displacement during placing of concrete. All exposed corners and edges shall have 3/4-inch fillets or chamfers. All joints shall be mortar tight; open joints shall be sealed as required.

2.7 CONCRETE MIX

A. Proportioning: Concrete shall conform to the following:
   1. Cement: 6 sacks per cubic yard, minimum.
   2. Water: Water shall be kept to an absolute minimum to maintain slump as specified.
   3. Aggregate: The sand factor shall be as required to give the best workable mix within the range of 46 to 52 percent of total aggregate by weight.
   4. Strength: Minimum 4000 psi at 28 days.

B. Slump: The maximum slump shall not exceed 4 inches. Determination of slump shall conform to ASTM C-143.

C. Mixing: Contractor shall use ready-mixed concrete, mixed and delivered in conformance with ASTM C-94.

D. Admixtures: Air entraining agents shall be added to the concrete to provide 4 to 6 percent entrained air when placed, in conformance with ASTM C-185.

PART 3 EXECUTION

3.1 PLACING REINFORCING STEEL

A. All bars are to be accurately placed and securely tied at all intersections.

B. Reinforcing steel shall be free from flaky or scaly rust which will destroy or reduce the bond strength at the time concrete is placed.

C. Unless shown otherwise on the Drawings, the following minimum concrete coverage shall be maintained:
1. Against earth: 3 inches
2. Against forms or when exposed to water or weather: 2 inches

3.2 PLACING CONCRETE

A. No concrete shall be deposited below water. The excavation may be damp but shall contain no free water.

B. Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent the separation or loss of materials. Re-tempering of concrete is not permissible.

C. All concrete shall be thoroughly compacted during placement by means of vibrators in conformance with ACI 309.

D. For formed surfaces, the Contractor shall break off ties, grout voids which are deeper than 1/2-inch and chip out honeycombed areas to solid concrete and grout flush with formed surface.

E. Curing shall be maintained continuously for seven days after placing concrete or until forms are removed and the surface finished. Concrete surface temperature is to be maintained between 50°F and 100°F for at least seven days.

F. Concrete shall not be placed on iced or frozen subgrade or when the air temperature is below 20°F. Concreting shall not be continued when the air temperature is below 45°F unless the following conditions are attained:
1. Mixing water shall be heated (to a maximum of 150°F).
2. Aggregates shall be heated until free of all ice and frost.
3. The concrete temperature after mixing shall be between 50°F and 70°F if the air temperature is 20°F to 45°F.
4. After the concrete is placed, it shall be covered, protected, and heated so as to maintain a minimum of 70°F air temperature for the first 24 hours and 50°F air temperature for the next six days. Open-flame type heaters are not permitted. Heating equipment not vented outside of the covering will not be permitted.
5. Moist conditions shall be maintained during the heating period.
6. All covering, heating equipment, etc., shall be on hand and approved by the Engineer before any concrete is placed.

G. Admixtures, such as calcium chloride, shall not be used.

H. Exposed concrete is not to be placed in air temperatures above 100°F. Cover, protect and cool work as required to maintain the temperature of the concrete below 100°F. The concrete temperature, after mixing, shall not be greater than 85°F. Spray and/or shade aggregate piles and cool mixing water as required.

3.3 FINISHING

A. Unformed Surfaces:

1. Screed Finish:
   a. Use as first stage for all concrete finishes.
   b. Use as final finish on surfaces that will be covered by additional concrete, grout placement, or mortar setting bed except as otherwise specified.
   c. Immediately after screeding, use a wood float, darby, or bull float to eliminate high and low spots and to embed large aggregate. This shall be done in a manner to produce even, uniform surfaces so that surface irregularities do not exceed 3/8 inch in 10 feet when used as final finish.
2. Floated Finish:
   a. Use as second stage of broomed, troweled, or magnesium-troweled finish.
   b. Use as final finish on all areas to receive built-up roofing.
   c. Float with mechanical float. Hand floating will be permitted only in areas inaccessible to mechanical float.
   d. On surfaces not to receive troweled or magnesium-troweled finish, finish with wood or cork float after mechanical floating to a true uniform surface so that surface irregularities do not exceed 1/8 inch in 10 feet, except at floor drains.
3. Broomed Finish:
   a. Use as final finish on all outdoor slabs including pavements and sidewalks.
   b. After floated finish, draw a stiff bristle broom across the surface making uniform corrugations, perpendicular to the direction of traffic, not more than 1/16 inch deep.
4. Troweled Finish:
   a. Use as final finish on inside floors and on all other unformed surfaces not otherwise indicated or specified.
   b. Trowel with steel trowel, mechanical or hand, to obtain a smooth, dense finish. The final troweling shall be done after the concrete has become hard enough so that no mortar adheres to the edge of trowel and a ringing sound is produced as the trowel passes over the surface.
   c. Do not trowel before surface water has evaporated or has been removed with a squeegee.
   d. Finish to a true uniform surface so that surface irregularities do not exceed 1/8 inch in 10 feet, except at floor drains.
   e. Do not add sand or cement to the floor surface.
5. Magnesium-Troweled Finish:
   a. Perform as specified for Troweled Finish, this Section, except use a magnesium trowel by hand instead of a steel trowel to obtain a dense, but not slick, finish.
   b. Use where floor will receive protective coating after curing.
6. Stair-Tread Finish:
   a. Apply to all interior and exterior concrete stair treads and landings that do not have abrasive nosings.
   b. Spread fine abrasive aggregate uniformly on concrete before it has set, in the amount of not less than 1/4-pound aggregate per square foot, and steel trowel into surface of concrete.
   c. Expose abrasive aggregate slightly by rubbing with an abrasive brush after concrete finish has set and cured.
   d. Aggregate and application shall conform to Specification “A” of the Norton Company.

7. Contraction Joints:
   a. Locate as indicated.
   b. Maintain true alignment with straightedge.
   c. Joints shall be grooved except where sawed joints or preformed joints are indicated.
   d. Grooved Joints:
      1) Perform during the finishing process.
      2) Width of groove shall not exceed 1/4 inch.
      3) Depth of groove shall be at least 1 inch.
   e. Sawed Joints:
      1) Cut joints with power blade as soon as concrete surface is firm enough to resist tearing or damage by the blade and before random shrinkage cracks can occur. (Usually required within 4 to 12 hours after finishing.)
      2) Make joints approximately 1/8 inch wide with depth as indicated.
      3) Seal with the same type sealant specified for expansion joint sealant.
   f. Preformed Joints:
      1) Install preformed joints as recommended by manufacturer.

B. Formed Surfaces:
   1. Repair surface defects as specified under Repair of Defective Surfaces, this Section.

C. Repair of Defective Surfaces:
   1. Defined as any concrete surface showing misalignment, rock pockets, poor joints, holes from ties, voids, honeycomb, or any other defective area.
   2. Repairing:
      a. Repair as soon as forms have been removed.
      b. Chip surface back to minimum depth of ½ inch, chip edges perpendicular to surface, pre-wet depression and brush with heat cement immediately before patching.
      c. Patch surfaces using still mortar with same sand-cement ratio as original concrete and with minimum water for placing. Blend with white cement to match concrete color.
      d. Compact mortar into depressions so that after curing, hole is filled and mortar is flush with surface. Use hammer and rod for compacting the holes.
      e. Moist-cure for 3 days or use curing compound.
      f. Engineer shall be notified of areas containing defects or where reinforcing steel is exposed, prior to determination of repair method.

3.4 FLOOR SURFACE TREATMENT

A. Apply sealer in accordance with manufacturer’s instructions on scheduled floor surfaces.

B. Prior to placing floor sealer, all stains from oils, greases, etc. shall be removed.

3.5 CONCRETE TEST CYLINDERS

A. All concrete test cylinders shall be provided by the Contractor, using a licensed testing laboratory. The making and testing of test cylinders, including transportation and all expenses, shall be paid for by the Contractor.

B. The Contractor's testing laboratory shall make at least four (4) test cylinders for each day's pour in excess of 6 cubic yards of each class of concrete, and two test cylinders for each additional 50 cubic yards or major fraction thereof, as directed by the Engineer.

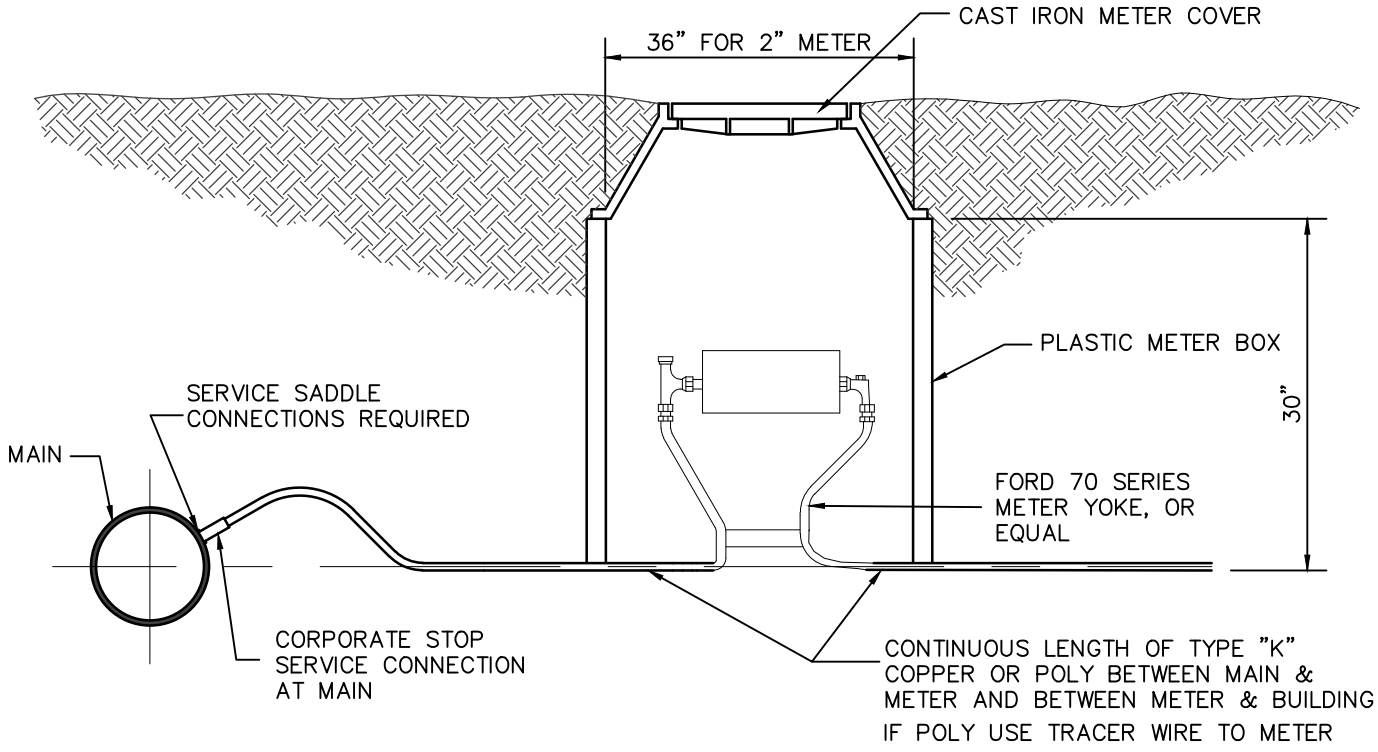
C. The Contractor shall ship the test cylinders to the laboratory on the fourth day, where the laboratory shall proceed to cure until tested. One cylinder shall be tested on the seventh day, and two cylinders tested on the 28th day (leaving one spare cylinder). The test cylinders shall be identified at the time cast, and as to which pour is represented. Unsatisfactory tests of cylinders shall make the concrete represented subject to rejection, with consequent removal and replacement required.

D. Concrete test cylinders shall be cast and tested in accordance with ASTM C-31 and C-39. The testing laboratory shall furnish four (4) copies of test reports for test cylinders for slump, air, temperature and compressive strength and distributed as follows:
1. 2 copies - Engineer
2. 2 copies - Contractor

END OF SECTION

APPENDIX A

STANDARD DETAILS



TYPICAL WATER SERVICE DETAILS (2" SERVICE)

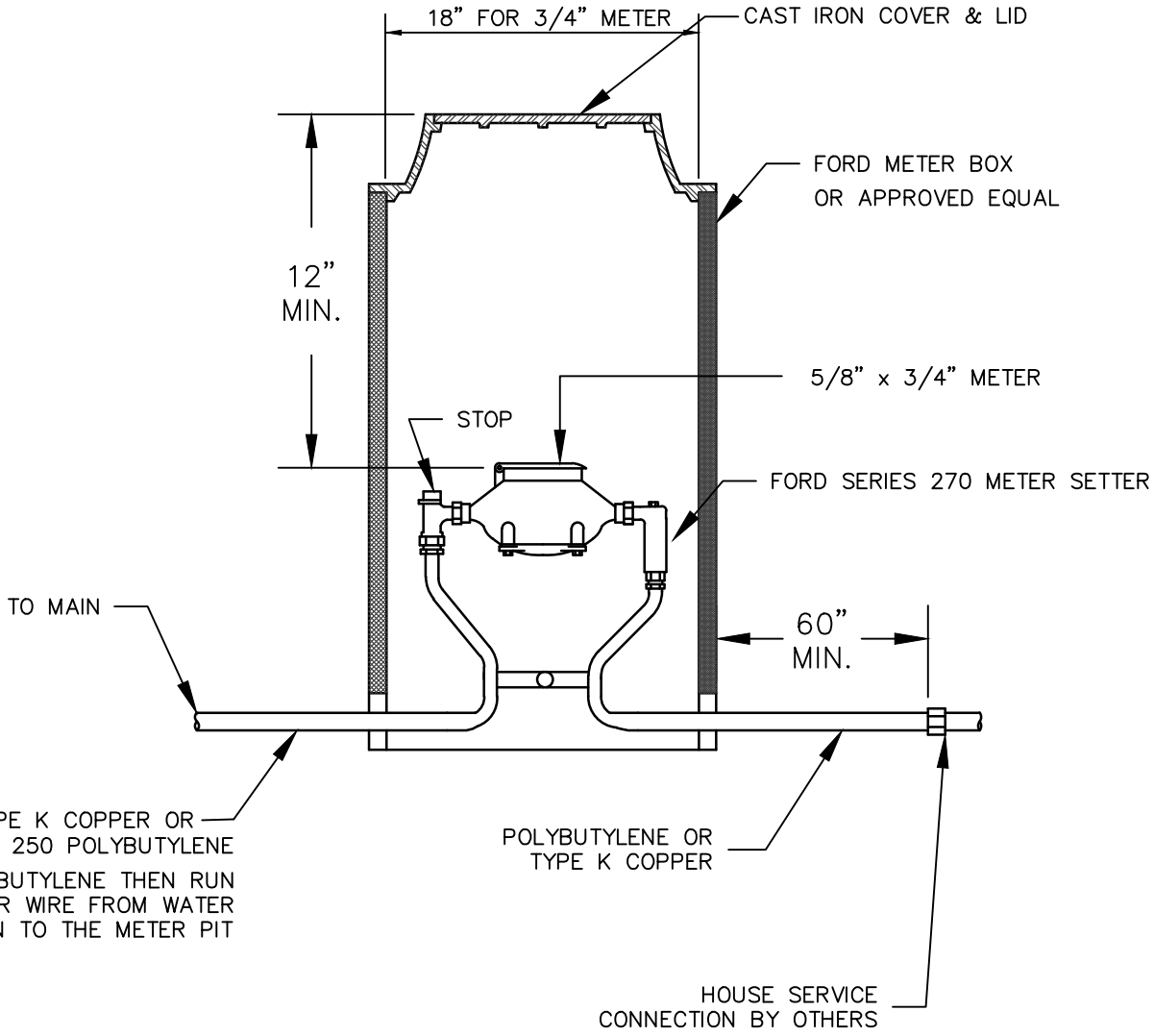
SHAFER, KLINE & WARREN, INC.
107 Butler St., P.O. Box 366, Macon, MO 63552
660/385-6441 FAX: 660/385-6614

CITY OF NEW FLORENCE, MO.
STANDARD WATER DETAILS

REVISED
1-16

TYPICAL 2"WATER
SERVICE DETAIL

NOTE:
METERS TO BE PLACED 5' WITHIN PROPERTY LINE OR PVC MAIN, AS LOCATED BY THE ENGINEER.



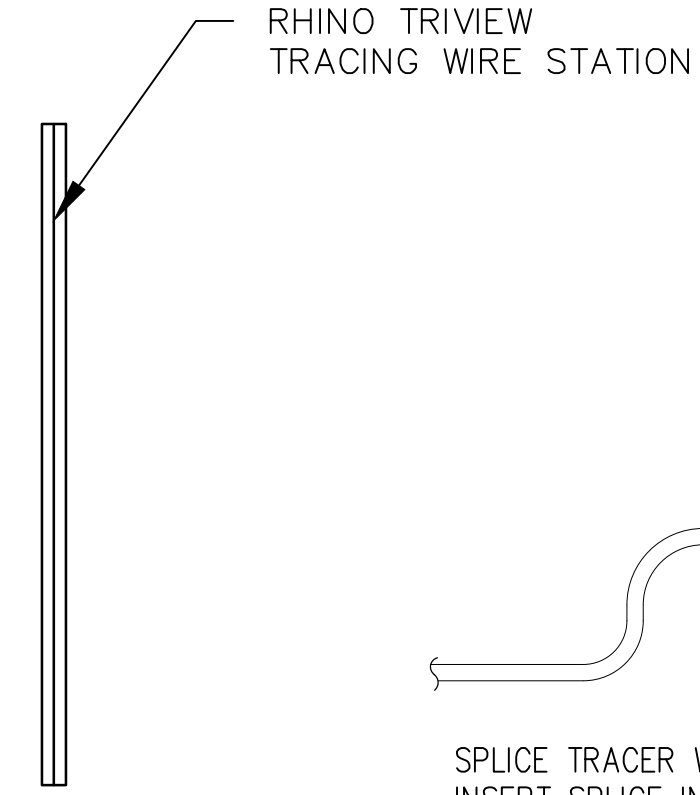
TYPICAL SERVICE METER SETTING

SHAFER, KLINE & WARREN, INC.
107 Butler St., P.O. Box 366, Macon, MO 63552
660/385-6441 FAX: 660/385-6614

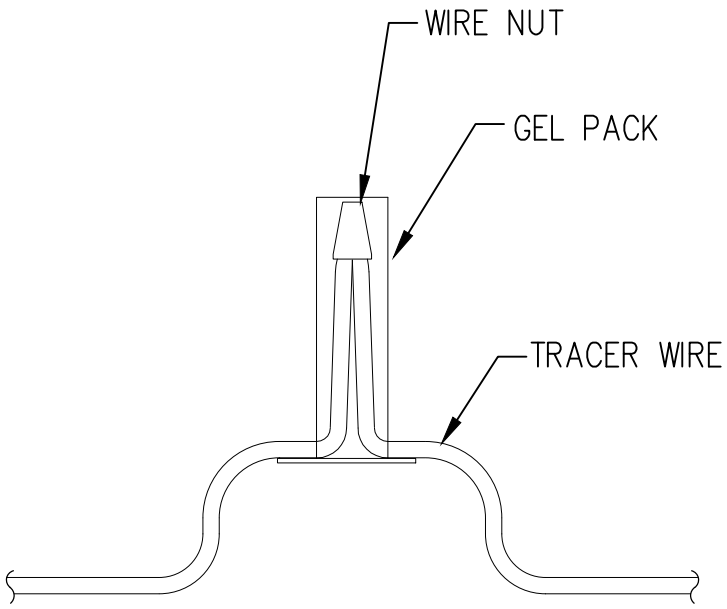
CITY OF NEW FLORENCE, MO.
STANDARD WATER DETAILS

REVISED
1-16

TYPICAL
SERVICE METER
SETTING



TEST STATION



SPLICE TRACER WITH WIRE NUT, THEN
INSERT SPLICE INTO GEL PACK

TRACER WIRE SPLICE

NOTE:

1. TRACER WIRE TEST STATIONS SHALL BE PLACED NEAR FENCE OR POWER POLES, IF POSSIBLE. MAXIMUM SPACING OF TEST STATIONS SHALL BE 1,500 FEET UNLESS NOTED OTHERWISE ON PLANS.

TRACER WIRE DETAILS

NOT TO SCALE

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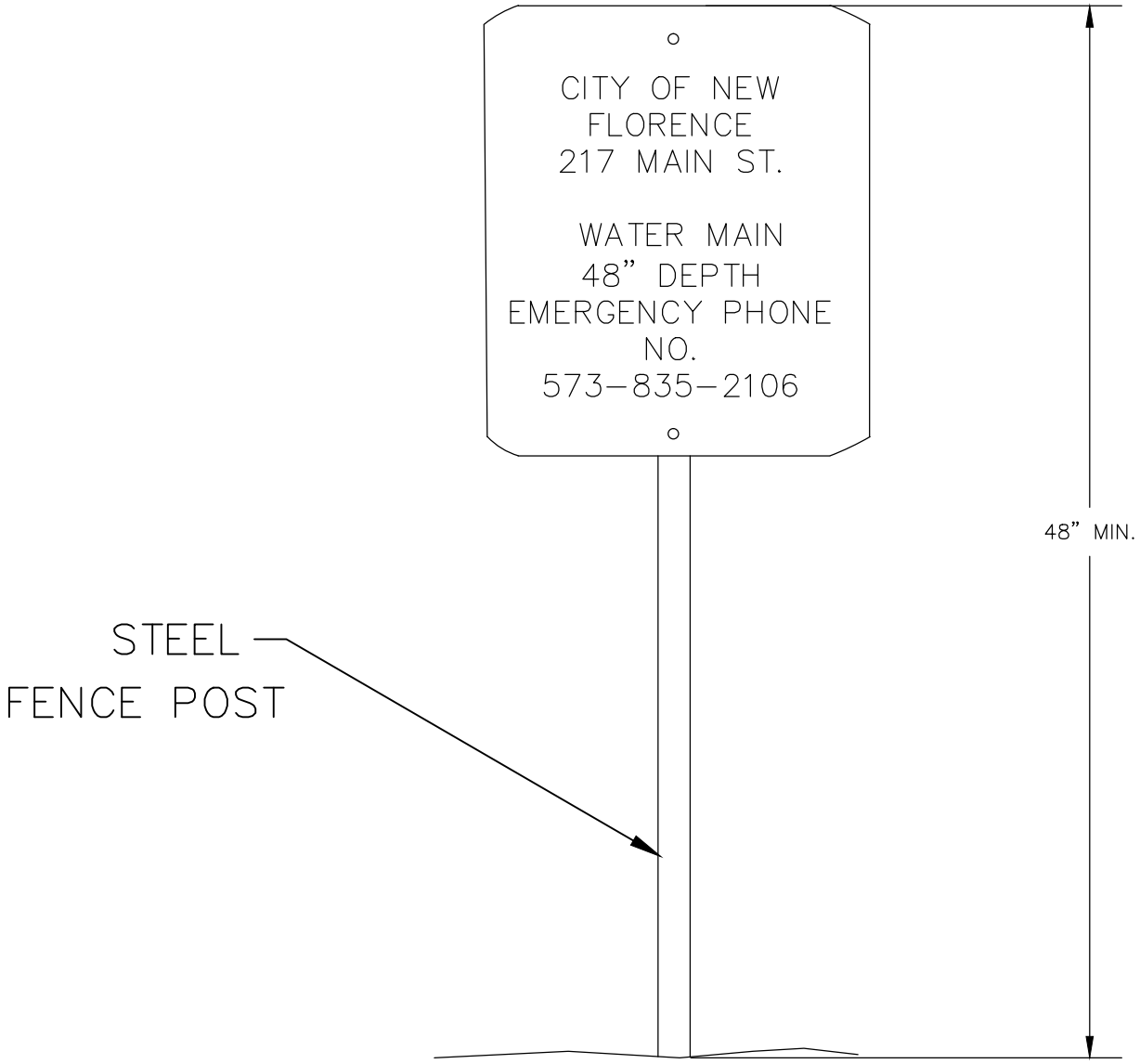
TYPICAL
TRACER WIRE
TEST STATION



TYPICAL
WATER CROSSING SIGN

NO SCALE

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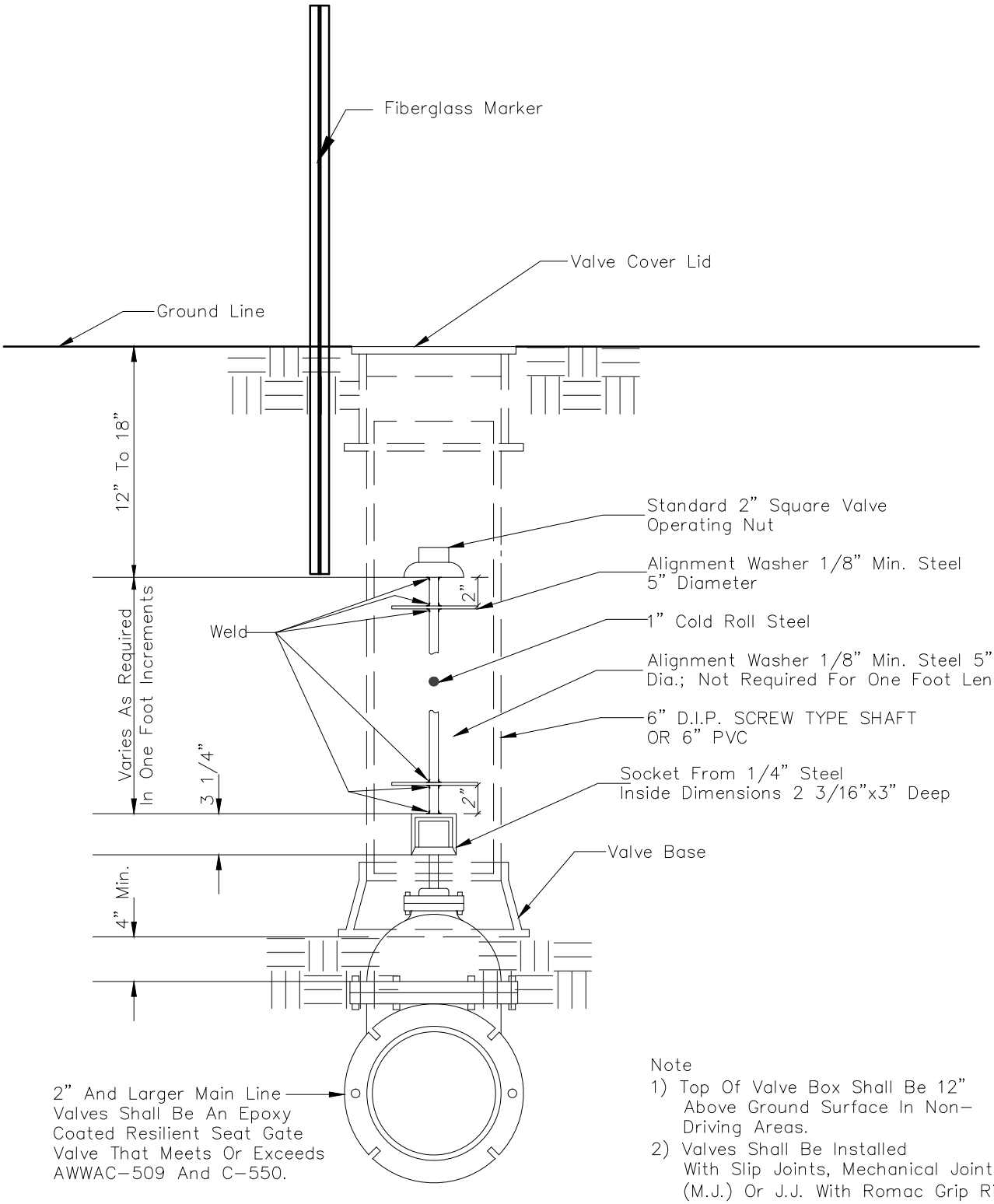
TYPICAL
WATER CROSSING
SIGN DETAIL



Note

1) Top Of Valve Box Shall Be 12" Above Ground Surface In Non-Driving Areas.
2) Valves Shall Be Installed With Slip Joints, Mechanical Joints (M.J.) Or J.J. With Romac Grip Rings.
3) When Depth From Ground To Opening Nut Exceeds 5'-0" Valve Extension Rod Assembly Shall Be Required.

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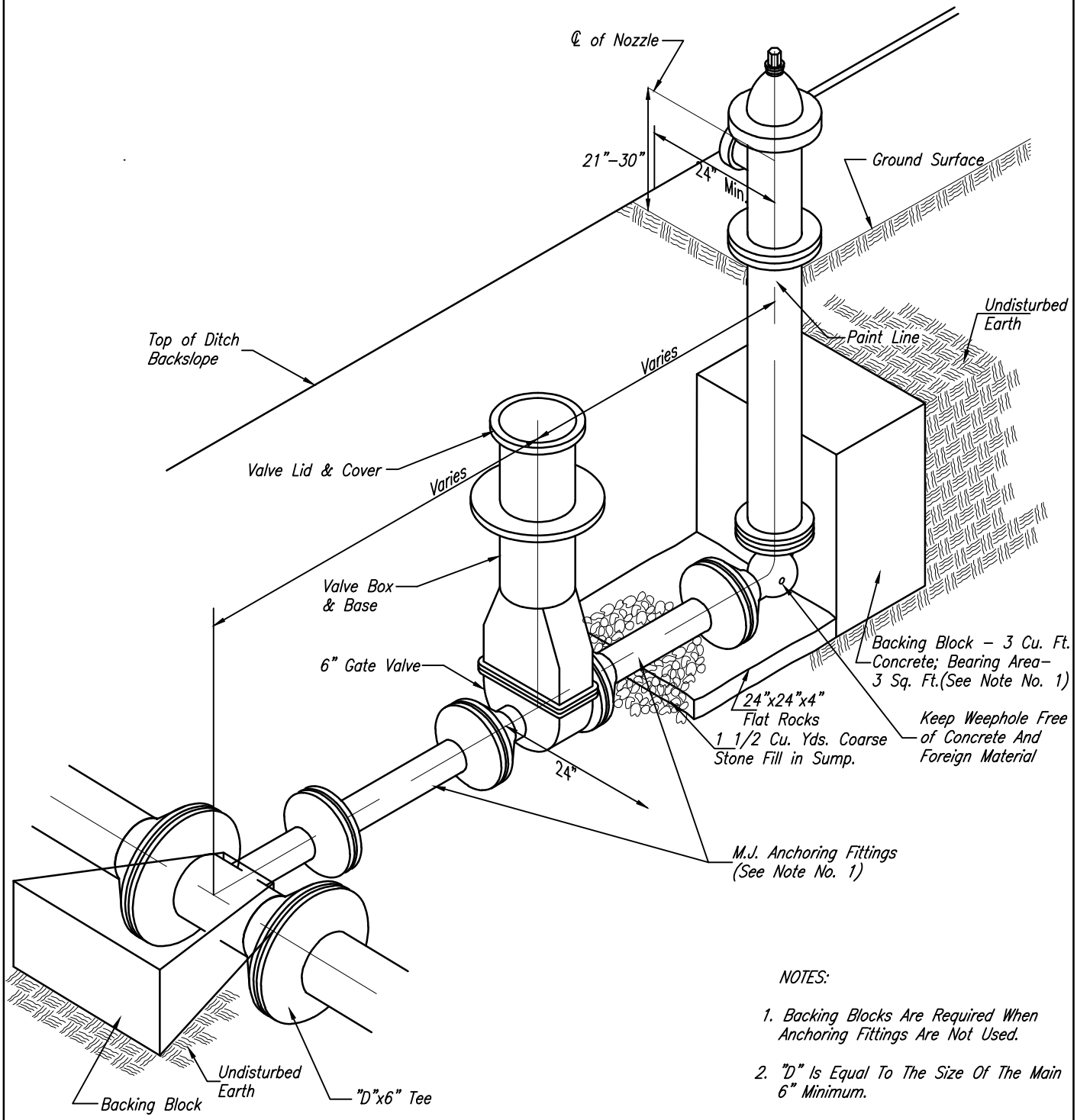
TYPICAL VALVE BOX OPERATING NUT EXTENSION



NOTES:

1. Backing Blocks Are Required When Anchoring Fittings Are Not Used.
2. "D" Is Equal To The Size Of The Main 6" Minimum.

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TYPICAL STRAIGHT SET FIRE HYDRANT

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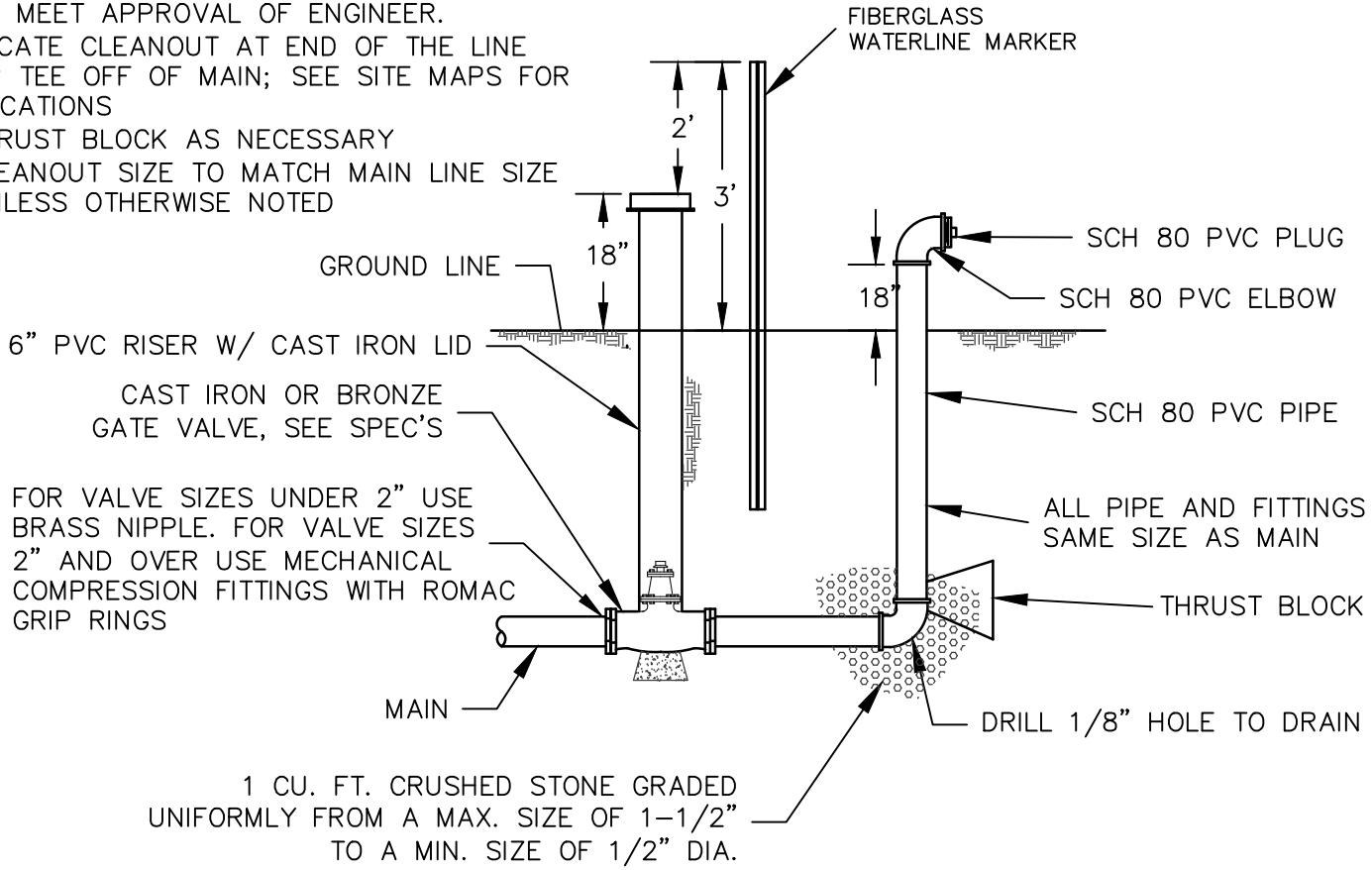
NOTES: CLEANOUT
1) BACKFILL AROUND VALVE, BOX, AND PIPING TO BE HAND PLACED AND TAMPED TO MEET APPROVAL OF ENGINEER.
2) LOCATE CLEANOUT AT END OF THE LINE OR TEE OFF OF MAIN; SEE SITE MAPS FOR LOCATIONS
3) THRUST BLOCK AS NECESSARY
4) CLEANOUT SIZE TO MATCH MAIN LINE SIZE UNLESS OTHERWISE NOTED



TYPICAL FLUSH HYDRANT DETAIL

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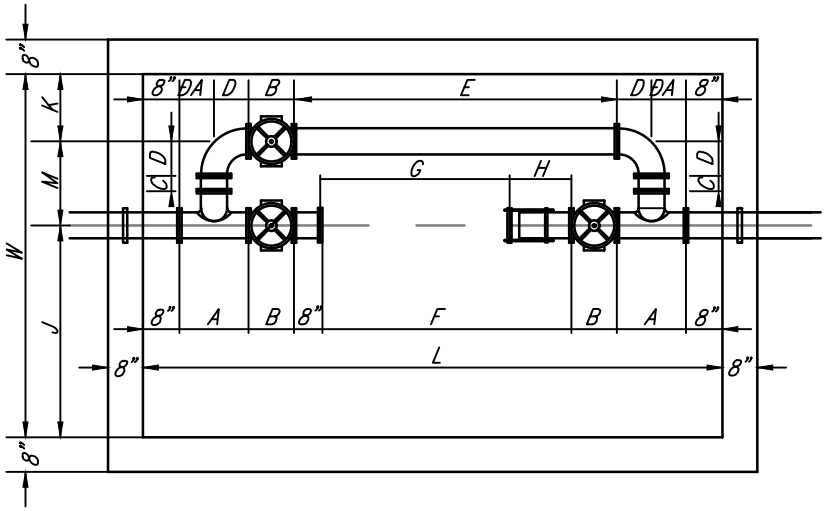
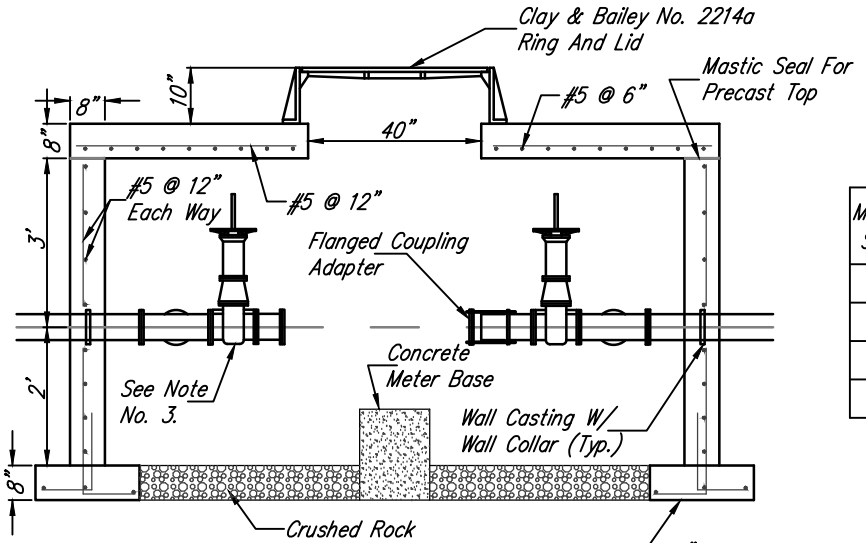
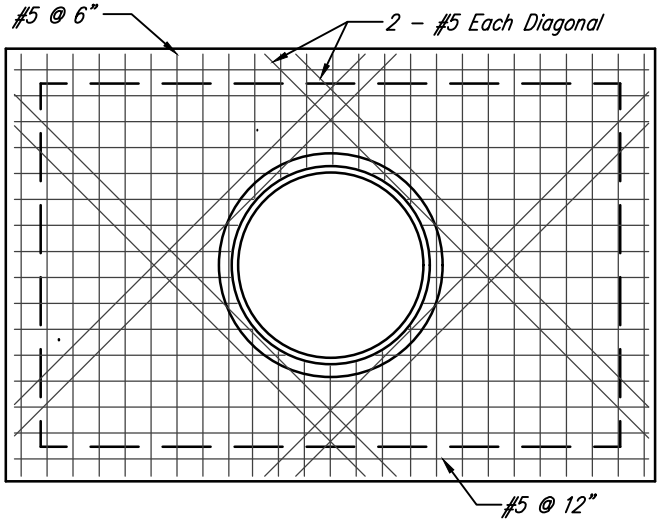
METER PIT & SETTING W/ BYPASS FOR SINGLE 2", 3", 4" & 6" METERS



PLAN



SECTION



ROOF SLAB

NOT FOR VEHICULAR TRAFFIC LOADS

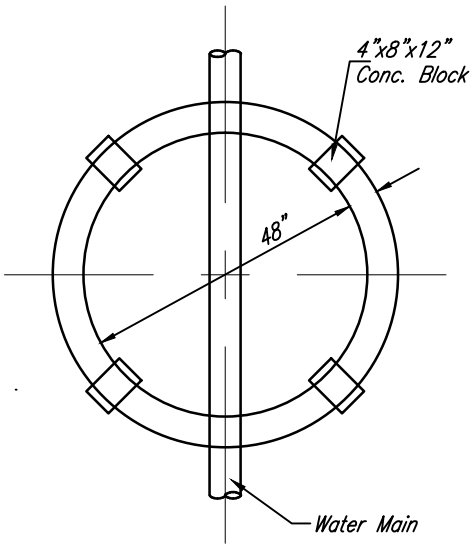
FOR VEHICULAR TRAFFIC - 10,000 LB. WHEEL LOAD

1. Increase Thickness To 12"
2. Increase Rebar From #5 To #7 Using Same NumberR Of Bars.

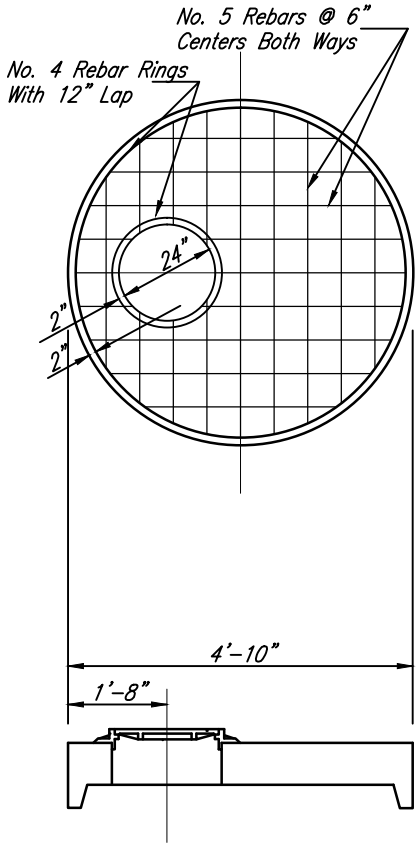
METER SIZE	L	W	A	B	C	D	E	F	I	J	K
2"	84"	48"	9"	7"	8"	6Đ"	39"	30"	18"	11"	19"
3"	102"	72"	11"	8"	12"	7Đ"	51Đ"	42"	24"	22Đ"	25Đ"
4"	108"	72"	13"	9"	12"	9"	52"	42"	24"	20Đ"	27Đ"
6"	126"	72"	16"	10Đ"	9"	11Đ"	61"	51"	24"	19Đ"	28Đ"

NOTES:

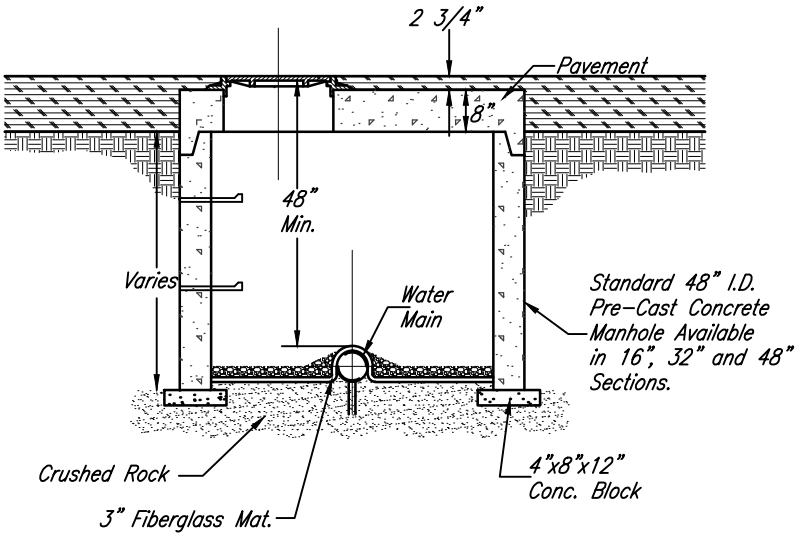
1. Pour Footing On Firm Undisturbed Earth.
2. All Piping In Meter Pit Shall Be D.I.P.
3. Valves Shall Be Gate Type. Bypass Valve Shall Be O.S. & Y.
4. Dimensions Of G & H, Shall Be Selected Per City Requirements.
5. Allow É" Per Gasket In Flange Fitting



PLAN



DETAIL
ROOF SLAB



SECTION

NOTES:

1. Vault Shall Be Standard 48" I.D. Precast Concrete Manhole Using A Minmum Riser Of 48 Inches. Additional Risers May Be Used, If Needed, To Adjust Depth Of Manhole.
2. Rings And Lids:
   a)Unpaved Areas: Clay And Bailey Manhole Cover No. 2007MR (With Brick Ring) A Maximum Of 3 Layers Of Brick May Be Used For For Adjusting To Grade.
   b)Paved Areas: Clay And Bailey Ring No. 2001 With Lid No. 2007 Or Approved Equal.
1. Steps:
   a)Steps Are Not Required On Pits 48 Inches, Or Less, In Depth.
   b)Steps Are To Be Polypropylene-Coated Steel.
   c)Steps Are To Be 16 Inches Center To Center.

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TYPICAL PRE-CAST
CONCRETE VAULT

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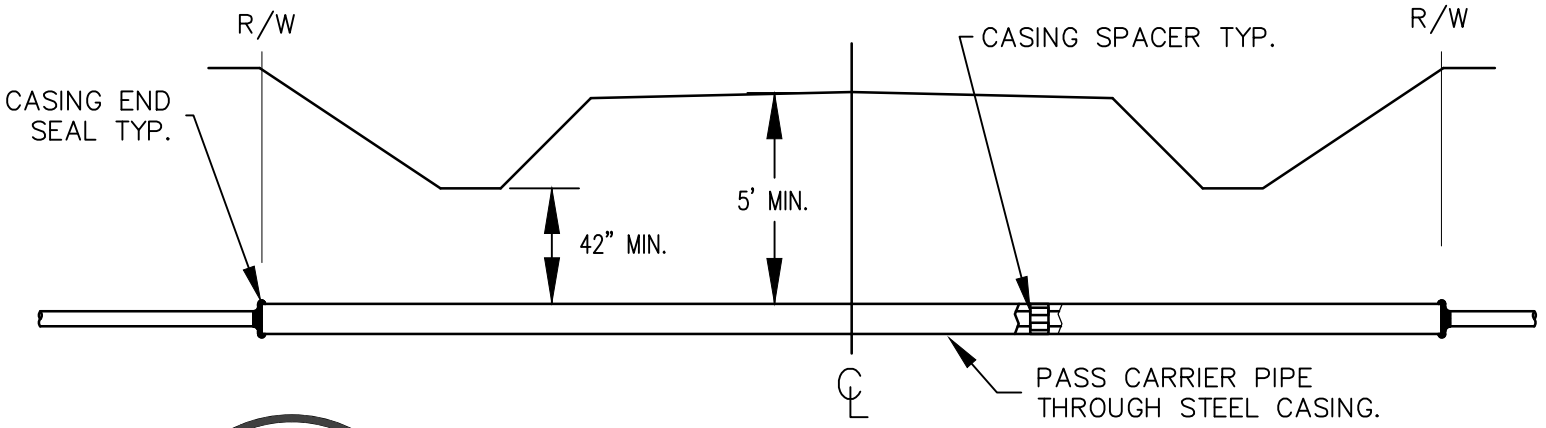
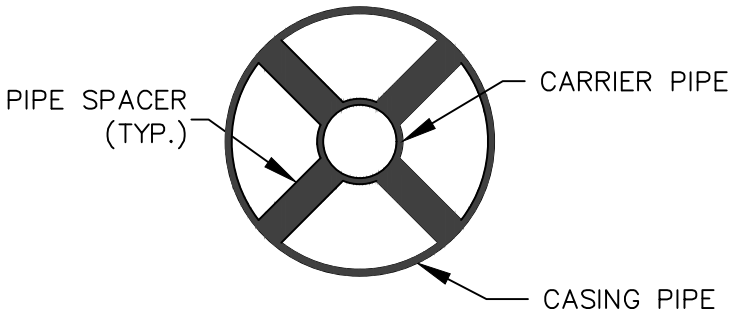
NOTES: MODOT ROAD CROSSINGS

1. CASING SHALL EXTEND FROM R/W TO R/W UNLESS OTHERWISE NOTED ON PLAN SHEETS.
2. CASING SHALL BE SMOOTH WALL, WELDED-STEEL PIPE. SEE WALL THICKNESSES BELOW.
3. INSTALL HDPE CASING SPACERS AND END SEALS PER THE MANUFACTURERS RECOMMENDATIONS BASED ON CARRIER PIPE AND CASING SIZES. SPACERS TO BE MODEL CI AND END SEAL TO BE BOOT TYPE "AC" AS MANUFACTURED BE ADVANCE PRODUCT AND SYSTEMS, INC. OR APPROVED EQUAL.
4. CARRIER PIPE SHALL BE PVC CL200 YELOMINE. CARRIER PIPE SHALL EXTEND A MINIMUM OF 10 LF PAST EACH END OF CASING IF MAIN LINE IS A DIFFERENT MATERIAL.
5. SIGNS TO BE PLACED ON EACH END OF BORE AT THE RIGHT OF WAY LINE.





END VIEW

NOMINAL SIZE CASING DIA.	MIN. WALL THICKNESS	NOMINAL SIZE CASING DIA.	MIN. WALL THICKNESS
6"	.188"	16"	.188"
8"	.188"	18"	.250"
10"	.188"	20"	.250"
12"	.188"	22"	.250"

TYPICAL STATE ROAD CROSSING

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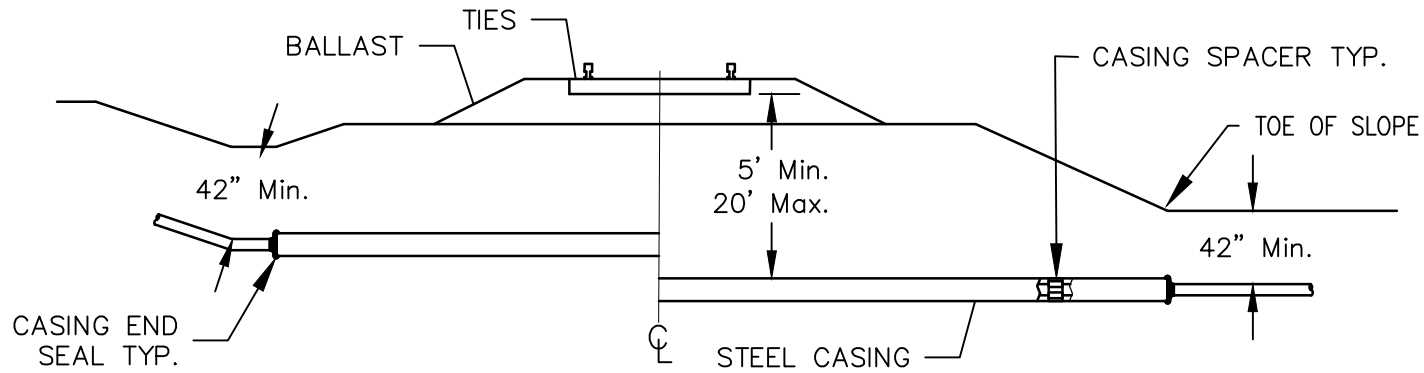
TYPICAL RAILROAD CROSSING

NOTES: RAILROAD CROSSING
1) USE STANDARD FITTINGS TO MAINTAIN MINIMUM COVER
2) SEE PERMIT FOR EXACT CROSSING DETAILS
3) INSTALL CASING SPACERS AND END SEALS PER THE MANUFACTURERS RECOMMENDATIONS BASED ON CARRIER AND CASING SIZES. SPACERS TO BE MODEL "CI" AND END SEALS TO BE BOOT TYPE "AC" AS MANUFACTURED BY ADVANCE PRODUCT & SYSTEMS, INC. OR APPROVED EQUAL



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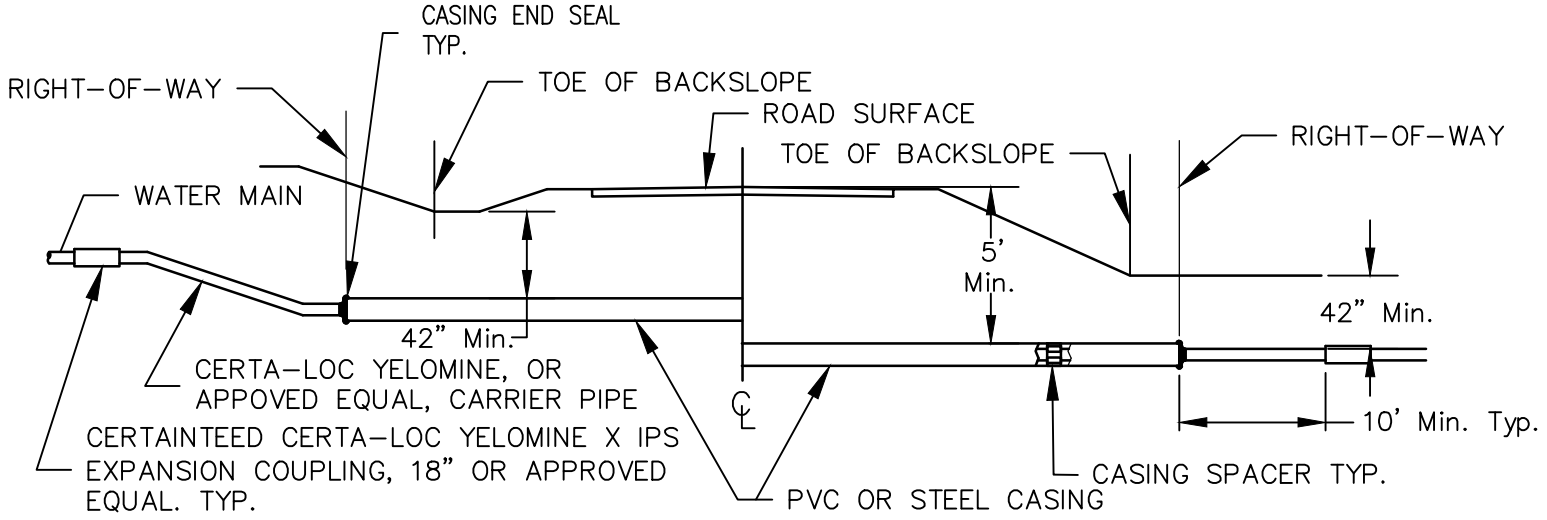
NOTES: COUNTY ROAD CROSSINGS

1) CARRIER PIPE BETWEEN COUPLINGS TO BE CERTA-LOC YELOMINE, OR APPROVED EQUAL; PIPING TO MEET ASTM D 2241. CROSSINGS LESS THAN 80 L.F. MAY BE SLIP JOINT PVC
2) FOR ALL PIPELINES 2" OR GREATER, MINIMUM CASING LENGTH SHALL BE FROM RIGHT-OF-WAY TO RIGHT-OF-WAY
3) INSTALL HDPE CASING SPACERS AND END SEALS PER THE MANUFACTURERS RECOMMENDATIONS BASED ON CARRIER PIPE AND CASING SIZES. SPACERS TO BE MODEL CI AND END SEAL TO BE BOOT TYPE "AC" AS MANUFACTURED BE ADVANCE PRODUCT AND SYSTEMS, INC. OR APPROVED EQUAL.
4) GRAVELED COUNTY ROADS MAY BE OPEN CUT UNLESS OTHERWISE NOTED ON PLANS OR COUNTY PERMITS
5) COUNTY ROAD PERMITS AND REGULATIONS SHALL BE FOLLOWED AND WILL SUPERCEDE CONTRACT PLANS AND SPECIFICATIONS



TYPICAL COUNTY ROAD CROSSING

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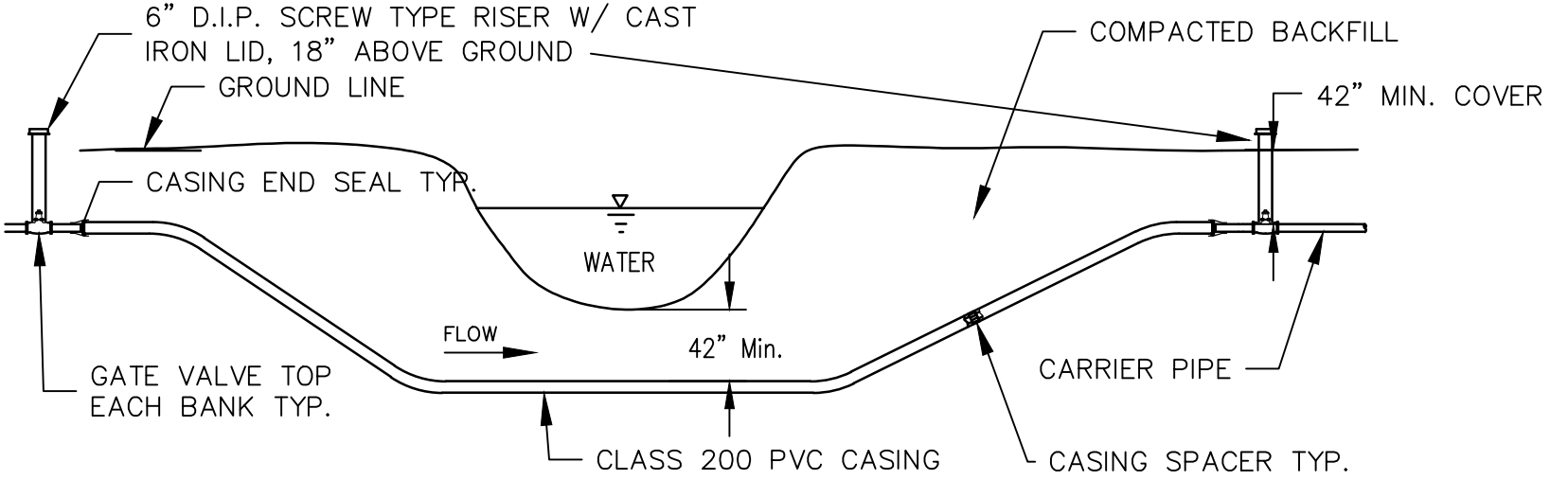
TYPICAL
RIVER/STREAM
CROSSING

NOTES: STREAM CROSSING

1) 2 GATE VALVES IN PAY ITEM
2) CARRIER PIPE BETWEEN GATE VALVES/COUPLINGS TO BE CERTA-LOK YELOMINE, OR APPROVED EQUAL CARRIER PIPE SHALL EXTEND A MINIMUM OF 10 L.F. PAST EACH END OF CASING.
3) CASING SHALL EXTEND TO POINT OF MINIMUM COVER ON BOTH SIDES OF CHANNEL.
4) IF SIGNIFICANT EROSION OCCURS, GRADING & SEEDING WILL BE REQUIRED.
5) COMPACT BACKFILL TO 90% STANDARD DENSITY BETWEEN VALVES.
7) INSTALL HDPE CASING SPACERS AND END SEALS PER THE MANUFACTURERS RECOMMENDATIONS BASED ON CARRIER PIPE AND CASING SIZES. SPACERS TO BE MODEL CI AND END SEAL TO BE BOOT TYPE "AC" " AS MANUFACTURED BE ADVANCE PRODUCT AND SYSTEMS, INC. OR APPROVED EQUAL.



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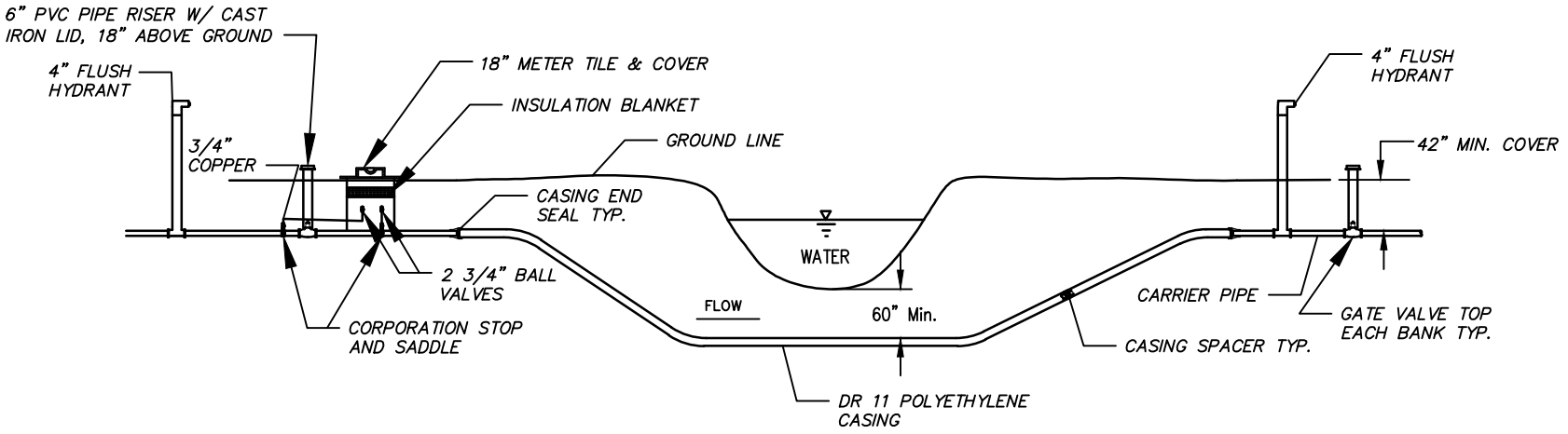
TYPICAL STREAM CROSSING FOR FLOWING STREAM

NOTES:

1) 2 GATE VALVES IN PAY ITEM
2) CARRIER PIPE BETWEEN GATE VALVES/COUPLINGS TO BE PVC CL200 YELOMINE, OR APPROVED EQUAL
3) CASING SHALL EXTEND TO POINT OF MINIMUM COVER ON BOTH SIDES OF CHANNEL.
4) INSTALL HDPE CASING SPACERS AND END SEALS PER THE MANUFACTURERS RECOMMENDATIONS BASED ON CARRIER PIPE AND CASING SIZES. SPACERS TO BE MODEL CI AND END SEAL TO BE BOOT TYPE "AC" AS MANUFACTURED BE ADVANCE PRODUCT AND SYSTEMS, INC. OR APPROVED EQUAL.
5) NAVIGABLE RIVER/STREAM CROSSINGS REQUIRE 84" MIN. COVER.
6) FLUSH HYDRANTS AS PER FLUSH HYDRANT DETAIL.
7) ABOVE THE ¾" BALL VALVES SHALL BE ¾" X ¼" REDUCER WITH A ¼" THREADED FEMALE CONNECTION FOR PRESSURE GUAGE



NOTES: PIPE INSTALLATION/BEDDING

1) PIPE SHALL BE BURIED TO A MINIMUM DEPTH OF 42" TO THE TOP OF THE MAIN LINE AND SERVICES.

2) ALL MAIN LINES SHALL BE "PIGGED" DURING THE DISINFECTION AND FLUSHING PROCESS.

3) PVC PIPE SHALL BE SLIP JOINT SDR21 AND SHALL MEET REQUIREMENTS OF ASTM 2241. JOINTS SHALL BE 20' IN LENGTH UNLESS PREAPPROVED BY THE ENGINEER.

4) ALL CHANGES IN THE MAIN LINE DIRECTION GREATER THAN 11.25° SHALL BE ACCOMPLISHED USING STANDARD FITTINGS.

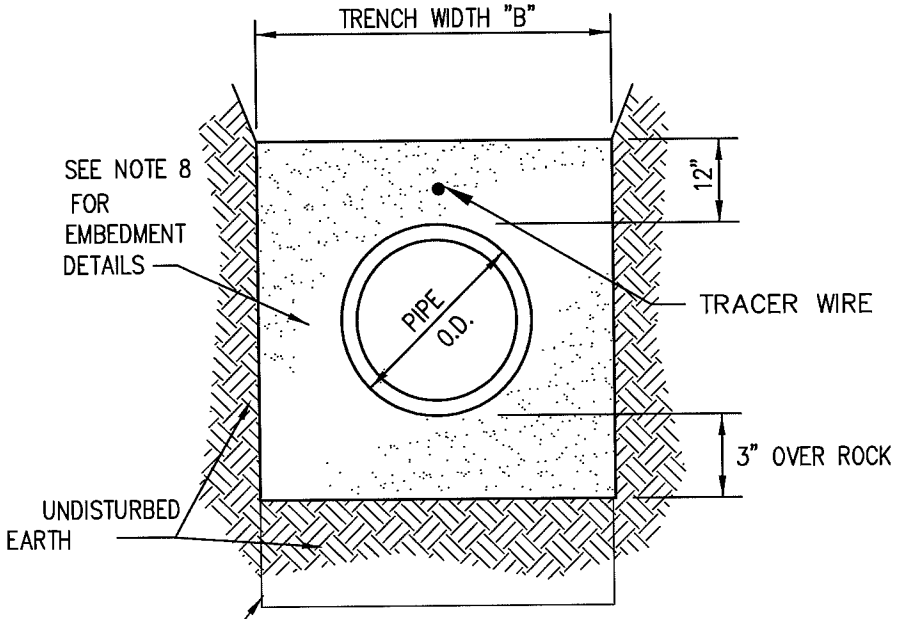
5) TRACER WIRE SHALL BE A #12 AWG (0.0808" DIAMETER) FULLY ANNEALED, HIGH CARBON 1055 GRADE STEEL, HIGH STRENGTH SOLID COPPER CLAD STEEL CONDUCTOR (HS–CCS), INSULATED WITH A 30 MIL, HIGH DENSITY, HIGH MOLECULAR WEIGHT POLYETHYLENE (HDPE) INSULATION, AND RATED FOR DIRECT BURIAL USE AT 30 VOLTS.

6) TRACER WIRE SHALL BE INSTALLED WITH ALL MAIN LINES AND SERVICE LINES.

7) TRACER WIRES SHALL BE SURFACED IN RHINO TRIVIEW FLEX AND HIDEOUT TRACING WIRE STATIONS (SEE TEST STATION DETAIL)

8) EMBEDMENT SHALL BE ½" CLEAN ROCK OR SELECT BACKFILL AS SPECIFIED..

	TRENCH WIDTH "B"		
PIPE SIZE (INCHES)	MIN. TRENCH WIDTH IN EARTH (INCHES)	MAX. TRENCH WIDTH IN EARTH (INCHES)	MIN. TRENCH WIDTH IN ROCK (INCHES)
< 4	20	26	20
4 – 6	22	30	24
8	22	30	24
10	24	32	24
12	27	36	26



NO SCALE

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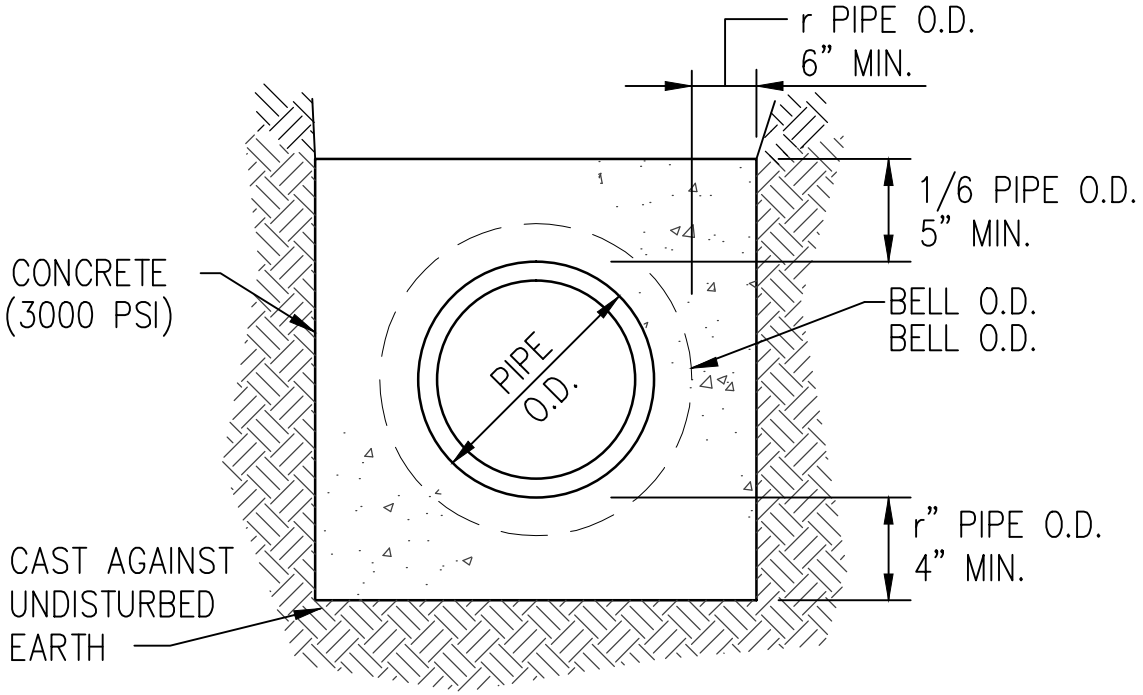
TYPICAL PIPE INSTALLATION/ BEDDING DETAIL



NOTES:

1. PROVIDE CONSTRUCTION JOINTS IN ENCASEMENT TO COINCIDE WITH PIPE JOINTS AT APPROX. 32' INTERVALS.

CONCRETE ENCASEMENT

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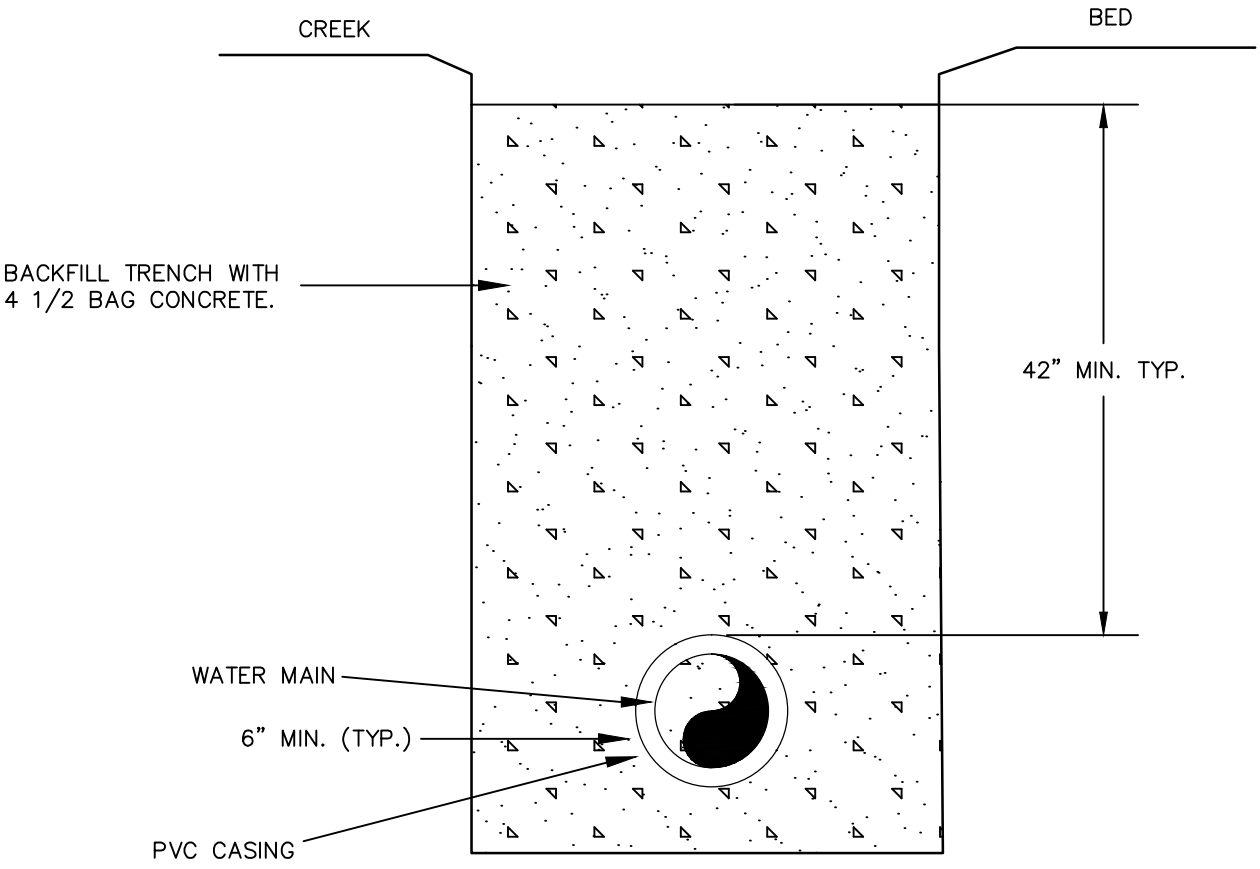
TYPICAL
CONCRETE
ENCASEMENT



TYPICAL RIVER/STREAM CROSSING

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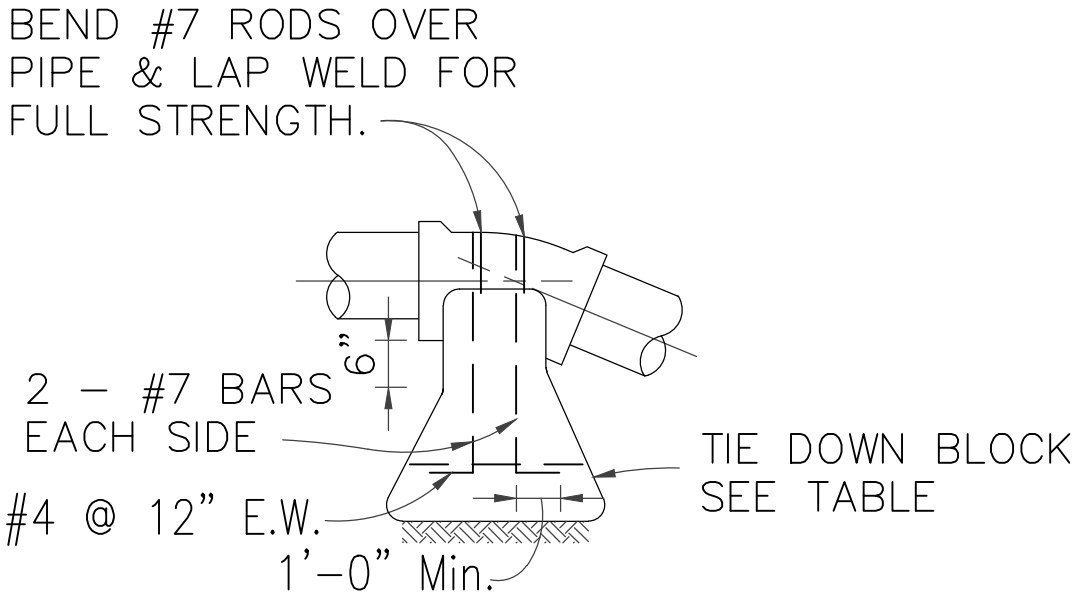
TYPICAL RIVER
STREAM CROSSING
ENCASEMENT



REQUIRED CU. FT. CONCRETE FOR TIE DOWN BLOCKS

BEND	PIPE SIZE						
	24"	20"	18"	12"	10"	8"	6"
90°	610	440	360	180	130	72	43
45°	350	260	220	110	72	43	25
22 1/2°	180	130	110	50	37	22	13
11 1/4°	90	60	53	25	19	11	7

CONCRETE TIE DOWN BLOCK

NO SCALE

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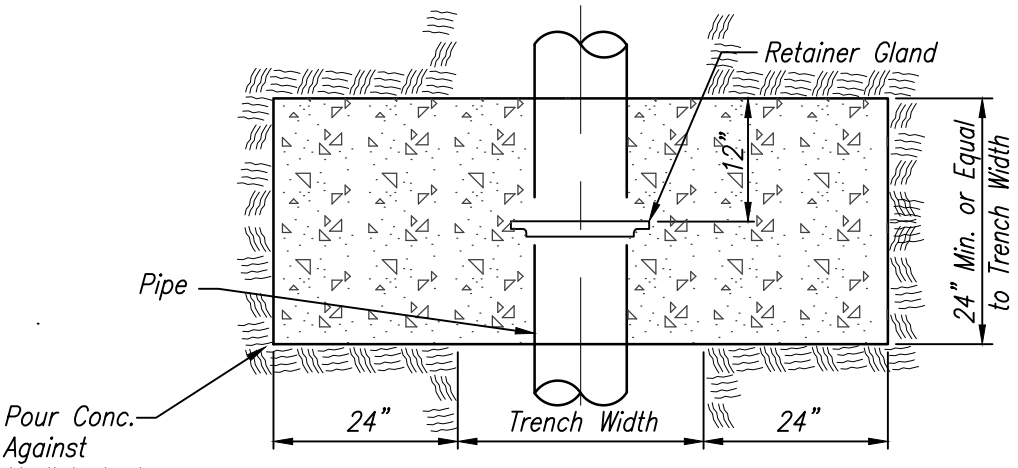
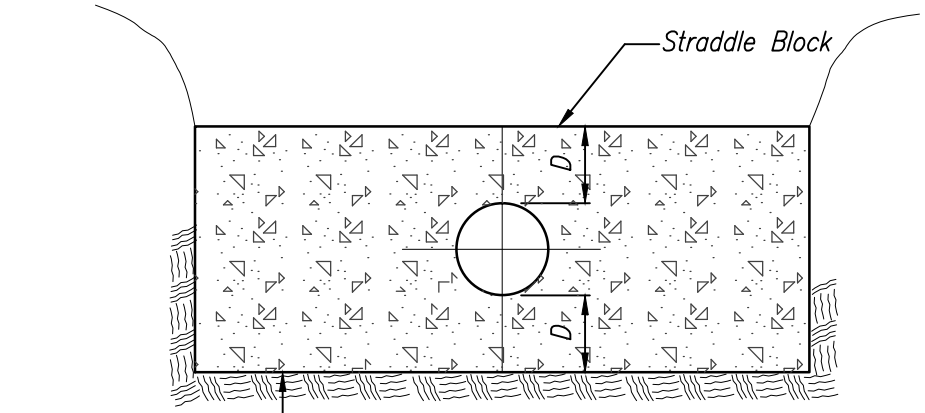
TYPICAL
CONCRETE
TIE DOWN BLOCK



PLAN



ELEVATION

NOTES:

1. Straddle Blocks Are Sized For 175 P.S.I. Line Pressure Plus 50% Surge.

PIPE SIZE	"D" MIN.	CUBIC FEET
2"	4"	12
4"	4"	18
6"	4"	18
8"	6.5	30
12"	6.5	61

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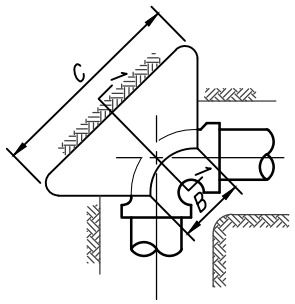
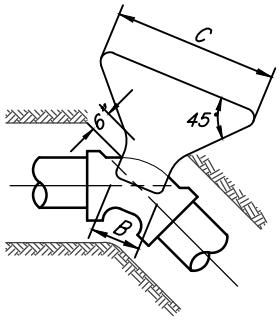
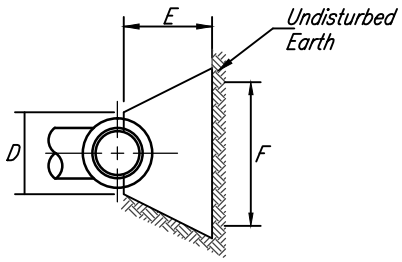
TYPICAL
STRADDLE BLOCK
2" THROUGH 12" PIPE



90° BEND



45° BEND
OR LESS



SECTION 1–1

NOTES:

1. *When Using A Bend With A Diameter Not Covered In These Charts, A Backing Block For The Next Larger Diameter Pipe With The Same Degree Of Bend Shall Be Used.*
2. *Backing Blocks For Piping Sizes Up Through 12–Inch Are Based On A Working Pressure Of 175 P.S.I. Plus 50% Surge.*
3. *Backing Blocks For Piping Sizes 16–Inch Through 24–Inch Are Based On A Working Pressure Of 150 P.S.I. Plus 50% Surge.*

BRANCH SIZE	B	C	D	E	F
4" 11 ¼° & 22 ½°	8"	12"	8"	24"	9"
4" 45°	8"	17"	24"	18"	12"
4" 90°	8"	27"	24"	24"	14"
6" 11 ¼° & 22 ½°	8"	12"	8"	24"	9"
6" 45°	8"	17"	24"	18"	12"
6" 90°	8"	27"	24"	24"	14"
8" 11 ¼° & 22 ½°	8"	16"	10"	24"	12"
8" 45°	8"	23"	10"	24"	16"
8" 90°	8"	34"	10"	24"	20"
12" 11 ¼° & 22 ½°	8"	26"	12"	24"	16"
12" 45°	8"	34"	12"	24"	24"
12" 90°	8"	50"	16"	24"	30"
16" 11 ¼°	8"	20"	16"	24"	16"
16" 22 ½°	8"	32"	16"	24"	20"
16" 45°	8"	42"	16"	30"	30"
16" 90°	8"	58"	16"	24"	40"
20" 11 ¼°	12"	24"	20"	24"	20"
20" 22 ½°	12"	42"	20"	30"	24"
20" 45°	12"	54"	20"	36"	36"
20" 90°	12"	75"	20"	42"	48"
24" 11 ¼°	12"	30"	24"	24"	24"
24" 22 ½°	12"	44"	24"	30"	33"
24" 45°	12"	59"	24"	42"	48"
24" 90°	12"	87"	24"	54"	60"

CUBIC FEET OF CONCRETE REQUIRED				
BEND	11 ¼°	22 ½°	45°	90°
4"	1.4	1.4	2.9	3.3
6"	1.4	1.4	2.9	3.3
8"	2.1	2.1	3.3	5.5
12"	3.8	3.8	6.5	11.3
16"	3.8	5.6	12.4	25.9
20"	5.4	11.2	23.2	47.2
24"	7.4	15.5	38.4	86.6

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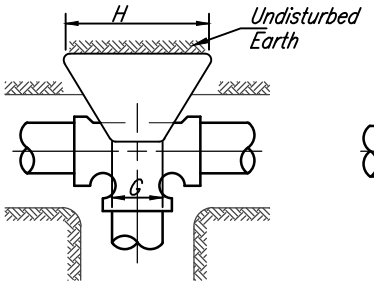
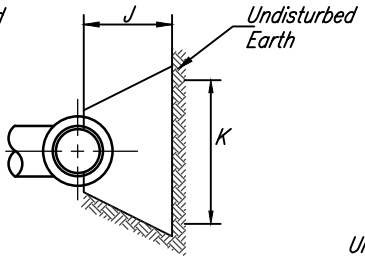
STANDARD WATER DETAILS

REVISED
1-16

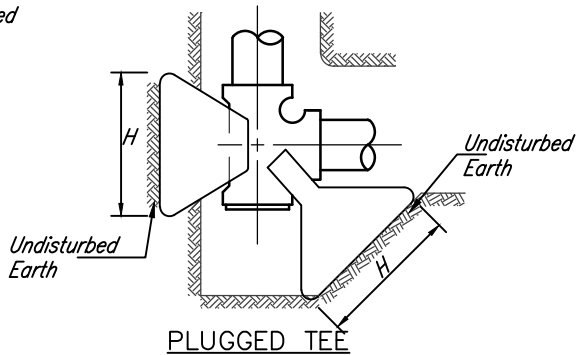
TYPICAL BACKING BLOCKS FOR BENDS



TEE



TYPICAL SECTION



PLUGGED TEE

NOTES:

1. When Using A Plug Or Tee With A Branch Size Not Covered In These Charts, A Backing Block For The Next Larger Plug Or Branch Shall Be Used.
2. Backing Blocks For Piping Sizes Up Through 12-Inch Are Based On A Working Pressure Of 175 P.S.I. Plus 50% Surge.
3. Backing Blocks For Piping Sizes 16-Inch Through 24-Inch Are Based On A Working Pressure Of 150 P.S.I. Plus 50% Surge.

BRANCH SIZE	G	H	J	K
4"	8"	30"	24"	18"
6"	8"	30"	24"	18"
8"	8"	40"	24"	24"
12"	12"	54"	30"	40"
16"	12"	65"	36"	50"
20"	16"	85"	40"	60"
24"	18"	102"	54"	72"

CUBIC FEET OF CONCRETE REQUIRED									
PLUG		TEE							
		RUN	BRANCH						
SIZE	CU. FT.		4	6	8	12	16	20	24
4"	5	4	5	–	–	–	–	–	–
6"	5	6	5	5	–	–	–	–	–
8"	8	8	5	5	8	–	–	–	–
12"	23	12	5	5	8	23	–	–	–
16"	40	16	5	5	8	23	40	–	–
20"	70	20	5	5	8	23	40	70	–
24"	135	24	5	5	8	23	40	70	135

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STANDARD WATER DETAILS

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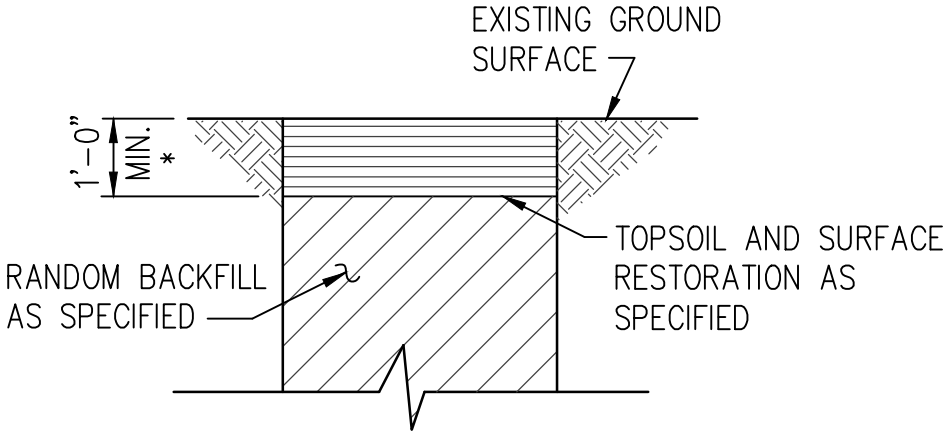
1-16

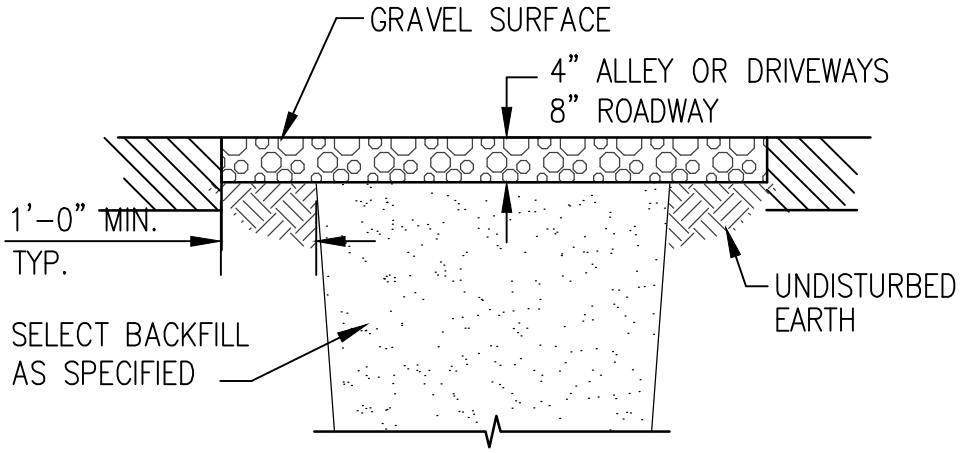
TYPICAL BACKING BLOCKS FOR TEES & PLUGS



* 2'-0" MINIMUM IN ESTABLISHED GARDENS

NON-PAVED AND NON-GRAVELED SURFACE AREA

NO SCALE



GRAVEL SURFACED AREA

NO SCALE

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STANDARD WATER DETAILS

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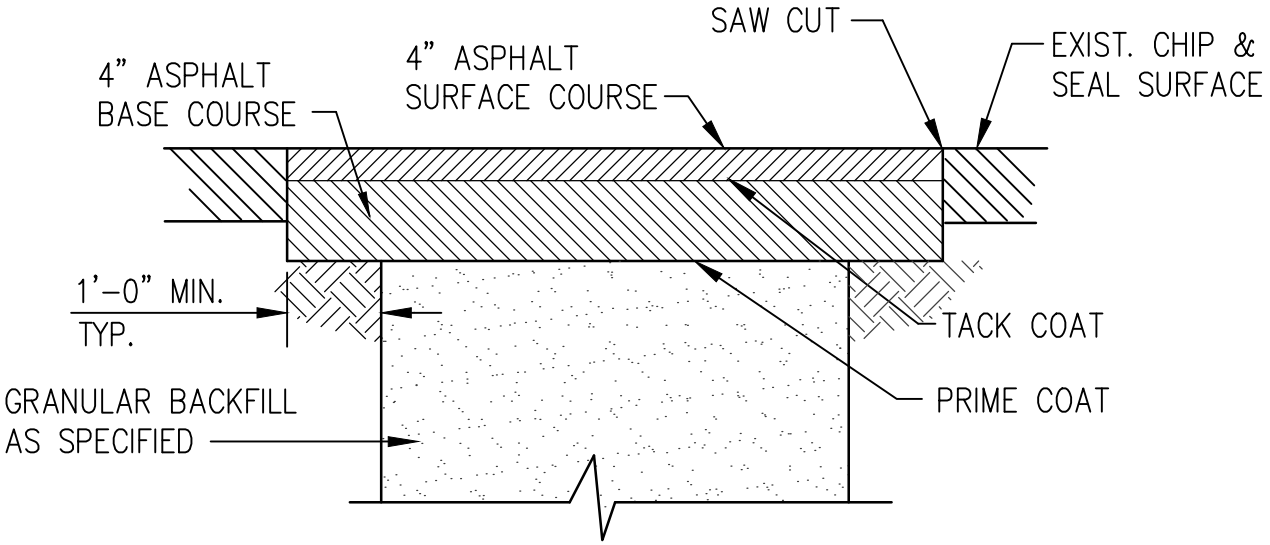
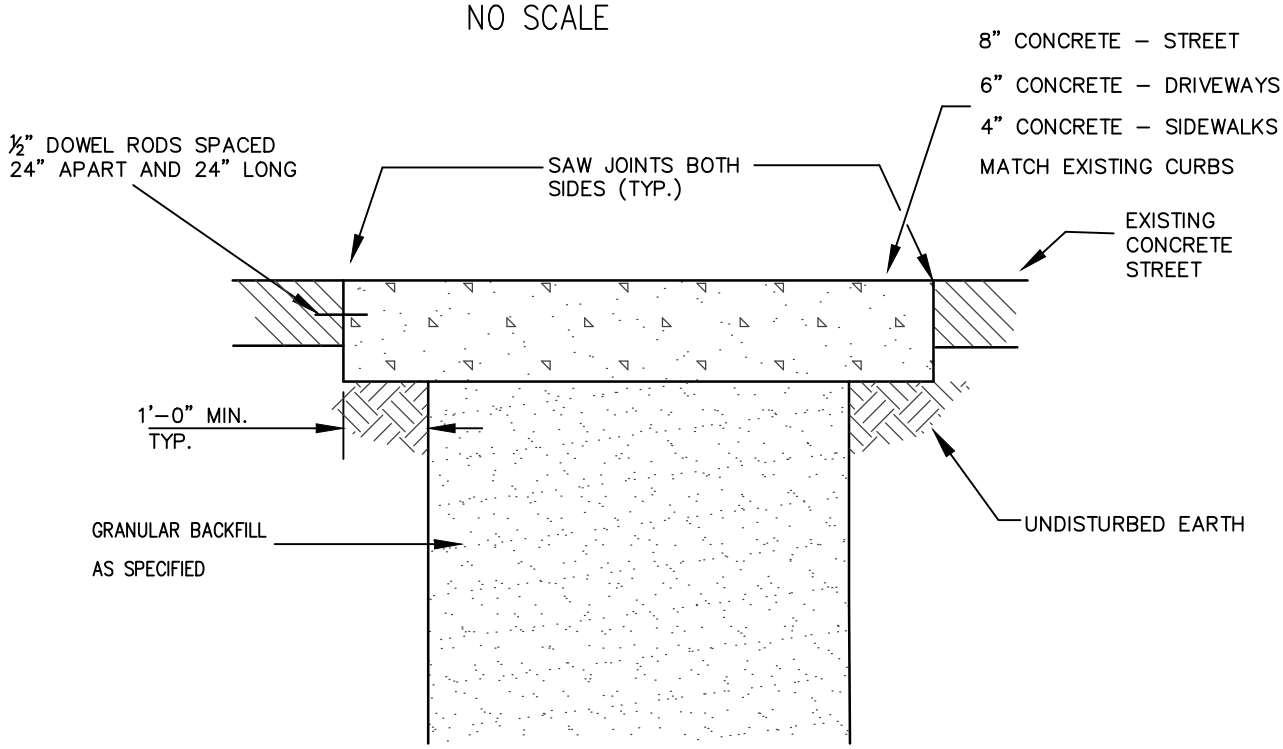
TYPICAL
SURFACE RESTORATION
DETAILS



ASPHALT OR CHIP & SEAL SURFACED AREA

NO SCALE



NOTES:
1) CONCRETE TO BE 6 ½ BAG MIX.

2) PATCH SHALL BE JOINTED TO MATCH EXISTING PAVEMENT.

CONCRETE SURFACED AREA

NO SCALE

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TYPICAL SURFACE RESTORATION DETAILS