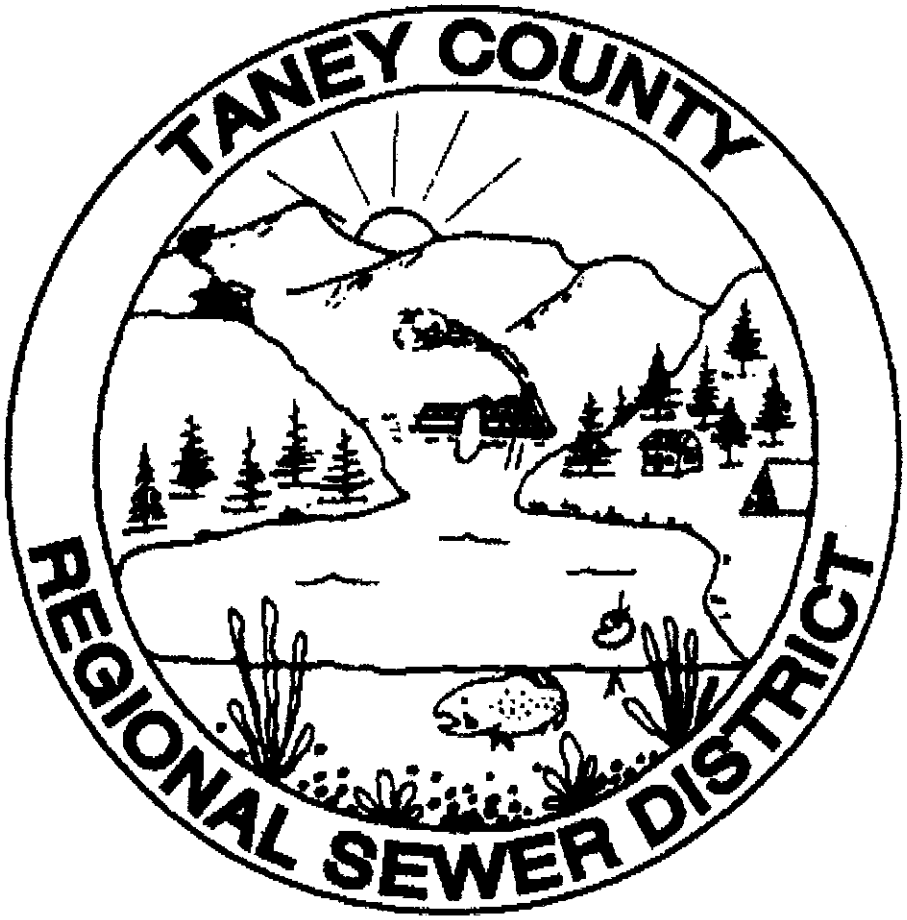
TANEY COUNTY REGIONAL SEWER DISTRICT



TECHNICAL SPECIFICATIONS

NOTE REGARDING THE USE OF THESE TECHNICAL SPECIFICATIONS:

The Taney County Regional Sewer District's technical specifications are approved by the Missouri Department of Natural Resources (SWROENG-0001) for typical sewer extensions to the Taney County Regional Sewer District's collection systems. However, the specifications are general in nature and may not be applicable to every project. It is the responsibility of the design engineer to review these specifications and make any modifications necessary for compliance with each individual project. The design engineer shall be wholly responsible for the use of these specifications. The specifications and any modifications shall be signed and sealed by the design engineer and sent to the Taney County Regional Sewer District for review.

TECHNICAL SPECIFICATIONS

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SECTION 01340

COMPLIANCE SUBMITTALS

PART 1 - GENERAL

1.01 GENERAL

A. This section specifies procedural requirements for non-administrative compliance submittals including shop drawings, product data, samples, miscellaneous, and closeout submittals.

B. Compliance submittals are required to amplify, expand, and coordinate the information contained in the Contract Documents.

C. Compliance Submittals are necessary:
   1. For the Engineer to determine that the equipment and materials conform with the design concept and comply with the intent of the Contract Documents.
   2. For the proper erection, installation, operation and maintenance of the equipment and materials which the Engineer will review for general content but not for substance.
   3. For the Engineer to determine what supports, anchorages, structural details, connections, and services are required for the equipment and materials, and the effects on contiguous or related structures, equipment, and materials.

1.02 SECTION INCLUDES

A. Shop Drawings.

B. Product Data.

C. Samples.

D. Miscellaneous Submittals.

E. Closeout Submittals.

F. Submittal Procedures.

G. Re-Submittal Procedures.

H. Engineer's Responsibilities.

I. Distribution of Submittals after Review.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.01 SHOP DRAWINGS

A. Shop drawings are technical drawings and data that have been specially prepared for the Project.

B. A qualified detailer must prepare shop drawings.

C. Shop drawings may include but are not limited to the following items:
   1. Fabrication and installation drawings showing foundation details, anchor bolt sizes and locations, base plate sizes, location of Owner's connections and all clearances required for erection, operation, and disassembly for maintenance.
   2. Setting diagrams.
   3. Shopwork manufacturing instructions.
   4. Templates.
   5. Patterns.
   6. Coordination drawings (for use on-site).
   7. Design mix formulas.
   8. Contractor's engineering computations.
   9. Electrical routing drawings, internal wiring diagrams, one-line diagrams, etc.

D. Identify details by reference to sheet and detail numbers shown on Contract Drawings.

E. Standard information prepared without specific reference to the Project is not considered to be shop drawings.

3.02 PRODUCT DATA

A. Product data includes standard printed information on manufactured products that is not original to the Project.

B. Product data may include but are not limited to the following items:
   1. Manufacturer's production specifications and installation instructions.
   2. Standard schematic drawings.
   3. Standard diagrams and illustrations.
   4. Standard schedules.
   5. Standard wiring diagrams.
   6. Catalog sheets and brochures.
   7. Printed performance curves and charts.
   8. Roughing-in diagram and templates.
   9. Standard color charts.
   10. Operational range diagrams.
   11. Mill reports.
   12. Standard product operating and maintenance manuals.
   13. Other standard descriptive data.

C. Modify drawings to delete information that is not applicable to the Project.

D. Supplement standard information to provide additional information that is applicable to the Project.

E. Clearly mark each copy to identify pertinent materials, products, or models.

F. Show dimensions and clearances required.

G. Show performance characteristics and capacities.

H. Show wiring diagrams and controls.

3.03 SAMPLES

A. Samples are physical examples to illustrate materials, equipment or workmanship, and to establish standards by which completed work is judged.

B. Samples may include but are not limited to the following items:
   1. Partial sections of manufacture's or fabricated work.
   2. Small cuts or containers of materials.
   3. Complete units of repetitively used materials.
   4. Swatches showing color, texture, and pattern.
   5. Color range sets.
   6. Units of work to be used for independent inspection and testing.

C. Samples shall be submitted of sufficient size and quantity to clearly illustrate the functional characteristics of product or material with integrally related parts and attachment devices.

D. Field samples and mock-ups shall be erected at the Project site at a location acceptable to Engineer.

E. Construct each field sample or mock-up complete, including work of all trades required in finished work.

F. After review, samples may be used in construction of the Project.

3.04 MISCELLANEOUS SUBMITTALS

A. Miscellaneous submittals are work-related, non-administrative submittals that do not fit in the three previous categories.

B. Miscellaneous submittals may include but are not limited to the following:
   1. Specially prepared and standard printed warranties.
   2. Maintenance agreements.
   3. Workmanship bonds.
   4. Survey data and reports.
   5. Project photographs.
   6. Testing and certification reports.
   7. Field measurement data.
   8. Keys and other security protection devices.

C. Contractor shall provide property surveys, field measurements, quantitative records of actual work, damage surveys, and similar data as required by the individual sections of these specifications.

D. Where submittal of a copy of standards is indicated and except where copies of standards are specified as an integral part of a "Product Data" submittal, submit a single copy of standards for the Engineer's use. Where workmanship, whether at the project site or elsewhere, is governed by a standard, furnish additional copies of the standard to fabricators, installers, and others involved in the performance of the work.

3.05 CLOSEOUT SUBMITTALS

A. Refer to individual sections of these specifications for specific submittal requirements of project closeout information, materials, spare parts, extra and overrun stock, tools, maintenance devices, keys, and similar items. In addition to submittals required in individual specification sections, the following submittals are required:
   1. Record Documents: Furnish a set of original documents as maintained on the project site. Also provide 2 photographic copies of marked-up drawings.
   2. Following completion of the Work and prior to final payment, Contractor shall furnish those drawings necessary to indicate "as constructed" conditions, including field modifications, in the number of copies specified and furnish additional copies for insertion in equipment instruction books as required. All such copes shall be clearly marked "AS CONSTRUCTED." Contractor shall provide two photographic copies of each "AS CONSTRUCTED" submittal for use by the Owner.
   3. Operating and Maintenance Manuals: Furnish 3 bound copies of operating data and maintenance manuals.

3.06 SUBMITTAL REQUIREMENTS

A. Contractor shall prepare for Engineer's concurrence a schedule for submission of all compliance submittals specified or necessary for Engineer's approval of the use of equipment and materials proposed for incorporation in the Work or needed for proper installation, operation, or maintenance.

B. Contractor's submittal schedule shall accompany the procurement schedule and work progress schedule submitted to the Engineer.

C. Schedule all submissions to permit review, fabrication, and delivery in time to cause no delay in the Work of Contractor or his Subcontractors or any other applicable contractors.

D. Contractor shall consult the requirements of the Contract Documents in establishing his schedule for submittals.

E. The Contractor's submittal schedule shall indicate the anticipated dates of original submission for each item and Engineer's acceptance thereof, and shall be based upon at least one re-submission of each item.

F. All submittals required prior to fabrication or manufacture shall be scheduled for submission sufficiently in advance of the installation dates for the corresponding items of materials or equipment. Submittals pertaining to storage, installation, and operation at the site shall be scheduled for Engineer's acceptance prior to delivery of the equipment or materials.

G. The Contractor shall submit all submittals of equipment and materials furnished by Subcontractors, manufacturers, and suppliers to the Engineer.

H. Submit number of copies of submittals that the Contractor requires for distribution plus three copies that will be retained by the Engineer.

I. Submit number of Samples specified in each of the specification sections.

J. Sequentially number transmittal forms.

K. Deliver submittals to the Engineer at their business address.

L. Accompany submittals with a transmittal letter, in duplicate, containing the following:
   1. Date.
   2. Project title and number.
   3. Contractor's name and address.
   4. The number of each Shop Drawing, Product Data, Sample, and Miscellaneous Submittal submitted.
   5. Specification section number and article number.
   6. Notification of deviations from Contract Documents.
   7. Other pertinent data.

   Unidentifiable submittals will be returned for proper identification.

M. Submittals shall include:
   1. Transmittal letter.
   2. Date and revision dates.
   3. Project title and number.
   4. The names of:
      a. Owner.
      b. Engineer.
      c. Contractor.
      d. Subcontractor.
      e. Supplier.
      f. Manufacturer.
      g. Separate detailer when pertinent.
   5. Identification of product or material.
   6. Relation to adjacent structure or materials.
   7. Field dimensions, clearly identified.
   8. Specification section number and article number.
   9. Applicable standards, such as ASTM number or Federal Specification.
   10. A blank space, 3 inches high by 5 inches wide, for the Engineer's stamp.
   11. Identification of deviations from Contract Documents.
   12. Contractor's stamp, initialed or signed, certifying review of submittal, verification of field measurements, and compliance with Contract Documents.
   13. Contractor's stamp of approval shall constitute a representation to the Owner and the Engineer that the Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or he assumes full responsibility for doing so, and that he has coordinated each submittal with the requirements of the Work and the Contract Documents.

N. Data submitted shall be complete with respect to dimensions, design criteria, materials of construction, and the like to enable the Engineer to review the information effectively. Where standard drawings are furnished that cover a number of variations of the general class of equipment, each such drawing shall be individually annotated to describe exactly which parts of the drawing apply to the equipment being furnished. Such annotations shall also include proper identification of the submittal permanently attached to the drawing. Reproduction or copies of Contract Drawings or portions thereof will not be accepted as complete fabrication or erection drawings, but will be acceptable when used by Contractor as a drawing upon which to indicate information on erection or to identify detail drawings.

O. Equipment operation and maintenance manuals shall be prepared by the manufacturer with loose-leaf pages mounted in durable covers and shall include the following:
   1. Index and tabs.
   2. Instructions for installation, start-up, operation, inspection, maintenance, parts lists, and recommended spare parts, and data sheets showing model numbers.

3. Applicable drawings.
4. Address, telephone number, and fax number of nearest manufacturer-authorized service facility.
5. All additional data specified.

P. If errors are discovered during manufacture or fabrication, the submittal shall be corrected and re-submitted for review.

Q. No Work requiring a Compliance Submittal shall be commenced or shipped until the submittal has been stamped "Approved" or "Approved as Noted" by Engineer. The Contractor shall keep a copy of each compliance submittal in good order at the site.

3.07 RE-SUBMITTAL REQUIREMENTS

A. Submittals shall be resubmitted the number of times required for Engineer's approval. Any need for re-submittals in excess of the number set forth in the acceptable schedule, or any other delay in obtaining acceptance of submittals, will not be grounds for extension of the Contract Time, provided that the Engineer completes his reviews within the times specified in the 'Engineer's Responsibilities' described below.

B. Submit number of copies of re-submittals that the Contractor requires for distribution plus three copies that will be retained by the Engineer.

C. Re-submittals will include the original submittal number and a sequential alphabetic suffix.

D. Revise initial drawings as required and re-submit as specified for initial submittal.

E. Indicate on drawings any changes that have been made other than those requested by the Engineer.

F. Submit new product data and samples as required for the initial submittal.

3.08 ENGINEER'S RESPONSIBILITIES

A. Engineer will review and return submittals to Contractor with appropriate annotations. The Engineer is allowed 15 days for review of each submittal, excluding delivery time to and from the Contractor.

B. Engineer will review instruction books and similar submittals for general content but not for substance. The approval for use of a separate item as such will not indicate approval for use of the assembly in which the item functions.

C. Review for:
1. Design concept of project.
2. Information given in Contract Documents.

D. Review of separate item does not constitute review of an assembly in which the item functions.

E. Samples will be reviewed only for aesthetic, color, or finish selection.

F. Engineer's review action stamp, appropriately completed, will appear on all Compliance Submittals of Contractor when returned by the Engineer.

G. Return submittals to Contractor for distribution.

H. Prints of accepted drawings transmitted for final distribution will not be further reviewed and are not to be revised.

I. Engineer's acceptance of compliance submittals will not relieve the Contractor from his responsibility for any deviations from the requirements of the Contract Documents unless the Contractor has in writing called the Engineer's attention to such deviation at the time of submission and the Engineer has given written approval to the specific deviation, nor shall any acceptance by the Engineer relieve the Contractor from responsibility for errors or omissions in compliance submittals.

J. Compliance submittals not requested will not be recognized or processed by the Engineer.

3.09 DISTRIBUTION OF SUBMITTALS AFTER REVIEW

A. Contractor shall distribute copies of compliance submittals that carry the Engineer's stamp to:
   1. Contractor's file.
   2. Job-site file.
   3. Record documents file.
   4. Subcontractors.
   5. Supplier.
   6. Fabricator.
   7. Installer.
   8. Governing Authorities.
   9. Others as necessary for the proper performance of the Work.

B. Contractor shall distribute samples as directed.

C. Contractor shall instruct parties to promptly report any inability to comply with requirements.

D. Contractor shall record distribution on transmittal forms.

END OF SECTION

SECTION 02115

DUST AND EROSION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. This item shall consist of temporary control measures during the life of the construction contract to control air pollution, soil erosion, and siltation through the use of berms, dikes, dams, sediment basins, fiber mats, gravel mulches, grasses, slope drains, and other erosion control devices or methods.

B. The Contractor is responsible for controlling erosion and discharge of sediment from the site at all times during construction. The Contractor shall provide necessary measures during all phases of his/her operations regardless of whether they are specifically noted on the Drawings and shall maintain and replace controls as necessary during the course of his/her operations.

C. The temporary erosion control measures contained herein shall be coordinated with the permanent erosion control measures specified as part of this contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.

D. Temporary control may include work outside the construction limits such as borrow pit operations, equipment and material storage sites, waste areas, and temporary plant sites.

E. The Contractor shall clean streets both interior and adjacent to the site as needed after each rainfall, and at the end of construction.

F. The Contractor is responsible for cleaning silt from storm drains prior to approval of construction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials shall meet commercial grade standards and shall be approved by the Engineer before being incorporated into the project.

B. Grass. Grass which will not compete with the grasses sown later for permanent cover shall be a quick-growing species (such as ryegrass, Italian ryegrass, or cereal grasses) suitable to the area providing a temporary cover.

C. Mulches. Mulches may be hay, straw fiber mats, netting, bark, wood chips, or other suitable material reasonably clean and free of noxious weeds and deleterious materials.

D. Fertilizer. Fertilizer shall be a standard commercial grade and shall conform to all Federal and state regulations and to the standards of the Association of Official Agricultural Chemists.

E. Slope Drains. Slope drains may be constructed of pipe, fiber mats, rubble, portland cement concrete, bituminous concrete, or other materials that will adequately control erosion.

PART 3 - EXECUTION

3.01 GENERAL

A. In the event of a conflict between these requirements and pollution control laws, rules, or regulations of other Federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

B. The Contractor shall be responsible for assuring compliance to the extent that construction practices, construction operations, and construction work are involved.

3.02 SCHEDULE

A. Prior to the start of construction, the Contractor shall submit schedules for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing; construction; paving; and structures at watercourses. The Contractor shall also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work shall not be started until the erosion control schedules and methods of operation for the applicable construction have been accepted by the Engineer.

B. Temporary construction entrance(s) and silt fences, straw bale dikes, or other initial sediment controls shown on the Drawings must be installed prior to any other work.

C. Sediment basins must be installed within 10 calendar days after construction begins or as soon as 2 or more acres are disturbed, whichever comes first.

3.03 METHODS

A. Several methods of controlling dust and other pollutants include, but are not limited to, the following:
   1. Exposing the minimum area of erodible earth.
   2. Applying temporary mulch with or without seeding.
   3. Using water sprinkler trucks.
   4. Using covered haul trucks.
   5. Using dust palliatives or penetration asphalt on haul roads.
   6. Using plastic sheet coverings.
   7. Using gravel.

3.04 AUTHORITY OF ENGINEER

A. The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, to limit the surface area of erodible earth material exposed by excavation, borrow and fill operations, and to direct the Contractor to provide immediate permanent or temporary erosion control measures to minimize loss of soil due to erosion and contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water empoundment.

3.05 CONSTRUCTION DETAILS

A. Prior to clearing and grubbing operations for the project, Contractor shall identify all areas where the potential for loss of soil due to erosion exists, and shall line the construction side of the creek within these areas with straw bales to minimize eroded materials from entering the creek. These shall be maintained throughout the construction period and removed when the permanent ground covering is established. The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practical time as outlined in the accepted schedule.

Except where future construction operations will damage slopes, the Contractor shall perform the permanent seeding and mulching and other specified slope protection work in stages, as soon as substantial areas of exposed slopes can be made available. Temporary erosion and pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

B. When erosion is likely to be a problem, clearing and grubbing operations should be scheduled and performed so that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise, temporary erosion control measures may be required between successive construction stages.

C. The Engineer will limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

D. In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as part of the work as scheduled or are ordered by the Engineer, such work shall be performed by the Contractor at his/her own expense.

E. The Engineer may increase or decrease the area of erodible earth material to be exposed at one time as determined by analysis of project conditions.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns, and plantings.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches within building lines.
8. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

1.02 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation.
1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Layer placed between the subbase course and asphalt paving.

C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations.
1. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Layer placed between the subgrade and base course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

K. Utilities include on-site underground pipes, conduits, ducts, and cables.

1.03 SUBMITTALS

A. Product Data: For the following:
   1. Each type of plastic warning tape.
   2. Drainage fabric.
   3. Separation fabric.

B. Samples: For the following:
   1. 30-lb samples, sealed in airtight containers, of each proposed soil material from on-site or borrow sources.
   2. 12-by-12-inch sample of drainage fabric.
   3. 12-by-12-inch sample of separation fabric.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
   2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill.

1.04 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548.

1.05 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Engineer not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Engineer's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Backfill and Fill: Satisfactory soil materials.

E. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2- inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

H. Bedding: Embedment for ordinary trench conditions for eight-inch (8") nominal diameter through fifteen-inch (15") nominal diameter PVC gravity sewer line is compacted ASTM D2487 Class IB dense graded, clean, manufactured and processed aggregates described as angular crushed stone, crushed rock, crushed gravel, or crushed stone/sand mixtures containing little or no fines with gradations selected to minimize migration of adjacent soils with amounts finer than each square opening laboratory sieve as mass percent of 100 percent passing a 3/4-inch sieve, 90-100 percent passing a 1/2-inch sieve, 0-15 percent passing a No. 4 sieve, and 0-5 percent passing a No. 8 sieve compacted to 85% or greater standard proctor density and tested to ensure proper compaction.

Sieve	% Passing
¾"	100
½"	90
No. 4	0-15
No. 8	0-5

I. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2- inch sieve and 0 to 5 percent passing a No. 8 sieve.

J. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.02 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
   1. Grab Tensile Strength: 110 lbf; ASTM D 4632.
   2. Tear Strength: 40 lbf; ASTM D 4533.
   3. Puncture Resistance: 50 lbf; ASTM D 4833.
   4. Water Flow Rate: 150 gpm per sq. ft.; ASTM D 4491.
   5. Apparent Opening Size: No. 50; ASTM D 4751.

C. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
   1. Grab Tensile Strength: 200 lbf; ASTM D 4632.
   2. Tear Strength: 75 lbf; ASTM D 4533.
   3. Puncture Resistance: 90 lbf; ASTM D 4833.
   4. Water Flow Rate: 4 gpm per sq. ft.; ASTM D 4491.
   5. Apparent Opening Size: No. 30; ASTM D 4751.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

   2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.03 BLASTING

A. The Contractor shall submit a site plan indicating the following:
   1. Location and number of magazines.
   2. Bunkers, if required.
   3. Distance to adjacent buildings and/or structures.

B. MSDS sheets shall be provided for all materials used on the job site.

C. No blasting material shall be stored on-site.

D. The equipment, processes and operations involving the manufacture, possession, storage, sale, transportation, maintenance and use of explosive materials shall comply with the requirements of Chapter 23 and the provisions of this chapter, NfiPA 495, ATF publication 5400.7 (6/90) and DOT 49 CFR listed in Chapter 44.

E. Scope: The equipment, processes and operations involving the manufacture, possession, storage, sale, transportation, maintenance and use of explosive materials shall comply with the requirements of Chapter 23 and the provisions of this chapter, NfiPA 495, ATF publication 5400.7 (6/90) and DOT 49 CFR listed in Chapter 44.

G. The Contractor shall meet the requirements as set out in NfiPA 495, sections 2-4.1 and 2-4.2.

H. A contractor who has successfully completed a blasters certification course by ISEE (International Society of Explosive Engineers), MPLA (Missouri Limestone Producers Association) or another recognized testing agency and has kept the certification current will be considered as having fulfilled the requirements of NfiPA 495 section 2-4.2.

I. Required Insurance Coverage: The blasting contractor or operator of a facility engaged in blasting shall provide proof of insurance for blasting liability in the amount of no less than $1,000,000 per incident and $2,000,000 per project on an occurrence basis.

J. Time: Blasting shall be conducted only between the hours of 8:00 a.m. and 5:00 p.m. Monday through Friday, unless otherwise approved by the Owner.

K. Signage: For electrically initiated blasts or blasts which may be affected by two-way radios or cellular phones, proper signage shall be set on all streets, roads or highways within one thousand (1000) feet of the blast area, unless otherwise approved by the Engineer, declaring "BLAST AREA TURN OFF TWO-WAY RADIOS AND NO CELLULAR PHONE USAGE". For other blasting proper signage shall be set on all streets, roads or highways within one thousand (1,000) feet of the blast area, unless otherwise approved by the Engineer, declaring "BLAST AREA."

L. Seismographs:

1. A minimum of one (1) seismograph shall be used on all blasting areas. The Engineer may require additional seismographs.
2. Seismic reading shall not exceed 1.0 IPS (Inches Per Second) at the closest structure or well.
3. Sound levels shall not exceed 140 decibels at the seismic area.
4. Weekly seismic readings and copies of the blasting log shall be provided to the Engineer unless more frequent readings and logs are requested.

M. Pre-Blast Survey: A pre-blast survey shall be conducted by an independent contractor/ consultant. The documentation of the existing conditions of a structure. The survey is used to determine whether subsequent blasting caused damage to the structure. Blasters shall be responsible for conducting pre-blast surveys when blasting within three hundred fifty (350) feet of any habitable structure, well, road or highway.

The pre-blast survey for a well shall document:

1. The casing count of the well.
2. Total depth of the well.
3. Static level of the well.
4. The results of a pump test.

N. Written Notice: Written notice shall be delivered to all property owners/managers within the pre-blast survey area and shall contain at a minimum:

1. Blasting contractor's or facility operator's name, address and phone number.
2. Starting and ending dates of blasting.
3. Approximate times of day blasting will occur.
4. Location of blasting and for whom the work is being done.

O. Fly Rock: No fly rock shall leave the immediate blast area. On special occasions it may be necessary to cover the shot to prevent fly rock from leaving the blast area.

P. Warnings/Blasting:

WARNINGS SHALL BE SOUNDED AS FOLLOWS:

1. The blasting contractor or facility operator shall be responsible for insuring that the blast area is visually inspected and made clear of people and/or animals before each shot.
2. Three (3) 5 to 10 second soundings from a siren, air horn or other approved warning device, with a minimum sound level of 140 decibels at one hundred (100) feet shall be sounded.
3. WAIT a full thirty (30) seconds.
4. Sound another 5 to 10 second sounding.
5. Immediately following the two (2) 5 to 10 second soundings give a VOICE COMMAND from an amplified bullhorn or equal stating 'DETONATION TO FOLLOW."
6. No person shall enter the blast area until such time that the blaster in charge has determined that no danger exists.
7. An "ALL CLEAR" voice command shall be given after the blast and when the blast area is safe to enter for inspection.

Q. ROCK EXCAVATION:

1. The maximum allowable rock size after blasting shall be no larger than 3' x 3' x 3'.
2. All blasting is performed at the Contractor's sole risk. The Contractor is solely responsible for any and all damages caused by blasting to any adjacent structure or any other underground facilities. If damage does occur to any above or below ground facilities the Contractor is fully liable.
3. All excavation is considered unclassified. No payment shall be made for rock encountered. Presence of rock shall not relieve Contractor of depth requirements.
4. In high hazard areas, rock shall be removed by jackhammering as necessary. No payment to be made for removal of rock, including that which cannot be blasted. Contractor shall make determination of whether or not rock can be blasted, but Contractor shall be fully liable for any damages.

3.04 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.05 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete form work, for installing services and other construction, and for inspections.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

   2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated. Do not disturb bottom of excavations intended for bearing surface.

3.06 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.07 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. One block or 400 feet (whichever is the shorter) shall be the maximum length of open trench permitted on any line under construction.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

C. Trench Bottoms: Excavate trenches 6 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
   1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Only sewer lines shall be placed in the Sewer District's trench. No other utilities will be permitted inside the trench.

3.08 APPROVAL OF SUBGRADE

A. Notify Engineer when excavations have reached required subgrade.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
   1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer.

3.09 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Engineer.
   1. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for record documents.
   3. Inspecting and testing underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.12 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

B. Backfill trenches excavated under footings and within 18 inches of bottom of footings; fill with concrete to elevation of bottom of footings.

C. Place and compact initial backfill of bedding material, to a height of 12 inches over the utility pipe or conduit.
   1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

D. Coordinate backfilling with utilities testing.

E. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.

F. For areas not under pavement, place and compact final backfill of satisfactory soil material to final subgrade.

G. For areas under pavement, place and compact final backfill using bedding material to final subgrade.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

C. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

3.14 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill material at 95 percent.

   2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 92 percent.

   3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 85 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Lawn or Unpaved Areas: Plus or minus 1 inch.

2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place a layer of drainage fabric around perimeter of drainage trench as indicated. Place a 6-inch course of filter material on drainage fabric to support drainage pipe. Encase drainage pipe in a minimum of 12 inches of filter material and wrap in drainage fabric, overlapping sides and ends at least 6 inches.
   1. Compact each course of filter material to 95 percent of maximum dry unit weight according to ASTM D 698.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade. Overlay drainage backfill with one layer of drainage fabric, overlapping sides and ends at least 6 inches.
   1. Compact each course of filter material to 95 percent of maximum dry density according to ASTM D 698.
   2. Place and compact impervious fill material over drainage backfill to final subgrade.

3.18 SUBBASE AND BASE COURSES

A. Under pavements and walks, place subbase course on prepared subgrade and as follows:
   1. Place base course material over subbase.
   2. Compact subbase and base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
   3. Shape subbase and base to required crown elevations and cross-slope grades.
   4. When thickness of compacted subbase or base course is 6 inches or less, place materials in a single layer.
   5. When thickness of compacted subbase or base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

B. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.19 DRAINAGE COURSE

A. Under slabs-on-grade, place drainage course on prepared subgrade and as follows:
   1. Compact drainage course to required cross sections and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
   2. When compacted thickness of drainage course is 6 inches or less, place materials in a single layer.
   3. When compacted thickness of drainage course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.

3.20 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
   1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
   2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet or less of wall length, but no fewer than two tests.
   3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses (1 year), remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

SECTION 02530

SANITARY SEWERAGE

PART 1 - GENERAL

1.01 DEFINITIONS

A. EPDM: Ethylene-propylene-diene-monomer rubber.

B. NPS: Nominal pipe size.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

1.02 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

B. Force-Main Pressure Ratings: At least equal to system operating pressure, but not less than 150 psig (1035 kPa).

1.03 SUBMITTALS

A. Product Data: For the following:
   1. Valves and cleanouts.
   2. Manhole cover inserts.
   3. Pipe and fittings.

B. Shop Drawings: Include plans, elevations, details, and attachments for precast concrete manholes, including frames and covers.

C. Record Drawings: At Project closeout of installed sanitary sewerage record drawings shall be submitted to the Sewer District. The record drawings shall accurately record actual locations of pipe runs, connections, cleanouts, manhole top and invert elevations, air-relief valves and lift station data. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves according to the following:
   1. Ensure that valves are dry and internally protected against rust and corrosion.
   2. Protect valves against damage to threaded ends and flange faces.
   3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves according to the following:
   1. Do not remove end protectors, unless necessary for inspection; then reinstall for storage.

2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves whose size requires handling by crane or lift. Rig valves to avoid damage to exposed valve parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support piping to prevent sagging and bending.

H. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.05 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated. Notify property owner not less than two days in advance of proposed utility interruptions.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.02 PIPES AND FITTINGS

A. Ductile-Iron Pressure Pipe: AWWA C151.
   1. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, buried or flooded pipe shall have mechanical joints, interior or exposed pipe shall have flanged unless otherwise indicated or specified.
   2. Gaskets: AWWA C111, Rubber
   3. Flanges: Ductile iron, conforming to ANSI B16.1 and shall be drilled class 125.
   4. Flange Bolts: Bolts shall conform to ASTM A307 Grade B.
   5. Flange Gaskets: Shall be 1/8" thick, full-faced synthetic rubber.

B. Ductile-Iron Sewer Pipe: ASTM A 746, for push-on joints.

1. Standard-Pattern, Ductile-Iron Fittings: AWWA C110, ductile or gray iron, for push-on joints.
2. Gaskets: AWWA C111, rubber.

C. PVC Pressure Pipe: AWWA C900, Class 200 or ASTM 2241, 200 psi, SDR 21, for gasketed joints.
1. Ductile-Iron, Compact Fittings: AWWA C153, for push-on joints.
2. Gaskets for Ductile-Iron Fittings: AWWA C111, rubber.

D. PVC Sewer Pipe and Fittings: According to the following:
1. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, gasketed joints. Gaskets are to conform to ASTM F 477, elastomeric seals.
2. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-1 wall thickness, bell and spigot for gasketed joints. Gaskets are to conform to ASTM F 477, elastomeric seals.

2.03 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Sleeve-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes to be joined, for nonpressure joints.
1. Sleeve Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
2. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
3. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.
4. Bands: Stainless steel, at least one at each pipe insert.

B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joints.
1. Material for Cast-Iron Soil Pipe: ASTM C 564, rubber.
2. Material for Plastic Pipe: ASTM F 477, elastomeric seal.
3. Material for Dissimilar Pipe: Compatible with pipe materials being joined.

C. Pressure-Type Pipe Couplings: AWWA C219, iron-body sleeve assembly matching OD of pipes to be joined, with AWWA C111 rubber gaskets, bolts, and nuts. Include PE film, pipe encasement.

D. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated. Include PE film, pipe encasement.

E. Ductile-Iron Deflection Fittings: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for up to 15 degrees deflection. Include PE film, pipe encasement.

F. Ductile-Iron Expansion Joints: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig minimum working pressure and for expansion indicated. Include PE film, pipe encasement.

2.04 VALVES AND ACCESSORIES

A. Nonrising-Stem, Resilient-Seated Gate Valves, 3-Inch NPS and Larger: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats,

bronze stem, and stem nut. Include 200-psig minimum working-pressure design, interior coating according to AWWA C550, and buried valves shall be mechanical-joint with a 2-inch operating nut, exposed or interior valves shall have flanged ends and have hand wheel operators. Valves shall open counter clockwise. Valve stems shall use double "O" ring seals.

B. Check Valves: AWWA C508, with 175-psig working-pressure rating. Include interior coating according to AWWA C550. Valve hinge pins shall be stainless steel. Valve disc shall be full opening with a composition to metal seat. Valve shall be flanged unless noted otherwise on the Drawings. Valves shall be equipped with an external lever that is spring assisted. The spring tension shall be field adjustable by a hex nut. The lever arm shall be keyed to the valve hinge shaft.

C. Check Valves - Cushioned: AWWA C508, with 175-psig working-pressure rating, with addition of exterior cushion chamber. Include interior coating according to AWWA C550. Swing disc type with stainless steel shaft and flanged body. Flanges shall be ANSI B16.1, Class 125. Valve disc shall have external lever and adjustable counterweight to initiate closure. Valves shall have a metal to composition seat.

D. Eccentric Plug Valves:

1. Plug valves shall be quarter-turn non-lubricated eccentric type with resilient faced plug. Alternate seat and plug materials may be considered provided this specification is met and, in addition, the manufacturer must prove prior to approval that the valve meets AWWA C504 "proof of design tests" (10,000 cycles) in both directions. Flanged valve ends shall be faced and drilled to conform to ANSI B16.1, Class 150 for diameter and drilling. Mechanical or push-on type rubber-gasketed joint ends shall conform to AWWA C111. Port areas for valves smaller than 20-inch shall be at least 80 percent of full pipe area. Port areas for valves 24-inch and larger shall be at least 70 percent of full pipe area.
2. Materials and Construction:
   a. Bodies shall be of ASTM A126, Class B cast iron.
   b. Valve plug shall be ASTM A126, Class B cast iron or ASTM A536 ductile iron. Resilient plug facing shall be synthetic rubber, neoprene or Buna N compound suitable for use with water and wastewater applications.
   c. Seats shall be a raised welded overlay of 90% pure nickel, a minimum of .125" thick and 0.50" wide, conforming to AWWA C504. When the plug is in the closed position, the resilient plug facing shall contact only nickel. Sprayed or plated mating seat surfaces are not acceptable for resilient plugs.
   d. Bearings shall be replaceable. Sleeve bearings in the upper and lower journals shall be permanently lubricated 316 stainless steel per ASTM A743 Grade CF-8M. Nonmetallic journal bearings shall not be acceptable. Thrust bearings shall be Teflon.
   e. Shaft seals shall be self-adjusting chevron-type conforming to AWWA C504. Valve shall be designed so it can be repacked while the valve is in line and under pressure without removing the actuator. O-ring seals shall not be acceptable in valves larger than 3".
   f. All exposed fastening hardware shall be zinc plated or stainless steel. Provide stainless steel bolting on buried service valves.
3. Manual Operators:
   a. All valves shall open counterclockwise.
   b. Provide indicators to show position of plug except on buried operators.
   c. Actuators: Manual valves shall have lever or worm gear actuators with handwheels, chainwheels, tee wrenches, extension stems, floorstands, etc., as shown on the plans or as called for in the valve schedule. Lever

actuators shall be furnished for valves 8" or smaller where the maximum shutoff pressure is 25 psi or less as indicated on the plans or in the valve schedule. Worm gear actuators shall be furnished for all valves 4" or larger where the maximum reverse shutoff pressure is greater than 25 psi. Worm gear actuators shall be sized for 150 psi. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. This adjustable stop shall be the only adjustment necessary to set the clearance between the valve plug and the seat while the valve is in line and under pressure. Handwheel and chainwheel sizes for worm gear actuators shall be no smaller than 6" in diameter and no larger than twice the diameter of the actuator's gear sector. All exposed nuts, bolts, and washers shall be zinc plated. Valves and gear actuators for buried or submerged service shall have seals on all shafts and gaskets on the valve and actuator covers to prevent the entry of water. Actuator mounting brackets for buried or submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs, and washers shall be stainless steel.

d. Handwheels shall be located for easy access on exposed valves.

e. Buried valves shall be operated by a 2" AWWA nut with valve box.

4. Testing: Furnish certified copies of results of tests prior to shipment. All valves shall be subjected to an AWWA C504 procedure leak test at 150 psi against the face of the plug and a body hydrostatic test at 300 psi. Valves shall be capable of providing drip-tight shutoff up to the full leak test rating with pressure in either direction.

E. Ball Valves (Polymer Service and Non-Potable Water 2" And Smaller)

1. Ball valves shall be PVC true union with either solvent socket or threaded pipe connections. Pressure rating shall exceed 230 psi.
2. Seats shall be PTFE with backing rings. Backing rings and seals shall be EPDM.
3. PVC shall meet or exceed cell classification 12454B, ASTM D-1784.
4. Socket end connections shall conform to ASTM D-2467. Threaded pipe connections shall conform to ANSI B2.1.
5. Exposed valves shall be operated by a 2" AWWA nut. Valve shall not be buried.

F. Backwater Valves

1. Gray-Iron Backwater Valves: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
   a. Horizontal Type: With swing check valve and hub-and-spigot ends.
   b. Combination Horizontal and Manual Gate-Valve Type: With swing check valve, integral gate valve, and hub-and-spigot ends.
   c. Terminal Type: With bronze seat, swing check valve, and hub inlet.
2. PVC Backwater Valves: Similar to ASME A112.14.1, horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

G. Air Release Valves:

Air release valves shall be A.R.I. model D-025 combination air valve for sewage.

H. Appurtenances:

1. Trace Wire: Magnetic detectable conductor (#12 copper). See Section 02537 for Tracer Wire Specification.

2.05 POLYETHYLENE PLASTIC (PE) FILM, PIPE ENCASEMENT

ASTM A 674 or AWWA C105; PE film, tube, or sheet; 8-mil thickness.

2.06 MANHOLES

A. Normal-Traffic Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
   1. Diameter: 48 inches minimum, unless otherwise indicated.
   2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
   3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
   4. Riser Sections: 5-inch minimum thickness and lengths to provide depth indicated.
   5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
   6. Gaskets: ASTM C 443 rubber.
   7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 12-inch total thickness, that match 24-inch diameter frame and cover.
   8. Steps: ASTM C478 plastic steps, individual steps. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals.
   9. Pipe Connectors: ASTM C 923 resilient, of size required, for each pipe connecting to base section. A-LOK manhole pipe connector or equal.
      a. When connecting into an existing manhole, the manhole shall be cored drilled to allow new pipe to enter. Cutting or chipping the opening is not permitted. A rubber gasket and non-shrink grout shall be used to provide a tight seal around pipe.

B. Heavy-Traffic Precast Concrete Manholes: ASTM C 913; designed according to ASTM C 890 for A-16, heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for rubber gasketed joints.
   1. Ballast: Increase thickness of one or more precast concrete sections or add concrete to structure, as required to prevent flotation.
   2. Gaskets: Rubber.
   3. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and cover.
   4. Steps: ASTM C478 plastic steps, individual steps. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
   5. Pipe Connectors: ASTM C 923 resilient, of size required, for each pipe connecting to base section. A-LOK manhole pipe connector or equal.

C. Manhole Frames and Covers: ASTM A48-76, Class 35. Standard manhole frames and covers shall have a minimum weight of 300 pounds and shall be Neenah R-1780A or Deeter 1315 or equal. Include indented top design with lettering "SANITARY SEWER" cast into cover.

2.07 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
   1. Cement: ASTM C 150, Type II.

2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope. Invert Slope is to be 5 percent through manhole (minimum).
   2. Benches: Concrete, sloped to drain into channel. Slope must be 5 percent (minimum).

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.08 PROTECTIVE COATINGS

A. Description: One- or two-coat, coal-tar epoxy; 1/8 inch minimum thickness, unless otherwise indicated; factory or field applied to the following surfaces (Refer to Section 07160 Bituminous Dampproofing):
   1. Concrete Manholes: On exterior surface.

2.09 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug. Use units with top-loading classifications according to the following applications:
   1. Light Duty: In earth or grass foot-traffic areas.
   2. Medium Duty: In paved foot-traffic areas.
   3. Heavy Duty: In vehicle-traffic service areas.
   4. Extra-Heavy Duty: In roads.
   5. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout. PVC Cleanout piping shall be Schedule 40.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

3.02 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

B. Hand trim excavations to required elevations. Correct over excavation with bedding material.

C. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

3.03 IDENTIFICATION

Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.

A. Use warning tape or detectable warning tape over ferrous piping.

B. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.04 PIPING APPLICATIONS

A. General: Include watertight joints.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.

C. Gravity-Flow Piping: As indicated on the Drawings:
   1. NPS 4 and NPS 6: PVC sewer pipe and fittings, solvent-cemented joints, or gaskets and gasketed joints. (4-inch pipe is allowed on gravity service laterals from building to main line only. All gravity sanitary sewer mains must be a minimum of 6-inch in diameter.)
   2. NPS 8 and NPS 10: PVC sewer pipe and fittings, or gaskets and gasketed joints.
   3. NPS 12 and NPS 15: PVC sewer pipe and fittings, or gaskets and gasketed joints.

D. Force-Main Piping: As indicated on the Drawings:
   1. NPS 4 to NPS 8: Ductile-iron sewer pipe; standard- or compact-pattern, ductile-iron fittings; gaskets; and gasketed joints.
   2. NPS 4 to NPS 8: PVC pressure pipe, PVC pressure fittings, gaskets, and gasketed joints.

3.05 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.
   1. Use the following pipe couplings for nonpressure applications:
      a. Sleeve type to join piping, of same size, or with small difference in OD.
      b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
      c. Bushing type to join piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
   2. Use pressure-type pipe couplings for force-main joints. Include PE film, pipe encasement.

B. Special Pipe Fittings: Use where indicated. Include PE film, pipe encasement.

3.06 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. For gravity sewers, manholes with a minimum diameter of forty-eight inches (48"), shall be installed at all changes in grade, size, alignment, intersections, and at distances of no greater than four hundred feet (400'). The use of fittings in the place of manholes is not acceptable.

D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Molded Tees shall be used for all "tee" connections for new construction of gravity sewers. Insterta-Tees® (or approved equal) shall be used on all tap connections to existing gravity sewer pipe.

F. Install ductile-iron, force-main piping according to AWWA C600.

G. Install PVC force-main piping according to AWWA M23.

H. Location of Sewers with Respect to Water Mains:

1. Horizontal Separation: Whenever possible, any sanitary sewer, storm sewer, or manhole shall be laid at least 10 feet, horizontally, from a water main. When local conditions prevent a lateral separation of 10 feet, the Department of Natural Resources may allow a sanitary or storm sewer be laid closer than 10 feet to a water main provided that the sanitary or storm sewer is laid at least 18 inches below the bottom of the water line. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, both the water main and sewers must be constructed of mechanical or slip-on joint ductile iron pipe or prestressed concrete cylinder pipe and should be pressure tested to assure watertightness before backfilling. Both of these alternate methods must be specifically approved by the Department of Natural Resources on a case-by-case basis.
2. Vertical Separation: Whenever sanitary sewers, house sewers, or storm sewers must cross water mains, the sewer or drain shall be laid at such an elevation that the bottom of the water main is no closer than 18 inches above the top of the drain or sewer. This vertical separation shall be maintained for that portion of the sanitary sewer, house sewer, or storm sewer located within 10 feet, horizontally, of any water line it crosses. The crossing shall be arranged so that the sewer joints will be equal distance and as far as possible from the water main joints.
3. Unusual Conditions: Where conditions prevent the minimum vertical separation set forth above from being maintained, or when it is necessary for the sewer line to pass over a water main, the sewer line shall be laid with slip-on mechanical joint cast iron or ductile iron pipe or pre-stressed concrete cylinder pipe, and the sewer line shall extend on each side of the crossing to a distance from the water main of at least 10 feet. In making such a crossing, a full length of cast iron or ductile iron pipe must be centered over or under the water main to be crossed so that the joints will be equidistant from the water main and as remote therefore as possible. The water main must also be constructed of cast iron or ductile iron pipe with slip-on or

mechanical joints until the nominal distance from the sewer line to the water main is at least 10 feet. Where a water main must cross under a sewer, a vertical separation of 18 inches between the bottom of the sewer and the top of the water main shall be maintained, with adequate support, especially for the larger sized sewer lines, to prevent them from settling on and breaking the water main. The sewer shall be constructed of cast iron pipe or ductile iron pipe for a distance of 10 feet on either side of the crossing, or other suitable protection as approved by the Missouri Department of Natural Resources shall be consulted as to the precautions to be taken to protect the public water supply.

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

I. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

J. All gravity sewer lines shall be installed with minimum slopes according to the following table:

Sewer Size	Minimum Slope (Feet per 100 Feet)
6 in.	0.60
8 in.	0.40
9 in.	0.33
10 in.	0.28
12 in.	0.22
14 in.	0.17
15 in.	0.15
16 in.	0.14
18 in.	0.12
21 in.	0.10
24 in.	0.08
27 in.	0.067
30 in.	0.058
36 in.	0.046

3.07 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. Ductile-Iron Sewer Pipe with Ductile-Iron Fittings: According to AWWA C600. Install PE film, pipe encasement over ductile-iron sewer pipe and ductile-iron fittings according to ASTM A 674 or AWWA C105.

C. PVC Pressure Pipe and Fittings: Join and install according to AWWA M23.

D. PVC Sewer Pipe and Fittings: As follows:
1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
2. Join profile sewer pipe fittings with gaskets according to ASTM D 2321 and manufacturer's written instructions.
3. Install according to ASTM D 2321.

E. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.

F. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

G. Install with top surfaces of components, except piping, flush with finished surface.

3.08 REACTION ANCHORAGE AND BLOCKING

A. All unlugged bell and spigot or all-bell tees, Y-branches and bends deflecting 11-1/4 degrees or more which are installed in piping subjected to internal hydrostatic heads in excess of 15 feet in exposed, or 30 feet in buried, piping shall be provided with suitable reaction blocking, struts, anchors, clamps, joint harness, or other adequate means for preventing any movement of the pipe caused by unbalanced internal liquid pressure.

B. Trench installation: Where in trench, the foregoing designated fittings shall be provided with concrete thrust blocking between the fitting and solid, undisturbed ground in each case, except where solid ground blocking support is not available. At the tops of slopes vertical angle bends shall be anchored by means of steel strap or rod anchors securely embedded in or attached to a mass of concrete of sufficient weight to resist the hydraulic thrust at the maximum pressures to which the pipe will be subjected. All concrete blocking and anchors shall be installed in such a manner that all joints between pipe and fittings are accessible for repair.

C. The bearing area of concrete reaction blocking against the ground or trench bank shall be as shown by the plans or as directed by the Engineer in each case. In the event that adequate support against undisturbed ground cannot be obtained, metal harness anchorages consisting of steel rods or bolts across the joint and securely anchored to pipe and fitting or other adequate anchorage facilities approved by the Engineer shall be installed to provide the necessary support. Should the lack of a solid vertical excavation face be due to careless or otherwise improper trench excavation, the entire cost of furnishing and installing metal harness anchorages in excess of the contract value of the concrete blocking replaced by such anchorages shall be borne by the Contractor.

D. For other locations: Reaction blocking, struts, anchorages, or other supports for fittings installed in fills or other unstable ground, above grade, or exposed within structures, shall be provided as required by the plans or as directed by the Engineer.

E. Protection of metal surfaces: All steel clamps, rods, bolts and other metal accessories used in reaction anchorages or joint harness subject to submergence or contact with earth or other fill material and not encased in concrete shall be adequately protected from corrosion with not less than two coats of Koppers "Bitumastic No. 50", or approved equal, heavy coal tar coating material, applied to clean, dry metal surfaces. The first coat shall be dry and hard before the second coat is applied. Metal surfaces exposed above grade or within structures shall be painted with two coats (in addition to a primer coat) of a paint approved by the Engineer.

3.09 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Form continuous concrete channels and benches between inlets and outlet. Manhole bottoms shall be formed to provide smooth continuous flow.

C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere, unless otherwise indicated.

D. Install precast concrete manhole sections with gaskets according to ASTM C 891.

E. Construct cast-in-place manholes as indicated.

3.10 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.11 BACKWATER VALVE INSTALLATION

A. Install horizontal units in piping where indicated.

B. Install combination units in piping and in structures where indicated.

3.12 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.13 AIR RELEASE FACILITIES

A. Air release valves shall be A.R.I. model D-025 combination air valve for sewage.

B. Air release facilities shall be located at the high points of all pressure sewer systems and shall be properly sized to prevent buildup of air or gases that will impede flow of the wastewater.

C. Air release valves must be automatic and designed to prevent wastewater solids and grease from reaching the valve operating mechanism.

D. Provisions for cleaning the valve by back flushing should be provided.

3.14 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so finished Work complies as nearly as practical with requirements specified for new Work.

B. Use Inserta-Tees® (or approved equal) to make branch connections into existing piping, NPS 4 to NPS 20. Install Inserta-Tee® and encase entire connection with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

C. Make branch connections from side into existing piping, NPS 21 or larger, or to underground structures by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
   1. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

D. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.15 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
   2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Structures: Excavate around structure as required and use one procedure below:
   1. Remove structure and close open ends of remaining piping.
   2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
   3. Backfill to grade according to Division 2 Section "Earthwork."

3.16 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
   1. Place plug in end of incomplete piping at end of day and when work stops.
   2. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
      c. Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into piping.
      e. Exfiltration: Water leakage from or around piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Re-inspect and repeat procedure until results are satisfactory.

3.17 FIELD TESTING

A. General:
   1. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   2. Leaks and loss in test pressure constitute defects that must be repaired.

3. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

B. Pressure Tests:
1. The Contractor shall furnish all pumps, piping, labor and other materials and services necessary to bring the piping up to the specified test pressure.
2. All pipes shall be pressure tested. Pipes which will be pressurized under normal operating conditions shall conform to the requirements of the hydrostatic pressure test. All other piping shall meet the requirements of the air leakage test.
3. Pipe in the sections to be tested shall be backfilled or center loaded, with thrust blocks installed and completely backfilled. Interior pipe supports and restraint systems shall be completely installed prior to testing.

C. Hydrostatic Pressure Test:
1. Test connections shall be made and the pipe filled with water. Unless otherwise specified, a pressure of not less than 1.25 times the normal operating pressure (for the lowest point on the pipe line) but not less than 100 pounds per square inch (psi) or not more than the rated working pressure for the pipe shall be used for testing.
2. After air removal, water shall be pumped in to bring the pipe to the specified pressure. 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. After two hours, additional water shall be drawn from a container of known volume. The amount of water required to return the system to the specified pressure shall not exceed the amount determined by the following formula:

$$Q = SD(P)^{1/2}/133200, \qquad \text{(Equation 1)}$$

Where

Q - Total allowable leakage in gallons per hour.
S - Length of section tested, feet.
D - Nominal pipe diameter, inches.
P - Test pressure, psi

The allowable leakage must not exceed the volumes specified below for each 1,000 feet of the particular diameter of pipe being tested:

Hydrostatic Testing Allowance per 1,000 ft of Pipeline* - gph (AWWA C-600)

Avg. Test Pressure	Nominal Pipe Diameter (in)										
(psi)	1.5	2	3	4	6	8	10	12	14	16	18
100	0.11	0.15	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.2	1.35
125	0.13	0.17	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51
150	0.14	0.18	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66
175	0.15	0.20	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79
200	0.16	0.21	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.7	1.91

* Calculated on the basis of Equation 1

3. All exposed pipe, fittings, valves, and joints shall be inspected and all evidence of moisture appearing on the surface of the ground during the test shall be investigated by the Contractor by excavation where the pipe has been covered with backfill. Should the leakage test results exceed allowable leakage, the test pressure shall be maintained for an additional period of time as directed by the Engineer to facilitate location of leaks.

4. All pipe, fittings, valves, pipe joints, and other materials which are found to be defective when the pipe line is tested shall be removed from the line immediately and replaced with new and acceptable material by and at the expense of the Contractor. The pressure test shall be repeated after repairing leaks and other defective work until the pipe line installation conforms to specified requirements and is accepted by the Engineer.

D. Air Leakage Test:

1. Contractor may perform air tests for all pipe sizes.
2. Air leakage testing shall be performed on lines as specified and on the following lines:
   a. Outfall line.
   b. Drain lines.
   c. Sanitary sewer lines.
3. Furnish all facilities required including necessary piping connections, test pumping equipment, pressure gauges, bulkheads, regulator to avoid over-pressurization, and all miscellaneous items required.
   a. The pipe plug for introducing air to the line shall be equipped with two taps. One tap will be used to introduce air into the line being tested, through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valves and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. An additional valve and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The pressure test gauge will also be used to indicate loss of air pressure due to leaks in the sewer line.
   b. The pressure test gauge shall meet the following minimum specifications:

i.	Size (diameter)	4-1/2 inches
ii.	Pressure Range	0-15 P.S.I.
iii.	Figure Intervals	1 P.S.I. Increments
iv.	Minor Subdivisions	0.05 P.S.I.
v.	Pressure Tube	Bourdon Tube or diaphragm
	Accuracy	+ 0.25% of maximum scale reading
vi.	Dial	White coated aluminum with black lettering, 270° Arc and mirror edge
vii.	Pipe Connection	Low male 1/2" N.P.T.

   Calibration data will be supplied with all pressure test gauges. Certification of pressure test gauge will be required from the gauge manufacturer. This certification and calibration data will be available to the Engineer whenever air tests are performed.
4. Test each reach of sewer pipe between manholes after completion of the installation of pipe and appurtenances and the backfill of sewer trench.
5. Plug ends of line and cap or plug all connections to withstand internal pressure. One of the plugs provided must have two taps for connecting equipment. After connecting air control equipment to the air hose, monitor air pressure so that internal pressure does not exceed 5.0 psig. After reaching 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least two (2) minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any leakage. If plugs are found to leak, bleed off air, tighten plugs, and again begin supplying air. After temperature has stabilized, the pressure is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop to 2.5 psig. If the time, in seconds, for the air pressure to decrease

from 3.5 psig to 2.5 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

Minimum Specified Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated for $Q = 0.0015$ (ASTM F 1417, TABLE 1)

Pipe Diameter, in.	Minimum Time, min:s	Length for Minimum Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	0.380L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

If air test fails to meet above requirements, repeat test as necessary after all leaks and defects have been repaired. Prior to acceptance, all constructed sewer lines shall satisfactorily pass the pressure air test.

6. In areas where ground water is known to exist, install a one-half inch diameter capped pipe nipple, approximately 10" long, through manhole wall on top of one of the sewer lines entering the manhole. This shall be done at the time the sewer line is installed. Immediately prior to the performance of the line acceptance test, ground water level shall be determined by removing pipe cap, blowing air through pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to pipe nipple. The hose shall be held vertically and a measurement of height in feet of water shall be taken after the water stops rising in this plastic tube. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings.

E. Vacuum Testing of Manholes:

1. Each manhole shall be tested immediately after assembly and prior to backfilling.
2. All lift holes shall be plugged with an approved non-shrink grout.
3. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole.
4. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturers' recommendations. Test head shall be as manufactured by P.A. Glazier, Inc., of Worcester, Massachusetts, or equal.
5. 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 9 inches. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the values indicated in the following table:

Minimum Test Times for Various Manhole Diameters in Seconds
(ASTM C 1244, TABLE 1)

Depth (ft)	Diameter, in.								
	30	33	36	42	48	54	60	66	72
	Time, in seconds								
8	60	60	60	60	60	60	60	60	60
10	60	60	60	60	60	60	60	60	60
12	60	60	60	60	60	60	60	60	60
14	60	60	60	60	60	60	60	60	60
16	60	60	60	60	60	60	60	60	67
18	60	60	60	60	60	60	60	65	73
20	60	60	60	60	60	60	65	72	81
22	60	60	60	60	60	64	72	79	89
24	60	60	60	60	60	64	78	87	97
26	60	60	60	60	64	75	85	94	105
28	60	60	60	60	69	81	91	101	113
30	60	60	60	63	74	87	98	108	121

6. If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Re-testing shall proceed until a satisfactory test is obtained.

F. Deflection Tests:
1. Deflection tests shall be performed on all flexible sewer pipe by the Contractor using a mandrel pull. The mandrel shall have not less than seven (7) arms. The mandrel pull cannot be performed any sooner than 30 days after the reach being tested has been installed and final backfill has been placed.
2. A section of sewer line reach shall be deemed as failed when the mandrel cannot be moved through it with reasonable force. The tests shall be performed without mechanical pulling devices.
3. At the conclusion of the mandrel pull, the Contractor, at his expense, shall be required to remove and replace all pipe which fails the test.
4. The mandrel diameter shall be based on 95% of the actual inside pipe diameter.

G. Alignment Tests: Sewer alignment shall be checked by either using a laser beam or lamping.

END OF SECTION

SECTION 02532

SEWAGE LIFT STATIONS

Sanitary sewer lift station specifications are to be considered on a project by project basis and inserted by the design engineer. The design engineer must submit lift station specifications to the Sewer District for review and approval.

SECTION 02537

INSTALLATION OF TRACE WIRE ON SEWAGE FORCE MAINS

PART 1 - GENERAL

1.01 This Construction Standard governs trace wire installation on sewage force mains and low pressure mains. Trace wire shall be installed where called for on project drawings.

PART 2 – PRODUCTS

2.01 EXTRA TRACE WIRE MATERIAL

- Trace wire shall be #12 TW solid, coated copper wire.
- Blue tri-wire plastic markers by Rhino w/Test Screws
- 4 ft U-channel posts
- Valve Box Top Sections
- Plastic test box
- Wire Nuts or Split-Bolts

PART 3 – EXECUTION

3.01 APPROVED TRACE WIRE CONNECTIONS

When tying trace wire together, ¾" to 1" of insulation should be removed and the bare copper wires twisted together with a wire nut. Fig 1 shows a typical splice using a plastic wire nut and tying the wire in a knot to strengthen the connection. When connecting a lead to the main run, a split-bolt may be used as shown in Fig. 2. Alternately, a 3M Scotchlok Electrical IDC 562 (or approved equal) can be used when connecting a lead to the main run. Always protect the connection with electrical tape when using the split-bolt. Alternately, 3M Heat Shrink Sleeves (or approved equal) can be used instead of electrical tape.

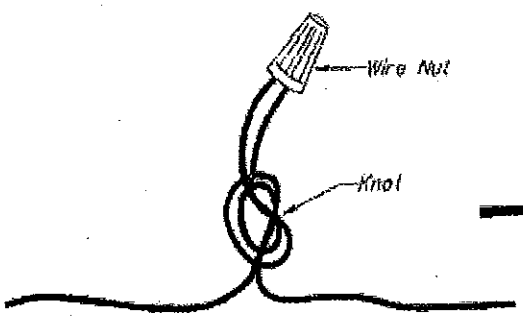


Fig 1

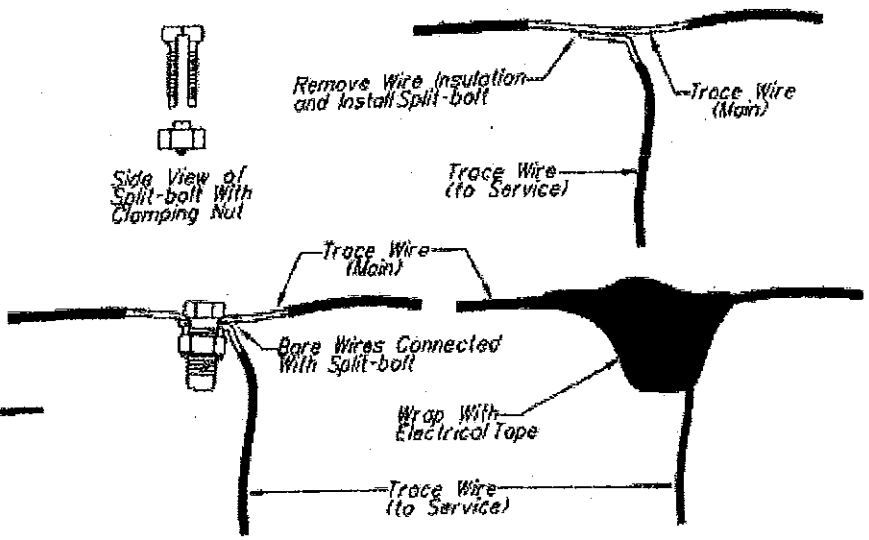


Fig 2

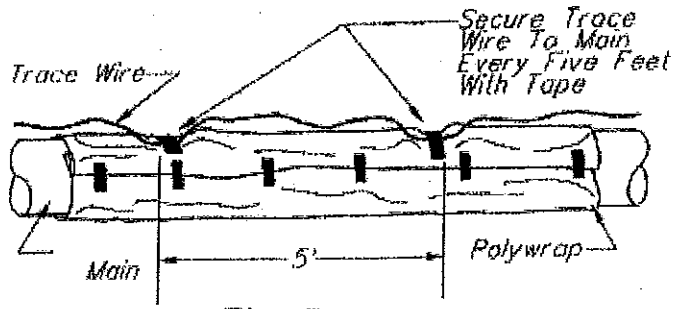


Fig 3

3.02 INSTALLATION

Install trace wire in top of main and secure to main every five (5) feet with tape as shown in Fig 3.

Bring trace wire to surface at a maximum spacing of one thousand (1,000) feet. The trace wire shall be brought to the surface in a vault, blue plastic marker, valve box top section, or in test box. Take care not to damage the wire coating. Repair damaged coating with electrical tape. Splice wire when necessary using wire nuts or split bolts. Terminate old wire runs and begin new ones at an approved access point.

Trace Wire in a Vault

When using a vault, bring the trace wire to the surface according to Fig 4. Do not wrap the trace wire around the steps or any other place where a person entering the vault could trip.

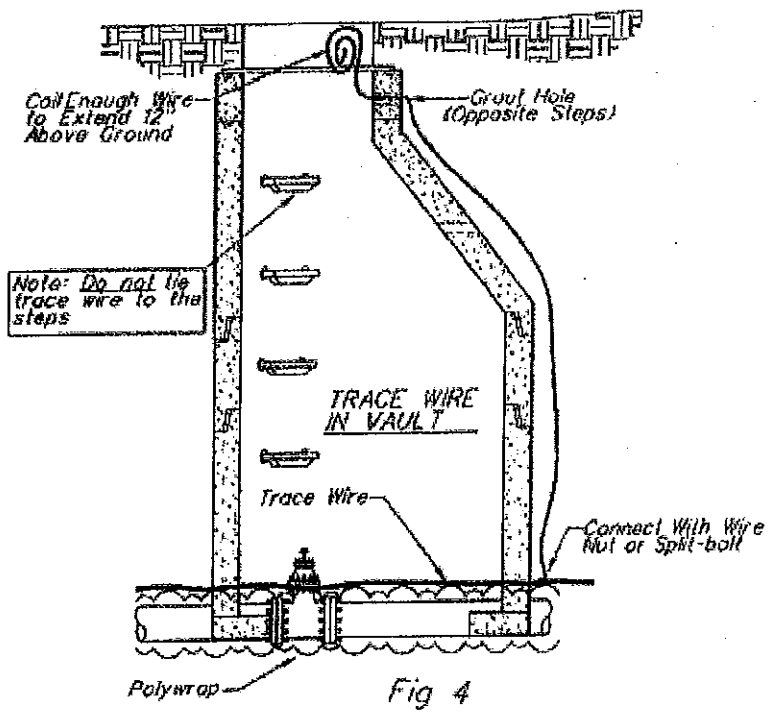


Fig 4

Trace Wire in Blue Plastic Marker

When bringing the trace wire up in a blue plastic marker, install the trace wire according to Fig 5. Bury a 4 foot u-channel post 2 feet in the ground. Run the trace wire up through the marker and slide the blue plastic marker over the post. Bury the bottom six inches of the marker. Connect the trace wire to the brass connecting screws and label the screws with a permanent marker as shown in Fig 5. Note location of trace wire marker on as-built drawings.

Note: If a marker is used only to mark the main location and not bring up the trace wire, use the blue markers without the test point connectors.

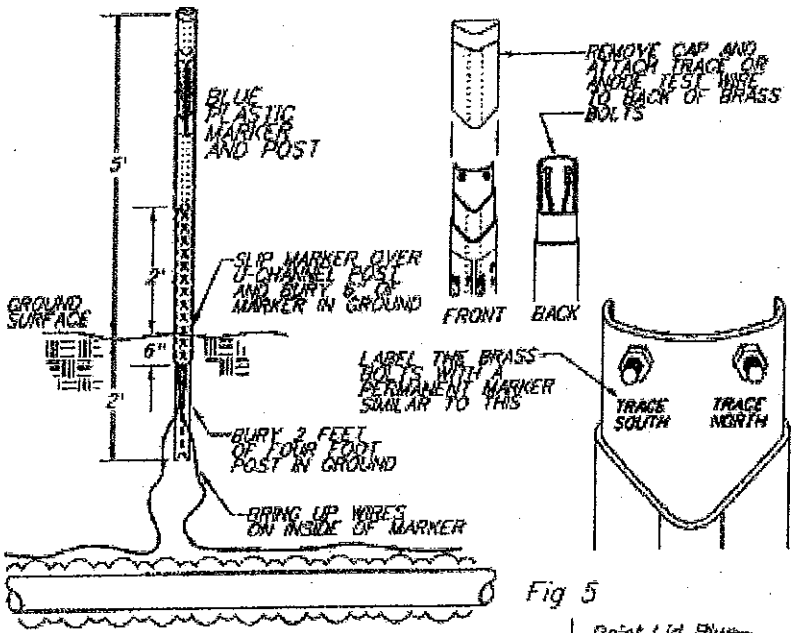


Fig 5

Trace Wire in a Test Box at a CC Valve Box

When bringing the trace wire at a valve box, install the trace wire in a test box about a foot from the valve box according to Fig 6. Make sure there is enough coiled wire to extend a foot above ground. Paint the lid blue. Note location of test box on as-built drawing.

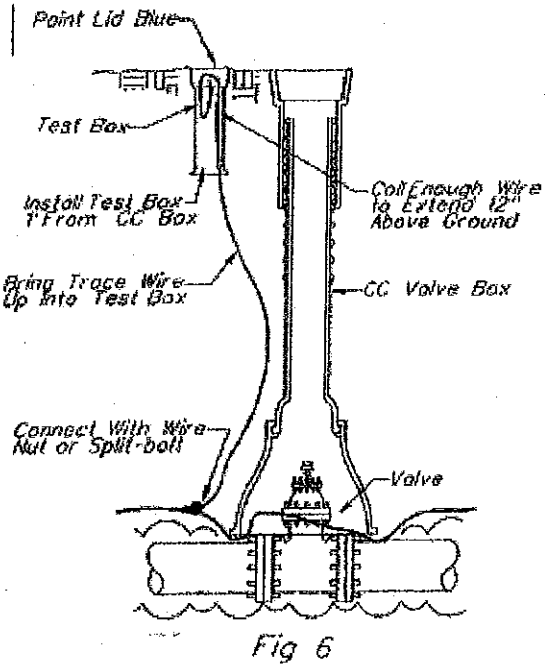


Fig 6

Trace Wire in a Valve Box Top Section

When trace wire is to be brought to the surface in an area where a marker is not practical, a valve box top section may be used as shown in Fig 7. Coil enough wire to extend a foot above the surface of the ground. Fill with sand to a foot from the top. Spray paint the lid blue. Note location of trace wire box on as-built drawings.

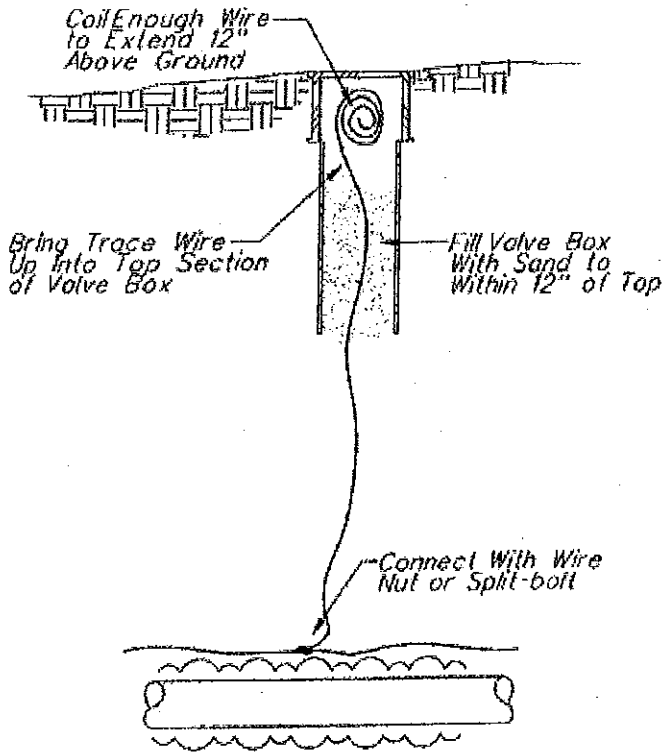


Fig 7

SECTION 02540

LOW PRESSURE SEWER SYSTEMS

PART 1 - GENERAL

1.01 DEFINITIONS

A. EPDM: Ethylene-propylene-diene-monomer rubber.

B. NPS: Nominal pipe size.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

1.02 PERFORMANCE REQUIREMENTS

A. Low Pressure Sewer Ratings: At least equal to system operating pressure, but not less than 200 psig.

1.03 SUBMITTALS

A. Product Data: For the following:
   1. Valves and cleanouts.
   2. Concrete structure cover inserts.
   3. Pipes and fittings.

B. Shop Drawings: Include plans, elevations, details, and attachments for precast concrete structures, including frames and covers to be submitted to the Sewer District upon approval of the design engineer.

C. Record Drawings: At Project closeout of installed sanitary sewerage record drawings shall be submitted to the Sewer District. The record drawings shall accurately record actual locations of pipe runs, connections, cleanouts, air-relief valves and grinder pump data. Identify and describe location of uncharted utilities.

D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping and valves with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

C. Protect flanges, fittings and specialties from moisture and dirt.

D. Store plastic piping protected from direct sunlight. Support piping to prevent sagging and bending.

E. Handle precast concrete structures according to manufacturer's written rigging instructions.

1.05 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated. Notify Sewer District and affected property owners not less than two days in advance of proposed utility interruptions.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.02 PIPES AND FITTINGS

A. PVC Pressure Pipe: AWWA C900, Class 200 or ASTM 2241, 200 psi, SDR 21.
   1. NPS 4 inch and larger:
      a. Ductile-Iron, Compact Fittings: AWWA C153, for push-on joints.
      b. Gaskets for Ductile-Iron Fittings: AWWA C111, rubber.
   2. NPS 1-¼ inch to 3 inch:
      a. Molded PVC Fittings suitable for pressurized conditions with a pressure rating not less than the pipe; minimum of Schedule 80.

B. PVC Gravity Service Lines: ASTM 1785, Schedule 40.
   1. Joints shall be push-on type with bell-end grooved to receive a synthetic rubber gasket. Joints shall be made in accordance with ASTM D 3212.

2.03 VALVES AND ACCESSORIES

A. Nonrising-Stem, Resilient-Seated Gate Valves (3 inch NPS and Larger): AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut. Include 200-psig minimum working-pressure design, interior coating according to AWWA C550, and buried valves shall be mechanical-joint with a 2-inch operating nut, exposed or interior valves shall have flanged ends and have hand wheel operators. Valves shall open counter clockwise. Valve stems shall use double "O" ring seals.

B. Check Valves (4 inch NPS and Larger): AWWA C508, with 175-psig working-pressure rating. Include interior coating according to AWWA C550. Valve hinge pins shall be stainless steel. Valve disc shall be full opening with a composition to metal seat. Valve shall be flanged unless noted otherwise on the Drawings. Valves shall be equipped with an external lever that is spring assisted. The spring tension shall be field adjustable by a hex nut. The lever arm shall be keyed to the valve hinge shaft.

C. Check Valves – Cushioned (4 inch NPS and Larger): AWWA C508, with 175-psig working-pressure rating, with addition of exterior cushion chamber. Include interior coating according to AWWA C550. Swing disc type with stainless steel shaft and flanged body. Flanges shall be ANSI B16.1, Class 125. Valve disc shall have external lever and adjustable counterweight to initiate closure. Valves shall have a metal to composition seat.

D. Check Valves (1-¼ inch to 3 inch NPS):
1. All thermoplastic check valves shall be True Union 2000 Industrial Ball Check type manufactured to ASTM F 1970 and constructed from PVC Type I, ASTM D1784, Cell Classification 12454 or CPVC Type IV, ASTM D1784 Cell Classification 23447.
2. All O-rings shall be EPDM.
3. All valve union nuts shall have Buttress threads.
4. All valve seats shall be a standard O-ring type.
5. All seal carriers shall be Safe-T-Blocked® or approved equal.
6. All valve components shall be replaceable.
7. All PVC and CPVC 1-¼" through 2" valves shall be pressure rated to 235 psi.
8. All 2-½" through 3" valves shall be pressure rated to 150 psi for water at 73°F.

E. Ball Valves (1-¼ Inch to 3 Inch NPS):
1. All thermoplastic ball valves shall be True Union 2000 Industrial type manufactured to ASTM F 1970 and constructed from PVC Type I, ASTM D1784 Cell Classification 12454 or CPVC Type IV, ASTM D1784 Cell Classification 23447.
2. All O-rings shall be EPDM or Viton®.
3. All valves shall have Safe-T-Shear® stem or approved equal with double O-ring stem seals.
4. All valve handles shall be polypropylene with built-in lockout mechanism.
5. All valve union nuts shall have Buttress threads.
6. All seal carriers shall be Safe-T-Blocked® or approved equal.
7. All valve components shall be replaceable.
8. All 1-¼" through 2" valves shall be pressure rated to 235 psi.
9. All 2-½" through 3" valves shall be pressure rated to 150 psi for water at 73°F.
10. All valves shall include manufacturers' optional 2" square/t-style operating nut.

F. Air Release Valves:
Air release valves shall be A.R.I. model D-025 combination air valve for sewage.

G. Appurtenances:
1. Trace Wire: Magnetic detectable conductor (#12 copper). See Section 02537 for Tracer Wire Specification.

2.04 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.05 PROTECTIVE COATINGS

A. Description: One- or two-coat, coal-tar epoxy; 1/8 inch minimum thickness, unless otherwise indicated; factory or field applied to the following surfaces (Refer to Section 07160 Bituminous Dampproofing):
   1. Concrete Structures: On exterior surface.

2.06 VALVE BOXES

A. Valve boxes shall be constructed of a minimum of Class 200 PVC pipe with metal lid and shall be provided for all valves installed underground.

B. All valve boxes shall be installed flush with the ground surface.

2.07 PRESSURE MAIN CLEANOUTS

A. In-line cleanouts shall include an isolating valve, capped Y-branch fitting located on either side of the isolating valve, and shall be pointed both upstream and downstream for access during maintenance procedures.

B. Cleanouts at the junction of pressure mains shall include an isolating valve and capped Y-branch fitting located on all sides of the tee connection.

2.08 PRESSURE MAIN CLEANOUT STRUCTURES

A. Cleanout structures shall be constructed of a 24" x 24" section of reinforced concrete pipe with a manhole ring and cover. Manhole ring and cover to be fully encased in a 4' x 4' x 8" concrete pad. See standard detail.

2.09 GRAVITY SERVICE CLEANOUTS

A. Gravity PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout. PVC Cleanout piping shall be Schedule 40.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

3.02 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

B. Hand trim excavations to required elevations. Correct over excavation with bedding material.

C. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

3.03 IDENTIFICATION

Materials and their installation are specified in Division 2 Section "Earthwork." Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.

A. Use warning tape or detectable warning tape over ferrous piping.

B. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.04 PIPING APPLICATIONS

A. General: Include watertight joints.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.

C. Low Pressure Piping (As indicated on the Drawings):
   1. 4-Inch NPS and Larger: PVC pressure pipe, PVC pressure fittings, gaskets, and gasketed joints.
   2. NPS 1-¼ inch to 3 inch: PVC pressure pipe, PVC pressure fittings, manufacturer recommended pipe cement and bell joints.
   3. The minimum diameter of the pressure sewer main shall be 1-½ inch.
   4. The minimum diameter of the pump discharge line shall be 1-¼ inch.

3.05 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. All pressure sewer mains should be constructed to a minimum depth of 30 inches or as required and as measured from the final ground surface to the top of the barrel of the pipe.

D. Use fittings for changes in direction. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

E. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

F. Location of Sewers with Respect to Water Mains:
   1. Horizontal Separation: Whenever possible, any sanitary sewer shall be laid at least 10 feet, horizontally, from a water main. When local conditions prevent a lateral separation of 10 feet, the Department of Natural Resources may allow a sanitary sewer be laid closer than 10 feet to a water main provided that the sanitary sewer is laid at least 18 inches below the bottom of the water line.

2. Vertical Separation: Whenever sanitary sewers must cross water mains, the sewer shall be laid at such an elevation that the bottom of the water main is no closer than 18 inches above the top of the sewer. This vertical separation shall be maintained for that portion of the sanitary sewer located within 10 feet, horizontally, of any water line it crosses. The crossing shall be arranged so that the sewer joints will be equal distance and as far as possible from the water main joints.
3. Unusual Conditions: Where conditions prevent the minimum horizontal or vertical separation set forth above from being maintained, or when it is necessary for the sewer line to pass over a water main, the sewer line shall be laid with slip-on mechanical joint cast iron or ductile iron pipe or pre-stressed concrete cylinder pipe, and the sewer line shall extend on each side of the crossing to a distance from the water main of at least 10 feet. In making such a crossing, a full length of cast iron or ductile iron pipe must be centered over or under the water main to be crossed so that the joints will be equidistant from the water main and as remote therefore as possible. The water main must also be constructed of cast iron or ductile iron pipe with slip-on or mechanical joints until the nominal distance from the sewer line to the water main is at least 10 feet. Where a water main must cross under a sewer, a vertical separation of 18 inches between the bottom of the sewer and the top of the water main shall be maintained, with adequate support, especially for the larger sized sewer lines, to prevent them from settling on and breaking the water main. The sewer shall be constructed of cast iron pipe or ductile iron pipe for a distance of 10 feet on either side of the crossing, or other suitable protection as approved by the Missouri Department of Natural Resources shall be consulted as to the precautions to be taken to protect the public water supply.
4. No water pipe shall pass through or come into contact with any part of a sewer.

G. Install PVC low pressure piping according to AWWA M23.

H. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

I. Termination of pressure mains: Pressure mains shall terminate in manholes using the following construction procedures:
1. The discharge shall be to the bottom of the manhole in line with the flow if possible.
2. Where piping must be installed to bring the discharge to the bottom of the manhole, the pipe shall be adequately braced to prevent movement, shall be vented on the top and shall allow access to the pressure main for cleaning purposes.

J. Two 45 degree bends shall be used to accomplish a 90 degree bend.

3.06 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to installations indicated.

B. PVC Pressure Pipe and Fittings: Join and install according to AWWA M23.

C. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.

D. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

E. Install with top surfaces of components, except piping, flush with finished surface.

3.07 REACTION ANCHORAGE AND BLOCKING

A. All unlugged bell and spigot or all-bell tees, Y-branches and bends deflecting 11-1/4 degrees or more which are installed in piping subjected to internal hydrostatic heads in excess of 15 feet in exposed, or 30 feet in buried, piping shall be provided with suitable reaction blocking, struts, anchors, clamps, joint harness, or other adequate means for preventing any movement of the pipe caused by unbalanced internal liquid pressure.

B. Trench installation: Where in trench, the foregoing designated fittings shall be provided with concrete thrust blocking between the fitting and solid, undisturbed ground in each case, except where solid ground blocking support is not available. At the tops of slopes vertical angle bends shall be anchored by means of steel strap or rod anchors securely embedded in or attached to a mass of concrete of sufficient weight to resist the hydraulic thrust at the maximum pressures to which the pipe will be subjected. All concrete blocking and anchors shall be installed in such a manner that all joints between pipe and fittings are accessible for repair.

C. The bearing area of concrete reaction blocking against the ground or trench bank shall be as shown by the plans or as directed by the Engineer in each case. In the event that adequate support against undisturbed ground cannot be obtained, metal harness anchorages consisting of steel rods or bolts across the joint and securely anchored to pipe and fitting or other adequate anchorage facilities approved by the Engineer shall be installed to provide the necessary support. Should the lack of a solid vertical excavation face be due to careless or otherwise improper trench excavation, the entire cost of furnishing and installing metal harness anchorages in excess of the contract value of the concrete blocking replaced by such anchorages shall be borne by the Contractor.

D. For other locations: Reaction blocking, struts, anchorages, or other supports for fittings installed in fills or other unstable ground, above grade, or exposed within structures, shall be provided as required by the plans or as directed by the Engineer.

E. Protection of metal surfaces: All steel clamps, rods, bolts and other metal accessories used in reaction anchorages or joint harness subject to submergence or contact with earth or other fill material and not encased in concrete shall be adequately protected from corrosion with not less than two coats of Koppers "Bitumastic No. 50", or approved equal, heavy coal tar coating material, applied to clean, dry metal surfaces. The first coat shall be dry and hard before the second coat is applied. Metal surfaces exposed above grade or within structures shall be painted with two coats (in addition to a primer coat) of a paint approved by the Engineer.

3.08 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

3.09 PRESSURE MAIN CLEANOUT INSTALLATION

A. Pressure systems shall have in-line flushing assemblies or cleanouts at the end of each main, intervals of approximately four hundred to five hundred feet (400' to 500') on straight runs, at major changes of direction, and where two or more mains come together and feed into another main.

3.10 GRAVITY SERVICE CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.11 AIR RELEASE FACILITIES

A. Air release valves shall be A.R.I. model D-025 combination air valve for sewage.

B. Air release facilities shall be located at the high points of all pressure sewer systems and shall be properly sized to prevent buildup of air or gases that will impede flow of the wastewater.

C. Air release valves must be automatic and designed to prevent wastewater solids and grease from reaching the valve operating mechanism.

D. Provisions for cleaning the valve by back flushing should be provided.

3.12 TAP CONNECTIONS

A. All connections to existing piping and underground structures shall be in accordance with the Drawings.

B. Connections to existing sewer mains (including installation of tees and live taps) must be approved by the District before construction can take place.

C. Connections to existing sewer lines shall be performed in such a manner as to minimize disruption to customers.

D. Notify District within 5 working days in intent to tie-in to existing sewer.

E. District shall be present for the construction of the connection to existing sewer.

F. Make branch connections from side into existing piping, NPS 21 or larger, or to underground structures by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
   1. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
   2. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

G. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.13 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Structures: Excavate around structure as required and use one procedure below:
1. Remove structure and close open ends of remaining piping.
2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
3. Backfill to grade according to Division 2 Section "Earthwork."

3.14 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
1. Place plug in end of incomplete piping at end of day and when work stops.

B. Inspect interior of piping to determine whether damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
   a. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
   b. Crushed, broken, cracked, or otherwise damaged piping.
   c. Infiltration: Water leakage into piping.
   d. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Re-inspect and repeat procedure until results are satisfactory.

3.15 FIELD TESTING

A. General:
1. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
2. Leaks and loss in test pressure constitute defects that must be repaired.
3. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

B. Pressure Tests:
1. The Contractor shall furnish all pumps, piping, labor and other materials and services necessary to bring the piping up to the specified test pressure.
2. All pipes shall be pressure tested. Pipes which will be pressurized under normal operating conditions shall conform to the requirements of the hydrostatic pressure test. All other piping shall meet the requirements of the air leakage test.
3. Pipe in the sections to be tested shall be backfilled or center loaded, with thrust blocks installed and completely backfilled. Interior pipe supports and restraint systems shall be completely installed prior to testing.

C. Hydrostatic Pressure Test:

1. Test connections shall be made and the pipe filled with water. Unless otherwise specified, a pressure of not less than 1.25 times the normal operating pressure (for the lowest point on the pipe line) but not less than 100 pounds per square inch (psi) or not more than the rated working pressure for the pipe shall be used for testing.
2. After air removal, water shall be pumped in to bring the pipe to the specified pressure. 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. After two hours, additional water shall be drawn from a container of known volume. The amount of water required to return the system to the specified pressure shall not exceed the amount determined by the following formula:

$$Q = SD(P)^{1/2}/133200, \qquad \text{(Equation 1)}$$

Where

Q - Total allowable leakage in gallons per hour.
S - Length of section tested, feet.
D - Nominal pipe diameter, inches.
P - Test pressure, psi

The allowable leakage must not exceed the volumes specified below for each 1,000 feet of the particular diameter of pipe being tested:

Hydrostatic Testing Allowance per 1,000 ft of Pipeline* - gph (AWWA C-600)

Avg. Test Pressure	Nominal Pipe Diameter (in)										
(psi)	1.5	2	3	4	6	8	10	12	14	16	18
100	0.11	0.15	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.2	1.35
125	0.13	0.17	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51
150	0.14	0.18	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66
175	0.15	0.20	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79
200	0.16	0.21	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.7	1.91

* Calculated on the basis of Equation 1

3. All exposed pipe, fittings, valves, and joints shall be inspected and all evidence of moisture appearing on the surface of the ground during the test shall be investigated by the Contractor by excavation where the pipe has been covered with backfill. Should the leakage test results exceed allowable leakage, the test pressure shall be maintained for an additional period of time as directed by the Engineer to facilitate location of leaks.
4. All pipe, fittings, valves, pipe joints, and other materials which are found to be defective when the pipe line is tested shall be removed from the line immediately and replaced with new and acceptable material by and at the expense of the Contractor. The pressure test shall be repeated after repairing leaks and other defective work until the pipe line installation conforms to specified requirements and is accepted by the Engineer.

END OF SECTION

SECTION 02550

GRINDER PUMPS

Sanitary sewer grinder pump specifications are to be considered on a project by project basis and inserted by the design engineer. The design engineer must submit grinder pump specifications to the Sewer District for review and approval.

SECTION 02920

LAWNS AND GRASSES

PART 1 – GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Soil Preparation
   2. Seeding
   3. Sodding
   4. Meadow grasses
   5. Lawn renovation
   6. Maintenance

1.02 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

E. Lawns: Areas of grass that are currently manicured and maintained

F. Meadows: Areas that are not manicured containing trees, brush, and native grasses left in natural condition.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Certification of Grass Seed: From seed vendor for each grass seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
   1. Certification of each seed mixture for identifying source, including name and telephone number of supplier.

C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.

D. Qualification Data: For landscape Installer.

E. Material Test Reports: For existing surface soil and imported topsoil.

F. Planting Schedule: Indicating anticipated planting dates for each type of planting.

G. Maintenance Instructions: Recommended procedures to be established by Owner for

maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

1.05 SCHEDULING

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
   1. Spring Planting: March 1st to June 1st
   2. Fall Planting: August 15th to November 1st

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.06 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
   1. Seeded Lawns: 60 days from date of Substantial Completion.
      a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
   2. Sodded Lawns: 30 days from date of Substantial Completion.
   3. Plugged Lawns: 30 days from date of Substantial Completion.
   4. Sprigged Lawns: 30 days from date of Substantial Completion.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
   1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from approved sources and to keep lawn uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
   2. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   3. Water lawn at a minimum rate of 1 inch per week until acceptance.

1.07 MEADOW MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 40 days from date of Substantial Completion.

B. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from approved sources and to keep meadow uniformly moist.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
2. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
3. Water meadow at a minimum rate of 1/2 inch per week until acceptance.

PART 2 – PRODUCTS

2.01 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   1. Full Sun: Bermudagrass (Cynodon dactylon).
   2. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
   3. Sun and Partial Shade: Proportioned by weight as follows:
      a. 50 percent Kentucky bluegrass (Poa pratensis).
      b. 30 percent chewings red fescue (Festuca rubra variety).
      c. 10 percent perennial ryegrass (Lolium perenne).
      d. 10 percent redtop (Agrostis alba).

C. Shade: Proportioned by weight as follows:
   1. 50 percent chewings red fescue (Festuca rubra variety).
   2. 35 percent rough bluegrass (Poa trivialis).
   3. 15 percent redtop (Agrostis alba).

2.02 TURFGRASS SOD

A. Turfgrass Sod: Approved Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   1. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
   2. Sun and Partial Shade: Proportioned by weight as follows:
      a. 50 percent Kentucky bluegrass (Poa pratensis).
      b. 30 percent chewings red fescue (Festuca rubra variety).
      c. 10 percent perennial ryegrass (Lolium perenne).
      d. 10 percent redtop (Agrostis alba).
   3. Shade: Proportioned by weight as follows:
      a. 50 percent chewings red fescue (Festuca rubra variety).
      b. 35 percent rough bluegrass (Poa trivialis).
      c. 15 percent redtop (Agrostis alba).

2.03 MEADOW GRASSES

A. Native Grass Seed: Fresh clean, dry, new seed, mixed species as follows:
   1. 20 percent Fescue
   2. 15 percent Little Bluestem
   3. 15 percent Side Oats Gramma
   4. 10 percent Broom Sedge

5. 10 percent Purple Prairie Clover
6. 10 percent Annual Rye
7. 10 percent Perennial Ryegrass
8. 5 percent Orchard Grass
9. 5 percent Timothy

   a. Native Grass Seed to be sown at a rate of 150 lbs/acre. Plant seed all months except July through late October.

B. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than two parts seed carrier to one part seed.

2.04 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
   1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
      a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2.05 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
   1. Class: Class O, with a minimum 95 percent passing through No. 8 sieve and a minimum 55 percent passing through No. 60 sieve.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.

G. Sand: Clean, washed, natural or manufactured, free of toxic materials.

H. Diatomaceous Earth: Calcined, diatomaceous earth, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.06 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture

content 35 to 55 percent by weight; 100 percent passing 3/4 inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Wood Derivatives: Decomposed, ground bark, or wood waste; of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, or other bedding materials; free of toxic substances, stones, sticks, weed seed, and material harmful to plant growth.

2.07 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.08 FERTILIZER

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.09 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Peat Mulch: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

G. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.10 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Varify the existence or non-existence of irrigation systems. Damaged systems shall be repaired with equipment to match existing and system tested for operation in an efficient and satisfactory manner. If damages to existing irrigation systems are incurred, the contractor shall be responsible for irrigation system repairs at the expense of the contractor.

3.02 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, retaining walls, irrigation systems, and other facilities, trees, shrubs, and other plantings from damage caused by restoration operations.
   1. Protect adjacent and adjoining areas from hydroseeding overspray.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
   1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least of 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
      a. Apply fertilizer directly to surface soil before loosening.
   3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
   4. Legally dispose of all waste material, including grass, vegetation, and turf, off Owner's property.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

D. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.04 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow lawn seed at the rate of 3 to 4 lb/1000 sq. ft. Meadow grasses to be sown at the rate noted in Section 2.03.

C. Rake seed lightly into top 1/8 inch (3 mm) of topsoil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches (38 mm) in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
   1. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.
   2. Bond straw mulch by spraying with asphalt emulsion at the rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

3.05 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
   1. Mix slurry with asphalt-emulsion tackifier.
   2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 1500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

3.06 SODDING

A. Sod shall be placed in areas were sod was pre-existing.

B. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

C. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks

between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
1. Lay sod across angle of slopes exceeding 1:3.
2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

D. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 4 inches below sod. Sod which dries out will be rejected.

3.07 LAWN RENOVATION

A. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
   1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.

B. Remove sod and vegetation from unsatisfactory lawn areas; do not bury in soil.

C. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil droppings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.

D. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

E. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

F. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

G. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.

H. Apply seed and protect with straw mulch or sod as required for new lawns.

I. Water newly planted areas and keep moist until new lawn is established.

3.08 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.

C. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.09 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

1.02 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

C. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
1. Cementitious materials and aggregates.
2. Form materials and form-release agents.
3. Steel reinforcement and reinforcement accessories.
4. Fiber reinforcement.
5. Admixtures.
6. Waterstops.
7. Curing materials.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Epoxy joint filler.
13. Joint-filler strips.
14. Repair materials.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

E. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
   1. ACI 301, "Specification for Structural Concrete."
   2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
   3. Before submitting design mixes, review concrete mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixes.
      c. Ready-mix concrete producer.
      d. Concrete subcontractor.

1.04 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle steel reinforcement to prevent bending and damage.

A. Avoid damaging coatings on steel reinforcement.
B. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963.

PART 2 - PRODUCTS

2.01 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints. Plywood, metal or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of the exposed concrete surface.
   2. Furnish ties that, when removed, will leave holes not larger than 1 inch in diameter in concrete surface.
   3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.02 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Epoxy-Coated Reinforcing Bars: ASTM A 775, and Steel Reinforcement: ASTM A 615, Grade 60, deformed.

C. Steel Bar Mats: ASTM A 184, assembled with clips. Steel Reinforcement: ASTM A 615, Grade 60, deformed bars.

D. Plain-Steel Wire: ASTM A 82, as drawn.

E. Deformed-Steel Wire: ASTM A 496.

F. Epoxy-Coated Wire: ASTM A 884, Class A coated, plain-steel wire.

G. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

H. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.

I. Epoxy-Coated Welded Wire Fabric: ASTM A 884, Class A, plain steel.

2.03 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
   1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
   2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

B. Joint Dowel Bars: Plain-steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.

C. Epoxy-Coated Joint Dowel Bars: ASTM A 775; with ASTM A 615, Grade 60, plain-steel bars.

D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775.

2.04 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I.

B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:

1. Class: Severe weathering region, but not less than 3S.
2. Nominal Maximum Aggregate Size: 1 inch.
3. Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 sieve, and less than 8 percent may be retained on sieves finer than No. 50.

C. Lightweight Aggregate: ASTM C 330 with nominal Maximum Aggregate Size of 1 inch.

D. Water: Potable and complying with ASTM C 94.

2.05 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.

B. Air-Entraining Admixture: ASTM C 260.

C. Water-Reducing Admixture: ASTM C 494, Type A.

D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.06 FIBER REINFORCEMENT

A. Synthetic Fiber: Fibrillated or monofilament polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

B. Products: Subject to compliance with requirements, provide one of the following Monofilament Fibers:

1. Fibrasol IIP; Axim Concrete Technologies.
2. Fiberstrand 100; Euclid Chemical Co.
3. Fibermix Stealth; Fibermesh, Div. of Synthetic Industries.
4. Forta Mono; Forta Corporation.
5. Grace MicroFiber; W. R. Grace & Co., Construction Products Div.
6. Hi-Tech PPM Fiber; Hi-Tech Fibers, Div. of Martin Color-Fi, Inc.
7. Polystrand 1000; Metalcrete Industries.

2.07 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. As indicated in Profile.

B. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. As indicated in Profile.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following rubber waterstops:
   1. Rubber Waterstops:
      a. Greenstreak.
      b. Progress Unlimited Inc.
      c. Westec Barrier Technologies; Div. of Western Textile Products, Inc.
      d. Williams Products, Inc.
   2. PVC Waterstops:
      a. Greenstreak.
      b. Meadows: W. R. Meadows, Inc.
      c. Murphy: Paul Murphy Plastics Co.
      d. Progress Unlimited Inc.
      e. Sternson Group.
      f. Tamms Industries Co.; Div. of LaPorte Construction Chemicals North America, Inc.
      g. Vinylex Corporation.
      h. Westec Barrier Technologies; Div. of Western Textile Products, Inc.

D. Self-Expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophylic material for adhesive bonding to concrete. Products are subject to comply with requirements. Provide one of the following:
   1. Volclay Waterstop-RX; Colloid Environmental Technologies Co.
   2. Conseal CS-231; Concrete Sealants Inc.
   3. Swellseal Joint; De Neef Construction Chemicals (U.S.) Inc.
   4. Hydrotite; Greenstreak.
   5. Mirastop; Mirafi Moisture Protection, Div. of Royal Ten Cate (USA), Inc.
   6. Adeka Ultra Seal; Mitsubishi International Corporation.
   7. Superstop; Progress Unlimited Inc.

2.08 VAPOR RETARDERS

A. Vapor Retarder: ASTM E 1745, Class C, of one of the following materials:
   1. Polyethylene sheet, ASTM D 4397, not less than 10 mils thick:
   2. Nonwoven, polyester-reinforced, polyethylene coated sheet; 10 mils thick.

B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; meeting deleterious substance limits of ASTM C 33 for fine aggregates.

C. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.09 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Solvent-Borne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

F. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.10 RELATED MATERIALS

A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Epoxy Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.

C. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
   1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
   2. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
   3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.11 CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
   1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
   2. Proportion lightweight structural concrete according to ACI 211.2 and ACI 301.

B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.

C. Proportion normal-weight concrete mix as follows:
   1. Compressive Strength (28 Days): 4000 psi.
   2. Maximum Slump: 4 inches.
   3. Maximum Slump for Concrete Containing High-Range Water-Reducing Admixture: 8 inches after admixture is added to concrete with 2- to 4-inch slump.
   4. Minimum Cementitious Materials Content: 540 lb/cu. yd.

D. Cementitious Materials: For concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements.

E. Maximum Water-Cementitious Materials Ratio: 0.40.

F. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated. Air content is to be 6 percent.

G. Do not air entrain concrete to trowel-finished interior floors and suspended slabs. Do not allow entrapped air content to exceed 3 percent.

H. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

I. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.

J. Admixtures: Use admixtures according to manufacturers written instructions.
1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.12 FABRICATING REINFORCEMENT

Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

PART 3 - EXECUTION

3.01 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
1. Class A, 1/8 inch.
2. Class B, 1/4 inch.
3. Class C, 1/2 inch.
4. Class D, 1 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood

inserts for forming keyways, reglets, recesses, and the like, for easy removal. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 EMBEDDED ITEMS

Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

A. Install anchor bolts, accurately located, to elevations required.

B. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

C. Install dovetail anchor slots in concrete structures as indicated.

3.03 REMOVING AND REUSING FORMS

A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

B. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until concrete has achieved the following:
   1. At least 70 percent of 28-day design compressive strength.
   2. Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.

3. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.04 SHORES AND RESHORES

A. Comply with ACI 318, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.05 VAPOR RETARDERS

A. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.

B. Fine-Graded Granular Material: Cover vapor retarder with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.

C. Granular Fill: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch. Place and compact a 1/2-inch- thick layer of fine-graded granular material over granular fill.

3.06 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963.

3.07 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.08 WATERSTOPS

Flexible Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's written instructions.

3.09 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Engineer.

C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.

D. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Limit dropping height of concrete in foms to 60 inches or less. Place each layer while preceding layer is still plastic, to avoid cold joints.
   1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
   2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Maintain reinforcement in position on chairs during concrete placement.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Slope surfaces uniformly to drains where required.
   5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

G. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch in height. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.

C. Rubbed Finish: Apply the following to smooth-formed finished concrete: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free

of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
2. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 10-foot- long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed 1/4 inch.

E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

G. Slip-Resistive Aggregate Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
2. After broadcasting and tamping, apply float finish.
3. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose slip-resistive aggregate

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.13 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed-formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31; cast and laboratory cure one set of four standard cylinder specimens for each composite sample. Cast and field cure one set of four standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.
   a. Test two field-cured specimens at 7 days and two at 28 days.
   b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

D. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

E. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28

days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.

F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer.

END OF SECTION

SECTION 07160

BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Extent of each type of dampproofing work is indicated on drawings and as follows:
   1. Manholes, all types and locations.
   2. All underground tanks.
   3. Similar work used as exposed finish is excluded by definition and, if required, is specified as waterproofing, vapor barrier, roofing, flooring, special coating or other appropriate category. Dampproofing shall be applied below elevation of finish grade only.

B. This Section includes the following:
   1. Cold-applied, cut-back asphalt dampproofing.

1.02 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data: Submit manufacturer's technical product data, installation instructions, and recommendations for each dampproofing material required. Include data substantiating that materials comply with requirements.

C. Certifications: Submit manufacturer's certification in writing that the product is suitable for the application specified. Certification letter shall state the required application rate to dampproof the indicated structures.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed bituminous dampproofing similar in material, design, and extent to that indicated for this Project and with a record (not less than three years) of successful in-service performance. The Installer must be acceptable to manufacturer of primary materials.

B. Single-Source Responsibility: Obtain primary dampproofing materials and primers from one source and by a single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

1.04 PROJECT CONDITIONS

A. Substrate: Proceed with dampproofing only after substrate construction and penetrating work have been completed.

B. Weather Limitations: Proceed with dampproofing only when existing and forecasted weather conditions will permit work to be performed according to manufacturer's recommendations and warranty requirements.

C. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has thoroughly cured.

PART 2 - PRODUCTS

2.01 BITUMINOUS DAMPPROOFING MATERIALS (BIT-DP)

A. General: Provide bituminous dampproofing materials that comply with the following requirements, or provide other similar products that are certified in writing by manufacturer of primary dampproofing materials to be superior in performance for application indicated.

B. Manufacturer: Subject to compliance with requirements, provide coal-tar products of one of the following:
   1. Celotex Corporation
   2. GAF Corporation
   3. Koppers Company, Inc.
   4. Or approved equal

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine Substrate and conditions under which dampproofing work is to be performed and notify Contractor in writing of unsatisfactory conditions. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PREPARATION

A. Clean substrate of projections and substances detrimental to work; comply with recommendations of prime materials manufacturer.

B. Install cant strips and similar accessories as shown and as recommended by prime materials manufacturer even though not shown.

C. Fill voids, seal joints, and apply bond breakers, if any, as recommended by prime materials manufacturer, with particular attention at construction joints.

D. Install separate flashings and corner protection stripping, as recommended by prime materials manufacturer, where indicated to precede application of dampproofing. Comply with details shown and with manufacturer's recommendations. Pay particular attention to requirements at building expansion joints, if any.

E. Prime substrate as recommended by prime materials manufacturer.

F. Protection of Other Work: Do not allow liquid and mastic compounds to enter and clog drains and conductors. Prevent spillage and migration onto other surfaces of work by masking or otherwise protecting adjoining work.

3.03 INSTALLATION

A. Comply with manufacturer's recommendations except where more stringent requirements are shown or specified, and except where project conditions require extra precautions or provisions to ensure satisfactory performance of work.

B. Cold Bitumen on Exterior Surfaces:
   1. Apply a coat of cold, semi-fibrated, semi-mastic asphalt dampproofing material, by brushing

or spraying at rate certified by manufacturer to produce uniform dry film thickness of not less than 30 mils.

C. Dampproof Protection Course:

1. General: Where indicated, install protection course of type indicated, over completed-and-cured dampproofing treatment. Comply with dampproofing materials manufacturer's recommendations for method of support or attachment of protection materials. Support with spot-application of plastic cement where not otherwise indicated.

END OF SECTION

SECTION 07900

JOINT SEALERS

PART I - GENERAL

1.01 DESCRIPTION OF WORK

A. The extent of each form and type of joint sealer is indicated on drawings and by provisions of this section.

B. The applications for joint sealers as work of this section include the following:
1. Pavement and sidewalk joints.
2. Concrete construction joints where indicated on the drawings.
3. Concrete and masonry control joints.
4. Door frames to masonry joints.
5. Floor joints (interior).
6. Wall joints (exterior).
7. Flashing and coping joints.
8. Gasketing of assemblies.

1.02 SYSTEM PERFORMANCES

A. Provide joint sealers that have been produced and installed to establish and maintain watertight and airtight continuous seals.

B. Provide joint sealers that have been recommended by the manufacturer for service under the conditions of the particular joint application, including but not limited to exterior exposure, thermal or other movement, abrasion, or submergence.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each joint sealer product required, including instructions for joint preparation and joint sealer application.

B. Product Certification: Submit certification in writing by the sealant manufacturer that each sealer product is recommended and suitable for the proposed application. The written certification shall name the sealer product and shall identify the specific structures and locations where the sealer will be installed.

C. Product Tests: If required by the Engineer, submit certified test reports for elastomeric sealants on aged performances as specified, including hardness, stain resistance, adhesion, cohesion or tensile strength, elongation, low- temperature flexibility, compression set, modulus of elasticity, water absorption, and resistance (aging, weight loss, deterioration) to heat and exposure to ozone and ultraviolet.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi-component materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. General: Manufacturers listed in this article include those known to produce the indicated category of prime joint sealer material, either as a nominally pure generic product or as an equivalent-performance modification thereof or proprietary product.

B. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
   1. Manufacturers of Elastomeric Sealants (Liquid):
      a. Dow Corning Corp.; Midland, MI
      b. General Electric Co.; Waterford, NY
      c. Gibson-Homans Co.; Waterford, NY
      d. W.R. Meadows, Inc.; Elgin, IL
      e. Pecora Corp.; Harleysville, PA
      f. Sika Chemical Corp.; Lindhurst, NJ
      g. Sonneborn, A Division of Rexnord; Minneapolis, MN
      h. Tremco, Inc.; Cleveland, OH
      i. Woodmont Products Inc.; Huntingdon Valley, PA
      j. Or approved equal.
   2. Manufacturers of Joint Fillers/Sealant Backers:
      a. Dow Chemical Co.; Midland, MI
      b. Hercules, Inc.; Middletown, DE
      c. W.R. Meadows, Inc.; Elgin, IL
      d. Sonneborn, A Division of Rexnord, Minneapolis, MN
      e. Woodmont Products, Inc.; Huntingdon Valley, PA
      f. Or approved equal.

2.02 MATERIALS

A. General Sealer Requirements: Provide colors indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors. Select materials for compatibility with joint surfaces and other indicated exposures, and except as otherwise indicated, select modulus of elasticity and hardness or grade recommended by manufacturer for each application indicated. Where exposed to foot traffic, select non-tracking materials of sufficient strength and hardness to withstand stiletto heel traffic without damage or deterioration of sealer system.

B. Elastomeric Sealants:
   1. Single-Component Polyurethane Sealant (1Pu-S): Except as otherwise indicated, provide manufacturer's standard, non-modified, one-part, polyurethane-based, air-curing, elastomeric sealant; complying with either ASTM C 920 type S Class 25, or FS TT-S-00230C Class A; self-leveling grade/type where used in joints of surfaces subject to traffic, otherwise non-sag grade/type. For use in all horizontal paving control joints. Bituminous Modification (-Bit): Where joint surfaces contain or are contaminated with bituminous materials, provide manufacturer's modified type sealant that is compatible with joint surfaces (modified with coal tar or asphalt as required).
   2. Single-Component Silicon Rubber Sealant (1SR-S): Except as otherwise indicated, provide manufacturer's standard, non-modified, one-part, silicone-rubber-based, air-curing, non-sag, elastomeric sealant; complying with either ASTM C 920 Type S Class 25 Grade NS, or FS TT-S-001543A Class A Type S Non-sag. For use in all vertical control joints in masonry, flashing and door frames.

C. Joint Fillers, Pavement Types:

1. Expanded Polyethylene Joint Filler (ExPe-JF): Provide flexible, compressible, closed-cell, polyethylene of not less than 10 psi compression deflection (25%); except provide higher compression deflection strength as may be necessary to withstand installation forces and provide proper support for sealants; surface water absorption of not more than 0.1 lbs. per sq. ft.
2. Open-Cell Polyurethane Joint Filler (OcPu-JF): Provide flexible, highly compressible, open-cell polyurethane foam of not less than 1.3 lbs. per cu. ft. density and not less than 2 psi compression deflection (25%), with not more than 10% compression set for 25 hours at 50% compression (ASTM D 3574 test methods).

D. Miscellaneous Materials
1. Joint Primer/Sealer: Provide type of joint primer/sealer recommended by sealant manufacturer for joint surfaces to be primed or sealed.
2. Bond Breaker Tape (BB-Tp): Provide polyethylene tape or other plastic tape as recommended by sealant manufacturer, to be applied to sealant- contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant. Provide self-adhesive tape where applicable.
3. Sealant Backer Rod (S-BR): Provide compressible rod stock of polyethylene foam, polyurethane foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absorptive material as recommended by sealant manufacturer for back-up of and compatibility with sealant. Where used with hot-applied sealant, provide heat-resistant type that will not be deteriorated by sealant application temperature as indicated.

PART 3 - EXECUTION

3.01 INSPECTION

A. Installer must examine substrates, (joint surfaces) and conditions under which joint sealer work is to be performed, and must notify Contractor in writing of unsatisfactory conditions. Do not proceed with joint sealer work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 JOINT PREPARATION

A. Surface Cleaning of Joints:

Clean out joints immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers and the following requirements.
1. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; oil; grease; waterproofing; water repellants; water; surface dirt and frost.
2. Clean concrete, masonry, unglazed surface of ceramic tile and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, acid washing or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
3. Remove laitance and form release agents from concrete.
4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile and other non-porous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.

B. Joint Priming:

1. Prime joint substrates where indicated, or where recommended by sealant manufacturer based on pre-construction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape:
   1. Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION

A. Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.

B. Set joint filler units at depth or position in joint as indicated to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint filler units.

C. Install sealant backer rod for liquid-applied sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application indicated.

D. Install bond breaker tape where indicated and where required by manufacturer's recommendations to ensure that liquid-applied sealants will perform as intended.

E. Employ only proven installation techniques, which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

F. Install liquid-applied sealants to depths as shown or, if not shown, as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) section of beads; (not applicable to sealants in lapped joints).

   For sidewalks, pavements and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width, but neither more than 5/8" deep nor less than 3/8" deep.

   For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 1/2" deep nor less than 1/4" deep.

G. Spillage:
   1. Do not allow sealants or compounds to overflow from confines of joints, or to spill onto adjoining work, or to migrate into voids of exposed finishes. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.

H. Do not overheat or reheat hot-applied sealants; discard (do not use).

I. Recess exposed edges of gaskets and exposed joint fillers slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.

J. Bond ends of gaskets together with adhesive or "weld" by other means as recommended by manufacturer to ensure continuous watertight and airtight performance. Miter-cut and bond ends at corners unless molded corner units are provided.

3.04 CURE AND PROTECTION

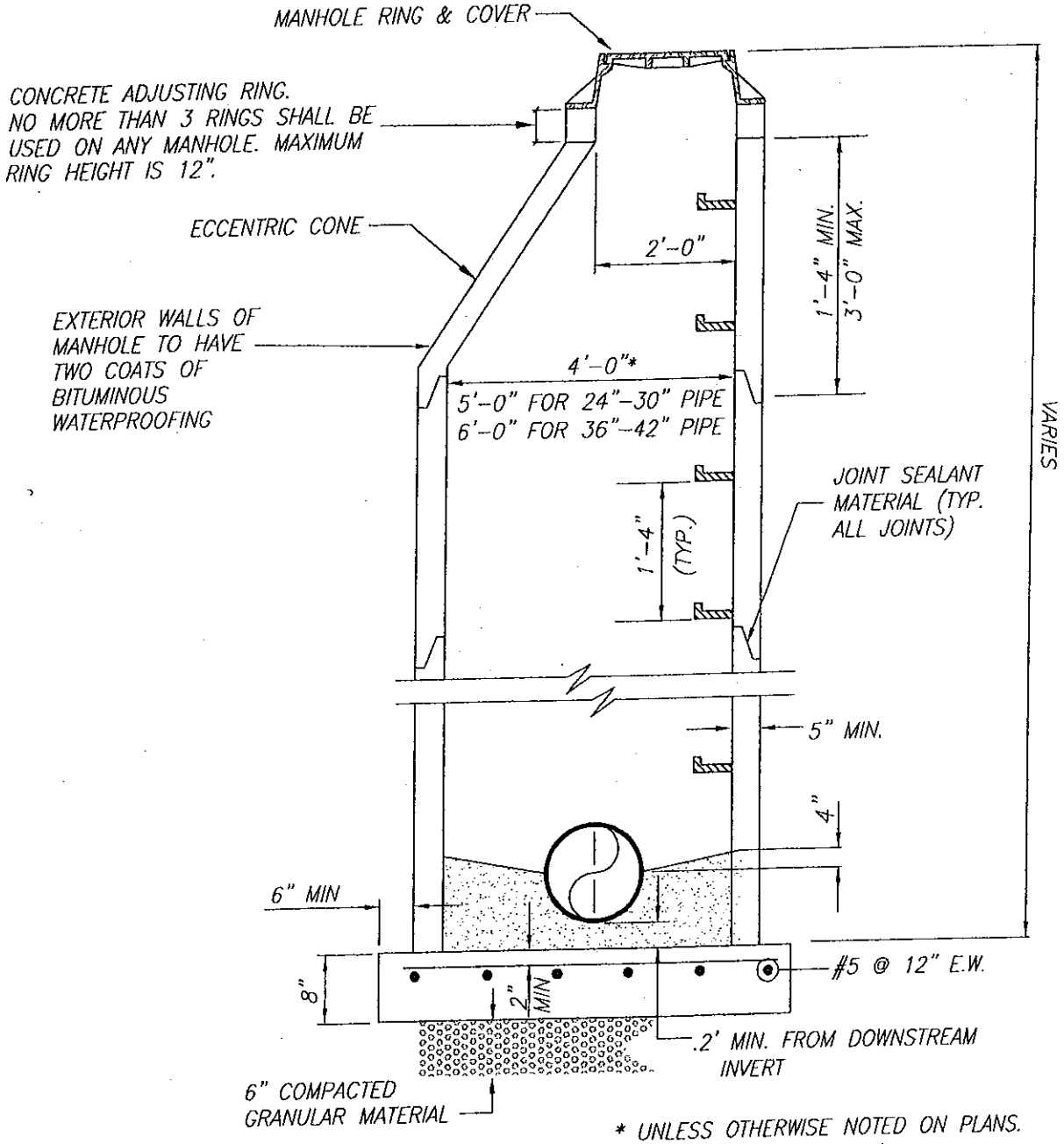
A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

C. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability. Advise Contractor of procedures required for cure and protection of joint sealers during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of substantial completion. Cure and protect sealants in a manner that will minimize increases in modulus of elasticity and other accelerated aging effects. Replace or restore sealants that are damaged or deteriorated during construction period.

END OF SECTION

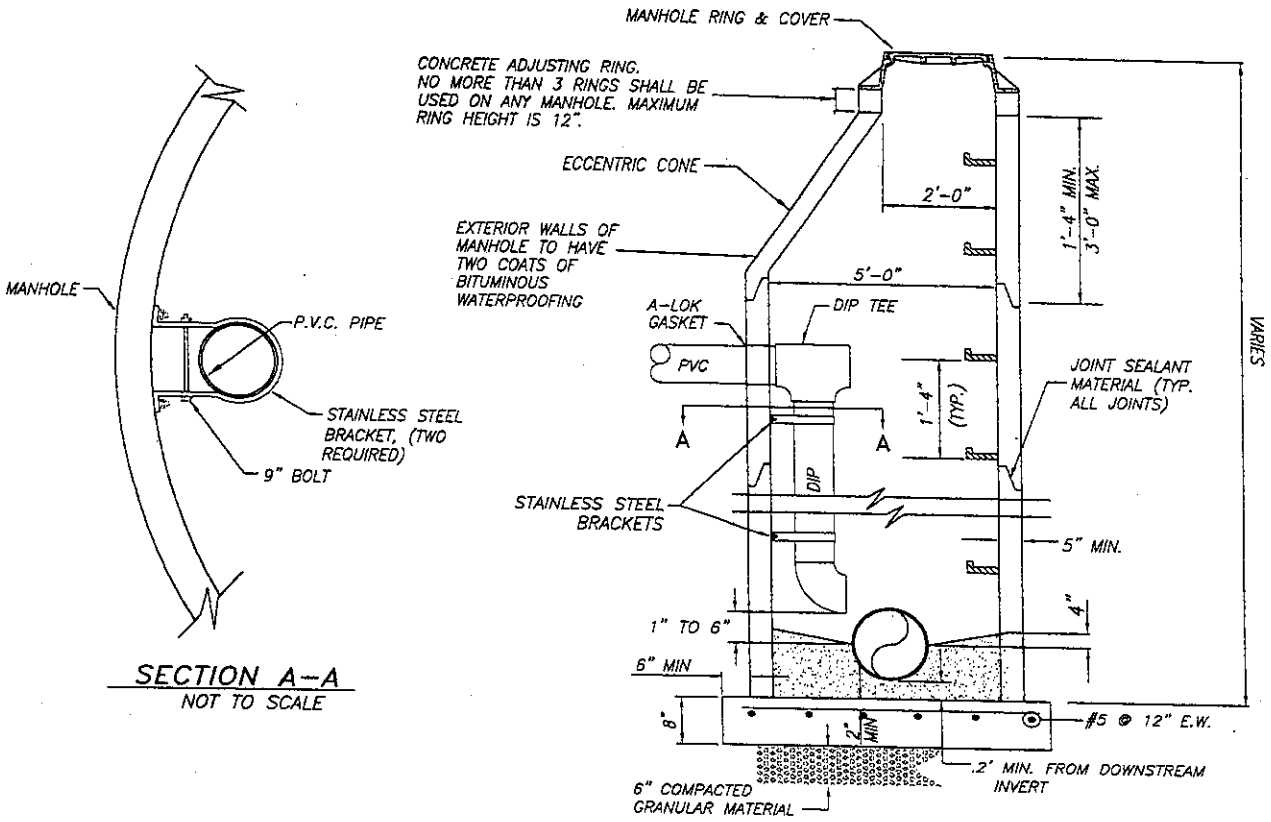
APPENDIX A
STANDARD DETAILS



NOTE: MANHOLE FLOW CHANNEL SHALL BE MADE TO CONFORM IN SHAPE AND SLOPE TO THAT OF THE SEWERS.

DETAIL 1: STANDARD PRECAST MANHOLE

NOT TO SCALE



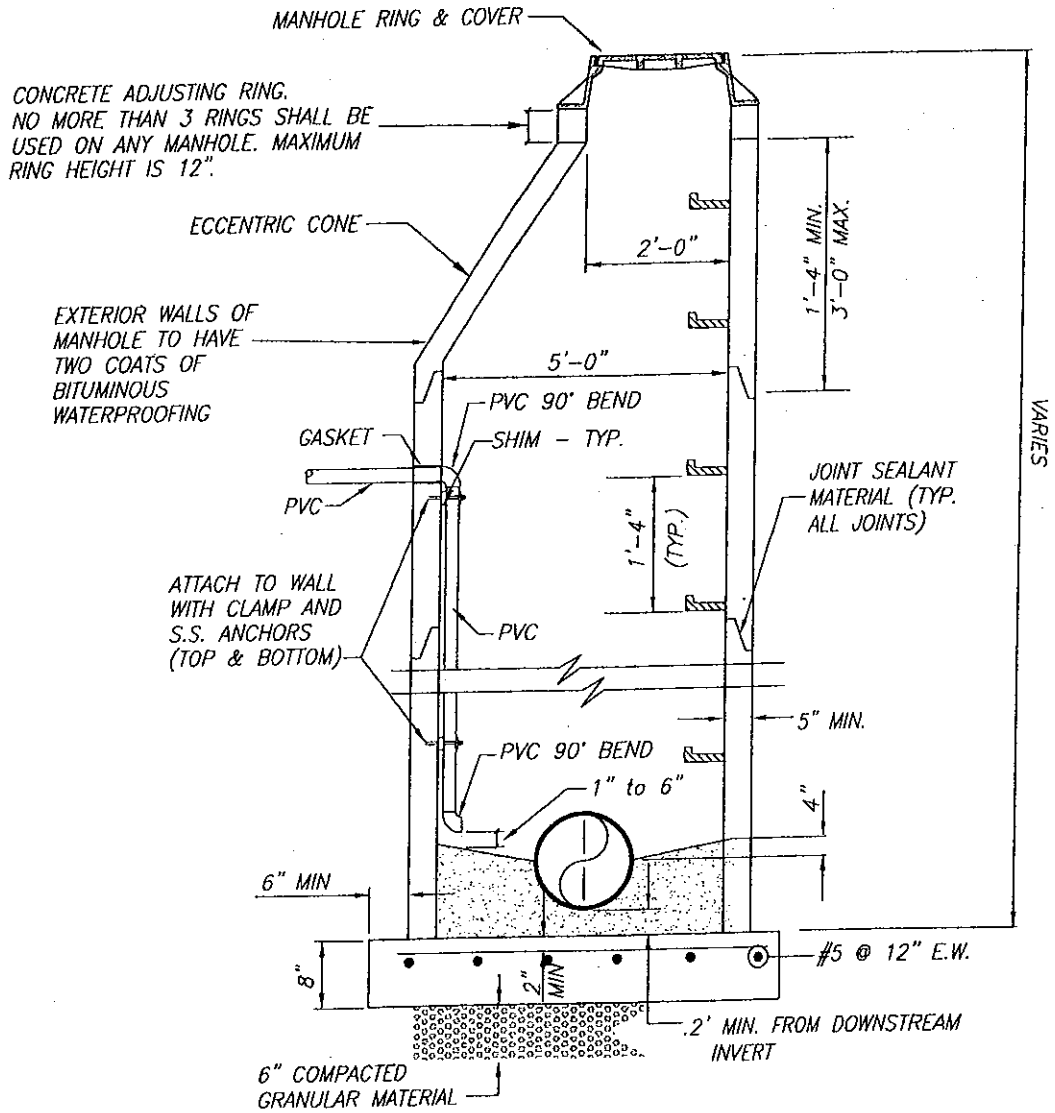
SECTION A-A
NOT TO SCALE

NOTES:

BITUMINOUS COAT ALL METAL SURFACES FOR ALL TYPES OF INTERIOR DROP MANHOLES.
CONFIGURATIONS SHOWN WILL ALSO BE UTILIZED FOR DROP ASSEMBLIES INSTALLED IN EXISTING MANHOLES.
UNLESS OTHERWISE NOTED, ALL PRECAST CONCRETE MANHOLES SHALL CONFORM TO ASTM C-478 REQUIREMENTS.

DETAIL 2: INSIDE DROP MANHOLE (GRAVITY)

NOT TO SCALE

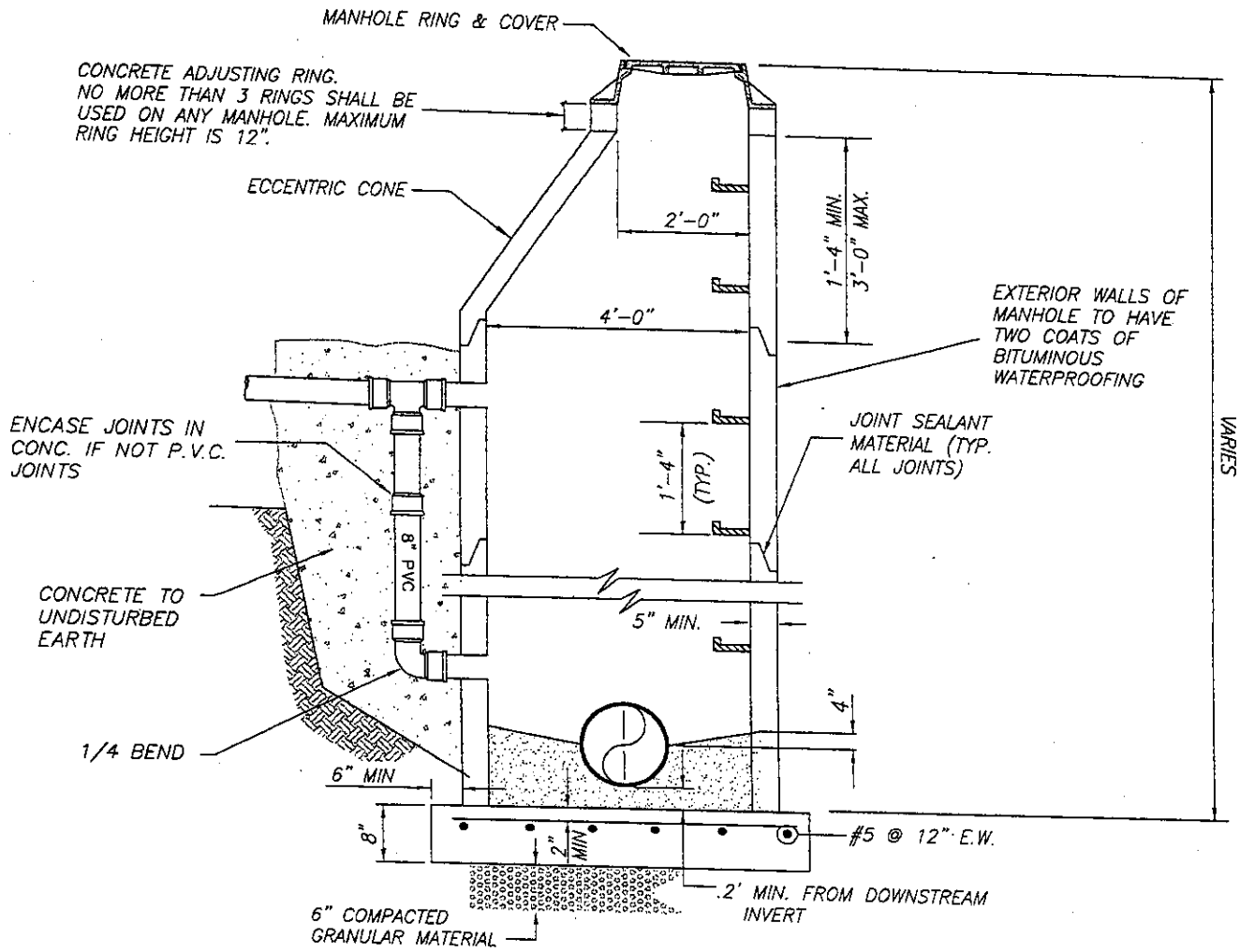


NOTES:

BITUMINOUS COAT ALL METAL SURFACES FOR ALL TYPES OF INTERIOR DROP MANHOLES.
CONFIGURATIONS SHOWN WILL ALSO BE UTILIZED FOR DROP ASSEMBLIES INSTALLED IN EXISTING MANHOLES.
UNLESS OTHERWISE NOTED, ALL PRECAST CONCRETE MANHOLES SHALL CONFORM TO ASTM C-478 REQUIREMENTS.

DETAIL 3: INSIDE DROP MANHOLE (FORCEMAIN)

NOT TO SCALE

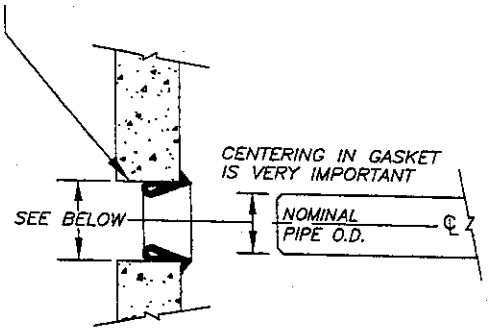


NOTE: MANHOLE FLOW CHANNEL SHALL BE MADE TO CONFORM IN SHAPE AND SLOPE TO THAT OF THE SEWERS.

DETAIL 4: OUTSIDE DROP MANHOLE

NOT TO SCALE

CORE HOLE IN THE EXISTING MANHOLE TO THE SPECIFIED DIMENSIONS BELOW AND USE AN "INSERTA-LOK" GASKET AS MANUFACTURED BY A-LOK OR APPROVED EQUAL.



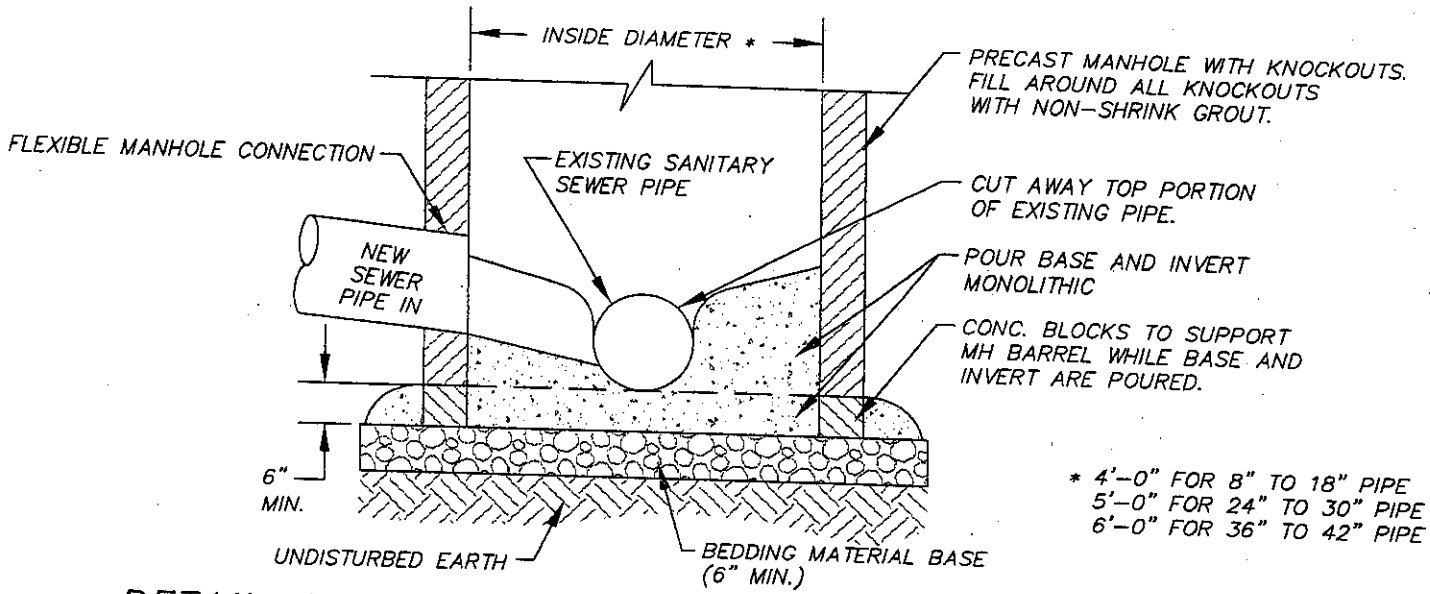
CORE HOLE EXAMPLES:

8"ø PVC = 10"ø HOLE
10"ø PVC = 12"ø HOLE
12"ø PVC = 14"ø HOLE

1. BEVEL PIPE WITH GRINDER
2. THEN LUBE PIPE
3. THEN LUBE INSERTA-LOK
4. THEN CENTER IN GASKET

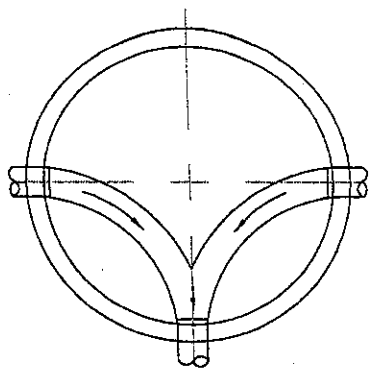
DETAIL 5: CONNECTION TO EXISTING MANHOLE

NOT TO SCALE

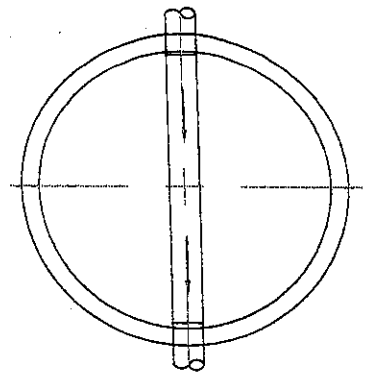


DETAIL 6: NEW MANHOLE ON EXISTING LINE

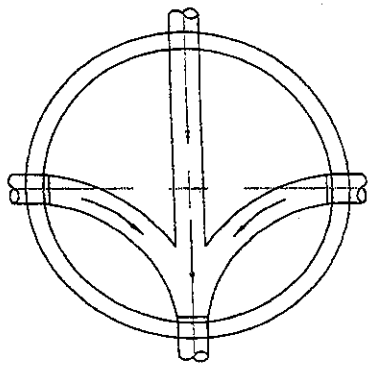
NOT TO SCALE



JUNCTION



STRAIGHT THRU



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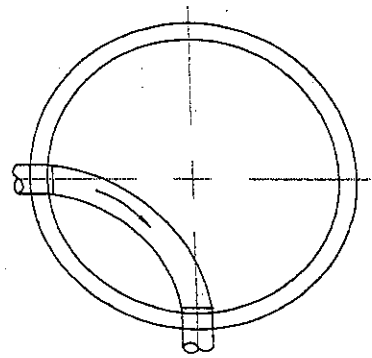


RIGHT ANGLE

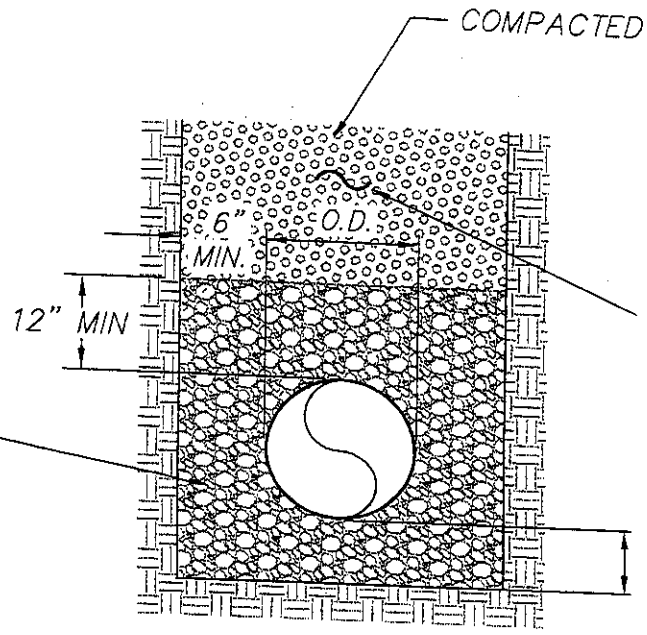
NOTE:

1. DEPTH OF CHANNELS TO BE 1/2 I.D. OF PIPE
2. PROVIDE SMOOTH FLOW ACROSS BOTTOM OF MANHOLE

DETAIL 7: MANHOLE BOTTOM

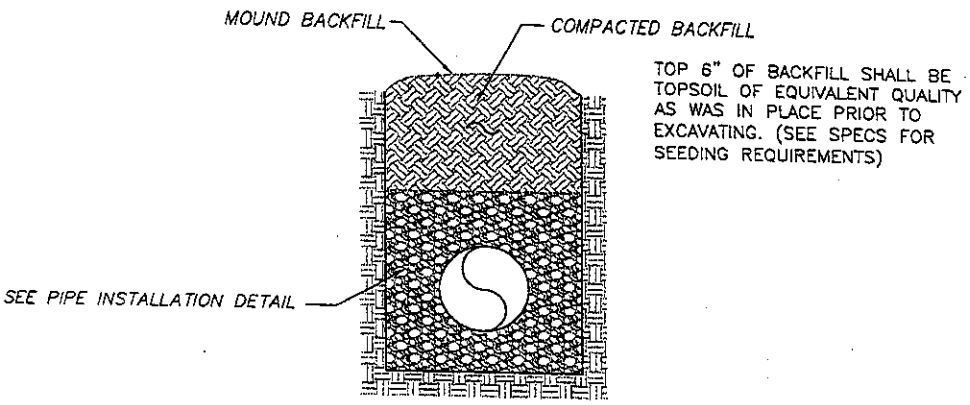
GRANULAR BEDDING MATERIAL PER ASTM D 2940 EXCEPT WITH THE FOLLOWING GRADATION.

SIEVE	% PASSING
3/4"	100%
1/2"	90–100%
No. 4	0–15%
No. 8	0–5%



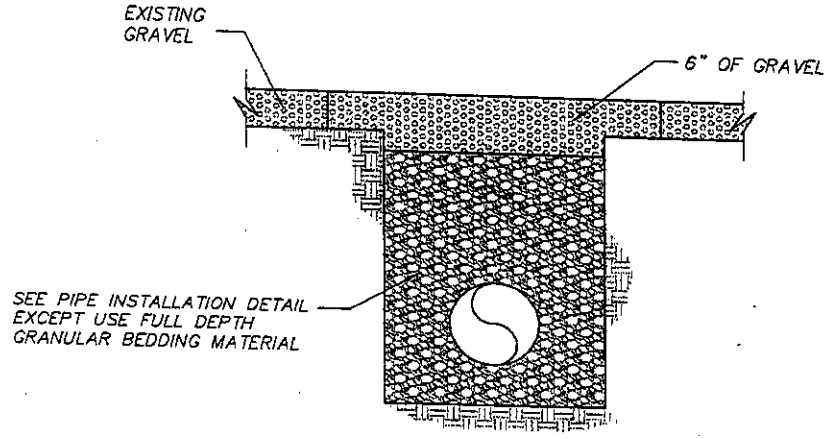
DETAIL 8: PIPE INSTALLATION

NOT TO SCALE



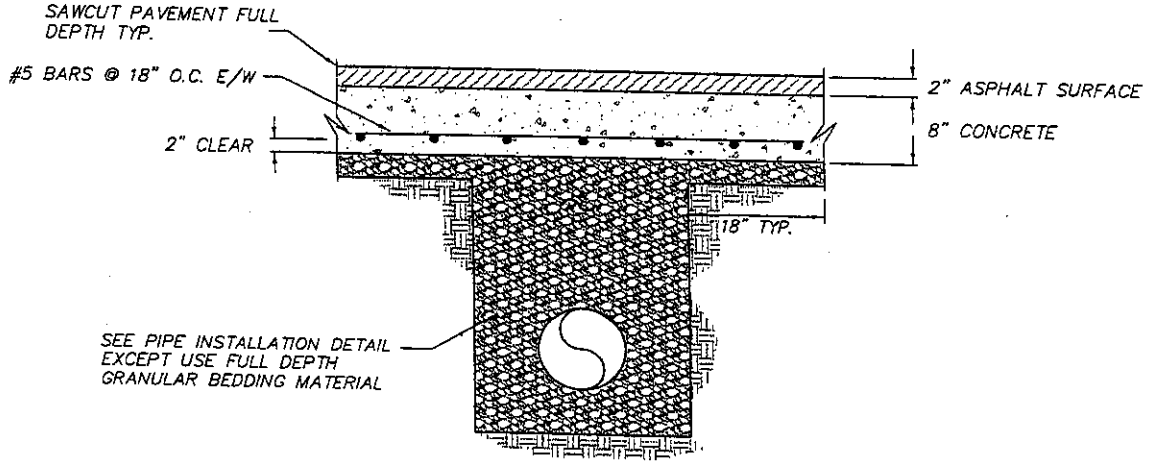
SEEDED AREA

NOT TO SCALE



GRAVEL SURFACE AREA

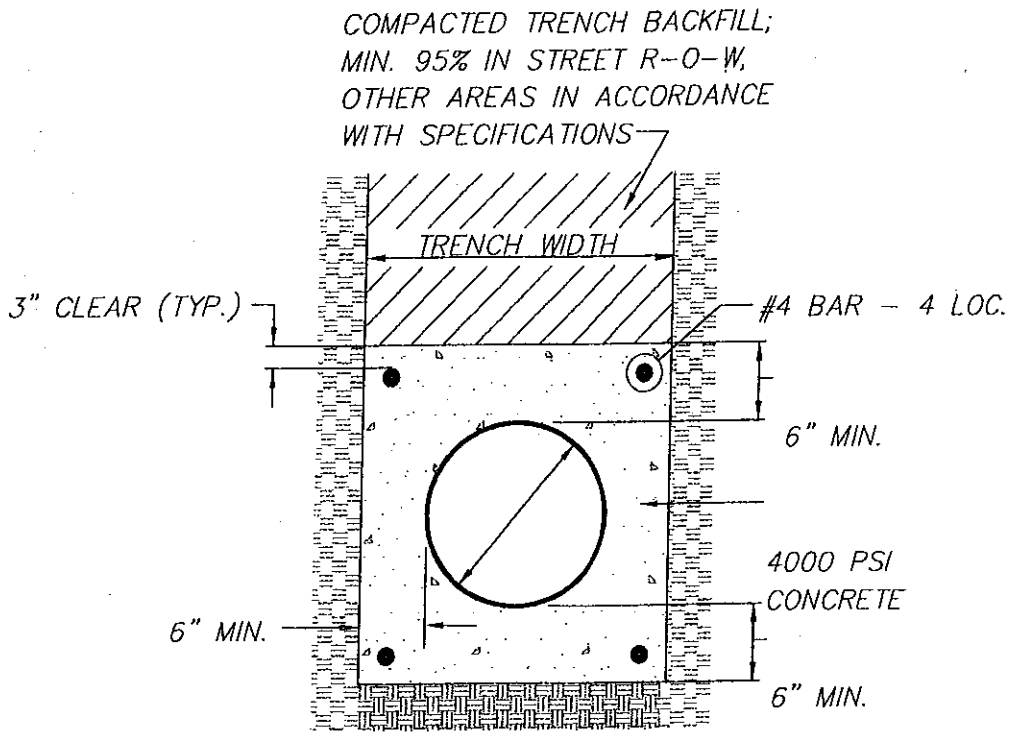
NOT TO SCALE



BITUMINOUS SURFACED AREA

NOT TO SCALE

DETAIL 9: TRENCHING BACKFILL METHODS

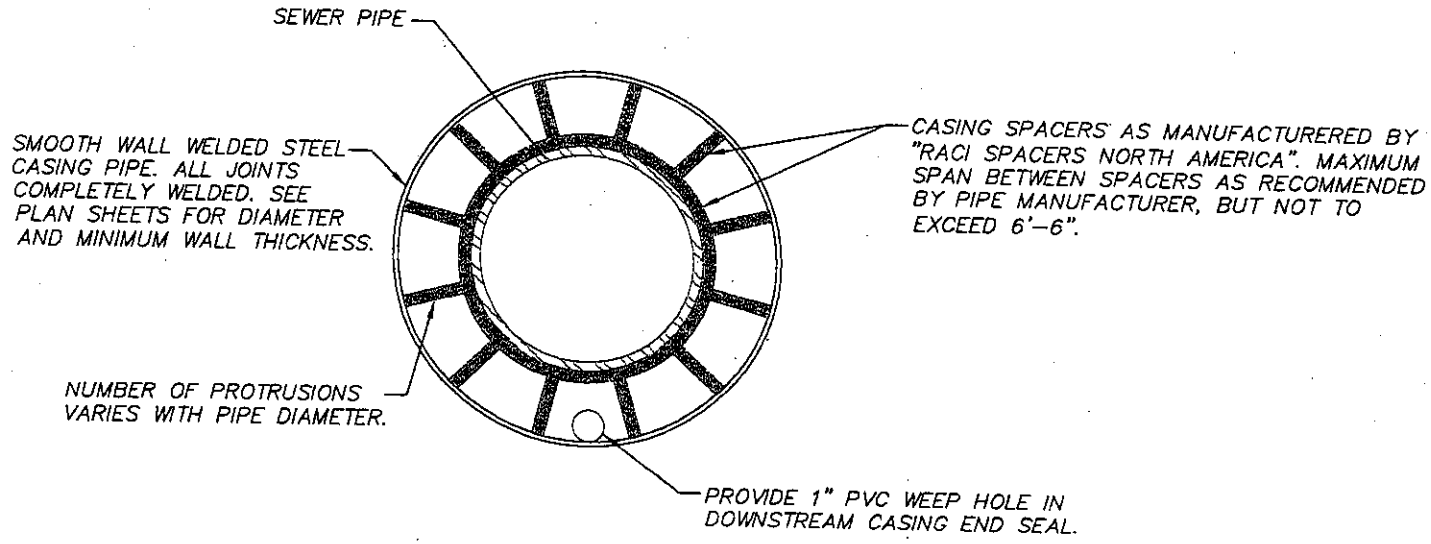


NOTES:

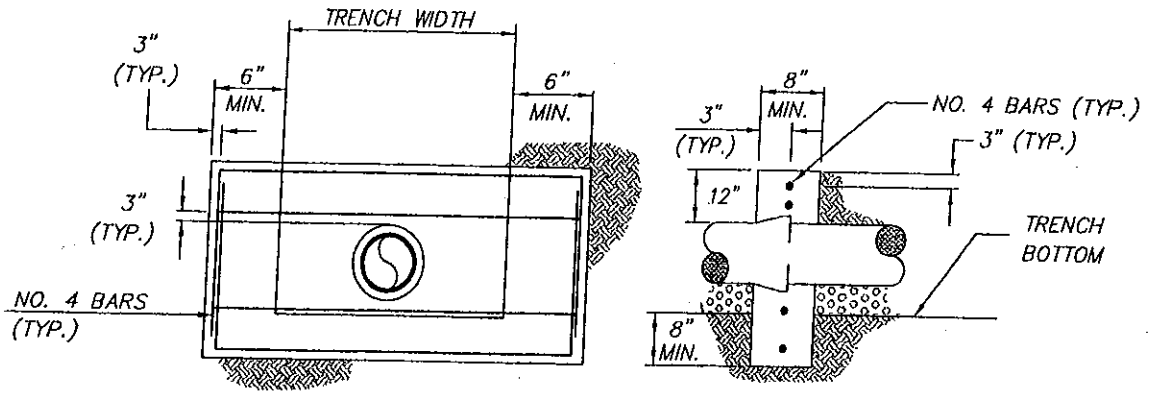
1. BLOCK UP PIPE TO PROVIDE MINIMUM CLEARANCE INDICATED.
2. CONTRACTOR SHALL INSTALL TIE DOWNS TO PREVENT FLOATING.

DETAIL 10: CONCRETE ENCASEMENT

NOT TO SCALE



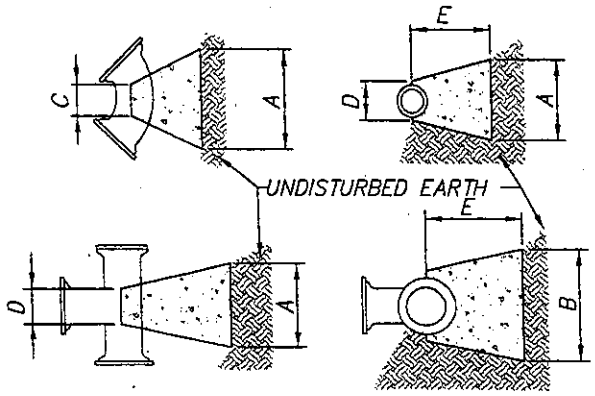
DETAIL 11: BORE CASING



SEWER SLOPE	MAX SPACING, FT
0 –19%	NOT REQ'D
20% – 34%	36
35% – 49%	24
≥ 50%	16

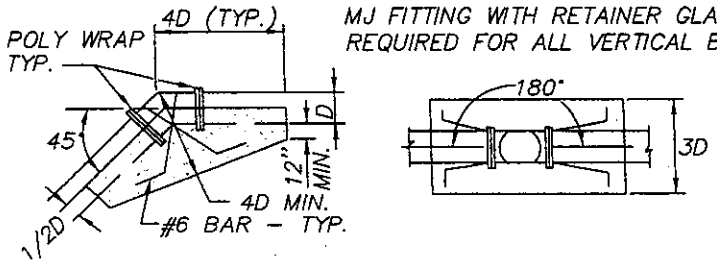
DETAIL 12: CONCRETE ANCHOR DETAIL

N.T.S.



CONCRETE THRUST BLOCK DETAIL

NOT TO SCALE



MJ FITTING WITH RETAINER GLANDS REQUIRED FOR ALL VERTICAL BENDS

VERTICAL BEND THRUST BLOCK DETAIL

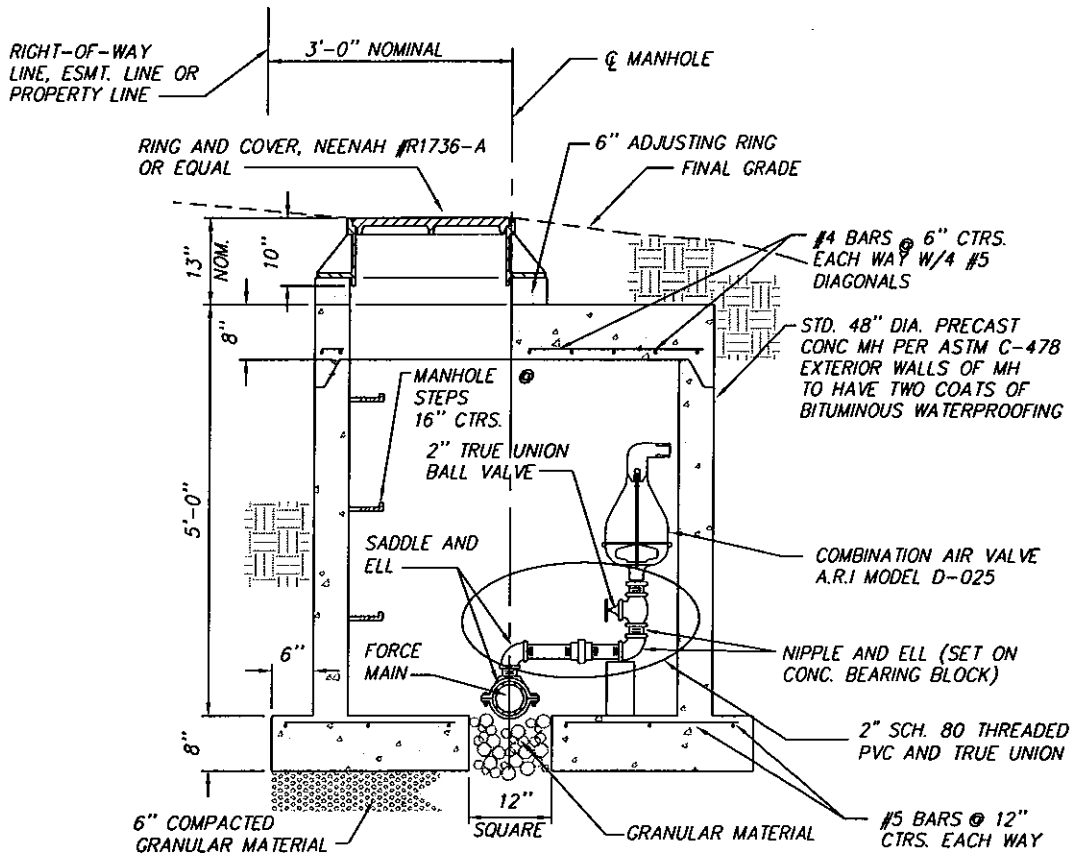
NOT TO SCALE

PIPE SIZE	FITTING	DISTANCE IN INCHES				
		A	B	C	D	E
4" AND SMALLER	11.25 & 22.5°	9	9	8	8	6
	45°	18	9	8	8	12
	90°	21	12	8	8	12
	TEE/PLUG	15	12	8	8	12
6"	11.25 & 22.5°	12	12	8	10	12
	45°	27	12	8	10	12
	90°	33	18	8	10	12
	TEE/PLUG	24	18	8	10	12
8"	11.25 & 22.5°	18	15	8	10	12
	45°	33	15	8	10	18
	90°	42	24	8	10	18
	TEE/PLUG	30	24	8	10	18
10" & 12"	11.25 & 22.5°	27	24	12	12	18
	45°	51	24	12	12	24
	90°	63	36	12	12	30
	TEE/PLUG	45	36	12	12	24
14" & 16"	11.25 & 22.5°	33	33	12	16	18
	45°	69	33	12	16	30
	90°	84	48	12	16	36
	TEE/PLUG	60	48	12	16	30

NOTES:

1. THRUST BLOCKS ARE BASED ON A WORKING PRESSURE OF 200 P.S.I., PLUS 0% SURGE, & 2000 P.S.F. ALLOWABLE SOIL BEARING PRESSURE.
2. FOR PIPE SIZES NOT SHOWN USE DIMENSIONS FOR NEXT LARGER SIZE.
3. USE 3/8" PLYWOOD SEPARATOR BETWEEN BLOCKS AND PLUGS TO PROVIDE FOR FUTURE REMOVAL.
4. WRAP ALL FITTINGS W/6 MIL POLY PRIOR TO PLACEMENT OF CONCRETE THRUST BLOCKING.

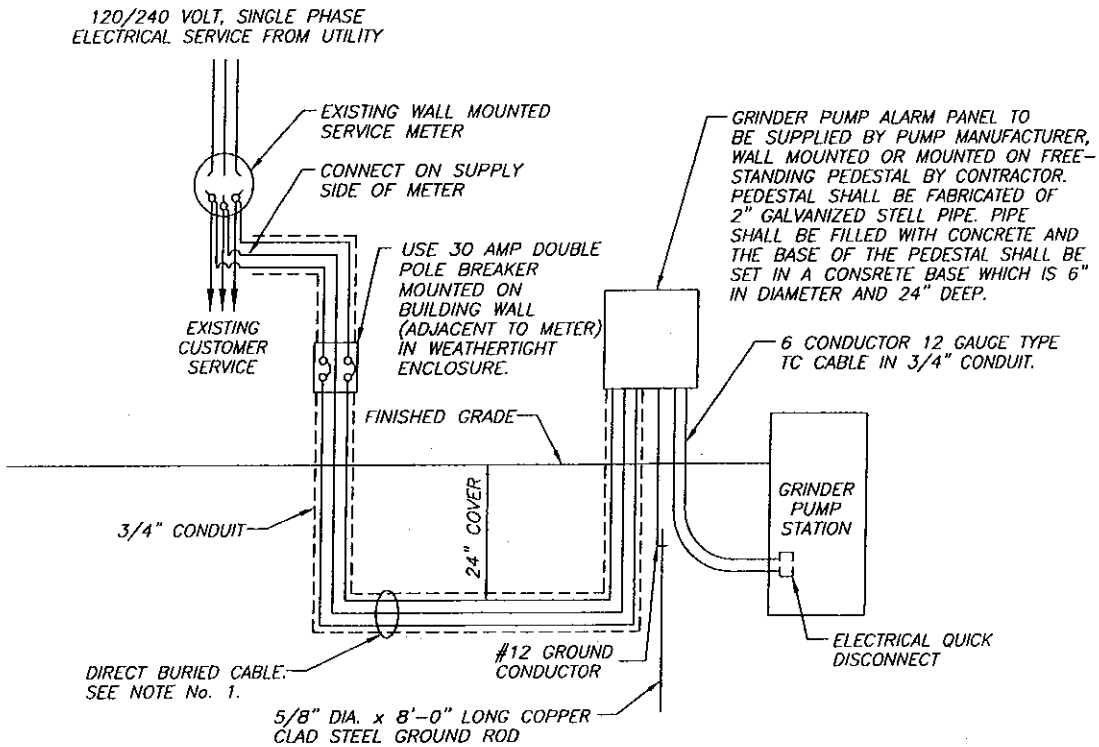
DETAIL 13: THRUST BLOCKING



DETAIL 14: AIR-VACUUM VALVE

NOT TO SCALE

CONTRACTOR NOTE:
AIR-VACUUM VALVE INSTALLATIONS POSITION RING AND COVER ON AIR-VACUUM VALVE ASSEMBLY MANHOLES NEAREST TO RIGHT OF WAY AS PRACTICABLE. INSTALL WARNING SIGN APPROXIMATELY 3" ON RIGHT OF WAY, ADJACENT TO MANHOLE. WARNING SIGN SHALL BE A MINIMUM 16 GAUGE, WHITE BACKGROUND WITH RED LETTER DENOTING ""CAUTION SEWER"". SIGN SHALL BE APPROXIMATELY 8" WIDE, 12" TALL, AND SHALL BE BOLTED TO A SUITABLE GALVANIZED POST A MINIMUM OF 6' IN LENGTH. SIGN SHALL BE POSITIONED WITH THE TOP OF THE SIGN APPROXIMATELY 42" ABOVE GRADE.

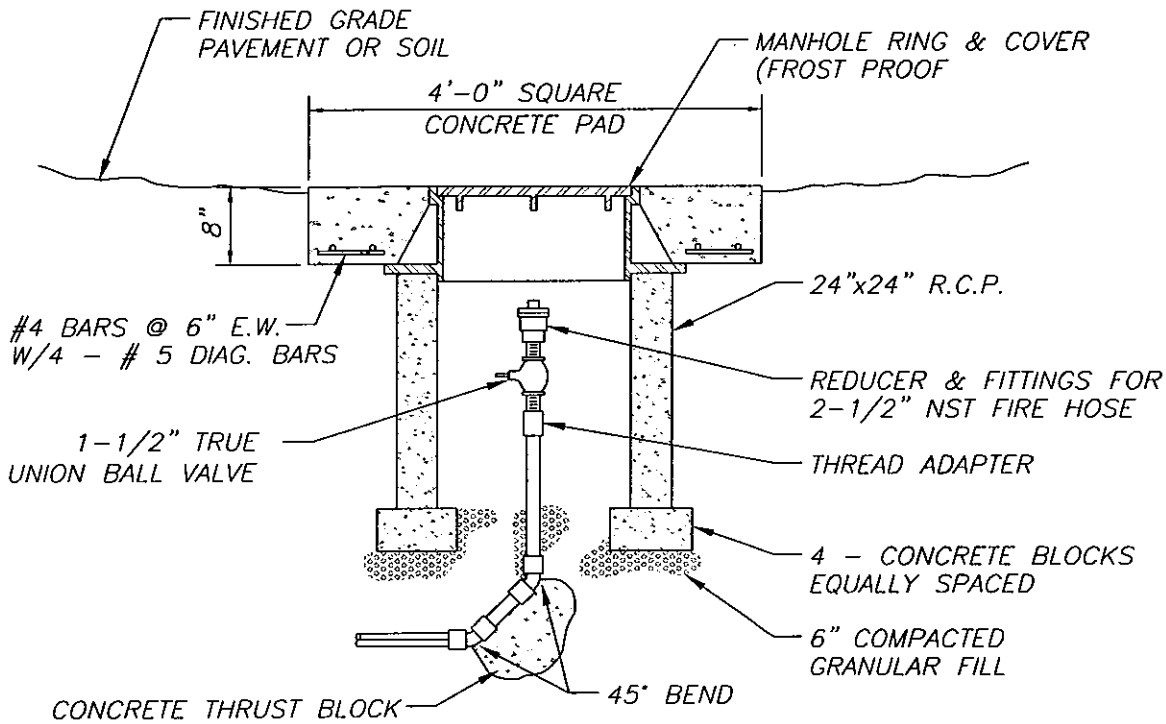


NOTES:

1. DIRECT BURIED CABLE SHALL BE 4 CONDUCTOR, #10
2. EACH SERVICE CONNECTION OF THIS TYPE SHALL REQUIRE THE TEMPORARY REMOVAL OF THE CUSTOMER ELECTRIC SERVICE METER. THE CONTRACTOR SHALL BE REQUIED TO CONTACT THE LOCAL UTILITY CO. AND MAKE ARRANGEMENTS FOR THE TEMPORARY REMOVAL OF EACH SERVICE METER AND REINSTALLATION OF METER. THE CONTRACTOR SHALL ALSO COORDINATE WITH THE INDIVIDUAL ELECTRIC SERVICE CUSTOMERS TO MINIMIZE INCONVENIENCE TO THE CUSTOMERS.

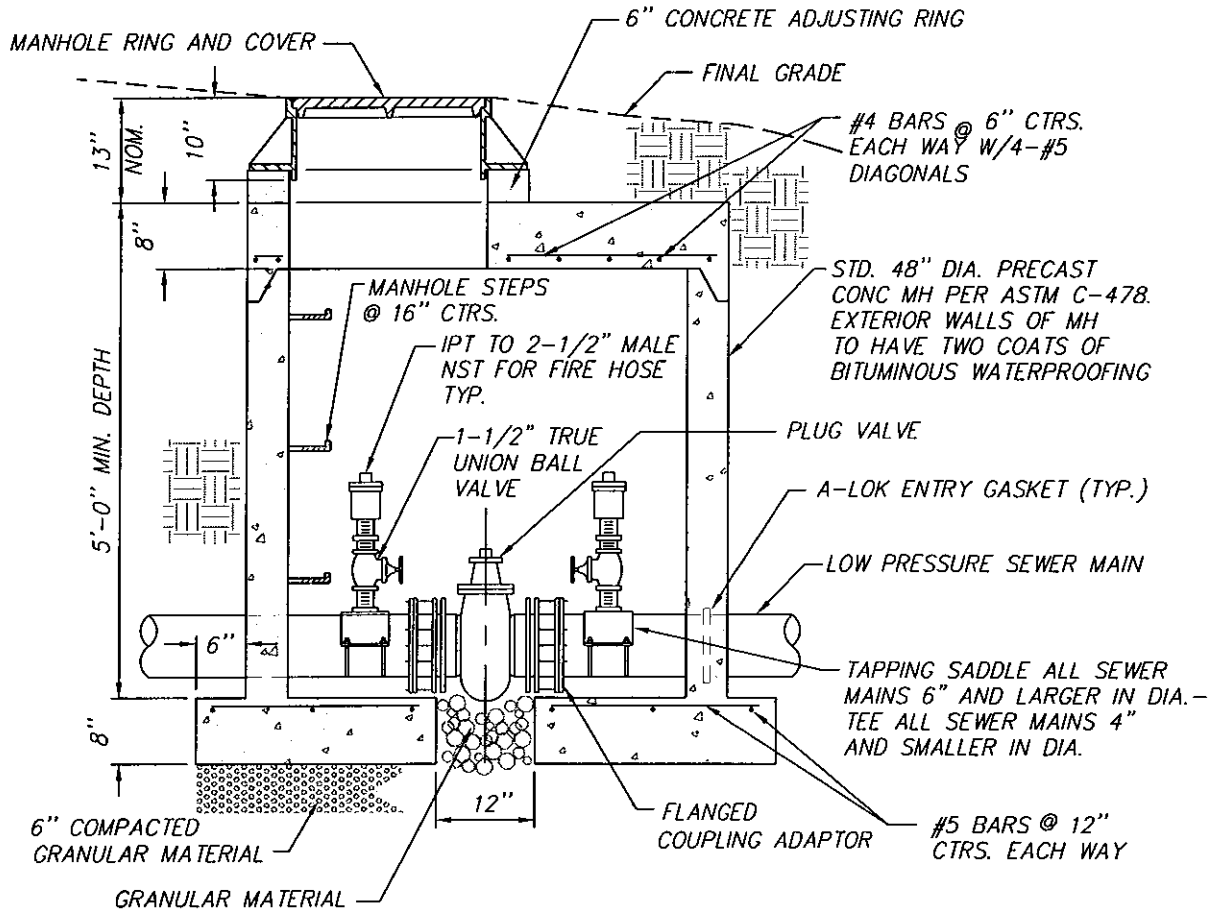
DETAIL 15: TYPICAL GRINDER PUMP STATION ELECTRIC SERVICE DIAGRAM

NOT TO SCALE



DETAIL 16: CLEANOUT ASSEMBLY

NOT TO SCALE



DETAIL 17: IN-LINE FLUSHING ASSEMBLY

NOT TO SCALE

GENERAL NOTES:

1. CONTRACTOR SHALL PROVIDE ADEQUATE PIPE SUPPORT.
2. CONTRACTOR SHALL PROVIDE ALL NECESSARY FITTINGS TO COMPLETE INSTALLATION TO DIFFERENT SIZE PRESSURE SEWER LINES.
3. ALL PRECAST CONCRET MANHOLE SECTIONS AND CONSTRUCTION SHALL CONFORM TO ASTM C478 STANDARDS (LATEST REVISIONS).