

GIBSON-THOMAS ENGINEERING CO., INC.**STANDARD SPECIFICATIONS**
SANITARY SEWER CONSTRUCTION

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A. GENERAL

1. Introductory

These Standard Specifications describe the requirements governing the construction of sanitary sewers and appurtenances. These Specifications are general in scope, are to be applied whenever applicable and are referred to as "Standards" in the other sections of the complete Contract Documents. Where the Standard Specifications and the Detailed Specifications differ in their specified intent, the wording of the Detailed Specifications will apply.

2. General Scope of Work

The location of the proposed work and actual extent of the various Contract items are either shown on the Contract Plans or described in the Detailed Specifications. The work to be done under this Contract shall include the furnishing of all labor, materials, equipment and tools necessary to construct the indicated sewer pipelines, including all appurtenances, complete and operable, in a satisfactory workmanlike manner and in accordance with the Contract Documents.

Wherever the words "sanitary sewer" shall occur in the Specifications, the meaning shall also include "trunk sewers", "main sewers", "lateral sewers" and "intercepting sewers", as well as all required manholes, service laterals and other appurtenances that are necessary for completion of the work in accordance with the Contract Documents.

The work shall include, but not be limited to, the following:

- a. Clearing and grubbing along the line of work.
- b. Provision of protection prior to starting work for all landscaping, utilities, structures and facilities which might be damaged if not protected.
- c. Removal and stockpiling of topsoil.
- d. Removal and storage of bushes, shrubs and trees to be replanted.
- e. Removal of paving, landscaping, fences, barriers and obstructions as required.
- f. Hauling, unloading and distribution of the pipe fittings and appurtenances.
- g. Excavation, including extra depth excavation for bells, joints and proper bedding.
- h. Barricades, fencing, lighting, watching and protection of the site.
- i. Reconstruction or relocation of other lines, pipes, ducts and utilities as necessary.
- j. All sheeting, bracing, shoring and supporting necessary to protect adjoining ground and adjacent structures.

- k. Sheet piling and shoring necessary for the safety of workmen in the trench and necessary to comply with all applicable safety codes.
- l. Pumping, bailing or draining of the trench as required to permit proper execution of the work.
- m. Laying of the sewer pipeline and installation of all appurtenances, including anchors, cradles, encasement, etc.
- n. Connection to other sewers as required and including installation of stubs, wyes and service laterals.
- o. Tunneling, boring, jacking and the installation of all types of carrier pipe, casing or liner plate.
- p. Backfilling and tamping of the pipeline trench.
- q. Repair or replacement of all damaged drains, sewers, utilities and structures, including gas lines, water lines, sanitary sewers, storm sewers, oil lines, gasoline lines, electrical conduit and cables, utility poles, culverts, bridges, foundations, driveways, streets and other items as required.
- r. Testing of completed pipeline sections for watertight condition.
- s. Elimination of all infiltration and/or exfiltration in excess of specifications.
- t. Replacing of removed topsoil and repair of or replanting of all landscaping, plants, trees and sod removed during the course of the work.
- u. Complete cleanup of the sites of the work.
- v. Removal and proper disposal of all waste materials, rubbish and surplus material.
- w. Maintenance of the streets and other surfaces over the trenches and other areas affected by the work.
- x. Proper completion of all work in accordance with the Contract Documents.

Any exception to the foregoing requirements will be specifically noted on the Drawings or in the Detailed Specifications.

3. Standard Drawings

Materials and construction shall conform to standards adopted for sewers and appurtenances where possible and any standards included in the Drawings shall be considered a part of the Contract Documents.

4. Permits and Inspection Charges

The Owner shall be responsible for the obtaining of all occupancy permits and for the payment of all fees relative thereto required by the various issuing agencies for the installation and location of sewer lines in the rights-of-way of roads and other thoroughfares.

The Contractor shall be responsible for compliance with all requirements and/or conditions set forth or established by occupancy permits obtained by the Owner. The Contractor shall determine, in particular, the requirements relative to road, stream and railroad crossing. Charges for inspection levied by PennDOT and other authorities will be paid by the Contractor, unless otherwise indicated in the detailed Specifications.

The Owner's responsibility shall not include obtaining blasting permits. All efforts to obtain blasting permits and all costs of blasting permits shall be the responsibility of the Contractor. The Owner will deduct payment to PennDOT from the Contractor's estimate, based on PennDOT submitted time sheets.

The Contractor shall obtain a separate Restoration Bond in the amount of the PennDOT work. See Detailed Specifications for actual bond amount

5. Engineering Field Work

The Owner will furnish basic centerline location data, monuments, reference points and bench marks for the establishment of elevations. The Contractor shall give the Engineer reasonable notice of his requirements for such survey lines and grades as he may require.

The Contractor shall furnish and shall be responsible for the general layout of all sewers, for the maintenance of all monuments, bench marks and reference points, shall maintain these points until completion of the work and shall make all necessary extensions therefrom for all work under this Contract.

The Owner reserves the right to check any or all such work under this Contract. The Contractor will be held responsible for the accuracy of such extensions, whether or not they are checked by the Owner. In addition, it is the Contractor's responsibility to notify the Engineer of any defects, problems, potential delays or any other item not specifically mentioned that will adversely affect the installation, progress or function of the work on this Contract.

6. Type of Proposal

a. General

Bids will be submitted on the Proposal Form provided in the Contract Documents and will be either Lump Sum Prices, or Unit Prices. A Lump Sum Price bid may require Supplemental Unit Prices for a complete submittal. These prices are defined in the Standard Contract Provisions and are further described as follows:

b. Lump Sum Prices

For the Lump Sum Price or Prices where shown on the Proposal Form, the Contractor will furnish and construct the work complete in place in accordance with the Specifications. No extra payment will be made for rock excavation unless so indicated in the Detailed Specifications. The Owner reserves the right to eliminate any lump sum item or items from the Contract and to increase or decrease the scope of remaining work to be installed. Where changes are made to the scope of the work, the Contractor will be paid only for the work actually performed, payment being based on the Lump Sum Prices and adjustments thereto being made on the basis of Supplemental Unit Prices for additions or deductions.

c. Unit Prices

The General Contract form is the Unit Price Contract where specific unit prices are solicited and the sum of the unit prices is computed as the Contractor's total bid. The work to be performed for each Unit Price will be as described below.

1) Sewer Pipeline

The price for these items will be a price per lineal foot for each size and type indicated, measured horizontally from the end of the pipe barrel to the end of the pipe barrel. This price per lineal foot shall include all costs to the Owner for a complete sewer furnished, installed, tested and maintained as specified, including backfill as required, and restoration.

Extra restoration of improved surfaces will be paid in accordance with extra removal and restoration as described later in the specifications. The only exceptions to the preceding will be for four-inch and six-inch service laterals which will be measured along the slope and include the test tee.

Concrete supporting service lateral risers will be constructed as directed by the Engineer and will be paid in accordance with concrete as described later in the Specifications.

Unit Price bids will be complete for work in place and include construction to the depth indicated. The cost of all excavation is included in the unit price unless specifically deleted in the Detailed Specifications.

Depth of sewer shall be determined by the Engineer and shall be based upon the difference between the existing ground centerline elevation and the proposed invert elevation. Payment for sewer line installation shall be in accordance with the following schedule and measurement for sewer pipe installation complete in place:

75% of the Contractor's unit price bid shall be paid upon completion of installation of pipe and proper backfill to the top of the ditch; 20% of the Contractor's unit price bid will be paid upon completion of pipeline restoration and ditch paving and the remaining 5% shall be paid to the completion of the Contractor's unit price bid upon the completion of all testing.

a) Measuring for Pipe

Payment for main line pipe will be done by measuring the distance from the center of manhole "X" to center of manhole "Y" and subtract 4' from the run. If a run includes a bore under a road, also subtract the length of the casing. The casing is paid under a separate pay item and the pipe and casing are included in the price of the bore. The same holds true for a run through a stream or wetland where concrete encasement is included. Concrete encasement is another separate pay item. The pipe that has been concrete encased is included in the price of the concrete encasement.

Mainline pipe is also paid (e.g., 0-8', 8'-12', 12'-16') depths. Cut Sheets will be used to determine what amount of pipe falls into each pay depth. 4" or 6" lateral service pipe has no pay depth and is paid by the foot, from the mainline to the end of the service. Where called for, a 4" or 6" lateral service may be extended onto a property to be within 150 feet of the house it is servicing. Your project plans will show how far a 4" or 6" service lateral is to extend onto a property when necessary. This is to be done only when a right of way drawings is available and signed for this work.

2) Eight-Foot Manhole: Adjustments for Depth Greater Than Eight Feet

The price bid for eight-foot manholes will be a price per each for every manhole installed to a maximum depth of eight feet or as noted in the Detailed Specifications as measured from the invert to top of the casting. For depths greater than eight feet this unit price will be increased by the amount as bid per vertical foot for adjustment. Measurements will be made by the Engineer and will be rounded off to the nearest half foot.

Unit Prices for these items shall include all costs to the Owner for furnished, installed, tested and maintained manholes complete in accordance with the Drawings and these Specifications, including foundations, base, walls, steps, top section and castings.

Payment to the Contractor for manhole installation shall be computed in accordance with the following schedule: The contractor shall be paid 50% of the unit price bid amount upon installation of the riser and base sections.

Upon complete installation of the frame and cover, 20% of the unit price amount shall be paid. Upon complete installation of inverts, 20% of the bid amount shall be paid and upon completion and testing, the remaining 10% of the bid shall be paid.

3) Watertight Manhole Covers

Unit Prices bid for this item shall include all additional costs for furnishing and installing a watertight manhole cover over and above the cost of a standard casting included in the standard manhole line item.

4) Drop Connections

The price bid for drop connections will be a price per vertical foot installed as measured between inverts of the drop pipe and inflow pipe.

Under the price bid for this item, the Contractor will supply all materials, labor and equipment and do all necessary work in accordance with these Specifications, to install and construct drop connections to manholes any inflow pipe entering a manhole at 24" or less above the effluent invert will be considered a splash and is paid as part of standard manhole costs.

5) Terminal Structures

The price bid for Terminal Structures will be a price per each for every Terminal Structure (lamphole) installed. Maximum depth for Terminal Structures will be six feet. Under this price the Contractor will supply all materials, labor and equipment and do all necessary work in accordance with these Specifications, to install and construct the various parts indicated, including all necessary earth excavation, backfill and cleanup work.

Unit Price bids will be complete in place and will include excavation and backfill to the specified depth. Additional depth shall be based on bid price per vertical foot installed, complete in place.

6) Wye Branches

Under the Unit Price per each bid for this item, the Contractor will supply all materials, labor and equipment and do all necessary work in accordance with these Specifications, complete in place, to install the indicated size of wye branch and plug during construction of the main sewer.

This price will represent only the additional costs over the cost of straight sewer installed as described in Article 1 above.

7) Cradles and Encasement

Under the price per lineal foot for each item, the Contractor will supply all materials, labor and equipment and do all necessary work in accordance with these Specifications, to construct and install encasements, cradles, etc., in accordance with the Standard Drawings and/or these Specifications, including any necessary earth/excavation.

Unit Price bids will be complete in place and will include excavation and backfill, special backfill riprap and pipe being cradled or encased, unless specifically deleted.

8) Pipe Anchors

Pipe anchors shall be installed on every line laid at a grade equal to or greater than twenty (20%) percent. The price for Pipe Anchors will be a price per each for every Pipe Anchor installed. The price as bid for this item shall represent the total cost to the Owner for furnishing and installing the anchors and also any additional cost involved in constructing the sewer line at these steep grades.

Unit Price bids will be complete in place and will include excavation and backfill, special backfill riprap and pipe being cradled or encased, unless specifically deleted.

9) Extra Excavation and Backfill

When specifically requested by the Engineer at the price per cubic yard for material measured in place for this item, the Contractor will supply all labor and equipment and do all necessary work in accordance with these Specifications to make any excavation and backfill around and over sewers and appurtenances which was specifically excluded under other pay items.

Payment for sewer excavation and backfill will be limited to a total width, as shown on the Maximum Trench Width Table on the Standard Drawing. Any excavation made at a greater width than this will be made at the expense of the Contractor, unless otherwise authorized by the Engineer.

10) Concrete

Under the price per cubic yard for this item, the Contractor will supply all material, labor and equipment to install and construct, in place, any concrete not covered under any other item price. This price will include all necessary forms, etc., but not include excavation.

11) Borings (Road, Railroad, Miscellaneous)

Under the Unit Price for this item, the Contractor shall furnish, complete in place, all excavation, materials, labor and equipment necessary to install the bore. This includes, but is not limited to the bore pit excavation, casing, pipeline through the casing, block and sealing of the casing, testing. No payment shall be made for this item until the complete installment is tested and approved by the Engineer. Boring installation that does not conform to the lines and grades established by the Engineer shall be unacceptable.

12) Work Along State Highway

This item is to include any and all costs related to work along state highway including traffic control. One hundred percent (100%) stone backfill within 3 ft. of the roadway, berm restoration where necessary, sidewalk, steps or curb replacement, and other incidental items. This item will be paid on a lineal foot basis. Bore pits for road crossings are not included in this item. The maintenance and restoration of the pits is part of the boring unit price.

13) Others

Other Unit Prices which may be indicated on the Bid Proposal will be described in the Detailed Specifications.

7. Estimated Quantities

The Contractor agrees that the Owner may, by revision of Drawings or written Change Order, increase or decrease the quantities or eliminate entirely any item or items, or part or parts of any item or items, or any part or parts of the Contract work as a whole.

Final quantities may vary greatly from estimated quantities for some work items. The extent of work for these items is contingent upon conditions found to exist during construction. No anticipated profit or loss shall be paid the Contractor on any quantity by which that given on the Proposal Form shall have been reduced and payment shall be for the actual work done.

The Contractor further agrees that the Owner may add or deduct material or work for which a Contract Supplemental Unit Price or a Unit Price is established. In accordance with the General Conditions of this Contract.

In addition, the Contractor shall be paid only on the quantity that the theoretical trench depth and maximum approved trench width indicate, as noted on the Contract Plans and these Specifications.

B. MATERIALS AND HANDLING

1. General

Unless superseded by Detailed Specifications, Drawings or special conditions or instructions, material used in the construction of sewers or appurtenances shall conform to the following. All sewers and appurtenances shall be manufactured in accordance with the latest applicable specifications as indicated herein. The Contractor shall submit such alternate bids as are required relative to the use of different types of pipe.

2. Pipeline Materials

a. Ductile Iron Pipe

All ductile iron pipe shall have an ultimate tensile strength of 60,000 pounds per square inch minimum, a yield point of 42,000 pounds per square inch minimum and an elongation of ten percent minimum. Ductile iron pipe shall be Class 52 manufactured in accordance with ANSI Specifications A21.51 (A.W.W.A. C151). All ductile iron pipe shall have rubber gasket push-on joints conforming to ANSI Specification A21.11; shall be unlined and bituminous seal coated in accordance with ANSI Specification A21.4; and the exterior shall be tar coated.

All ductile iron pipe shall be Class 3 unless otherwise indicated on the Plans. All fittings shall be manufactured in accordance with Specification ANSI A21.10 (A.W.W.A. C110).

The fittings may have rubber gasket push-on joints or may have mechanical joints. All fittings shall have the interior cement lined and seal coated and the exterior coal tar coated. Certified tests furnished by the manufacturer shall be submitted to the Engineer. Each piece of pipe shall have the weight and class designation conspicuously painted on it. Each piece of pipe shall also have distinctly cast or stamped into the metal on the face or outside surface of the bell or on the body near the bell the manufacturer's mark and the year in which the pipe was cast.

b. Steel Pipe

Steel pipe, where shown on the Contract Plans, either for use as a sewer or casing, bored or jacked underneath roads or railroads, shall have wall thicknesses of 1/4 inch for sizes up to and including sixteen inches, 3/8 inch for sizes from eighteen inches up to and including twenty-four inches, 1/2 inch for sizes twenty-six inches up to and including thirty-four inches and 5/8 inch for sizes thirty-six inches and larger. The casing shall be black steel material and all joints shall be welded. The pipe shall have a yield strength of 35,000 psi. The lines placed in the casing shall have the type of joints as indicated on the Plans and shall be thoroughly braced against movement.

c. PVC Gravity Sewer Pipe

PVC Gravity Sewer Pipe shall meet or exceed the requirements of Standard Specifications for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings A.S.T.M. Designation D-3034, latest revision, and as further described herein. The pipe and fittings shall have thicknesses, dimensions and properties as described under the Designation SDR-35. Pipe shall be furnished in standard lengths of twelve and one-half feet with a tolerance of one inch.

All fittings and accessories shall be manufactured and furnished by the pipe manufacturer. Pipe shall be capable of passing the pipe stiffness, pipe flattening, impact resistance and joint tightness tests as described in A.S.T.M. Designation D-3034 and other referenced A.S.T.M. designations. Pipe shall have compression joints conforming to the material, testing and performance requirements of Standard Specifications A.S.T.M. Designation D-1869, latest revision.

All PVC pipe and fittings used on the project shall be certified by the manufacturer to have met the requirements of these Specifications. Each section of pipe shall be marked as indicated in A.S.T.M. Designation D-3034, with the manufacturer's name, wall thickness and type. All PVC pipe must not be stored in areas where it is exposed to extreme temperatures, hot and cold, and direct sunlight. Any material showing discoloration will not be permitted for use in the system.

d. Notification Tape and Detectable Wire

All installations of non-metallic pipeline shall include the furnishing and installation of identification tape and copper tracing wire (#10 size). This tape shall be constructed of non-degradable plastic at least 6" wide, shall be green in color and imprinted in a contrasting color with the words "CAUTION – BURIED SEWER LINE BELOW". The tape shall be installed at a depth of twelve to eighteen inches below the surface. Cost is to be included in pipe installation.

3. Manhole Materials

a. General

The manholes shall have approved, pre-cast concrete bases with precast concrete walls and cone sections and shall be provided with approved steps and cast iron frames and covers and shall be constructed in accordance with the details and dimensions as shown on the Standard Drawings.

Pre-cast risers will be used to adjust elevations to meet grade.

b. Manhole Wall and Base Sections

Manhole wall sections shall meet or exceed the requirements of Standard Specifications for Precast Reinforced Concrete Manhole Sections, A.S.T.M. Designation C-478, latest revision, except as modified herein.

All manhole wall sections will be four feet-zero inches diameter or as specified. Cone sections shall be eccentric with the manhole steps installed on the straight side. The clear opening at the top of the manhole shall be thirty inches in diameter.

Manhole bases shall be designed as shown on the standard details. If a manhole is to be provided with a watertight frame and cover, the clear opening shall be adjusted to provide proper bearing surface for the frame.

The barrel shall be not less than five inches thick. Wall sections shall be made with either tongue and groove or male and female ends.

Joints between sections shall be made with round rubber or pre-formed plastic gaskets.

When male/female end manhole sections are used, joint gaskets shall be placed on both the upper and lower lip. Rubber gaskets used to seal wall section joints shall conform to the A.S.T.M. Standard Specifications for Joints for Circular Concrete Sewer and Culvert Pipe, using Flexible, Watertight, Rubber Gaskets, C-443, latest revision.

The gaskets shall be installed in accordance with the instructions of the manufacturer. The interior and exterior surfaces of joints between sections shall be pointed with mortar after installation of the gaskets. Pre-formed plastic gaskets used to seal manhole joints shall meet or exceed all requirements of Federal Specifications SS-S-00210 S, Sealing Compound, Preformed Plastic for Pipe Joints, Type 1, Rope Form.

Such plastic gaskets shall meet the following requirements:

The sealing compound shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with invert mineral filler, and shall contain no solvents, irritating fumes or obnoxious odors.

The compound shall not depend on oxidizing, evaporating or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded rope-form of suitable cross section and of such sizes as to seal the joint space when the pipes are laid. The sealing compound shall be protected by a suitable removable two-piece wrapper.

The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half to facilitate application of the sealing compound. The gaskets shall be installed in accordance with the instructions of the manufacturer.

Mortar used to point the gasketed joints shall conform to the appropriate sections of these Specifications. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside of the barrel.

c. Frames and Covers

- 1) Every manhole and lamphole, unless otherwise called for on the Plans, shall be fitted with a cast iron frame and cover of the type and dimensions shown on the Standard Drawings or as designated in the Detailed Specifications.
- 2) The covers shall be free from imperfections and thoroughly cleaned. Castings shall be of best quality gray iron, tough and of even grade and shall ring clear and sharp when struck.
- 3) After cleaning they shall be double dipped in hot coal tar pitch.

- 4) The frame and cover shall be straight and true to pattern and the cover must have a continuous and even bearing in the frame and shall be properly seated as to avoid rocking.
- 5) The cover must also fit into the frame as nearly as possible without jamming, and must fit the frames in any position.
- 6) The frames and covers shall meet the requirements of A.S.T.M. Standard Specifications for Gray Iron Casting, latest revision.

d. Manhole Steps

- 1) The manhole steps shall be made of cast iron or polypropylene and shall be of the dropped front design with a ridged or rough tread, in accordance with the details shown on the Contract Plans.
- 2) The manhole steps shall be in accordance with these Specifications, twelve inches on centers, shall be twelve inches in width, shall project not less than seven inches from the wall and shall be placed while the concrete is green.
- 3) Should field grouting of steps be approved, such grouting shall be completed utilizing pre-mixed grout material known as Embeco, as manufactured by U.S. Grout Corporation, or approved equal.

e. Drop Connections

- 1) In all junction manholes where the grade line of one sewer is considerably higher than that of the other, the drop connection shall be made as shown on the Contract Plans.
- 2) Wye branch fittings shall be utilized for the drop connection where requested by the Engineer. Concrete for encasement shall be Class B, as described elsewhere under Materials in this section. A drop pipe shall be provided for the sewer entering the manhole 24 inches or more above the invert.

f. Other Materials

Other materials used in the construction of manholes will conform to appropriate sections of these Specifications.

4. Miscellaneous Materials

a. Concrete

All materials shall conform to the requirements as listed below. Where reference is made to a standard code or specification, it shall mean the most current issue of that standard.

- | | |
|-----------------------------------|--------------------|
| 1) Reinforcing Steel | ASTM A-61 or A-432 |
| 2) Wire Fabric | ASTM A-185 |
| 3) Concrete Aggregates | ASTM C-33 |
| 4) Ready-Mix Concrete | ASTM C-94 |
| 5) Portland Cement | ASTM C-150 |
| 6) Air Entraining Portland Cement | ASTM C-175 |
| 7) Air Entraining Admixtures | ASTM C-260 |
| 8) Concrete | ACI 318-63 |

- 9) Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials or other deleterious substances.

Concrete for manhole bases, inverts and slabs and for lampholes shall conform to Class A and shall have a compressive strength at 28 days of 4,000 pounds per square inch. Concrete for pipe arches, cradles and encasement shall conform to Class B and shall have a compressive strength at 28 days of 3,500 pounds per square inch.

b. Masonry

All materials shall conform to the requirements as listed below. Where reference is made to a standard code or specification, it shall mean the most current issue of that standard.

- | | |
|--|------------|
| 1) Aggregate for Masonry Mortar | ASTM C-144 |
| 2) Mortar | ASTM C-270 |
| 3) Portland Cement | ASTM C-150 |
| 4) Lime | ASTM C-207 |
| 5) Joint Reinforcement | ASTM A-83 |
| 6) Water used in mixing mortar shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials or other deleterious substances. | |
| 7) Brick shall conform to ASTM Standard Specification for Sewer Brick, latest revision, Grade N.A., unless otherwise shown on the Plans. | |

c. Granulated Slag

No slag will be accepted on the job.

d. Sheeting and Shoring

All lumber used for sheeting and sheet piling and all timber used for braces, shores and stringers or waling strips shall be sound, straight, free from cracks, shakes and large or loose knots and of the required dimensions throughout. Plank shall be tongued and grooved, or grooved and splined if so required by the exigencies of the work, or as directed by the Engineer.

e. Backfill Materials

All backfill material shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks, stones or other material which, in the opinion of the Engineer, is unsuitable. The pipe shall be laid only on granular bedding material a minimum of 6" in depth, or greater depth if specified. The granular bedding material used shall be PennDOT approved, Type 2B stone, no slag is permitted, and shall be placed from a depth of 6" below the bottom of the exterior of the pipe 1'- 0" above the pipe or as indicated on the Plans. The use of other materials shall be subject to the written approval of the Engineer.

5. Delivery, Handling and Storage

The Contractor shall be responsible for all materials and equipment furnished by him and shall replace, at his own expense, all such material or equipment found defective in manufacture or damaged in delivery or in handling after delivery. This shall include responsibility for furnishing labor and material required for the replacement of installed material found defective prior to the final acceptance of the work.

The pipe, fittings and other appurtenances shall be hauled to the site from the point of delivery and unloaded by means that will not result in any damage and, under no circumstances, shall material be dropped from the truck. The pipe and fittings shall always be handled with care to prevent damage when being transported, loaded or unloaded. The pipe and fittings shall be unloaded and either stored or placed near where they are to be laid in the trench, with the bell or proper ends facing in the direction in which the work will proceed, exercising care and keeping the pipe and fittings free from dirt and foreign material.

C. EXCAVATION

1. Location and Protection of Existing Facilities

Before any start is made on excavation work for the sewer pipeline trench, the Contractor shall determine the location of existing pipes, cables, tracks, poles, wires, conduits, survey monuments, bench marks and other structures which may be encountered in the prosecution of the work. Any damage to said pipes, cables, tracks, poles, wires, conduits, survey monuments, bench marks and other structures shall be the sole responsibility of the Contractor.

Any indication on the Contract Plans of utilities of facilities is presented only as a guide and must not be accepted by the Contractor as either accurate or complete.

The Contractor shall hold the Owner harmless for, and will defend the Owner against, any claims resulting from damages to the said pipes, cables, tracks, poles, wires, conduits, survey monuments, bench marks and other structures.

In backfilling and excavating of trenches and laying of sewers, care must be taken not injure any facilities encountered in such work. Survey marks and property corners disturbed by the Contractor must be replaced at no cost to the Owner. These obstructions may interfere with the installation of the new sewer lines and the Contractor must allow for such interference in his bid.

All public utilities, including building service connections whether indicated on the Plans or not, which in the opinion of the Engineer can be satisfactorily secured in place and maintained without interfering with the proper execution of the work, shall be taken care of by the Contractor, or at his expense by the utility concerned in such a manner as to secure the safety of the public and said structures.

Whenever it becomes necessary to remove and replace any building service connections or other utility facility, the work shall be done at the Contractor's expense to meet the requirements of the utility concerned. All damage as may occur to existing utilities as a result of the Contractor's work shall be suitably repaired by the Contractor.

2. Use of Public or Private Property

The operations of the Contractor in public streets, public highways or alleys, shall be confined to as small a space as is practicable so as not to cause undue inconvenience to the public or abutting properties and shall be subject to the approval of the Engineer. The operations shall be confined to the limits of right-of-way over private property unless otherwise indicated and, if additional area is required, the Contractor shall obtain the right to use adjacent or such property as required at no additional cost to the Owner. The Contractor shall take cognizance of his responsibility to protect property on each side of the right-of-way.

3. Maintenance of Traffic

During the progress of the work, the Contractor shall accommodate both vehicular and foot traffic and shall provide free access to abutting property, fire hydrants, water and gas valves, and such other facilities. Street intersections may be blocked, by one half at a time, and the Contractor shall lay and maintain temporary driveways, bridges and crossings, such as in the opinion of the Engineer are necessary to accommodate the public. In the event of the Contractor's failure to comply with the foregoing provisions, the Owner may, with or without notice, cause the same to be done and deduct the costs of such work from monies due or to become due the Contractor under this Contract; but the performance of such work by the Owner or at its insistence shall serve in no way to release the Contractor from his general or particular liability for the safety of public or the work.

Where it is necessary, in the opinion of the Engineer, to close a portion of a street to traffic, the Contractor shall post suitable signs, or workmen, to indicate that a street is closed and shall place other necessary detour signs for the proper convenience or maintenance of traffic. The Contractor shall comply with all requirements relative to the maintenance of traffic, as stipulated by the State and County Highway and Transportation Department and the local municipal subdivision. During the entire prosecution of the work, the Contractor shall be responsible for all open excavations and, as a means of protection, will keep flashing red lights burning at all times. Such red lights to be placed at proper intervals on any open excavation.

As a further means of protection, the Contractor shall display warning and danger signs and barricades on all open excavations or other locations where there is chance of injury to the public. Any and all piles of material, equipment and/or pipe, which may serve as obstruction to traffic and the public, shall be enclosed by fences or barricades and shall be protected by proper warning lights when the visibility is poor.

4. Maintenance of Streets

The Contractor shall clean and keep clean the streets, and on public or private property occupied by him, the area shall be free from waste or refuse resulting from his operations. Trucks hauling excavated material, cement, sand, stone and other loose materials from or to the site shall be tight, so that no spillage will occur on adjacent streets. Before trucks start away from the site, their loads shall be trimmed. If the Contractor neglects his duties in maintaining the proper street cleanliness, the Owner, at first option, may take necessary steps to perform such cleaning and the Contractor shall pay for all cost therefore upon presentation of an itemized invoice.

5. Maintenance of Existing Drainage

Drainage through existing sewers and drains shall be maintained at all times during construction, and all gutters shall be kept open for drainage. Where existing sewers are encountered in the line of work which interfere with the construction, the flow in the sewers, including both dry weather flow and storm flow, shall be maintained by pumping, or by both.

6. Orderly Prosecution of Work

The Contractor shall keep the work and all property occupied by him in a neat and orderly condition at all times, as set forth in detail later herein. Waste materials, rubbish and debris shall not be allowed to accumulate. The Contractor's equipment, temporary buildings and excess materials shall be promptly removed as they become no longer needed for the progress of work. At the completion of the work, the premises shall be left rake clean.

The newly constructed sewers, concrete sewers, flumes and manholes shall be cleared of all scaffolding, centering and debris of all sorts.

7. Excavation

a. General

The work discussed under this section of the Specifications describes the excavation and grading required for the proper execution of the Contract and includes descriptions of the auxiliary requirements of protection, shoring, bracing, dewatering, removal, disposal, storage, repair, replacement, etc. All excavation shall be unclassified, unless otherwise indicated, and no extra payment shall be made for rock or the removal of existing concrete or masonry foundations or other such materials.

b. Material Classification

The materials of excavation shall be unclassified excavation and shall include whatever materials are encountered to the depths shown on the Drawings, or as directed by the Engineer.

The following definitions shall apply to the materials of excavation: Excavation shall include all material excavation and shall include but not be limited to clay, silt, loam, sand, gravel, slate, hard-pan, pavements of all kinds, sandstone, loose stone, limestone, shale and all boulders.

c. Site Preparation

Prior to any excavation, the Contractor shall properly prepare the right-of-way or site of the work. The Contractor shall first provide adequate protection for all lawns, trees, shrubs, landscape work, fences, utilities and sidewalks that are to remain in place, and for such other existing similar growth, structures and facilities. Such protection shall be maintained so long as necessary to prevent damage due to the operations of the Contractor.

All grass and sod shall be carefully removed from all lawns and stored, protected and relaid following backfill and tamping of the excavated areas, providing it is in suitable growing condition. If the sod is not satisfactory for replanting, the Contractor shall seed the excavated area in accordance with Specifications set forth later herein.

The Contractor shall also remove all plant material, store and replant the material following completion of the work or replace with suitable material.

The plant material shall be examined six months after being planted, and all material not growing shall be replaced. The clearing and grubbing operations shall be maintained a sufficient distance ahead of the excavating operation. The site shall be cleared of all dead trees, stumps, brush, roots and other objectionable material.

The Contractor shall exercise care to protect living trees and shall cut no trees outside the limits of the permanent sewer right-of-way. The material shall be burned or removed in a satisfactory manner, all in accordance with the requirements of the County and other requirements regulating open fires and local ordinances regulating open fires.

Prior to excavation in fields, cultivated areas, pastures, landscaped areas and such other areas, topsoil shall be removed from the site to its full depth, stored and saved until after completion of all construction work, then shall be evenly distributed over the entire remaining area, including embankments that are to be graded and seeded, unless otherwise indicated.

Prior to excavation in wooded areas, the topsoil shall be removed after completion of cleaning and grubbing and shall be free from grass, trees, bushes, roots, stones, hard clods, construction debris and deleterious matter, and shall be stored and protected for later use when placed back in its original position.

The Contractor shall remove all street and sidewalk pavement, curbing, rip-rap, barriers and such other obstacles as required for the proper execution of the work, and shall store and protect all materials that can be used in restoring the site to its original condition. The amount of pavement and road surface to be removed shall depend on the width of the trench and the width and length of the pavement area required for the construction of all structures and appurtenances.

The width of the pavement removed along the normal trench for the installation of the pipe shall not exceed the width of the trench by more than twelve inches on each side of the trench. The width and length of the area of pavement removed for the construction of structures and sewer appurtenances shall not exceed the maximum linear dimensions of such structures by more than twelve inches on each side.

The Contractor shall use saw cutting to assure the breaking of the pavement along straight lines. The face of the remaining pavement shall be approximately vertical.

d. Excavation to Line and Grade

The trench excavation shall be of sufficient width and depth to provide adequate room for the construction of installation of the work and shall be to the lines and grades indicated on the Contract Plans. The trenches for pipe sewers shall have widths at the spring line of the pipe, so that there will be a minimum clearance of six inches between the outside of the pipe and the side of the trench.

Where pipe bedding, cradles or encasements are used, trenches shall have a clear width equal to the maximum width of the bedding, cradle or encasement. The schedule of maximum trench width is on the standard detail sheet included in the Contract Plans. This width shall not be exceeded from a point six inches above the grade of the top of the pipe to the bottom of the trench. Should the maximum width be exceeded, additional or alternate bedding, as approved by the Engineer, will be required at the Contractor's expense.

The trench shall be excavated throughout its length to conform to the exterior of the pipe or to a depth at least six inches below the bottom of the exterior of the pipe where granular bedding material is required by job conditions or used for the convenience of the Contractor.

Where granular bedding material is not required or used, the bottom of the trench shall be shaped by hand excavation to insure proper bedding of the pipe.

Bell holes of sufficient size shall be carefully excavated at proper intervals so that no part of the trench load on the sewer is supported by the bells, and so that sewer joints can be made properly and in accordance with good practice.

In all cases, the bottom quadrant of the pipe shall be fully and uniformly supported. The full load of the pipe shall rest on the barrel of the pipe. Unauthorized excavation below the depth required shall be filled with approved granular material or concrete, as directed by the Engineer and at no cost to Owner.

Where an underdrain is necessary, the excavation shall be carried to the depth and width required on the Contract Plans. In cases where the bottom of the excavation is found unsuitable as a foundation, it shall be further excavated and prepared by placement of approved granular material or placement of concrete, as the Engineer may direct.

Pipe laid in rock trenches will always require a supplementary foundation to provide uniform support for the bearing surface of the pipe. The foundation shall be formed by placing a layer of approved granular material in the bottom of the trench to a depth of eight (8) inches.

The trench shall at all times during the progress of the work be excavated to the required width and depth for a distance of at least ten feet in advance of the end of the pipe in place, except that the trench in rock shall be opened thirty feet in advance. No trench shall be excavated more than one hundred fifty feet in advance of the completed sewer without the written permission of the Engineer.

Whenever a branch for a proposed sewer or extension of a sewer is built in rock, the required trench shall be excavated a distance of not less than five feet beyond the end of the branch, in the direction of the proposed sewer or extension.

No backfill will be permitted under manholes and any excavation below the required levels shall be filled with concrete at the Contractor's expenses. The excavation shall be made at least eighteen inches larger than the exterior of the manhole. The manhole excavation within roads, berms, driveways or where ordered shall be backfilled with an approved granular material and shall be thoroughly compacted in one-foot layers with approved mechanical tampers. The backfill material around all other manholes shall be approved dry suitable excavated material, thoroughly compacted in one-foot layers with approved mechanical tampers.

If field conditions classify the excavation as unsafe or there is not sufficient room to permit the operation of mechanical compactors, then the entire excavation around the manhole shall be backfilled with PennDOT Type 2B, approved stone backfill to a depth of within twelve inches of the surface of the ground. In all PennDOT berms and pavement, the excavation backfill shall be 100% stone.

e. Excavated Materials

The excavated material shall be deposited in such a manner as to interfere as little as possible with the excavation of the whole work and to avoid obstructing driveways and sidewalks.

During the progress of the work, the Contractor shall maintain crosswalks and roadways in satisfactory condition. The work shall, at all times, be so conducted as to cause a minimum of inconvenience to public travel and to permit safe and convenient access to private and public property along the line of the work.

The requirements of the County, State or local governing officials shall control the operations. If all the excavated material cannot be stored on the street in such a

manner as to maintain traffic movement, the surplus shall be removed from the work and stored, and the suitable material returned for backfilling. The work shall be done to allow accessibility to all fire hydrants, valve pit covers, valve boxes, curb stop boxes, fire and police call boxes or other utility controls, at all times until the work is completed.

The Contractor shall keep all gutters clear or provide other satisfactory facilities for street drainage and shall not obstruct natural water courses, and shall, where necessary, provide temporary channels to allow the flow of all water either along or across the site of the work

The Contractor shall not, without permission of the Engineer, remove from the work any sand, gravel, loam or material excavated from the trench which may be suitable for filling the trench until the trench has been backfilled to completion. All surplus materials that have been excavated from the trench shall be disposed of by the Contractor at no additional cost to the Owner.

f. Sheeting and Shoring

The Contractor shall furnish, install and maintain such sheeting, shoring and bracing as required to protect life and property and as required by governing Federal and State Laws and Municipal Ordinances.

Due care must be exercised to prevent voids outside the sheeting, but if voids are found, they shall be immediately filled and rammed. All the sheeting, bracing or shoring shall be removed unless required to be left in place.

The Engineer may order that timber used for sheeting and bracing be cut off at any specified elevation. The Contractor may, at his own expense, leave in place sheeting and bracing in addition to that required by the Contract Plans if for the purpose of preventing injury to persons, corporation or property. No sheeting and bracing shall be left within three feet of the surface without written permission of the Engineer.

Sheeting, shoring and bracing removed shall be removed in such a manner as not to endanger persons, the constructed sewer or other structures, utilities or property, whether public or private. The Contractor shall eliminate all voids left or caused by the withdrawal of sheeting by immediately refilling with sand, by ramming with tool adapted to this purpose, by watering, or by other approved methods.

The right of the Owner or the Engineer to order sheeting and bracing left in place shall not be construed as creating any obligation on their part to issue such orders, and the failure to exercise the right to do so shall not relieve the Contractor from liability for damages to persons or property, occurring from or upon the work of constructing the sewer, occasioned by negligence otherwise growing out of the failure on the part of the Contractor to leave in place in the trench sufficient sheeting and bracing to prevent any caving in or moving of the ground adjacent to the banks of the trench.

g. Dewatering

The Contractor shall remove by pumping, bailing or other means, any water which may accumulate or may be found in the trenches or other excavations included in this Contract, and shall form all dams, flumes or other works necessary to keep

them entirely clear of water while the sewers and their foundations and other structures are being constructed.

The Contractor shall have sufficient pumping machinery available at all times on the site ready for immediate use and he shall not open more trench than the available pumping or removal facilities are able to dewater. The water from the trenches and excavation shall be disposed of in such a manner as will not cause a public health nuisance or injure public or private property, work completed or in progress, surface of streets, or cause interference with use of the area by public. Where points of drainage discharge are in question, approval shall be obtained from the Engineer before such discharge is made.

Sanitary sewers, new or old, will not be used to drain the ditch line or constructed area. Lines should be plugged and sealed at the end of each construction day.

h. Blasting

All blasting will be permitted only after securing approval from the Engineer or his authorized representative. No blasting shall be done adjacent to existing lines or structures which may be damaged through blasting operations, and under no circumstances shall blasting be done on the site during or for a period of at least forty-eight hours after concrete has been placed.

The blasting of rock within five feet of water or gas mains shall be done with light charges of explosive, and the utmost care shall be exercised to avoid disturbance of the main.

All exposed sewers and special structures shall be carefully protected from the effects of blasts, and any damage to them by blasting shall be promptly repaired by the Contractor at his expense, and in no case shall blasting be done within 25 feet of newly laid sewer.

All shots shall be covered with cable, timber mats or trench backfill, if permitted, placed in accordance with governing regulations, and special care shall be exercised in the areas where high tension power lines are located. Prior to blasting sufficient warning shall be given all persons in the vicinity and traffic shall be stopped at the proper distance from the site and controlled by watchmen. The Contractor shall use the utmost care in the use of explosives necessary for the prosecution of the work, not to endanger life or property.

All blasting operations shall be conducted by experienced men who have proper certificates or licenses. The handling and use of explosives shall be done strictly in accordance with the Specifications issued by the United States Bureau of Mines and with any Federal to State regulations in effect; and in compliance with the local and state laws. Failure to observe necessary precautions will be sufficient grounds for temporary suspension of work.

All explosives shall be transported and stored in a secure manner and in accordance with the local and State laws; all vehicles and such storage places shall be marked clearly "Dangerous EXPLOSIVES", and shall be in care of a competent watchman at all times.

In no case shall caps or other detonators be stored or transported with dynamite or other explosives. The location of magazines for the storage of explosives and for the separate storage of detonators shall be subject to the approval of the Engineer and applicable State agencies.

i. Tunneling

1) General

Tunneling will not be permitted without the approval of the Engineer and the method of tunneling and location of all shafts and portals and the type and location of mechanical plant used in the tunneling operations shall also be subject the approval of the Engineer.

The work shall include all required excavation, bracing and supports, liner plates or steel casing if required, disposal of water, installation of sewer pipe, grouting backpacking and disposal of excavated material. The construction of the tunnels shall be executed without disturbance to embankments or settlement of land surfaces. The work must be executed by men fully equipped and experienced in tunnel work.

2) Regulations for Tunnel Construction

All work shall be done in accordance with the Regulations for Tunnel Construction and Work in Compressed Air of the Department of Labor and Industry of the Commonwealth of Pennsylvania and any applicable requirements of the Federal safety laws. Any requirements specified herein are in addition to the State and Federal requirements. In case of conflict between any requirement herein and Federal and State Requirements, the governmental requirements shall control.

3) Safety Requirements

The responsibility of the Contractor to comply with all laws, rules and regulations with respect to the work to be done is set forth in the Standard Contract Provisions. The Contractor shall furnish approved cases for the transportation of explosives. No explosives shall be transported into the shaft except in these cases and primed cartridges shall not be carried with unprimed cartridges. The Contractor shall also provide, at each shaft during construction of the tunnel, an approved ladder giving means of emergency egress from the tunnel.

4) Explosives and Blasting

All operations involving the handling, storage and use of explosives in tunneling of railroad property and/or Pennsylvania Department of Transportation property must be approved by the regulating agency. Blasting, if approved, must be controlled to prevent damage to the railroad and/or Pennsylvania Department of Transportation facilities. The Contractor shall notify the regulating agency and the Engineer in advance of the hour when charges are to be set off. The Contractor will be responsible for any damage to surface and/or subsurface facilities.

5) Ventilation

The Contractor shall provide and maintain a complete and adequate system of ventilation. The air in the tunnel shall be maintained at all times in a condition suitable for the health of the men and clear enough for surveying operations.

A sufficient supply of air shall be provided at all times at all places underground, and provisions shall be made for the quick removal of gases and dusts generated in the tunnel.

6) Power and Lighting

All power machinery within the tunnel shall be operated by electricity, compressed air or other approved power. Gasoline or diesel engine equipment may be used on the surface. The shafts and tunnel shall be lighted with electric lights in sufficient number to insure proper work and inspection. These are minimum requirements. At headings and at places where grouting is being done, and at other points where work is going on or inspection is being made, adequate special illumination shall be provided.

All wiring for electric light and power shall be installed and maintained in a first-class manner, as ordered or approved, and at all points securely fastened in place.

Electric light and power wires shall be kept as far as practicable from wires used for firing blasts. Special precautions shall be taken to avoid short circuits in any part of the wiring system.

7) Approval of Methods

Before beginning any work on the tunnel, the Contractor shall submit to the Engineer plans and statements describing in detail the materials and methods which he proposes to use, and he shall not proceed with this work until such plans and methods have been approved.

The Contractor shall be responsible for supporting the tunnel to the required lines and grades with minimum loss of material from outside the supporting lining, and for providing adequate lining and bracing to do this; and the approval by the Engineer of any plans or methods shall not relieve the Contractor of his responsibility in any way.

8) Tunnel and Shaft Excavation

The Contractor shall do all necessary cutting, loosening, loading, removing, transporting and disposing of all materials, wet or dry, necessary to be removed for the purpose of construction; all timbering, sheeting, shoring, bracing, draining, pumping and protective work to maintain excavations and render them free of water; all lighting and ventilating for construction purposes; all backfilling and disposal of excess material; and all grouting or dry packing outside the liner plate if required.

No extra payment shall be made for rock.

In planning the operations, the Contractor shall give due consideration to the materials likely to be encountered and the proper allowances to be made for line and grade and to meet uncertainties.

Methods of excavation shall be such as to insure the safety of the tunnel heading at all times, and to prevent the loss of movement of ground adjacent to the tunnel.

Complete courses of liner plates shall be installed promptly, as close to the heading as may be necessary to prevent loss of ground. Where necessary to withstand external pressure, structural steel ribs shall be installed with the steel liner plates. Wherever liner plates are used, they shall be left in place.

9) Supports

a) General

The Contractor shall place all sheeting, bracing, timbering, supports and protective lining as may be necessary for the safety of the workmen and others, for inspection and for the work itself. All timbering and bracing shall be removed before completion of the work.

The Contractor is responsible for the prosecution and success of his tunnel operations including the use and type of tunnel support, subject to approval of the Engineer.

If any type or various types of support are shown, they are suggestive only of the types which the Engineer will consider when the Contractor chooses and recommends for approval support at any needed or desirable location. The Contractor's responsibility for the adequacy and proper use of support at any location will not in any way be relieved by the details so indicated.

b) Tunnel Supports

The Contractor shall furnish and erect tunnel supports of structural steel shapes. Acceptable types are shown on the Contract Drawings, but other types may be approved. If required, plain structural shapes and shields of continuous steel plates, for protection against excessive wetness over relatively large areas, shall be furnished and installed.

c) Timbering

The Contractor may substitute at approved locations and in approved manners timber supports to maintain the completed excavations. Such timber shall also include posts to support steel plates, blocking or other timbering between rock and exterior surfaces of structural steel support and stops and lagging for protection in rock which tends to spall off but which is not expected to develop serious pressure. Acceptable designs for support may be shown on the Drawings, but other designs may be used if approved or ordered and the most economical design that is practicable shall be employed. Sufficient blocking over the timber of the roof support shall be used to prevent falls of rock and slabbing off, and lagging shall be used as required for the safety of the men. Such sizes and spacing of timber and such thickness of lagging shall be used as the nature of the rock may require.

d) Roof Bolts

If the location is suitable and if it is safe to maintain proper roof control by the use of roof bolts, the bolts shall be installed as soon as possible after the roof is exposed and before critical sag can occur. The roof bolting methods consists of reinforcing the tunnel roof strata with steel bolts so as to form a strong, consolidated beam. Such bolts may be of the split and wedge or of the expansion type, as shown on the Drawings, or as approved.

Safety jacks shall be installed while the holes are being drilled and the roof bolts are being installed. Bolts shall be spotted, installed and maintained by workmen experienced in their use and installation.

Suitable bearing plates or channel-shaped members must be provided to consolidate the roof strata when the bolts are tightened. The tensile strength of the bolts shall be high enough to prevent critical sagging of the roof. Roof bolts must be so designed that they can be tightened and anchored securely. Bolts shall be power driven and anchored in firm roof material.

10) Liner Plates

a) General

For tunnel in earth or soft rock, steel liner plates may be required. The plates shall conform to the A.A.S.H.O. Interim Specification for Steel Tunnel Liner Plates, dated May 28, 1971, as developed by A.A.S.H.O. Committee on Bridges and Structures. Liner plates of 4-flange or 2-flange design can be used. The plates shall have a minimum thickness of 1/8 inch and shall be bituminous coats inside and out.

b) Installation

The completed liner shall consist of a series of steel liner plates assembled with staggered longitudinal joints. Liner plates shall be fabricated to fit the cross section of the tunnel. All plates shall be connected by bolts on both longitudinal and circumferential seams or joints and shall be so fabricated as to permit complete erection from the inside of the tunnel. Grout holes two inches or larger in diameter shall be provided as shown on the Plans or as directed by the Engineer to permit grouting as the erection of tunnel liner plates progresses.

The holes shall consist of two-inch standard half-pipe couplings complete with two-inch cast iron plugs. All plates shall be formed to provide circumferential flanged joints. Longitudinal joints may be flanged or of the offset lap seam type. All plates shall be punched for bolting on both longitudinal and circumferential seams of joints.

Both spacing in circumferential flanges shall be in accordance with the manufacturer's standard spacing and shall be a multiple of the plate length so that plates having the same curvature shall be interchangeable and will permit staggering of the longitudinal seams. Bolt spacing at flanged longitudinal seams shall be in accordance with the manufacturer's standard spacing.

For lapped longitudinal seams, bolt size and spacing shall be in accordance with the manufacturer's standard, but not less than that required to meet longitudinal seam strength requirements. Liner plates for the full length of a tunnel shall be of one type only, either the flanged or the lapped seam type of construction. Liner plates shall be assembled in accordance with the manufacturer's instructions.

The plates shall be handled in such a manner as to prevent bruising, scaling or breaking of the bituminous coating. Any plates that are damaged during handling or placing shall be replaced by the Contractor at his expense, except that small areas with minor damage may be repaired by the Contractor as directed by the Engineer. Voids occurring between the liner plate and the tunnel wall shall be force-grouted. The grout shall be forced through the grouting holes in the plates with such pressure that all voids will be completely filled.

11) Drilling or Jacking of Casing

The installation of casing by drilling or jacking shall be carried on without disturbing the embankment. All working operations of the Contractor, subcontractor and/or their agents or employees must be subordinate to the free and unobstructed use of the right-of-way for the passage of traffic without delay or danger to life, equipment or property. The Contractor shall conduct his operations in such a manner that all work will be performed below road level and standard clearances shall be maintained at all times.

The Contractor shall inspect the location where pipe is to be drilled or jacked and familiarize himself with the conditions under which the work will be performed and with all necessary detail as to the orderly prosecution of the work.

If, in the opinion of the Engineer, the installation of the pipe is being conducted in an unsafe manner, the Contractor shall be required to stop work until suitable agreements are reached between the Contractor and the Engineer.

The Contractor must be fully equipped and experienced in the installation of pipes by drilling or jacking. As evidence of his experience in this type of work, the Contractor shall submit to the Engineer specific information covering the successful installation by his company of at least five similar projects under heavy traffic.

Any project involving the installation of casing of substantially different diameter or length or under dissimilar circumstances will not be considered as satisfactory evidence of experience.

All drilling operations shall be conducted using an approved type of drilling equipment. The drilling machine shall be of the rotating auger type and shall be designed to permit the augers to operate inside of the casing being installed. The casing shall be installed at the same time as the hole is drilled, the cutting head being the only item of the drilling equipment being permitted beyond the forward end of the casing.

The auger train shall be of the maximum size which will fit in the interior of the casing being installed. Drilling machines which operate in such manner as to permit the entire hole being drilled prior to the installation of the casing are not approved for this operation.

Jacking operations shall be done by means of a hydraulic jack. In this operation all material shall be removed from the casing by flushing, shoveling or other approved method.

A suitable drive block shall be inserted in the end of the casing to eliminate all damage to the casing end due to excessive pressures of the jack, and a cutting shoe shall be used on the forward end of the casing.

Prior to the beginning of the drilling or jacking operation, the Contractor shall establish a grade for the casing and shall, to the maximum possible extent, insure that the grade is maintained during the entire operation. The Contractor shall furnish all materials and equipment and shall do all work required to drill or jack pipe casings under roads and railroad tracks and elsewhere as indicated on the Drawings.

All drilling or jacking shall begin and terminate in pits or a continuation of a trench which is tightly sheeted and suitably braced. The Contractor shall ascertain and conform to all requirements and regulations of the agencies having jurisdiction over the road or railroad.

The Contractor shall conduct the work in such a manner as to safeguard all property and appurtenances of the railroad or other property and minimize interference with the railroad, highway or other operations.

The Contractor shall do NO blasting within the limits of this work.

In excavating from within a sheeted pit and from within the pipe, extreme care shall be taken to avoid loss of material outside the casing. Excavation shall be carried ahead of the casing to only such extent as will result in a safe condition for the operation of the railroad or highway and to the satisfaction of the responsible agency or official having jurisdiction.

Drainage shall be adequate to keep the bottom of the pit and the end of the bore firm and dry. The Contractor shall set railroad rails or other suitable steel runners within the jacking pit and to the proper line and grade, upon which the pipe will bear, to act as guides for proper alignment of pipe. Suitable sighting devices for controlling line and grade shall be used.

Adequate provision shall be made for taking the reaction of the jacks against the excavation, and once started, the operation of excavation the bore and jacking the pipe shall be carried to completion without interruption. Jacking of pipe can be accomplished in a rock tunnel by use of mining methods.

A shield shall be used which is large enough in diameter to permit the excavation of a tunnel through which the bells of the pipe can be jacked. The pipe shall be laid backwards, with the bell end of the pipe facing downstream, so that the frictional resistance, due to the shape of the bell, is reduced. The pipe shall be restrained from floating.

The space between the pipe and the tunnel wall shall be completely backfilled with a dry 1:3 mix of cement and sand or as detailed. Prior to the beginning of the drilling or jacking operation, the Contractor shall establish a grade for the casing and shall, to the maximum possible extent, insure that the grade is maintained during the entire operation.

The casing pipe shall be black steel having a minimum yield strength of 35,000 psi. The pipe shall have minimum wall thickness in accordance with the following:

Up to 16 inches in diameter	1/4 inch
18 to 24 inches in diameter	3/8 inch
26 to 34 inches in diameter	1/2 inch
36 to 42 inches in diameter	5/8 inch

The casing pipe size shall be a minimum of two times the diameter of pipe being installed.

12) Soil Erosion and Siltation Control

During the entire construction period, the Contractor will observe the requirements for Erosion and Siltation Prevention set forth in Section IV-D Standard Contract Provisions, Number 32; in addition, when the construction work is near or affects a stream, the following requirements will be met:

- a) All construction debris, excavated material, brush, rocks and refuse incidental to this work shall be removed entirely from the stream channel and placed either on shore above the influence of flood water or at such dumping ground as may be approved by the Engineer.
- b) There shall be no unreasonable interference with the free discharge of the river or stream during construction.
- c) Prior to blasting in the vicinity of a stream, the Owner shall obtain a permit from the Pennsylvania Fish Commission and the Owner and Contractor shall comply with the rules and regulations of said Commission governing the use of explosives. A permit cannot be obtained for a period of more than a month and the Contractor must advise the Owner of the need in due time.
- d) Backfilling of a trenched stream crossing shall be done so as to eliminate the formation of a permanent ridge in the stream bed.
- e) Construction of the stream crossing shall proceed in such a manner as to expedite completion of the entire crossing as one operation and shall include removal of the excess material from the stream channel and the restoration and seeding of the disturbed bank areas.

- f) The Contractor shall communicate with the Pennsylvania Fish Commission prior to starting the work and shall comply with the rules and regulations of said Commission relative to eliminating any objectionable turbidity during installation of the pipeline.
- g) Reduce by the greatest extent practicable the area and duration of exposure of readily erodible soils.
- h) Protect the soils by use of temporary vegetation or seeding and mulch, or by accelerating the establishment of permanent vegetation. Complete and protect segments of work as rapidly as is consistent with construction schedules.
- i) Retard the rate of runoff from the construction site and control disposal of runoff.
- j) Trap sediment resulting from construction in temporary or permanent silt holding basins. This includes pump discharges resulting from dewatering operations. Basins should be constructed of stone rip-rap and cloth.
- k) Sprinkle or apply dust suppressors, or otherwise keep dust within tolerable limits on haul roads and at the site.
- l) Use temporary bridges or culverts where fording of streams is objectionable. Borrow areas should be at a location where pollution from the operation can be minimized.
- m) Should construction operations be suspended for any appreciable length of time, interim measures for the control of erosion must be utilized.
- n) Provision must be made for protection against discharge of pollutants such as chemicals, fuel, lubricants, sewage and such other materials into the stream.
- o) The location of sanitary facilities over or adjacent to streams, wells or springs is prohibited.
- p) All operations shall be conducted in such a manner to minimize turbidity in the stream at and below the site of the structure. The requirement on turbidity as established by the Pennsylvania Department of Environmental Protection shall be met.

D. INSTALLATION OF MATERIALS

1. Laying of Pipe

a. General

All pipe shall be laid to a uniform line and grade, socket ends upgrade, with a firm and even bearing along the barrel of pipe, close joints and smooth invert. The spigot end of the pipe is to be centered in and shoved tight and secured against the

bell of socket of the previously laid pipe. The interior of each pipe shall be free of all foreign material before the next pipe is laid.

No pipe shall be laid in water or when trench conditions or weather conditions are unsuitable for such work. Unless modified herein, pipe shall be installed in accordance with the instructions of the manufacturer. PVC gravity sewer pipe shall be installed in accordance with Specifications of the Plastic Pipe Institute.

b. Distribution

Pipe, fittings and other appurtenances shall be delivered, unloaded and distributed along the line of the work, near where they are to be installed and with the socket end facing upgrade. Care shall be exercised to prevent damage to the material and to keep it free from dirt and foreign material.

c. Inspection

The pipe and fittings shall be inspected for defects immediately before placing into the trench, and shall, in the case of ductile iron pipe, be tapped with a light hammer to detect cracks. Those pipes and fittings found unsatisfactory shall be rejected, a large cross-mark painted red on these materials and the materials removed from the immediate site of the work. The pipe and fittings shall be thoroughly cleaned before lowering into the trench, and maintained clean.

d. Installation to Line and Grade

The Contractor shall lay the sewer to line and grade by using batter boards, construction laser beam equipment or other methods approved by the Engineer. If batter boards are used, a minimum of three, spaced at 25-foot intervals will be required at all times. Complete cut sheets shall be furnished to the Engineer for his approval three working days or more prior to the beginning of construction of a section of sewer.

The Contractor shall provide proper tools, implements and facilities for handling, supporting and placing of the pipe. The pipe, fittings and other appurtenances shall be carefully lowered into the trench by means of a derrick, ropes or other suitable tools or equipment in such a manner as to prevent damage to the pipe or pipe coating.

The pipe and fittings shall, under no circumstances, be dropped or rolled into the trench or dropped on the surface of the ground. Each pipe unit shall be handled into its position in the trench only in such manner and by such means as the Engineer approves as satisfactory. All work must be done to the line and grade as shown on the Drawings or as modified by the Engineer.

e. Bedding of Pipe

The Contractor shall excavate six inches below the bottom of the pipe and backfill the six-inch depth with granular backfill material or coarse aggregate, such material to be suitable for bedding of pipe and shall not be subject to floating. The bedding shall be as indicated on the Plans or as required by the Engineer.

In all cases, the bottom quadrant of the entire length of the pipe shall be fully and uniformly supported, except the bell, under which a recess to allow ample space for making the joint. No pipe or fitting shall be supported on saddles, blocking or stone.

If the excavation has been made too deep, granular bedding material shall be placed in the bottom of the trench, thoroughly rammed, and a new bed made for the pipe. The pipe shall not be raised by ramming earth beneath of the bottom.

When the pipe has been bedded satisfactorily and the joint made, the recess under the bell shall be refilled with bedding materials and enough granular material placed and tamped on each side of the pipe to hold it securely in place, care being taken not to disturb the position of the pipe during this process.

f. Pipe Joints

1) Poly Vinyl Chloride

Joint shall be bell and spigot type with a high-grade elastomeric gasket. The joint shall conform to ASTM D-3212 and UNI-B-1, latest revisions. The gaskets shall be manufactured in accordance with the requirement of ASTM F-477, latest revision. All lubricants used for joint assembly shall have no detrimental effects on the gasket or pipe.

2) Concrete Sewer Pipe

After the pipe units are aligned in the trench and are ready to be joined, all joint surfaces shall be cleaned. Immediately before joining the pipe, the bell or groove shall be lubricated in accordance with the manufacturer's recommendation. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. Suitable devices shall be used to force the pipes together so that they will fit with a minimum open recess inside and outside and have tightly sealed joints. Care shall be taken not to use such force as to wedge apart and split the bell or groove ends.

Joints shall not be "pulled" or "cramped" without approval of the Engineer. Immediately after the pipe units are put together, the position of the gasket in the joint shall be inspected, using an approved feeler gauge furnished by the Contractor, to be sure it is properly put together and is tight. Joints where the gasket is damaged or not properly positioned shall be pulled apart and remade using a new gasket. Where any two pipe units do not fit each other closely enough to enable them to be properly jointed, they shall be removed and replaced with suitable units and new gaskets.

Details of gasket, attachment and joint formation shall follow the directions of the manufacturer's of the joint material and of the pipe, all subject to approval of the Engineer. All concrete exterior surfaces of the joints shall be sealed by the diaper method, unless directed otherwise in the Detailed Specifications.

The diaper shall be made from a suitable fabric or sufficiently close weave to prevent the loss of cement from the grout, but shall not be waterproof.

The fabric shall be hemmed on each edge with a steel strap contained within each hem. The hemmed diaper fabric shall be wide enough to tie back of the bell, depending upon the design of the bell and shall be of a length at least ninety percent of the largest outside circumference of the pipe.

The tie wire or strap shall be sufficiently longer than the outside circumference of the pipe to allow a secure attachment of the diaper to the pipe.

After one of the edges of the diaper has been tightly stretched, and the tie wire or strap firmly connected around the bell end of the pipe, the other edge of the diaper shall be stretched and fastened around the tongue end of the pipe just entered, leaving an opening between the ends of the diaper at the top of the pipe.

Through this opening the grout shall be poured from one side until the grout has flowed under the bottom of the pipe, then poured from the opposite side to completely fill the diaper.

The joint grout shall consist of three parts of sand to one part of portland cement, mixed with sufficient water to maintain a freely pouring consistency. If necessary, in order to facilitate the movement of mortar within the diaper, the water content of the grout used inside the diaper shall be increased, as directed by the Engineer.

For pipe placed on undisturbed material, compacted sand or screened gravel, the bell hole shall be filled with the bedding material so placed and compacted that the spigot will not move in the bell of the adjoining pipe under backfill load.

3) Ductile Iron Pipe

All ductile iron pressure pipe shall have push-on joints or such other type of ends as indicated on the Plans.

The following is set forth relative to the various types of joints:

a) Push-On Joints

The inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove oil, grit, excess coating and other foreign matter. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the bell socket. A thin film of gasket lubricant shall be applied to either the inside surface of the gasket or the spigot end of the pipe or both. Gasket lubricant shall be as supplied by the pipe manufacturer and approved by the Engineer.

The spigot end of the pipe shall be entered into the socket with care used to keep the joint from contacting the ground. The joint shall then be completed by forcing the plain end to the bottom of the socket with a forked tool or jack-type tool or other device approved by the Engineer.

Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint. Field cut pipe lengths shall be filed or ground to resemble the spigot end of such pipe as manufactured. Complete assembly instructions are available from the pipe manufacturer.

b) Mechanical Joints

The joints on the mechanical joint pipe shall be made in accordance with the following procedures:

The socket and plain end shall be lubricated and the gland and gasket slipped over the plain end of the pipe.

The small side of the gasket and the lip side of the gland shall be placed facing the bell.

The gasket shall be painted with the lubricant.

The gasket shall be pushed into position so that it is evenly seated in the socket.

The gland shall now be slid into position, the bolts inserted and the nuts made finger tight.

The bolts shall be brought to a uniform tightness with a ratchet wrench.

The bolts, 180 degrees apart, shall be tightened alternately in order to bring the gland up evenly all around.

The bolt at the bottom of the joint to be tightened first, the bolt at the top of the joint next and the bolt tightening continued in this manner.

4) Miscellaneous

a) Plugging Ends, Branches and Specials

The ends of all pipe sewers, branches, laterals and other such points of terminus shall be closed with plugs equipped with a joint identical to the spigot end of the sewer pipe being used.

All ends shall be plugged and blocked so as to permit the making of tests without leakage or movement of the plug and/or blocking. The installation shall withstand at least a 20-foot hydrostatic head. During all times when pipe laying is not actually in progress, the open ends of pipe shall be closed by temporary watertight plugs or by other approved means.

If water is in the trench when work is resumed, the plug shall not be removed until all danger of earth or other materials entering the pipe has passed.

b) Connections to Existing Sewers

Where a connection is made to an existing sewer, a trench of proper width shall be excavated back a distance of six feet, to expose the existing sewer, and at least two lengths of pipe removed and replaced with new pipe.

There will be no additional payment for the replacement of the existing old sewer. The Contractor shall make all connections to existing sewers as indicated on the Contract Plans.

The Contractor shall cut neat openings into existing manholes, reconstruct the bottoms to form proper inverts, eliminate connections no longer needed, properly plug and make watertight all openings, all annular spaces between pipe and openings, and such other areas, repair the existing manholes, clean all surfaces and apply two coats of Thoroseal to all interior surfaces, and perform any other required work.

The final connections shall be delayed until sewage flows can be conducted to proper points of discharge. The Contractor shall remove and dispose of all excess materials. The Contractor shall install such plug openings as are required for future sewers in all new manholes.

c) Sewers on Steep Slopes

Concrete anchors, as detailed on the Standard Construction Appurtenances and Miscellaneous Details sheet shall be provided as follows:

Maximum 36 feet center to center on grades from 20% to 35%;
Maximum 24 feet center to center on grades from 35% to 50%;
Maximum 16 feet center to center on grades over 50%.

Ductile iron pipe shall be used on all grades in excess of 40%.

d) Concrete Cradle and Encasement

Where a concrete cradle is required or has been specified, the cradle shall be constructed as per detail sheets of the Contract Drawings, and in rock excavation shall be sufficient to fill the space around the pipe.

The concrete shall be deposited continuously and carefully tamped in such a manner as to avoid changing the position of the pipe, to ensure uniform support for the pipe, and to ensure the placement of a uniform homogeneous cradle or encasement.

e) Wye Branches

Branches for connections fitted with suitable stoppers shall be laid at the points and in the positions called for on the Drawings or as directed by the Engineer. Each branch shall be located by the Contractor and its station recorded relative to the downstream manhole.

During the process of laying the pipe, care shall be taken to protect both pipe and joint from disturbance, and the trench shall be kept free of water until the joint shall have set.

At all times when pipe laying is not actually in progress, the open ends of pipe shall be closed by temporary watertight plugs or by other approved means. If water is in the trench when work is resumed, the plug shall not be removed until all danger of earth or other materials entering the pipe has passed.

2. Manhole Type Structures

a. Concrete Base and Invert

1) General

The concrete work shall be done in accordance with the requirements set forth herein, unless otherwise indicated in the Detailed Specifications. All construction shall be in accordance with the Standard Detail Sheets and Detailed Specifications.

The manhole base shall be oriented with respect to the centerline of the sewer so that the distance between the inside surface of the sewer pipe at the spring line and the base wall at a point opposite the width of the bench space is provided on the straight side. The base shall be reinforced as shown on the Plans.

Inverts can be poured in place in the precast bottom, or precast into the base. Any revisions to precast inverts due to field changes, or minor realignment, will be incidental to the job. Inverts and transitions must be smooth and rubbed free of imperfections.

The inverts shall be shaped as indicated on the Contract Plans, with the sides of the invert made vertical from the spring line of the pipe to a point six inches higher or to the top of the inlet pipe, whichever is higher.

All concrete following placement shall be protected during rainfall by means of tarpaulins or other approved methods until the concrete is set. During cold weather, when the air temperature is at or below 40 degrees Fahrenheit, or whenever it shall appear to the Owner's Engineer, from weather reports or otherwise, that the air temperature may fall below 40 degrees Fahrenheit within the twenty-four hour period next following the completion of the concrete pour, the Contractor shall heat the mixing water and aggregates for the concrete, and take precautions to maintain the concrete at a temperature of at least 50 degrees Fahrenheit for not less than 72 hours after its placement and shall protect same from freezing for 72 hours immediately following the 72 hours of protection at 50 degrees Fahrenheit.

Salt shall not be added to the mix; however, calcium chloride in complete solution may be added to the mixing water in amounts not exceeding two pounds per bag of cement, or an accelerator may be added in accordance with the manufacturer's specifications and approved by the Engineer. No concrete shall be deposited on a frozen subgrade or subbase. Before placing concrete in cold weather, all forms reinforcing and bearing strata shall be thoroughly heated so as to raise the temperature well above the freezing point.

After the concrete is placed it shall be protected against freezing by means of a tight covering and sufficient heat supplied around the concrete and forms to maintain the temperature of the concrete above 50 degrees Fahrenheit for the period above stipulated.

When heating concrete materials and water, sufficient heat shall be used so that the temperature of the concrete at time of placement shall be not less than 70 degrees nor more than 100 degrees Fahrenheit.

b. Precast Concrete Manhole Walls and Bases

1) General

The manholes shall be constructed in accordance with the details and dimensions shown on the Contract Plans and described herein. As a minimum, bases shall have a minimum thickness of 9" base and thickness and 8" flange with appropriate reinforcement as detailed on the standard drawings.

2) Installation

All manhole sections shall be carefully handled during shipment and unloading. The manhole shall not be rolled under any conditions. Any chipping of manhole joints shall be cause for rejection of the particular section. Field adjustments in pipe openings shall be done by drilling holes and cutting openings with a core drill only. A sledge hammer will not be permitted for this use.

The outside surface of all concrete manholes shall be coated with one coat of Thoroseal, bitumastic coating.

Stubs places as specified and indicated on the Drawings shall be either short pieces cut from the bell ends of pipe and shall have water stops placed integral with the base (A-lok, or equal).

Stubs shall be set accurately to the required line and elevation and encased in the manhole masonry as indicated on the drawings. Friction type seals will be acceptable if approved by the Engineer.

E. BACKFILL AND SURFACE RESTORATION

1. Backfill Operations

a. General

The sewers and other work shall not be covered until approved by the Engineer. If the work is found not satisfactory with respect to workmanship and materials, the Contractor shall immediately remedy or remove and replace that part rejected. The Contractor shall backfill all trenches and excavations as soon as possible and before the end of the day; however, to allow the proper degree of hardening of concrete in the case of stream crossings and manholes, no less than 18 hours and no more than 48 hours shall pass prior to backfilling.

The select backfill used for bedding pipe and backfilling trenches to a depth of at least 1 ft. over the top of the pipe shall be Type 2-B stone. PennDot Type 2RC crushed aggregate limestone, or other material approved by the Engineer, can be used in the remainder of the trench for stone backfill, provided it is compacted. The remainder of the trench above an elevation 12", higher than the crown of the sewer, shall be backfilled with the excavated material, provided that such material consists of loam, clay, sand, gravel or other materials which, in the opinion of the Engineer, are suitable for backfilling, except as indicated later herein, or on the standard trench details.

Where excavated material is indicated on the Drawings or specified for backfill, and there is a deficiency due to a rejection in part thereof, the Contractor shall furnish the required amount of sand, gravel or other approved material. Where tunneling under roads is approved, the Contractor shall backfill with a 1:3 mixture of cement and sand of dry consistency, thoroughly tamped.

Backfill material to be used within two feet of manholes, catch basins, flush tanks and other structures shall be made with sand or other approved material.

Backfill material to be used within two feet of the pipe, where iron pipe is installed, shall be well compacted clay, sand, gravel or other such material that is not injurious to iron pipe. No cinders, rubbish or other such materials shall be used. Where sand, gravel or screenings backfill is not indicated in the Contract Documents but is required by the Engineer, the Contractor shall furnish and backfill with sand or gravel as directed.

b. Backfill Methods

The trench shall first be backfilled with approved bedding material to a depth of six inches, prior to the installation of the sewer. The bedding material shall be sand, gravel and/or equal granular material.

The material used must not be subject to floating where wet conditions exist. The bedding shall be Type 1B or 2B as approved by the Engineer, unless otherwise indicated on the Plans. This material shall be carefully placed and thoroughly consolidated so as to furnish a solid foundation for the bedding of the pipe.

Immediately subsequent to laying the pipe, the space between the pipe and the bottom and sides of the trench shall be backfilled by hand, keeping each side of the sewer at the same level, and shall be thoroughly tamped with pipe rammers or tampers made for this purpose. The approved select backfill shall then be carried to a depth of at least one foot above the crown of the sewer, unless specified, with the material being placed in six inch layers, thoroughly tamped and compacted.

The material shall be deposited carefully in the trench by hand shoveling to avoid injury to the sewer and shall be tamped with an appropriate tamper in such a manner as to avoid injury or movement of the completed sewer. A backhoe bucket or shovel bucket are not considered suitable tamping equipment.

The remainder of the trench above an elevation of two (2) feet higher than the crown of the sewer or as specified shall be backfilled with approved material, free of organic matter, no layer more than six inches thick, except as otherwise approved by the Engineer when granular materials are being utilized and shall be mechanically rammed or tamped.

No heavy rock shall be dropped into the trench and if rock is placed in the trench, all void spaces between the pieces of rock shall be filled with earth. The tamping or ramming of each layer of backfill material shall be continued until it is thoroughly consolidated, after which another layer shall be spread and compacted in the same manner.

Wide trenches may be compacted by approved rollers once the backfill has been placed and compacted to a point at least two feet above the top of the pipe. When dry cement or concrete is required for backfilling, the material shall be placed and thoroughly compacted in six-inch to twelve-inch layers with mechanical rammers.

Backfilling material placed within two feet of manholes, catch basins, flush tanks and other structures shall be deposited uniformly around the sides in layers not exceeding six inches in depth, and solidly tamped in such a manner as to avoid impairing the structures or producing unequal pressures on them.

All manholes are to be protected, if necessary, by an embankment at least three feet above the top of the sewer. The backfill under manholes or other structures which have been excavated below the levels shown on the Plans shall be made with concrete as described elsewhere in these Specifications.

Where the crown of the sewer comes close to the surface of the ground or extends above it, the sewer shall be covered by an embankment at least three feet thick over the top and sides of the sewer, with side slopes at least 1:1.5 to the surface of the ground, unless otherwise shown on the Contract Plans.

Where such slopes would extend into or obstruct a natural watercourse, street or private property, the Contractor shall retain the slopes by rip-rap and, where indicated, the sewer shall be covered to a depth of six inches with concrete and plastered with portland cement.

When sheeting is removed, all cavities remaining in or adjoining the trench shall be solidly filled and when the sheeting is left in place, all cavities behind such sheeting shall be solidly filled.

The Contractor shall, in general, tamp all backfill by mechanical means in layers not to exceed six inches in thickness, except that, at the option of the Contractor, the backfill two feet or more above the top of the pipe may be compacted by flooding, only if permitted by the Engineer.

The Contractor shall comply fully with the requirements of the Pennsylvania Department of Transportation, the County Department of Highways and any applicable ordinance relative to backfill for all work along any highways, and meet the requirements in excess of these Specifications.

The Contractor shall also comply fully with the requirements of the State and County Highway Departments relative to other conditions of operations and to the requirements of all local municipalities where local streets and highways are involved.

Where settlement is unimportant and/or where shown on the Drawings or specified, the Contractor may backfill the trench from six inches (6") above the pipe to the top of the trench with excavated materials, unless otherwise noted on the detail plans, and the backfill shall be machined, compacted and neatly rounded over the trench to sufficient height to allow for settlement to grade after consolidation.

This condition will generally apply to work along untraveled portions of private rights-of-way (not landscaped areas) and shall be approved by the Engineer prior to being put to use.

Backfilling shall not be done in freezing weather, except by permission of the Engineer, and it shall not be made with frozen material. No backfill shall be made where the material already in the trench is frozen.

No walking or working will be permitted on the completed pipe until the trench has been backfilled to a height of at least two feet over the top of the pipe, except as required for tamping or backfilling. The final grade of the trench shall be even with the grade of the roadway or adjacent ground and shall be maintained during this work and for a period of two years after final acceptance of the work.

c. Compaction Equipment

The Contractor shall furnish adequate facilities for the operation of the pneumatic rammers and shall provide a compressor plant of sufficient capacity to insure the continuous operation of the least one rammer for each thirty lineal feet of trench being backfilled. The rammers shall be in satisfactory condition and an adequate number available prior to starting work. The equipment shall be maintained in approved condition throughout the operation and the pads and other mechanical parts on the rammers replaced or repaired immediately when necessary. The equipment shall maintain a working pressure of at least eighty pounds at the nozzle of each rammer. The Engineer may require additional facilities, if in his opinion, the equipment is not adequate. Hoe pacs are also acceptable, but must be approved by the Engineer.

d. Temporary Surfacing

When the backfilling is completed, the Contractor shall, in high volume areas, temporarily repave or resurface the openings in the pavements in such a manner that the roadway may be used for traffic, and he shall maintain such temporary surfaces until permanent paving is placed in all other traffic area.

The Contractor shall complete permanent paving as directed by the Engineer. In no circumstance shall more than 600 l.f. of pavement be disturbed at one time until permanent pavement is installed, unless specified by the Engineer. If the contractor exceeds this distance, the Engineer and Owner, at its sole discretion, shall prohibit the installation of additional pipeline until such time the Owner and Engineer directs start-up.

2. Surface Restoration

a. General

The Contractor shall restore all pavement, sidewalks, curbing, gutter, fences, poles and other property and surface structures removed or disturbed as a part of the work to a condition at least equal to that before the work began, furnishing all labor and materials incidental thereto. Driveways and parking lots are incidental to the Contract. In restoring pavement, sound granite blocks, sound brick or asphalt paving blocks may be reused.

No permanent surface shall be restored unless and until, in the opinion of the Engineer, the condition of the backfill is such as to properly support the surface.

Surface restoration shall begin immediately upon completion of compaction. No more than 600' of pipe installation shall be authorized without restoration unless specifically authorized, in writing, by the Engineer.

This can occur when in the opinion of the Engineer, the restoration cannot be completed because of site specific conditions, such as temperature, season, soil and/or pavement conditions, etc.

In all cases, restoration must be completed to the degree approved by the engineer prior to the installation of additional pipeline over 600 l.f. This is an aggregate amount for each construction contract. Therefore, multiple crews working on the same contract can have not more than 600 ft of total pipe un-restored and previously designated.

b. Pavement

1) General

The paved surfaces shall be restored with new pavements within thirty days after backfilling, unless otherwise indicated by the Engineer. The Contractor shall construct a concrete base beneath the hard surfaced roads, where indicated on the Contract Drawings or where required by the State Highway Departments.

All material and labor required for the maintenance of the trenches, surfaces and adjacent structures shall be supplied by the Contractor for the period required by the Maintenance Bond. The restoration of all surface work disturbed shall be in accordance with the following requirements.

2) Roadways and Appurtenances

Where the Contractor cuts across roads or driveways, he shall surface with granulated stone properly tamped as promptly as possible, and shall maintain a crossing at grade at all times. Prior to paving, he shall remove enough of the top stone and surfacing, where required to obtain solid, undisturbed support on each side of the trench for the new surfaces and shall repave in the same manner and with the material as per the Detailed Specifications or as approved by the Engineer.

Where the trench is opened parallel to a paved area, the Contractor shall restore any breaks or ragged edges on the paving as may be caused by his operations by cutting the existing pavement and installing new pavement in a manner approved by the Engineer.

When the backfilling is completed, the Contractor shall temporarily repave or resurface the openings in the pavements in such a manner that the roadway may be used for traffic and maintain such work until permanent repaving is placed. This work is incidental to the contract.

Roadway appurtenances shall be replaced as directed, subject to the approval of the Owner, the Engineer and the governing agency under whose jurisdiction the property is maintained. Berms shall be properly graded and finished.

In the event of overlay paving, 1" ID-2 top material, full width of roadway shall be required. The price will be paid at the square yard measure in the field at the unit price shown. Overlay paving shall be required as necessary at the notification of the Engineer.

3) Gutters

Gutters of dirt, macadam, telford or gravel shall be repaved where directed with cobbles, field or random stones of satisfactory quality, none of which shall be less than 5 inches in any dimension and all of which shall be at least 8 inches in two dimensions. The stones shall be carefully laid by hand to line and grade, well bedded in fine gravel or sand thoroughly rammed.

The joints shall be filled with sand. Should such pavement, with its joints filled with portland cement, grout, or sand, settle or become displaced, or should there be any defective work of any kind, such work must be removed at once and replaced by the Contractor in a satisfactory manner without additional compensation.

Concrete gutters shall be placed in accordance with the original design or as required by the controlling authorities. When an open or covered cross gutter or pipe drainage channel exists in the surface of the roadway, which will be rendered useless by the construction of a storm inlet or other work by the Contractor, the Contractor shall be required to remove the whole of it and lay or relay the pavement to the grade and surface designated by the Engineer.

4) Curbing

Curbs shall be replaced with the type originally installed. Specifications covering Class A concrete work shall be followed as to materials and method of doing work when replacing.

5) Walks

Where sidewalk replacement is required, the site shall be excavated and graded to the width directed, to a subgrade, a foundation of clean approved base material shall be placed, which shall be well consolidated by ramming.

The backfill shall be well watered during ramming and the top surface shall be brought to a height of four inches below and parallel to the finished surface, which shall have transverse grade 1/4 inch per foot upward from the curb. On this foundation shall be placed 4 inches of cement concrete which shall be cut by joints into blocks not larger than 5 foot square.

One expansion joint shall be provided to intervals not exceeding 30 feet and shall contain 1/2 inch premolded expansion joint material. The surface shall be screeded, floated and troweled to a smooth even surface. A drier, made of equal parts of sand and cement, well mixed, shall be sprinkled in a dry state over the surface, and then floated or troweled.

Joints shall be troweled with a small jointer and entire surface indented in a manner satisfactory to the Engineer. When the pavement is completed, it shall be kept covered for three days and shall be kept moist by sprinkling, if required by the Engineer, and thoroughly protected against freezing.

Surface shall be smooth broomed, floated or finished to conform to the finish of the removed surface. Where stone walks are removed, they shall be replaced, following the same procedure for subgrade and base as set forth in the preceding paragraph, and a concrete sub-base shall be constructed as shown on the Contract Plans, following which the stone shall be laid, with stone similar in quality, color and texture to the existing stone walks.

Where bitumastic walks are removed, they shall be replaced, following the same procedure set forth under the preceding paragraph as relates to subgrade and base, and the walk shall be replaced in the same manner and with the same materials as the existing walks. The walks shall be excavated at least twelve inches beyond the edge of the trench or line of excavation, unless otherwise indicated, and replaced for this width.

c. Landscaping

1) General

The Contractor shall provide adequate protection for all lawns, trees, shrubs and landscape work that are to remain in place and shall remove and preserve all landscaping within areas in which it cannot be protected. Such protection or preservation shall be maintained so long as necessary to prevent damage or deterioration.

All landscape work and topsoil that must be removed shall be stored and protected and replanted or relaid following backfill and tamping of the excavated areas, providing it is suitable for reuse.

If such material is not suitable it must be replaced. All areas other than traveled roads and landscaped areas that are disturbed shall be graded and a ground cover of rye grass planted so that erosion of said areas is kept to a minimum until natural vegetation flourishes and predominates.

2) Lawns

a) General

All lawns which are damaged due to the execution of this work shall be replaced in accordance with the following instructions:

b) Planting Seasons

The sowing of seed shall be done only within the seasons extending from September 1st to October 15th and from April 15th to June 1st. In the event that conditions permit, and upon approval of the Engineer, seeding may start earlier and/or be continued later than the specified dates.

The sowing of seed shall be started on all areas during the first planting season after the areas have been released to the Contractor for landscaping operations.

The preparation of lawns areas shall not start until immediately preceding the season for seeding, except that topsoil may be spread at the option of the Contractor, provided that it be thoroughly loosened for its full depth and brought to a pliable mellow condition before the seed is placed.

c) Preparation of Subgrade Soil

The subgrade shall be established, uniformly sloped in the direction indicated, and be finished 6 inches below the final grade. The subgrade shall be brought up to the proper elevation with clean, loamy earth properly placed and compacted.

d) Preparation of Surface

All topsoil that was removed and preserved prior to excavation shall be used for lawns and planting, provided it is suitable for such use.

Any additional topsoil to be furnished shall be fertile, friable, natural topsoil, typical of topsoil of the locality. It shall be free from stones, without admixture or subsoil plants, or roots, sticks or other extraneous matter, and shall not be used for planting operations while in a muddy or frozen condition.

The topsoil shall be spread and brought to the finished grade, then leveled and finally rolled, but not compacted, the topsoil to have a depth of not less than six inches after final compaction. The surface shall be rolled with a 200 pound roller. The surfaces, when finished and settled, shall conform to the finished grade and shall be free of hollows or other inequalities and from stones, sticks and other debris. The topsoil requirements shall apply to seeding and sod work.

e) Fertilizer

The Contractor shall apply limestone to the surface if necessary and in sufficient quantities to raise the pH to between 6.5 and 7.0 and spread super-phosphate and commercial fertilizer at the rate of 25 lbs per 1,000 s.f. and dried blood nitrogen compound at a rate sufficient to provide a minimum of 2 lbs of actual nitrogen per 1,000 s.f.

The commercial fertilizer shall bear the manufacturer's guaranteed statement of analysis and contain at least 16% available phosphoric acid, and contain at least 4% total ash.

The superphosphate shall have a minimum guaranteed analysis of 20% available phosphoric acid. Commercial fertilizer shall be also approved under these Specifications. The fertilizer shall be thoroughly incorporated into the top three to five inches of topsoil at least two days prior to seeding.

f) Seeding and Mulching

Lawn seed of a type which will produce a lawn similar the existing one shall be sown evenly at the rate of seven pounds to 1,000 sq. ft. of lawn area, one-half sown in one direction and the balance in the other direction, and shall be lightly raked into the surface. The area shall then be lightly rolled once and thoroughly watered with a fine spray. Care shall be taken that the seed is not washed out.

No seeding shall be permitted after rain unless the surface of the ground is loosened, nor when the velocity of the wind exceeds a gentle breeze of about five miles per hour.

Extreme care shall be exercised during the seeding and raking, so that no change in grade is made and so that the seed is not raked from one spot to another. All seeded areas shall be mulched with a light covering of wheat-free straw in the amount of sixty pounds per 1,000 sq. ft. All sloped areas shall be covered with cheesecloth or muslin laid in a continuous surface, properly supported in place.

g) Clean Up of Undisturbed Adjacent Areas

All areas adjacent to the disturbed areas of work shall be cleaned of all rubbish, debris and other materials, following the completion of the lawn and planting work.

3) Fields, Woods and Pasturesa) General

All areas other than traveled roads and landscaped areas that are disturbed shall be graded and a ground cover planted so that erosion of said areas is kept to a minimum until natural vegetation flourishes and predominates.

Prior to excavation in fields, cultivated fields, pastures and landscaped areas, all topsoil shall be removed from the work area and stored and protected until replaced.

b) Temporary or Permanent Seeding

The Specifications for the temporary or permanent seeding shall be as follows:

Site Preparation

- (1) Install needed surface water control measures.
- (2) Perform all planting operations at right angles to the slope.
- (3) Apply lime at the rate of three tons ground limestone per acre (150 lb. per 1,000 sq. ft.)
- (4) Apply fertilizer at the time of seeding at the rate of 1,000 lb. of 10-10-10, or equivalent, per acre. (25 lbs. per 1,000 sq. ft.)

Establishment

- (1) Smooth and firm seedbed with cultipacker or other similar equipment, prior to seeding.
- (2) Unless otherwise specified in the Detailed Specifications apply KY 31 Tall Fescue 75 percent and Perennial rye grass 25 percent at the rate of 40 lbs. per acre (1 - 2 lbs. per 1,000 sq. ft.) during November 15 to March 1 for dormant seedings when mulched and March 1 to October 15 for regular seeding when not mulched, by broadcasting, drilling and hydraulic application.
- (3) Cover grass seeds with 1/4 inch of soil with suitable equipment.
- (4) Use a mulch on all disturbed areas over 10% slope. All areas on which grading and final preparations prior to seeding are completed after October 15 will be well mulched and protected from erosion until such time in the spring of the year when effective restoration and seeding can be undertaken.

4) Stream Crossings

The Contractor shall be required to place stone rip-rap on all disturbed stream banks affected by sewer construction. Uniformly graded stone rip-rap shall conform to the quality requirements and sizes as specified below:

<u>Stone Size, Pounds</u>		<u>Percentage Large Than</u>
75		40 - 60
5		70 - 80

<u>Test</u>	<u>A.S.T.M. Test Method</u>	<u>Requirement</u>
Apparent Specific Gravity	C 127-59	2.50 Minimum
Absorption	C 127-59	2% Maximum
Loss of Soundness	C 88-63	5% Maximum

Stone shall be of such shape as to form a stable protection structure for the required sections. Rounded cobbles or boulders shall not be used on slopes steeper than 2:1. Stones shall be placed so as to provide a minimum of voids and the larger stones shall be placed in the toe course and on the outside surface of the slope protection. Rip-rap shall be sandstone only, placed at a minimum thickness of 12 inches. The Contractor shall at all times keep the premises free from unnecessary accumulation of waste material or rubbish that has been caused by his employees or work. At the completion of the work, he shall remove all rubbish from and about the premises and all tools and any surplus materials.

In case of dispute, the Contractor, as the Owner, shall determine to be just and reasonable. After the pipe has been laid and the trench has been backfilled, any surplus earth or rock materials shall be removed or distributed as directed by the Owner. All material not used in the laying of the pipeline shall be returned by the Contractor to his warehouse or to the storage yard of the Owner, as the case may require.

F. TESTING OF SEWERS

1. General

Each section of sewer between manholes shall be cleaned, tested and inspected. The Contractor shall test each section of sewer between manholes to determine the tightness of the sewer joints, it being necessary to keep infiltration to a minimum.

The Contractor must make all required tests immediately following the installation of the first 400 to 600 feet of sewer, in order to determine that the workmanship and materials are satisfactory, before proceeding with any other work. He shall repeat this procedure with each change in size, material or manufacturer.

After completion of the sewer, the Contractor shall thoroughly flush sewers to remove all foreign matter that may have accumulated therein during construction. The cost of testing for obstruction, exfiltration or infiltration tests, and sewer flushing, shall be included in the price bid for the work.

The testing procedure will consist of the visual test, infiltration tests as the work progresses (if the Engineer determines that there appears to be an excessive flow in the completed sewers), and either an air test for final acceptance or an exfiltration test if approved by the Engineer. Testing shall be performed as described in the following articles.

Visual tests of the installation of the sewers shall be made before the backfill work is completed in the following manner:

After the mains have been laid and backfill placed to not more than one foot above the pipe, a light will be flashed between manholes, or if the manhole has not yet been constructed, between the location of manholes, by means of a flashlight or mirrored light to determine whether the alignment of the main is true to line and grade, or whether any pipe has been displaced subsequent to laying. In case where the alignment of the sewer is shown to be correct and that no other defects are disclosed, backfilling may be continued. In case the test shows poor alignment of the main, misplaced pipe or other defects, such defects shall be remedied by the Contractor, to the satisfaction of the Engineer, before the work of backfilling proceeds.

In case an obstruction is visible in the completed sewer, the Engineer may require an additional test prior to allowing the backfill operation to proceed.

The Contractor shall test the sewers by passing a ball or a closed cylinder through the sewer from manhole to manhole. The rigid ball or mandrel used for the deflection test shall have a diameter not less than 95% of the base inside diameter or average inside diameter of the pipe, depending on which is specified in the ASTM Specification, including the appendix, to which the pipe is manufactured. The pipe shall be measured in compliance with ASTM D 2122 Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings. The test shall be performed without mechanical pulling devices. Any obstruction that may prevent the passage of the ball or piece through the sewer must be removed.

2. Infiltration Tests

Sewers shall be tested for infiltration as the work progresses in sections not exceeding six hundred feet in length. The test shall be made by plugging the upstream end of the section being tested and measuring the amount of water that flows from the downstream end.

Sewer sections, or parts thereof, in which the rates of infiltration exceed those given in these Specifications shall be rebuilt prior to the acceptance of the work.

The Engineer shall conduct the test, but the Contractor shall make all necessary preparations for such testing and pump or bail the water as may be necessary during the test. The infiltration of water, as determined by this test, shall not exceed 100 gallons per inch of diameter of pipe per mile per day. This amount includes manholes. Where approved by the Engineer, the Contractor may provide an exfiltration test. The section of the sewer being tested shall be bulkheaded or plugged at the lower end of the sewer and at the inlet side of the upstream manhole.

The Contractor shall fill the upstream manhole with water and shall maintain a column of water in the manhole at least four feet above the top of the sewer at the highest point of the section being tested. The test shall not start until thirty minutes after the pipe has been filled, in order to allow for absorption of water by the pipe and the test shall last for one hour.

During periods that the ground water table is higher than the sewer, the water column in the manhole shall be at least four feet above the water table elevation.

The exfiltration of water, as determined by this test, shall not exceed 100 gallons per inch of diameter of pipe per mile per day when the pipe is subjected to a minimum head of four feet. The pipe will not be tested against a head greater than twenty feet of water, but must be satisfactory for up to a twenty foot head. For heads in excess of twenty feet, the sewer must be tested by air.

3. Air Tests

Where required by these Specifications, the Contractor shall provide a low pressure air test. The section of pipe to be tested must be isolated by completely plugging all outlets. All plugs must be braced to prevent slippage and blow-out due to the internal pressure. One of the plugs must be equipped with an air inlet tap for connection of an air hose. This test should be performed on a pipe which is in a damp condition to minimize loss of air through the pipe wall as a result of air permeability.

When air pressure is applied, it should be monitored and controlled so that at no time will it exceed 5 psig. The air pressure should be maintained between 4.0 and 3.5 psig for a period of at least two minutes in order to stabilize the air temperature. During this period, plugs may be checked for tightness.

After the air temperature has been allowed to stabilize, the air supply is to be disconnected and the pressure allowed to decrease to 3.5 psig. At 3.5 psig a stop watch will be started to determine the time required for the pressure to drop to 2.5 psig. This time required for a loss of 1.0 psi at an average pressure must be 3 psi greater than the average back pressure of any ground water in order for the test to have significance and, therefore, if the ground water surface is higher than the sewer centerline the air test pressure is to be increased by one psig for each 2.3 feet by which the water surface is higher than the pipe centerline.

The pipeline will pass the low pressure air test if the loss of air is not greater than a rate of 0.0030 cubic feet per minute per square foot of internal pipe surface.

The loss of air will be considered acceptable if the time for the pressure to drop one psi is not less than that shown in the following table, for the respective pipe diameters:

ALLOWABLE TIME TABLE

Pipe Size	Time Min.	Time Sec.	Pipe Size	Time Min.	Time Sec.
6"	2	15	36"	17	00
7"	3	18	42"	19	50
8"	3	57	48"	22	40
10"	4	43	54"	25	30
12"	5	40	60"	28	20
15"	7	5	66"	31	10
18"	8	30	72"	34	00
21"	9	50	84"	39	40
24"	11	20	96"	47	00
27"	12	45	108"	51	00
30"	14	10			

If the leakage exceeds these amounts, the Contractor shall determine the cause of the leakage and make such repairs or replacement as found necessary until the sewer is found to comply with the requirements of this hydrostatic test.

4. Test For Deflection

After the pipe has been laid and backfilled, the Engineer will require deflection testing. This test is conducted by pulling a pointed mandrell through the pipe. The mandrell supplied by the Contractor shall be subject to approval by the Engineer. Upon completion of backfill, the maximum allowable deflection shall not exceed five percent of the pipe's internal diameter.

Minimum acceptable internal diameters are shown below. Testing shall be conducted on a manhole to manhole basis. To assure accurate measurement, it is important that the line to be tested is completely water flushed. In all cases the completed pipeline shall offer full moon visibility.

MINIMUM ACCEPTABLE INTERNAL DIAMETERS

<u>Size</u>	<u>PSP</u>	<u>PSM</u>	<u>PSM (z)</u>
4	3.57	3.57	3.57
6	5.37	5.32	5.32
8	6.98	7.20	7.13
10	8.73	9.00	8.91
12	10.48	10.71	10.60
15	13.09	----	----

a. Test Rejection

Should the result of any test fail to meet the criteria established in this Specification, the Contractor shall, at his own expense, locate and repair rejected section and retest until it is within specified allowance.

Deflection measurements shall be made upon completion of the project providing the pipe has been installed for not less than thirty days and not more than twelve months prior to testing.

The Engineer shall require deflection testing on a manhole to manhole basis throughout the project for all sewers, particularly in areas as described below:

- 1) Where high ground water was encountered.
- 2) Where trench walls or bottom were difficult to stabilize.
- 3) Where compaction density was difficult to achieve.
- 4) Where heavy rains were encountered during construction.
- 5) Any other areas that could present special problems.

Note: The Contractor shall include this testing in his unit price bid or pipeline construction.

Instructions for mandrell deflections testing are as follows:

- 1) Completely flush the line making sure the pipe is clean of any mud or trash that would hinder the passage of the mandrell.
- 2) Draw mandrell through the sewer line.
- 3) An increasing resistance to pull is an indication of excessive deflection. If this occurs, measure beginning marker on rope the distance to manhole. Locate section and replace bedding or pipe if visual examination reveals damage.
- 4) Retest.

G. TESTING OF MANHOLES

Exfiltration tests for manholes shall be required. These may include water or vacuum testing. In the water test, exfiltration shall not exceed a rate of 0.019 gallons per day per inch of manhole diameter per vertical foot of manhole during a continuous four-hour test period, or shall not exceed 100 gal. per inch per mile per day for the pipeline and the manholes included.

The vacuum testing shall be in accordance with the testing equipment manufacturer's written instructions and the test results compared to the manufacturer's published vacuum test tables as described below:

1. Preliminary manhole testing shall take place following its construction after all connections are made, and before backfilling. Test results derived from this test will allow time for necessary repairs to be completed before further construction proceeds and hinders such repairs.
 - a. Before entering any manhole, follow all local state and federal safety precautions.
 - b. Plug all manhole entrances and exits other than the manhole top access using suitably sized pneumatic or mechanical pipeline plugs and follow all manufacturer's recommendations and warning for proper and safe installation of such plugs.

Make sure such plugs are properly rated for the pressures required for the test. The standard test of 10" Hg. (mercury) is equivalent to approximately 5 PSIG (.03 bar) backpressure. Unless such plugs are mechanically restrained, it is recommended that the plugs are used with a minimum two times (2x) safety factor or a minimum of 10 PSIG (0.7 bar) backpressure usage rating.

CAUTION: BRACE INVERTS IF LINES ENTERING THE MANHOLE HAVE NOT BEEN BACKFILLED TO PREVENT PIPE FROM BEING DISLODGED AND PULLED INTO THE MANHOLE.

- c. Install the vacuum tester head assembly at the top access of manhole. Adjust the cross brace to insure that the inflatable sealing element inflates and seals against the straight top section of the manhole if possible.
- d. Attach the vacuum pump assembly to the proper connection on the test assembly. Make sure the vacuum inlet/outlet valve is in the closed position.
- e. Following safety precautions and manufacturers' instructions, inflate sealing element to the recommended maximum inflation pressure.

CAUTION: DO NOT OVER INFLATE!

- f. Start the vacuum pump assembly engine and allow preset RPM to stabilize.
- g. Open the inlet/outlet ball valve and evacuate the manhole to 10" Hg. (approximately negative 5 PSIG, 0.3 bar).

CAUTION: DO NOT PRESSURIZE MANHOLE! THIS MAY RESULT IN MANHOLE DAMAGE AND/OR RESULT IN MANHOLE TEST HEAD DISLODGING FROM MANHOLE INLET!

- h. Close vacuum inlet/outlet ball valve and monitor vacuum for specified test period. If vacuum does not drop in excess of 1" Hg., manhole is considered acceptable and the manhole passes the test. If manhole fails the test, complete necessary repairs and repeat test procedures until satisfactory results are obtained.
- i. Minimum Test Times for Various Manhole Diameters

MH Depth (feet)	4' Diameter MH	5' Diameter MH	6' Diameter MH
15 Feet or less	50 sec.	1 min. 5 sec.	1 min. 20 sec.
15.01 to 30 Feet	1 min. 20 sec.	1 min. 45 sec.	2 min. 10 sec.

2. Repeat the above test procedure after backfilling manhole for final acceptance test.

H. RELATION TO WATER MAINS

1. Horizontal Separation

Whenever possible, sewers should be laid at least 10 feet, horizontally, from any existing or proposed water mains. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if:

- a. it is laid in a separate trench; or if

- b. it is laid in the same trench, with the water main located at one side of a bench of undisturbed earth; and if
- c. in either case the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

2. Vertical Separation

Whenever sewers must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation, for a distance of 10 feet extending on each side of the sewer. If possible, one full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

The water main should be constructed of slip-on or mechanical-joint, cast-iron pipe, PVC pipe, or pre-stressed concrete cylinder pipe and the sewer constructed of mechanical-joint, cast-iron pipe for any portion within 10 feet of the water main.

Both services shall be pressure tested to assure watertightness prior to backfilling. Where less than an 18" vertical separation exists between the water and sewer line, the sewer line may be concrete encased 10 feet on either side of the water main.

If possible, sewers crossing water mains shall be constructed so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.