

**SECTION 33 31 00**  
**OPEN CUT SANITARY SEWER SPECIFICATONS**

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**PART 1 GENERAL**

**1.01 SUMMARY**

- A. These specifications form a part of the Contract and are intended to describe, technically, the nature of the materials, equipment and workmanship required to complete the sewers and appurtenances shown on the accompanying plans in a workmanlike manner.
- B. All labor, tools, machinery, equipment and materials necessary to excavate for, lay, join, backfill and finish sewer, and to complete all restoration shall be considered as part of the sewer construction.
- C. This work shall be performed in accordance with the general conditions and general specifications unless otherwise noted in an addendum.
- D. Methods of construction will generally be left to the discretion of the contractor so long as satisfactory progress is made, good workmanship is produced, and required precautions are taken for safety.
- E. Unless otherwise allowed under specific specification for a particular type of sewer or unless otherwise permitted by the Engineer, construction shall begin at the outlet end of sewer and proceed upgrade.

**1.02 PRICE AND PAYMENT PROCEDURES**

- A. Unless specified otherwise, sewer of the diameter specified will be paid for at the Contract unit price per lineal foot, measured in place, which price shall be payment in full for furnishing the materials, including stubs, connections, tees, wyes, or any other fittings shown on the plans, all necessary excavation, removal and replacement of existing sewers or drains, sheeting or bracing, draining, dewatering, laying, jointing, new connections and connecting in of existing facilities, bedding, testing, video inspections, backfilling, sand and gravel backfill, restoration of pavements, walks and drives, disposal of surplus excavated material, and all other work incidental to the construction of the sewer.
- B. Measurements will be taken from the start of each section to its respective ends, (center of end manholes, when they exist), with no reductions for intermediate manholes. Special structures or special sewer sections for which either lump sum or unit bids have been taken will be deducted from the total length of sewer and will be paid for at the prices bid, therefore.
- C. Unless specified otherwise, structures will be paid for at the Contract unit price each, which price shall be payment in full for furnishing the materials, including the required fittings, frames, lids, grates and steps, and for all labor, equipment and tools, all necessary excavation, backfilling, disposal of surplus material, and all work incidental to the completed structure.

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**PART 2 PRODUCTS**

**2.01 SOURCE QUALITY CONTROL**

- A. The Contractor shall provide the Owner a list of all suppliers. Each of the suppliers shall provide the Owner with a Certificate of Intent of Compliance prior to material delivery. The Certificate shall certify that all materials supplied for the work will be manufactured, tested and inspected in accordance with the contract documents. Following the delivery of the materials, the supplier shall provide the Owner with a Certificate of Compliance. The Certificate shall certify that all materials supplied have been manufactured, tested and inspected in accordance with the contract documents. Each of the above Certificates shall include the following: suppliers name and mailing address; project title, a description of each material supplied, a statement that all materials will be (or have been) manufactured, tested and inspected in accordance with the contract documents for the project and shall be signed and notarized. All of the above shall be provided at the Contractor's Expense.

**PART 3 EXECUTION**

**3.01 EXCAVATION**

- A. Excavation shall include clearing of the site and the removal and disposal of all materials necessary to be removed in the construction of all work under this Contract. Excavation shall be of sufficient widths and depths to provide adequate room for construction and installation of the work to lines, grades, and dimensions called for on the plans within the provided easements.
- B. Where the trench is excavated to a stable, foundation, sub-grade for the bedding specified in Section 3.03 pipe bedding of this specification, the pipe shall be laid in accordance with OCSS, Section 3.02, LAYING PIPE. Where the depth of excavation exceeds such a limit, the Contractor shall fill the space with compacted angular-shaped, crushed stone containing sufficient smaller sized aggregate to provide proper "Keying" of the material to insure that the pipe, when laid, will maintain correct alignment and grade, and to prevent the migration of smaller-sized earth particles of bedding, trench wall or backfill material into voids of the stone. When crushed stone is used as a foundation material, it shall also be used as bedding material for pipe for the entire width of trench, and from sub-grade depth upwards to the top of the pipe. The remainder of bedding to a point twelve (12) inches above the top of the pipe shall be constructed as specified for Standard Pipe Bedding. Materials placed as foundation or bedding material shall be compacted in six (6) inch layers. Crushed stone shall not exceed one and one-half (1 1/2) inches in size and crushed stone shall be at least 85% angular-shaped crushed material. All such material shall be approved by the Engineer before use. "Pea" stone or uncrushed and ungraded "float" stone shall not be approved for use.
- C. Excavation to Three (3) Feet below Invert of Pipe

Where through the Contractor's construction procedure, or where excavation has not uncovered stable foundation sub-grade for the bedding specified in Section 3.03 of this specification the Contractor shall continue to excavate downward to a maximum distance of three (3) feet below the specified pipe invert grade to reach stable foundation soil. The space resulting from such excavation and the pipe bedding shall be filled and constructed

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in the same manner and using the same materials specified above. All costs for such construction shall be borne by the Contractor.

**D. Excavation Below Limits Specified in Paragraph (1)**

Where excavation has not uncovered stable, foundation sub-grade at depths specified in Paragraph (1), above, and where the Contractor intends to make claims for additional cost, then, the Contractor shall stop further excavation and immediately notify the Engineer of the condition and of his intent to make claim for additional cost. The Engineer shall investigate the soil conditions at the site and shall prescribe the appropriate pipe support system to be used and the Contractor shall construct such pipe support system as directed by the Engineer. Within ten (10) days after the Engineer determines the appropriate pipe support system to be used, the Contractor shall submit a detailed claim for additional cost, excluding the costs to be borne by the Contractor in Paragraph (1), above. Such claim for additional cost shall include only those additional costs necessary to construct the pipe support system directed by the Engineer. Claims shall not include construction costs prior to stoppage of work.

**E. Special Excavation**

In certain instances, the Contract Plans and Profiles may show specific requirements for removal of unsuitable earth or other materials and construction of compacted fills composed of crushed stone or other specified materials. All costs for removal of unsuitable earth or other materials and construction of compacted fills shall be included in the appropriate unit prices bid.

**F. The widths of a trench from the bottom of the pipe to a height twelve (12) inches above the top of the pipe barrel shall be as follows:**

Pipe Internal Dia.	Maximum Trench Width
Less than 18"	30"
18" to 24"	Pipe O.D. plus 18"
Greater than 24"	Pipe O.C. plus 24"

If such trench width is exceeded, unless otherwise shown on the contract plans, the Contractor shall install at his own expense such concrete cradle bedding, concrete arch bedding, or other bedding all as approved by the Engineer. The Contractor, as an alternative and with the approval of the Engineer, may construct such bedding of crushed stone as specified above, at no additional cost to the Owner.

**G. Excavated materials may be temporarily stored along the trench in a manner that will not cause damage to trees, shrubs, fences, or other property, nor that will endanger the bank of the trench by imposing too great a load thereon.**

**H. Open cut excavation for shafts or other structures shall be adequately braced and/or sheeted to prevent caving or squeezing of the soil. Tunnels shall be sheeted, shored and/or braced, as necessary, to enable the work to be performed with safety to the men, the work, and neighboring structures. All excavations shall be completely dewatered prior to construction of the sewer or other structures; and adequate provisions shall be made to prevent water from flowing through or over newly placed concrete or masonry work. Drainage shall be carried to sumps from which the water may be pumped.**

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**3.02 LAYING PIPE**

- A. All pipe shall be laid to the line and grade called for on the plans. The contractor will use laser equipment to maintain line and grade control. The finished work shall be straight and shall be sighted through between manholes.
- B. Each pipe shall be inspected for defects prior to being lowered into the trench; and inside of pipe and outside of spigot shall be cleaned of any dirt or foreign matter.
- C. Construction shall begin at the outlet end and proceed upgrade with spigot ends pointing in the direction of flow. The pipe shall be laid on bedding as described in Section 3.03. For pipe with raised bells or collars, bell holes shall be carefully formed at proper intervals so that the bells support no part of the load. The pipe shall be centered in the bell or groove and pushed tight together to form a smooth and continuous invert. After laying of pipe, care shall be taken not to disturb its line and grade. Any pipe found off grade or out of line shall be re-laid properly by the contractor.
- D. The remainder of the pipe bedding, free from stones and lumps, shall be placed with care, in six (6) inch layers, to an elevation providing twelve (12) inches of cover over the pipe. Each layer shall be thoroughly compacted by power tamping.
- E. Completion of the pipe bedding and backfilling the remainder of the trench shall follow closely behind the laying of the pipe.
- F. Concrete pipe 42" and larger shall have all joints inside cement pointed, with cement mortar compound of one (1) part of cement and two (2) parts of sand.
- G. Where pipe is laid in wet trenches or trenches with running sand, the Contractor shall provide and use mechanical means for pulling the pipe home in making up the joint and for holding the pipe joint tight until completion of the line. Mechanical means shall consist of a cable placed inside of the pipe with suitable winch, jack, or come-along for pulling the pipe home and holding the pipe in position.
- H. Mechanical means shall be used for pulling home all rubber gasketed pipe regardless of trench condition where manual means will not result in pushing and holding the pipe home.
- I. Cutting of pipe lengths, where required, shall be performed by the use of tools or equipment that will provide a neat, perpendicular cut without damage to the pipe. Bowing or warping of pipe can occur with temperature fluctuations. The Contractor shall store and protect the pipe to minimize bowing. Nominal 12'-6" pipe lengths having deviations from straight greater than 1" shall not be used.

**3.03 PIPE BEDDING**

- A. Concrete Pipe  
Bedding for concrete pipe is shown on the standard detail sheet for sanitary sewers. Standard pipe bedding is defined as the envelope surrounding the pipe and extending from a sub-grade of six (6) inches below the bottom of the pipe upwards, bearing laterally against the sides of the trench, to an elevation providing twelve (12) inches of cover over the pipe. If the contractor wishes to use a bedding material different than indicated on the

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standard detail sheet, prior approval regarding material and method of installation must be obtained from the engineer. If the trench is wet or unstable or an undercut is required, sand bedding will not be allowed. All costs for pipe bedding, including material, labor and equipment will be incidental to the contract unless otherwise indicated.

**B. Truss and Solid Wall Plastic Pipe Bedding**

1. Bedding for ABS and PVC pipe shall be in accordance with ASTM D2321-00, except:
  - a. Only Class I and Class II materials having a maximum particle size of one and one-half (1-½) inch may be used.
  - b. Standard pipe bedding is defined as the envelope surrounding the pipe and extending from a subgrade of four (4) inches below the bottom of the pipe upwards, bearing laterally against the sides of the trench, to an elevation providing twelve (12) inches of cover over the pipe.
  - c. Flooding or puddling shall not be used.
2. It is essential that it be recognized that the successful use of flexible pipe requires bedding that provides unyielding side support and complete bedding contact under pipe haunches. Bedding material must be properly placed and compacted to provide lateral restraint against deflection in the pipe diameter. Pipe must be bedded to true line and grade throughout its length. Bell holes shall be provided where required.
3. Where unstable bottoms are encountered, the contractor shall provide a foundation consisting of an approved graded processed angular stone or filter fabric to act as an impervious mat to impede migration or vertical movement of unstable soils or bedding materials. Where trench sheeting, plates, or a trench box are used due to severe ground conditions, all voids to the side and below the top of the pipe caused by the sheeting, plates or box withdrawal shall be completely filled or the supports left in place below the top of the pipe.
4. Concrete cradle bedding shall not be used where allowable trench widths are exceeded. In lieu of concrete cradle bedding, standard pipe bedding shown shall be provided to the full width between undisturbed trench walls or at least to 2.5 pipe diameters on both sides of the pipe.
5. Due to potential damage to exterior walls of truss or plastic pipe, particularly under cold weather conditions, if rocks, frozen material or large objects strike the pipe, the contractor shall carefully avoid dumping any materials other than approved bedding sand or stone on the pipe until twelve (12) inches of cover is over the pipe. Pipe walls and joints shall also be protected from abrasion and damage during handling, and shall be fully inspected just prior to placing in trench.
6. Care shall be taken during bedding compaction to avoid distorting the shape of the pipe or damaging its wall. Mobile equipment shall not be used over the pipe trench until forty-eight (48) inches of cover has been placed.

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7. House connections shall be made to wye fittings. Bedding for house connection sewers shall be equal to that of the main sewer bedding. Risers in deep and unstable trenches should be bedded in Class I angular stone to avoid settlement. Concrete shall not be used for bedding. End caps or plugs shall be braced or anchored to withstand air test pressures.
8. Class I, II, IIA, grading requirements for granular materials are defined per ASTM C-136.

**3.04 BACKFILL**

- A. Backfill is defined as that material placed into trench from the top of the standard pipe bedding (as previously defined) to the ground surface. Backfill shall be placed into the trench according to one of the following specified manners as determined by the location of the trench or the edge of trench nearest the existing pavement, roadway, sidewalk, driveway or parking area.
- B. Selected excavated material for use in backfill is defined as soil that is capable of meeting specified compaction requirements and is free of large or frozen lumps, asphalt, concrete rubble, boulders, blue clay, topsoil, peat, marl, wood, debris, vegetation, or other extraneous materials as determined by the Engineer.
- C. Zone of influence is defined as a one to one (1 horizontal to 1 vertical) slope from the edge of pavement to the trench bottom.
- D. Wherever compaction is required, it shall be by suitable mechanical compaction equipment approved by the Engineer. Initial compaction test will be made by a representative of the Owner and paid for by the Owner. However, if it is necessary to repeat compaction tests because initial compaction methods or construction procedures failed to produce required density, in place, the Contractor shall be billed for the cost of all repeat testing until material meets specifications.
- E. Concrete and Asphalt (Roads, Sidewalks, Driveways & Parking Areas) (No frozen materials permitted)

**Trench Location**

1. Under concrete and asphalt surfaces and within the zone of influence.
2. Outside the zone of influence and within road right-of-way.

**Backfill Requirements**

Backfill shall be in accordance with detail sheet with mechanically tamped Class II sand or stone in six (6) inch layers, loose measure, with each layer compacted to not less than 95% of the maximum dry density as determined by the ASTM D 1557 Compaction Standard.

Backfill material shall be placed into trench in six (6) inch layers, loose measure, each layer compacted to not less than 90% of maximum dry density as determined by the ASTM D 1557 Compaction Standard. Selected excavated material may be used, provided compaction requirements can be met.

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- F. Gravel (Roads, Driveways, and Parking Areas) (No frozen materials permitted)
1. Within the zone of influence and within road right-of-way. Backfill material shall be placed into trench in six (6) inch layers, loose measure, with each layer compacted to not less than 90% of maximum dry density as determined by the ASTM D 1557 Compaction Standard. Selected excavated material may be used, provided compaction requirement can be met. The Contractor shall immediately restore all roads, driveways, and parking areas with MDOT 21AA gravel at least eight (8) inches thick and shall maintain them in good, dust-free condition during the life of the contract. Additional aggregate shall be added if settlement occurs. Before final acceptance of the road, driveways, or parking area, it shall be top-dressed with approved material to match the original surface treatment. Gravel shall be suitably stabilized with calcium chloride.
  2. Outside the zone of influence and within the road right-of-way. Same as F. (1) above.
- G. Open Fields and Lawn Areas
1. Backfill material shall be placed into trench in 12" layers, loose measure, with each layer compacted to not less than 90% of maximum dry density as determined by the ASTM D 1557 Compaction Standard. Selected excavated material may be used provided compaction requirement can be met. Compaction will be tested at the inspector's discretion.
  2. Contractor shall regrade as necessary during the life of the Contract. For restoring lawn and landscaped areas see General Specifications Section 7, "Final Cleanup and Restoration". No frozen materials permitted.
- H. Special Backfill

Where called for on the plans or where required by Road Permits, the Contractor shall backfill trenches in accordance with the requirements of said plans or Road Permits.

Where "Special Backfill Requirements" are called for along highways under the jurisdiction of the State of Michigan, The Road Commission for Oakland County, or the local unit of government, the Owner will employ an independent testing laboratory to make compaction tests and the costs of the tests will be paid for by the Contractor.

Backfilling around all structures shall be placed in compacted one-foot layers, in a manner that will not cause unequal pressure or damage to any exterior coating or plastering.

**3.05 HOUSE LEADS, WYES AND RISERS**

- A. Wyes and/or risers and/or house leads shall be constructed at such points as are called for on the plans and as may otherwise be directed by the Engineer. Wyes shall be installed at an angle not to exceed 30 degrees. The wye opening or the end of the riser or house



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lead shall be fitted with waterproof stoppers as recommended by the manufacturer, properly blocked to withstand air or other approved testing.

- B. One house lead (and riser where required) shall be provided for each lot and acreage parcel or as indicated on the plans. The actual location of house leads will be determined in the field during construction. Leads to existing houses shall be located to suit the property owner. On vacant lots, leads shall be as shown on plans or as directed in the field.
- C. The Contractor shall install risers as necessary to provide for depth of bury of the house lead at the property line as specified on the plans or as directed by the Engineer.
- D. House leads and risers shall be six (6) inch diameter pipe to the property line unless otherwise specified. Joints for wyes, risers and house leads shall be as specified in Materials - Sanitary Sewer Pipe, contained herein. Joints shall connect to wye branches constructed as part of the sewer proper. House leads shall be constructed at a minimum grade of one-eighth (1/8) inch per foot and at a depth sufficient to properly serve the adjacent property. Wherever possible, the house lead shall have a minimum depth of ten (10) feet to the property line. For house leads requested less than ten (10) feet at property line, grade adjustment will be made within four (4) feet of the property line using an approved bend to make requested depth.
- E. House lead shall be installed no closer than ten (10) feet from side lot line.
- F. Risers shall be constructed where shown on the plans or as may be directed by the Engineer. Backfill at all risers shall be carefully placed and tamped sufficiently to insure against damage from backfill settlement or backfilling operations.
- G. House lead and/or riser construction shall progress concurrently with main sewer construction.
- H. The Contractor shall bury a 1/4" diameter by 8' long steel rebar at the end of all six (6) inch leads or wye openings, extending from the wye opening or the lead to within six (6) inches of the ground surface.

**3.06 SANITARY MANHOLES**

- A. Manholes shall be constructed of the type and in accordance with the details shown on the plans and at the locations shown on the plans. All necessary steps, frames and covers shall be furnished and installed. Covers shall be set at the required final elevation so that no subsequent adjustment shall be necessary.
- B. Connections to manholes shall be properly supported and braced with specified material where not resting on original ground so that any settlement will not disturb the connection.
- C. Excavation shall be carried to the depth required to permit the construction of the required base and bottom of excavation shall be trimmed to a uniform horizontal bed. The excavation shall be sufficiently wide to allow for shoring, bracing, or form work, should any or all be necessary, to allow for accessibility. The excavated section shall be completely dewatered before any concrete is placed therein.
- D. All manholes shall be adjusted in accordance with the Standard Detail Sheet.
- E. Interior joints of all structures shall be pointed.
- F. Unless otherwise specified by the Engineer:

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1. Drop manholes, as called for on the plans, shall be manufactured and constructed as "Pre-Cast Flexible Joint Sewer Manholes", and are included in the proposal under "Drop Manholes".
2. Sump manholes, as called for on the plans, shall be considered as incidental as the cost shall be included in the unit price bid for "Manholes" or "Drop Manholes".
3. All manholes shall be constructed of precast reinforced concrete (manufactured with Type I, IA, IP, II, or IIA cement), and shall be the eccentric cone type. All manholes for pipe sizes twenty-four (24) inch diameter and smaller shall be the precast flexible-joint type, unless otherwise specified.
4. Pipe shall not extend into a manhole beyond the inside face of the manhole wall. Field cutting of pipe to be used at manholes shall be done in a neat, workmanlike manner, using methods approved by the Engineer. Exposed ends of reinforcing steel shall be cut flush with the pipe end.
5. Concrete placed inside precast flexible-joint manholes to form the channel through the manhole shall not be placed between the pipe and the opening in the manhole base section so as to interfere in any way with the flexibility of the joint. Block and brick filler or dry mix shall not be used to construct channel. Concrete shall be made with Type I or IA cement.
6. The joint between a precast riser section and the base of the structure shall be set in a full bed of mortar.
7. All manholes shall rest on a minimum of eight (8) inch thick 3,000 p.s.i. concrete base. Pre-cast concrete bases may be used if a uniform bearing is provided. The base shall protrude a minimum of six (6) inches beyond the outside diameter of the structures, unless precast concrete bases are used. If precast bases are used, they shall protrude a nominal four (4) inches beyond the outside diameter of the structure. All concrete bases shall be cast utilizing Type I or IA cement.
8. Precast reinforced concrete sections shall, as a minimum, conform to ASTM C478. Structures shall have modified groove tongue joints with gaskets manufactured to conform to ASTM C443.
9. The joint between the pipe and the base section of precast flexible-joint manholes shall be a mechanically compressed flexible-joint, such as the Res-Seal, Link-Seal, or Press Wedge II, or equal flexible-rubber manhole joint. The joint shall be capable of meeting infiltration requirements and shall permit a deflection of at least six (6) degrees in all directions as measured from all centerline of the pipe.
10. Water for concrete and for mortar shall be clean and fresh, free from oil, acids and organic matter.
11. Mortar for pointing of joints shall be composed of one (1) part Type IIA Portland cement and two and one-half (2-1/2) parts masonry sand. No lime shall be used in the mortar.
12. The frame and cover shall be as noted on the plans. Lettering on the cover shall be as required by the Owner.
13. Manhole steps shall be plastic coated steel meeting the requirements in ASTM D 2146, Type II, Grade 49108 M.A. Industries P.S.I. Polypropylene or approved equal with foot recess, suitably scored to provide a non-slip surface and shall be

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on 16" centers, 21" maximum below casting elevation and 24" maximum above structure bottom or top of fillet.

14. All manholes built over existing systems shall be installed with monolithic concrete poured base.
15. All manholes shall be backfilled with compacted sand to a distance of 3 feet of the outer periphery of the structure.

**3.07 STUBS, CONNECTIONS, BULKHEADS, AND MISCELLANEOUS ITEMS OF WORK**

- A. The Contractor shall furnish all material and labor and shall install and/or construct the stubs, connections, bulkheads, and miscellaneous items of work called for on the plans and/or specifications. The cost of this work shall be included in the unit prices bid for manholes and/or sewers.
- B. Where called for on the drawings, existing sewers shall be connected in.
- C. Where called for on the drawings, drop connections, bulkheads, and stubs for future sewer connections shall be provided.
- D. Where called for on the drawings, bulkheads shall be constructed or removed as called for.
- E. Unless otherwise noted on the drawings, stubs shall consist of one full length of sewer pipe, minimum length eight (8) feet, with watertight bulkhead constructed of material compatible with the pipe material, and shall conform to the following specifications. Six (6) inch to fifteen (15) inch stubs shall be truss or solid wall pipe, conforming to Material Sanitary Sewer Pipe. Stubs eighteen (18) inches and larger shall be a minimum ASTM C-76 Class IV Concrete Pipe. The type of joint shall be as those specified under Materials - Sanitary Sewer Pipe, contained herein.
- F. No separate payment will be made for such stubs, connections, bulkheads, and miscellaneous items of work covered in this paragraph. Such work shall be considered incidental and the cost thereof shall be included in the unit price bids.

**3.08 CAST IN PLACE CONCRETE STRUCTURES**

- A. The Contractor shall submit to the Engineer complete shop drawings of concrete structures, including the size and spacing of reinforcing steel. The plans will be approved or corrected and returned to the Contractor who shall furnish three sets of approved or corrected plans to the Engineer, a minimum of three (3) working days prior to proceeding with the work.
- B. Unless otherwise noted, structural concrete shall be Grade A ( $f_c = 3500$  psi.), and reinforcing steel shall be Grade 60. All exposed concrete edges shall have 3/4" chamfer.
- C. The finish of concrete surfaces on inside walls and floor shall be made as smooth as possible, special consideration being given to those surfaces which will be exposed to the flow.
- D. As soon as the forms are removed, the surface of the concrete shall be carefully examined and any irregularities of surface shall be treated as directed by the Engineer. Fins and

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irregular projections shall be removed in a workmanlike manner, care being exercised to prevent undue spalling of adjacent surfaces.

- E. If, in the opinion of the Engineer, the defects in the concrete are of such a nature as to warrant rejection, that portion of the pour may be ordered replaced in its entirety and the Contractor shall promptly replace same without additional compensation. The Contractor alone shall be responsible for the trueness of the surface of the concrete and shall correct any deviation in the manner ordered by the Engineer.
- F. If due to weather conditions or unacceptable workmanship, exposed concrete surfaces cannot be satisfactorily finished as determined by the Engineer, the Contractor shall apply two coats of Thorosexl mixed with Acryl 60 (or approved equal) to all exposed concrete surfaces. Mixing and application of cement-based water proofing shall be in accordance with manufacturer recommendations for "finishing concrete."
- G. Rubbing with a Carborundum stone and/or the use of grinding wheels to obtain smooth finish will be required for exposed to view exterior concrete surface.
- H. Floors, walkways and stairs of structures and buildings shall be given a steel trowel finish unless otherwise specified. Pavement and sidewalk shall be given a standard float finish including brush coat.
- I. In tunnel construction, in addition to the removal of fins and irregular projections, the entire interior surface shall be given a cement mortar brush coat.

### **3.09 TUNNELING**

#### **A. Bored and Jacked Pipe Sanitary Sewers**

- 1. All bored and jacked sanitary sewer pipe shall be installed within a casing pipe consisting of new and unused steel spiral welded pipe conforming to ASTM A-139, Grade B.
- 2. Casing pipe ends shall be prepared for field welding. Welders performing field welding shall have satisfactorily passed "Structural Welding Code" qualification tests within the previous 12 months. Joints in casing pipe shall be fully welded along the circumference of the pipe.
- 3. The diameter of the casing pipe shall be sufficient to house the pipe, wooded skids, and provide a minimum of 3" of clearance as measured from the crown of the bell of the pipe to the casing. Unless otherwise indicated on the Plans, the minimum wall thickness of the casing pipe shall conform to the following table:

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<b>ALLOWABLE HEIGHT OF COVER (H) IN FEET, FOR STEEL CASING</b>											
<b>WALL THICKNESS (INCHES)</b>		<b>STEEL CASING OUTSIDE DIAMETER (INCHES)</b>									
<b>FRACTION</b>	<b>DECIMAL</b>	12	14	16	18	20	24	28	30	36	42
3/16	.1675	39	30	24	21	19	17	16			
1/4	.250	50	50	39	31	27	21	19	18	16	
5/16	.3125			50	48	39	28	23	21	18	17
3/8	.375				50	50	39	29	27	22	19
7/16	.4375						50	39	34	26	21
1/2	.500							50	44	31	25
9/16	.5625								50	39	30
5/8	.625									48	35

THIS TABLE NOT APPLICABLE AT RAILROAD CROSSINGS

4. The casing pipe shall be installed by a continuous boring-jacking operation. The boring auger shall not proceed ahead of the casing pipe. Water shall not be used in the boring operation.
5. The face of the jacking pits generally shall be located a minimum of ten feet (10') from the edge of the pavement and/or back of curb, and shall be sheeted and shored sufficiently to protect the pavement and/or track installations, existing underground utilities and the safety of the workman. Access pits shall be protected from vehicular traffic and shall be provided with suitable fencing and barricades to prohibit public access to the work site. Equipment shall not be used in lieu of fencing to protect access sites.
6. The sanitary sewer shall be supported within the casing pipe by means of construction grade (No. 2) 4" x 4" pressure preservative treated timber skids. Skids shall be continuous from bell to bell. A minimum of four (4) skids, positioned 45° each side of the top and bottom centerlines of the sanitary sewer are required. Skids are to be strapped to the sanitary sewer by 1 1/8" wide, 12 gauge galvanized steel or stainless steel bands. A minimum of four (4) straps per pipe length are to be installed.
7. After the sanitary sewer is pushed through the casing, masonry bulkheads shall be installed tight around the sanitary sewer at both casing ends. Stand pipes suitable to receive pressure grouting shall also be installed.
8. The void between the sanitary sewer and the casing pipe shall be pressure grouted using a concrete grout mix as approved by the Engineer.
9. If the Contractor proposes to employ a different method of tunnel crossing than the method described in these specifications, he shall obtain written approval from the Engineer.

**B. Jacked-in-Place Pipe Sanitary Sewers**

1. Jacked-in-Place pipe tunnel sanitary sewer shall be constructed of reinforced

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concrete pipe, ASTM C76 Class V with 2 rings of circular reinforcement extending into the bell and into the spigot ends of the pipes. Elliptical reinforcement will not be allowed. In such construction, excavation shall not proceed ahead of the cutting edge of the pipe. Voids shall be filled by means of pressure grouting with 1:3 cement-sand mortar.

2. All pipe 42" and larger shall have inside cement pointing with cement mortar compound of one (1) part of cement and two (2) parts of sand.

**C. Monolithic Concrete Tunnel**

1. Monolithic concrete tunnel sanitary sewers as detailed on the Drawings.
2. All voids shall be filled by means of pressure grouting with 1:3 cement sand mortar.
3. Shaft locations shall be subject to the approval of the Owner and the Contractor shall submit a schedule of desired locations of shafts for approval.
4. The method of constructing the shafts and the type of support are at the option of the Contractor, but subject to approval by the Engineer.
5. The Contractor will receive no extra compensation for constructing, maintaining, or removing shafts, but the cost of same shall be included in the prices bid for the sanitary sewers.

**3.10 FIELD QUALITY CONTROL**

- A. All sewers shall be subjected to exfiltration, infiltration or air tests, or a combination of same, or alternate method as approved by the Engineer, prior to acceptance by the Owner.
- B. For testing purposes, sewer manholes shall be equipped with a one-half (1/2) inch diameter galvanized capped pipe nipple extending through the manhole wall and projecting 3" into the manhole space, and at the same elevation as the crown of the pipe.
- C. Prior to testing, the ground water elevation shall be determined by blowing air through the pipe nipple to clear it and then connecting a clear plastic sight tube to the pipe nipple. The sight tube shall be suspended vertically in the manhole and the ground water elevation determined by observing the water level in the sight tube.
- D. After all tests are performed and the sewer is ready for final acceptance, the pipe nipple shall be removed and the hole in the manhole wall shall be plugged with hydraulic cement or the nipple can be plugged with a galvanized cap.
- E. All sewers greater than twenty-four (24) inch diameter shall be subjected to infiltration or exfiltration tests.
- F. Sewers greater than twenty-four (24) inch diameter where the ground water level above the top of the sewer is less than seven (7) feet shall be subjected to an exfiltration test.

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- G. All sewers where the ground water level above the top of the sewer is over seven (7) feet shall be subjected to an infiltration test.
- H. All sewers of twenty-four (24) inch diameter or less, where the ground water level above the top of the sewer is less than seven (7) feet shall be subjected to air tests.

**I. Infiltration Test**

1. Determine ground water elevation. Ground water must be not less than 7 feet above the highest point of the sewer pipe.
2. Plug incoming pipes in upstream manhole.
3. Insert calibrated 90-degree V-notch weir in pipe on downstream manhole.
4. Allow water to rise and flow over weir until it stabilizes.
5. Take five (5) readings of accumulated volume over a 2-hour period and calculate the average reading. Multiply the average reading x 12 and compare to allowable infiltration rate. Maximum infiltration rate shall not exceed 100 gallons per inch of diameter per mile of pipe over a 24-hour period, in any individual run of pipe between manholes.

**J. Air Test**

1. Per ASTM standard F 1417-92, the procedure for air testing of sewers shall be as follows:
  - a. The sewer line shall be tested in increments between manholes. The line shall be cleaned and plugged at each manhole. Such plugs shall be designed to hold against the test pressure and shall provide an air-tight seal. One of the plugs shall have an orifice through which air can be introduced into the sewer. An air supply line shall be connected to the orifice. The supply line shall be fitted with suitable control valves and a pressure gauge for continually measuring the air pressure in the sewer. The pressure gauge shall have a minimum diameter of three and one-half (3 1/2) inches and a range of 0-10 or 0-15 PSIG. The gauge shall have divisions in 1/10 of a pound increments and an accuracy of plus or minus ( $\pm$ ) 0.04 psi.
  - b. All test pressures are measured as gage pressure, which is any pressure greater than atmospheric pressure. Since water produces a pressure of 0.43 psi for every foot depth, air test pressures must be increased to offset the depth of ground water over the sewer line. If the ground water level is 2 ft. or more above the top of the pipe at the upstream end, or if the air pressure required for the test is greater than 9-psi gage, the air test method should not be used. Before the air test method is used, the ground water level should be lowered by pumping or dewatering.

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- c. The sewer shall be pressurized to 4 PSIG greater than the greatest back pressure caused by ground water over the top of the sewer pipe. At least two (2) minutes shall be allowed for the air pressure to stabilize between 3.5 and 4 PSIG. If necessary, air shall be added to the sewer to maintain a pressure of 3.5 PSIG or greater.
- d. After the stabilization period, the air supply control valve shall be closed so that no more air will enter the sewer. The sewer air pressure shall be noted and timing for the test begun. The test shall not begin if the air pressure is less than 3.5 PSIG, or such other pressure as is necessary to compensate for ground water level.
- e. All gauges shall be calibrated every six (6) months, with the last certification date provided to WRC prior to testing.
- f. The time required for the air pressure to decrease 1.0 PSIG during the test shall not be less than the time shown in the following Air Test Tables.

**AIR TEST TABLES**

**MINIMUM HOLDING TIME IN MINUTES REQUIRED  
FOR PRESSURE TO DROP FROM 3 1/2 TO 2 1/2 PSIG**

Pipe Diameter, in.	Minimum Time, min:s	Length for Minimum Time, ft.	Time for Longer Length, seconds	Specification Time for Length (L) Shown, mins.							
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33

**K. Exfiltration Test**

- 1. An exfiltration test is performed on the sewer by filling the sewer with water to a specified test head and the rate of water loss is measured. If the rate of water loss is less than or equal to the allowable loss, the section of sewer tested is acceptable. The sewer shall be free of debris before testing.



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2. Determine the groundwater elevation at both ends of the test section. If the groundwater is less than 2 feet above the crown of the upstream pipe, the exfiltration test shall be used. The test head pressure shall be a minimum of two (2) feet above the crown of the upstream pipe or ground water level.
  3. All manholes, ends of branches, laterals, wyes and stubs to be included in the test section shall be plugged securely to prevent leakage or blowout due to testing pressure.
  4. Conduct testing from manhole to manhole or multiple manholes, provided the entire test section does not exceed 700 feet.
  5. Fill the pipe test section with water to the test head elevation and allow the pipe to be saturated a minimum of 4 hours to a maximum of 72 hours. After the saturation period, refill the pipe to the required test head.
  6. Take five (5) readings of accumulated volume over a 2-hour period and calculate the average reading. Multiply the average reading x 12 and compare to allowable infiltration rate. Maximum infiltration rate shall not exceed 100 gallons per inch of diameter per mile of pipe over a 24-hour period, in any individual run of pipe between manholes.
  7. Manholes shall be tested separately and independently or with the pipeline, with an allowable leakage of 0.1 gallons/foot diameter/feet of head.
- L. Within a reasonable length of time following pipe laying and backfilling, the Contractor shall complete all work necessary to perform testing. If, in the opinion of the Engineer, work has not progressed in a reasonable manner, he shall have the right to direct the Contractor to proceed with the work or any portion thereof immediately. The Contractor shall perform all necessary preliminary tests and shall make all necessary repairs, including the repair of all visible leaks and cracks, and retests with his own forces to ready the sewers for final inspection and witnessing of tests by the Owner. Immediately after the sewers have passed such preliminary tests, the Contractor shall submit a written request to the Owner for final inspection and witnessing of tests.
- M. Where ground water conditions require dewatering operations in order to construct sewers of twenty-four (24) inch diameter or smaller, the Contractor may, at his option, perform preliminary air tests after backfilling and while the dewatering equipment is still operating.
- N. Where preliminary acceptance tests have been performed shortly after sewer construction, such tests will not automatically result in acceptance of the sewer. The Owner will cooperate fully with the Contractor in the performance of preliminary tests but recognizes the value of such tests as an early means of only tentative evaluation of workmanship and materials. Final acceptance will not be considered until after a reasonable length of time following pipe laying and backfilling to allow as much as possible for development of the earth load on the pipe.
- O. If a sewer fails to pass any of the previously described tests, the Contractor shall determine the location of the leaks, repair them and retest the sewer. The tests shall be repeated until satisfactory results are obtained.

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- P. Method of testing and measurement shall be approved by the Engineer. The Contractor shall provide the necessary certified equipment, and labor for making tests, and the cost of same shall be included in the unit price bid for complete sewer.
- Q. Chemical or cement grouting will not be considered an acceptable method of repairing leaking pipe, joints or structural failures, except where specifically approved by the Engineer. In this regard the decision of the Engineer shall be final.

**R. Mandrel Testing**

1. The Engineer may, at his discretion, require mandrel (go/no-go) gauging test run on all ABS and PVC pipes. Mandrels shall have nine (9) arms and dimensions shall be ninety-five percent (95%) less a statistical tolerance of ASTM average diameter (see table below). The completed installation shall at no point have out-of-round pipe deflections greater than five percent (5%).
2. Mandrel testing shall not take place until a minimum of thirty (30) days has elapsed since the trench was backfilled to final grade. Any pipe sections not passing the mandrel test as described above shall be uncovered and the Contractor shall replace and/or re-compact the embedment backfill material to the satisfaction of the Engineer. After another thirty (30) day period, the pipe section shall be re-tested with the mandrel as described above.

Nominal Pipe Size	ABS or PVC Truss Pipe (D-2680)		PVC Solid Wall Pipe SDR 35 (D-3034)	
	Pipe I.D. (min.)	Mandrel O.D.	Pipe I.D.	Mandrel O.D.
8	7.75	7.362	7.665	7.281
10	9.75	9.262	9.563	9.084
12	11.75	11.162	11.361	10.792
15	14.75	14.012	13.898	13.203

**S. Hydrostatic Tests of Force Mains**

- 1.. Prior to acceptance, force mains shall be inspected and hydrostatically tested as specified herein.
2. The Contractor shall furnish all necessary personnel, temporary timber bracing, plugs, test pumps and all other necessary apparatus for conducting the test. All gauges and meters used for testing shall be rated at or above required test. All gauges and meters used for testing shall be rated at or above required test pressure. Test gauges will be 3½" diameter readable in one-pound increments. Meters and gauges shall be calibrated every six months. Calibration will be to an

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accuracy of  $\pm 1\%$  or better. Verification of calibration shall be furnished to WRC personnel prior to start of test.

3. Before applying test pressure, all air shall be expelled from the pipe. If necessary, to accomplish this, taps shall be made at points of highest elevation in the pipe and such openings subsequently closed, prior to test, with tight threaded brass plugs.
4. Test pressure shall be maintained at 150 pounds per square inch at the point of highest elevation in the test section by pumping water into the pipe for a period of two (2) hours and in all cases long enough to permit assurance of a satisfactory test. Leakage as measured by the quantity of water pumped into the pipe to maintain 150 p.s.i. pressure during the test, shall not exceed a rate of 50 gallons per inch diameter of main, per mile of pipe in twenty-four (24) hours per ASTM E 1003-95.
5. The Contractor shall furnish all water used on this project including water used for hydrostatic testing. If he elects to purchase water from the Owner, he shall pay for the full metered amount at the current water rate for the system used.
6. If a meter is not available to measure the volume of water the Contractor shall pay for a minimum of three (3) times the volume of the pipe installed or as otherwise determined by the Engineer.

**T. Video Inspection**

1. The Contractor shall inspect the inside of all sewers by television inspection and provide related color video DVDs.
2. This work shall include dewatering or diverting flow in sewers to the degree necessary for video inspection and color videotaping.
3. Dewatering shall include necessary pumping equipment, plugs and temporary piping between manhole sections.
4. The Contractor shall, prior to starting work, furnish the Engineer for approval, his proposed method for dewatering sewers.
5. For inactive sewers, the sewers shall be flooded with clean water and allowed to dewater prior to televising of the sewer.
6. CCTV inspection shall be performed by CCTV personnel who are trained and certified in the use of NASSCO's Pipeline Assessment and Certification Program (PACP®). Reports will be done in a digital format (mdb) compatible with WinCan8 or other NASSCO approve software acceptable to the Owner.
7. The camera shall be pulled through the pipe at a speed no greater than 30 ft./minute, unless approved by the Owner. The video shall also display the pipe footage counter.
8. The Contractor shall furnish all labor, electronic equipment and technicians to perform the closed-circuit television inspection of the sewers. Operation of the equipment is to be controlled from above ground with a certified technician at the control panel in the television studio, controlling the movement of the television

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camera. The technician shall have the capability to adjust the brilliance of the built-in lighting system and be able to change the focus of the television camera by remote control.

9. The view seen by the television camera shall be transmitted to a monitor of not less than 17 inches. The monitor shall be located inside a mobile TV studio. The stationing of the television camera shall be continuously displayed on the television monitor while the sewer line is inspected. The Contractor's mobile studio shall be large enough to accommodate up to three people for the purpose of viewing the monitor while the inspection is in progress. The Owner's representative shall have access to view the television screen at all times.
10. The electricity for all operations will be furnished by the Contractor. If required to improve the quality of the television inspection, a ventilating system shall be furnished and installed between manhole sections.
11. The inspection reports and television DVDs shall become the property of the Owner.

END OF SECTION