

CITY OF COLUMBIA ENGINEERING REGULATIONS

PART 17: SPECIFICATIONS FOR SANITARY SEWER

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CITY OF COLUMBIA ENGINEERING REGULATIONS

PART 17: SPECIFICATIONS FOR SANITARY SEWER

17.1 General

Construction detail drawings are a part of these specifications. No project will be constructed that does not comply with Part 3, Design of Sanitary Sewers.

- 17.1.1 These specifications cover materials and procedures for the complete installation of certain sanitary sewers and appurtenances incident to the construction of extensions to be connected to the City of Columbia, South Carolina Sewerage System. All construction, repair and replacement of sanitary sewer mains, service connections and appurtenances shall be carried out in accordance with these standard specifications, General Specifications, any Special Provisions, and in conformity with the line and grade as shown on the plans.
- 17.1.2 Pipe and appurtenances shall be installed at the locations shown on the plans and to the position, alignment and grade shown thereon, or in the event of grade conflicts, as directed by the Engineer. The Contractor shall erect, mark and maintain suitable barricades to protect the work and maintain public safety.
- 17.1.3 All pipe, special castings and fittings for sanitary sewer construction shall be furnished in accordance with specifications as outlined herein and in the Special Provisions and proposal form.
- 17.1.4 Sewer Pipe – Pipe for sanitary sewers shall be SDR polyvinyl chloride (PVC) pipe, centrifugally cast fiberglass reinforced polymer mortar pipe (CCFRPMP) or, where indicated, ductile iron pipe. All pipe shall be first quality, with smooth interior and exterior surfaces, free from cracks, blisters, honeycombs and other imperfections, and true to theoretical shapes and forms throughout the full length. Pipe material shall be consistent from manhole to manhole unless approved by City Engineer using fitting as specified in Section 2.1.1. All pipe shall be subject to inspection by the Engineer at the pipe plant, trench, or other point of deliver, for the purpose of culling and rejecting pipe, independent of laboratory tests, which does not conform to the requirements of these specifications. Such pipe shall be marked by the Engineer and the Contractor shall remove it from the project site upon notice being received of its rejection. All sewer pipe shall be tested by an independent laboratory, approved by the City Engineer, in accordance with applicable specifications. Character of tests shall be as follows:
- 17.1.4.1 Ductile Iron Pipe: As required by ANSI A21.6, latest revision
- 17.1.4.2 SDR Polyvinyl Chloride (PVC) Pipe: As required by ANSI/ASTM D 3034-78.
- 17.1.5 Water used for construction and testing will be furnished by the City through approved connections to the City water system. Check valves to reduce possibility of contamination will be furnished by the contractor when directed by the City Engineer.

- 17.1.6 All materials furnished by the Contractor shall be delivered and distributed at the site by the Contractor. Materials furnished by the owner shall be picked up by the Contractor at points designated by the City and hauled to the distribution site.
- 17.1.7 Sewer pipe and appurtenances shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.
- 17.1.8 In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench.
- 17.1.9 Pipe shall be so handled that the coating and lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a manner satisfactory to the Engineer.
- 17.1.10 Affidavit of Compliance – The manufacturer shall furnish an affidavit that all material delivered does comply with the requirements of these specifications.
- 17.1.11 The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures, both known and unknown, may be determined. He shall be held responsible for the repair of such structures when broken or otherwise damaged.
- 17.1.12 All pipe shall be laid to the depth shown on the contract drawings. Any variation therefrom shall be made only at the order of the Engineer.
- 17.1.12.1 Minimum depth of cover for any sanitary sewer main between manholes shall be three feet unless encasement and/or iron pipe is used.
- 17.1.12.2 Minimum distance from the top of ring to top of pipe for manholes shall be four feet for four feet diameter manholes. Larger diameter manholes shall be proportionately deeper.
- 17.1.12.3 Depths less than specified above required special approval by the engineer. It shall be incumbent upon the Contractor to determine if such approval has been granted. Work not meeting this specification shall be removed and replaced properly at no expense to the City.
- 17.1.13 Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least six inches below and on each side of all pipe, and fittings. The specified minimum clearance is the minimum clear distance that will be permitted between any part of the pipe and appurtenance being laid and any part, projection, or point of rock, boulder, or stone.
- 17.1.14 The trench shall be dug so that the pipe can be laid to the alignment and depth required. The trench shall be so braced and drained that the workmen may work in it safely and efficiently. It is essential that the discharge of trench dewatering pumps be conducted to natural drainage channels, drains, or storm sewers. The length of trench excavated in

advance of the pipe laying, shall be kept to a minimum, and in no case shall it exceed three hundred (300) feet unless specifically authorized by the Engineer. In no case shall two consecutive intersections be closed to traffic due to uncompleted work. Each intersection must be opened to traffic before closing of the next one.

- 17.1.15 The width of the trench shall be ample to permit the pipe to be laid and joined properly, and the backfill to be placed and compacted as specified. Trenches shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting and bracing, and handling of specials. No extra payment will be allowed for this work, the cost of which will be included in the Contractor's unit bid prices.
- 17.1.16 Construction in Easements – In easements across private property, the Contractor shall confine all operations to the easement area and shall be responsible and liable for all damage outside of the easement area. Trees, fences, shrubbery or other type of surface improvements located in easements shall be protected during construction. The provisions above shall apply to all easement areas as well as to public rights-of-way. Precautions shall be taken by adequate sheeting or other approved method to prevent any cave-in or disturbance beyond the easement limits or damage to improvements within the easement. In general, the easement area is intended to provide reasonable access and working area for efficient operations to be performed within the restrictions shown on the plans. The Contractor shall be responsible for organizing his operations to perform within the restrictions shown on the plans. When requested, the owner shall make available to the bidders and furnish to the contractor a copy of the construction easements. (See General Specifications).
- 17.1.17 Barricades, Guards and Safety Provisions – To protect persons from injury and to avoid property damage, adequate barricades, construction signs, torches, lanterns and guards as required shall be place and maintained by the Contractor at his expense during the progress of the construction. All material piles, equipment and pipe which may serve as obstructions to traffic shall be enclosed by fences or barricades and shall be protected by proper lights when the visibility is poor. The rules and regulations of O.S.H.A. and appropriate authorities respecting safety provisions shall be observed. (See General Specifications).
- 17.1.18 Protection of Property and Surface Structures – Trees, shrubbery, fences, poles and all other property and surface structures shall be protected during construction operations unless their removal is authorized by the Engineer. Any fences, poles or other manmade surface improvements which are moved or disturbed by the Contractor shall be restored to their original condition, after construction is completed, at the Contractor's expense. Any trees, shrubbery or other vegetation which are approved or ordered for removal by the Engineer shall be removed completely, including stumps and roots, by the Contractor. Responsibility for any damage or claims for damage caused by construction operations to shrubbery or other landscape improvements which were not authorized for removal by the Engineer shall be assumed by the Contractor.

17.2 Construction Materials

17.2.1 Ductile Iron Pipe – Ductile iron pipe shall be manufactured in accordance with ANSI specification A 21.51 (AWWA C151) of latest revision. Joints shall be Bell and Spigot, Push-on (Glamorgan Tyton, American Fastite, Clow Bell-Tite, or equivalent), or mechanical; unless otherwise called for on the proposal form. Pipe will be seal-coated in accordance with ANSI specification A 21.4 (AWWA C104) of latest revision.

17.2.2 All pipes shall have a minimum pressure rating as indicated on the following table, and corresponding minimum wall thickness unless otherwise approved or specified:

Table 17-1. *Ductile Iron Pipe Size and Minimum Pressure Class*

Pipe Sizes (inches)	Minimum Pressure Class (psi)
4 - 12	350
14 - 18	250
24 - 48	200

17.2.3 Joints shall be push-on unless otherwise specified. All fittings shall be standard push-on. Joints shall conform to AWWA C111.

17.2.4 The appropriate gaskets shall be provided for joints. Gaskets for flange joints shall be made of 1/8 inch thick cloth and reinforced rubber gaskets may be ring type of full face.

17.2.5 Interior lining: Ductile iron pipe and fittings shall be lined with polyethylene, calcium aluminates cement or a ceramic epoxy, as specified below:

17.2.5.1 Linings shall cover all exposed surfaces of pipe and fittings subject to contact with sewer liquid or gas.

17.2.5.2 The lining of the pipe barrel shall extend from spigot end through the socket to the edge of the gasket sealing area or recess for pipe using push-on gaskets and to the edge of the gasket seat for mechanical joints.

17.2.5.3 The lining shall also cover the exterior of the spigot end from the end of the pipe to beyond the gasket sealing area.

17.2.5.4 The lining in fittings shall cover the interior surfaces including socket areas. All linings shall be hermetically sealed at the ends.

17.2.6 Lining Materials: Ductile iron pipe shall be lined with one of the following lining systems or an approved equal:

17.2.6.1 Protector 401 Ceramic Epoxy lining as manufactured by Vulcan Chemical Technologies, Inc., with a nominal thickness of 40 mils. The lining shall be installed by an approved applicator in accordance with the manufacturer's specifications.

- 17.2.6.2 American Polybond Plus lining as manufactured by American Ductile Iron Pipe Company with a nominal thickness of 60 mils. The lining shall be installed at the pipe manufacturer's plant and in accordance with their specifications.
- 17.2.6.3 SewperCoat as manufactured by Lafarge Calcium Aluminates. The calcium aluminate lining shall be applied at a minimum thickness of 0.125 inches. Pipe lined with this lining shall be Ductile Iron H2 Sewer Safe pipe as manufactured by Griffin Pipe Products Company. The lining shall be installed at the manufacturer's plant and in accordance with their specifications.
- 17.2.7 Flexible Compression, Factory Fabricated Joints –Couplings and transition fittings must be a Shielded Sewer Mission Flex-Seal ARC or Harco fitting or approved equal.
- 17.2.8 Vitrified Clay Pipe – Vitrified clay pipe is not approved for construction of sanitary sewers.
- 17.2.9 Concrete Pipe – Concrete pipe is not approved for construction of sanitary sewers.
- 17.2.10 Cast Iron Soil Pipe – Cast iron soil pipe is not approved for construction of sanitary sewers.
- 17.2.11 SDR Polyvinyl Chloride (PVC) Pipe – PVC pipe and fittings must meet ANSI/ASTM D 3034-78 and shall be installed in accordance with ANSI/ASTM D 2321-74. Only Class I, II, and III embedment materials, as defined in paragraph 6 in figure 1 may be used in bedding, haunching and initial backfill. Minimum wall thickness for PVC pipe shall be SDR 35 for all sanitary sewer mains and all sanitary sewer laterals.
- 17.2.11.1 Flexible Compression, Factory Fabricated Joints –Couplings and transition fittings must be a Shielded Sewer Mission Flex-Seal ARC or Harco fitting or approved equal.
- 17.2.12 Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe (CCFRPMP)
 - 17.2.12.1 Pipe Material
 - 17.2.12.1.1 Manufacturer shall use only polyester resin systems with a proven history of performance in the application of manufacturing pipe for gravity sewer.
 - 17.2.12.1.2 The reinforcing glass fibers used to manufacture the components shall be of the highest quality E-glass filaments with binder and sizing compatible with impregnating resins.
 - 17.2.12.1.3 Manufacturer shall use silica sand comprised of 98% silica with a maximum moisture content of 0.2%.
 - 17.2.12.2 Construction of CCFRPMP
 - 17.2.12.2.1 The pipe shall be manufactured by the centrifugal cast process.
 - 17.2.12.2.2 The interior surface shall be manufactured using a resin with minimum 50% elongation in accordance with ASTM D638.

- 17.2.12.2.3 The exterior shall be comprised of a sand and resin which provides UV protection with no other special coatings.
- 17.2.12.2.4 The outside diameter shall be in accordance with ASTM D3262 for sizes 18-inch through 48-inch. For other diameters, dimensions will be in accordance with manufacturer's standard dimensions.
- 17.2.12.2.5 Pipe shall be supplied in nominal lengths of 20 feet.
- 17.2.12.2.6 Provide wall thickness in accordance with manufacturer's stated design thickness to provide a minimum pipe stiffness of SN 72 (nominal stiffness of 72 psi) in accordance with ASTM D2412 test method.
- 17.2.12.2.7 The 50-year strain corrosion value shall not be less than 0.9% as determined with ASTM D3681 and ASTM D3262.
- 17.2.12.3 Joints
 - 17.2.12.3.1 The pipe shall be field connected with fiberglass sleeve couplings with elastomeric sealing gaskets. The joints must meet the performance requirements of ASTM D4161.
 - 17.2.12.3.2 The manufacturer shall supply elastomeric gaskets in accordance with ASTM F477.
- 17.2.12.4 The manufacturer shall be HOBAS Pipe, USA or pre-approved equal.
- 17.2.13 Asbestos – Cement Pipe – Asbestos cement pipe is not approved for construction of sanitary sewers.
- 17.2.14 Steel Pipe (Casing) – Steel casing pipe for underground installation by dry bore and jacking shall be manufactured in accordance with ANSI Specification A 53 or latest revision. The steel casing pipe shall be Type S, Grade B, plain end beveled steel contained in USA Standard USAS B36 or latest revision. All steel casing pipe shall be furnished in 20 feet lengths, all joints welded. The minimum wall thickness shall be as follows:

Table 17-2. Steel Pipe (Casing) Diameter and Thickness

Nominal Diameter (inches)	Nominal Thickness (inches)
Under 14	0.188
14 and 16	0.219
18	0.250
20	0.281
22	0.312
24	0.344
26	0.375
28 and 30	0.406
32	0.469
38, 40 and 42	0.500

- 17.2.14.1 Steel casing pipe shall have a minimum yield strength of 35,000 psi.
- 17.2.14.2 When casing pipe is installed without a protective coating and is not cathodically protected, the wall thickness shown above shall be increased to the next standard size.
- 17.2.15 Brick – Common brick shall conform to the specifications of the ASTM, Serial Designation C62, or latest revision.
- 17.2.15.1 Portland Cement concrete brick shall conform to the specifications of the ASTM, Serial Designation C55-71 for grade “N” brick, or latest revision.
- 17.2.15.2 Brick for manholes shall be grade “MS” or equal and shall conform to ASTM C32.
- 17.2.16 Manhole Ring and Cover: All manhole ring and covers shall have bearing surfaces ground so that the covers will fit solidly in all positions and insure a tight fit. This specification is applicable for ductile iron and cast iron castings. Ductile iron castings shall be manufactured from iron conforming to ASTM A536 grade 80-55-06 as noted in section 3.2 of AASHTO M306-04. Cast iron castings shall be manufactured from iron conforming to ASTM A48 Class 35B as noted in section 3.1 of AASHTO M306-04. All manhole ring and covers shall be marked “City of Columbia” and “Sanitary Sewer”. Only heavy duty manhole ring and covers are to be used, and this apply for both traveled and non-traveled way.
- 17.2.16.1 Watertight Manhole Frame and Cover: Where watertight manhole and covers are required, castings for covers shall be as follows:
- East Jordan Iron Works, Inc. (EIJW) model # 1033 HingeCo
 - Neenah Foundry model “Lift Mate”
 - US Foundry model #750-KI.
- 17.2.16.2 Standard Frame and Cover: Standard manhole and covers shall be as follows:
- East Jordan Iron Works, Inc. (EJIW) model # 1045 frame and 1040A cover
 - Neenah Foundry R-1642 ring & cover
 - US Foundry model # 755-NC.
- 17.2.16.3 Additional castings will be reviewed for approval upon request.
- 17.2.16.4 Steps: Steps shall be made of Polypropylene and approximately 12” wide. Steps shall be as manufactured by M.A. Industries model #PSI-PF or approved equal.
- 17.2.16.5 Cleanouts
- 17.2.16.5.1 Cleanouts shall be placed on all sewer service laterals.
- 17.2.16.5.2 The bodies of clean out ferrules shall conform in thickness to that required for pipe and fittings of the same material. The cleanout plug shall be of heavy brass or PVC, not less than one-eighth (1/8) of an inch thick and shall be provided with a recessed socket for removal. Both ferrule and plug shall have ANSI Standard tapered threads.

- 17.2.16.5.3 Clean-outs shall be installed at the property line, right-of-way, or edge of easement for each service connection. Cleanouts shall also be installed at every change in direction of the service line.
- 17.2.16.5.4 Cleanout Box: Cleanout boxes will be marked "Sewer Cleanout" and shall be as follows:
- East Jordan Iron Works, Inc. (EJIW) model #V8502
 - US Foundry model # 7637-VA.
- 17.2.17 Drop Manholes – Where the free drop in manholes exceeds two feet, measured from the invert of the inlet sewer to the invert of the outlet sewer, the Contractor shall construct drop manholes in accordance with detailed plans. Materials and workmanship shall be in accordance with the General Specifications.
- 17.2.18 Precast Concrete Manhole Sections – Precast concrete sections, if used, shall conform to the ASTM Tentative Specifications for Precast Reinforced Concrete Manhole Risers and Tops, Designation C478, with the following exceptions and additional requirements. All precast concrete sections shall be lined as specified hereinbefore for concrete pipe.
- 17.2.18.1 Type II cement shall be used except as otherwise approved.
- 17.2.18.2 Manhole steps are specified under Item 2.9.4. Steps shall be cast into the section as it is made.
- 17.2.18.3 Sections shall be steam cured and shall not be shipped until at least five days after having been cast.
- 17.2.18.4 Minimum wall thickness shall be five (5) inches.
- 17.2.18.5 Acceptance of the sections will be on the basis of material tests and inspection of the completed product.
- 17.2.18.6 Domes shall be of the eccentric type.
- 17.2.18.7 Joints in riser sections shall be gasket type conforming to ASTM Designation C361 series, or others approved by the Engineer.
- 17.2.18.8 No more than two lift holes may be cast or drilled in each section.
- 17.2.18.9 The date of manufacture and the name or trademark of manufacturer shall be clearly marked on the inside of the barrel.
- 17.2.19 Portland Cement Concrete – Portland cement concrete for structures shall conform to Section 701 of the SCDOT Standard Specifications for Highway Construction, latest edition.
- 17.2.19.1 The 28-day compressive strength of concrete shall not be less than 3000 psi which shall be demonstrated by standard compressive tests. Each test shall consist of duplicate cylinders and not less than one test shall be made for each 50 cubic yards. One cylinder

of each pair shall be tested after seven days and shall have a compressive strength of not less than 2000 psi.

- 17.2.19.2 Concrete shall contain not less than six sacks of cement per cubic yard and not more than six gallons of water per sack of cement, including water contained in aggregate.
- 17.2.20 Concrete and Masonry Mortar – This section includes all concrete work required, of every description, shown or specified, including pavements, bedding concrete, thrust blocks, etc.
- 17.2.20.1 All materials incorporated shall conform to the SCDOT Standard Specifications for Highway Construction, latest edition.
- 17.2.21 Reinforcing Steel – Reinforcing steel shall be of new billet steel intermediate grade made by the open hearth process, conforming to the requirements of the “Standard Specifications for Billet Steel Concrete Reinforcement Bars”, Serial Designation C15-33 of the ASTM Designation A615-68. Bars must be deformed in rolling, and the design of the deformation shall be in accordance with ASTM designation A615-68. In addition to the reinforcing indicated on the plans, the Contractor shall furnish all necessary support bars, tie bars, etc., required for properly supporting and spacing the bars in the forms. The reinforcement will be subject to field inspection for rust, shape and dimensions.
- 17.2.21.1 Wire mesh used as reinforcement shall be of the size and spacing shown on the plans. The wire mesh shall comply with ASTM-A-185.
- 17.2.22 Fencing – See Standard Fencing Specifications.
- 17.2.23 Paving Materials- Subbase, base and surfacing materials used for replacing existing pavements or constructing new pavements shall conform to the SCDOT Standard Specifications for Highway Construction, latest edition.
- 17.2.24 Portland Cement Mortar – Portland Cement Mortar shall consist of Portland cement, fine aggregate and water.
- 17.2.24.1 Ingredients – All materials for mortar shall conform to requirements of the SCDOT Standard Specifications where applicable and the following specifications:
 - 17.2.24.1.1 Portland Cement – ASTM Designation C150, Section 501, Concrete Materials.
 - 17.2.24.1.2 Sand – 501.04 Fine Aggregate; Section 501, Concrete Materials.
 - 17.2.24.1.3 Water – 501.06 Water; Section 501, Concrete Materials.
- 17.2.24.2 All equipment, tools and machinery used in mixing and handling mortar shall be approved by the Engineer.

- 17.2.24.3 Composition – The proportions of Portland cement, fine aggregate and water shall be such as to produce a plastic mortar. The workability shall be consistent with the type of work for which it is used in order to secure the best results.
- 17.2.24.3.1 The mortar as specified for the several types of work, shall be proportioned one part cement and three parts by volume fine aggregate.
- 17.2.24.3.2 Proportioning of batches shall be by volume unless otherwise shown on the plans or specified in the Special Provisions. One sack of cement weighing ninety-four (94) pounds shall be considered on (1) cubic foot. Correction for bulking of the fine aggregate shall be made as directed by the Engineer.
- 17.2.24.4 Admixture
- 17.2.24.4.1 Lime – Lime which has been thoroughly air slaked may be added, up to ten (10) percent of the cement content of the mix to increase the workability of the mortar, upon approval of or direction of the Engineer. Lime shall conform to ASTM Specifications, Designation C 141.
- 17.2.24.4.2 Commercial Admixtures – Commercial admixtures to increase the workability of mortar or concrete will not be used unless specifically approved in writing by the Engineer.
- 17.2.25 All other materials, not herein specified shall conform to applicable sections of SCDOT Standard Specifications for Highway Construction, latest edition.

17.3 Construction Methods

- 17.3.1 Order of Construction – The construction of all sewers shall begin at the low point in the line in every case working toward the high point. Each section of sewer pipe shall be specified to be laid to the appropriate line and grade, as designed, working in the upstream direction with the bell end laid upgrade.
- 17.3.2 Excavation in Advance of Construction – The amount of trench excavated approximately to grade shall not exceed one hundred fifty (150) feet, and no trench excavation whatever shall be made farther than three hundred (300) feet in advance of sewer construction, unless specifically authorized by the Engineer.
- 17.3.3 Use of Explosives – Should the Contractor elect to use explosives to loosen rock or for any other purposes in the prosecution of the work, he shall obtain the required permits and the written permission of the Engineer. The City Fire Chief and Police Chief shall be notified. If construction is outside the City Limits, the Contractor shall be responsible for determining whether a County permit is required and for obtaining any permit so required. The Contractor shall be responsible for and shall make good any damage caused by blasting or accidental explosions. All necessary precautions shall be taken by the Contractor as required by Federal and State laws, County regulations, if applicable, City regulations, the Standard Fire Prevention Code and O.S.H.A. Rules and Regulations. (See General Specifications.)

- 17.3.3.1 The hours of blasting will be fixed by the Engineer. Any damage caused by blasting shall be repaired by the Contractor at his expense. The Contractor's methods and procedures in blasting shall conform to Federal and State laws, County regulations, if applicable, City regulations, the Standard Fire Prevention Code and O.S.H.A. Rules and Regulations. (See General Specifications.)
- 17.3.4 Delivery of Materials – Materials delivery shall be so scheduled by the Contractor to provide the least interference and inconvenience to the public.
- 17.3.5 Connections to Other Sewers or to Appurtenances – The connecting of sewers or sewer appurtenances to other sewers or to sewer appurtenances shall be made in accordance with the plans, or under the direction of the Engineer. The work shall be done in a workmanlike manner in such a way as to prevent damage to any of the structures involved. No sewer shall project beyond the inside wall line of other sewer pipe, or of sewer appurtenances unless otherwise shown on the plans.
- 17.3.5.1 Stoppers or Bulkheads – Dead ends of all sewers, wyes, etc. shall be closed with approved stoppers securely cemented in place. When shown on the plans or required by the Engineer, such openings shall be tightly walled up with brick masonry or concrete. Tight fitting stoppers or bulkheads shall be securely placed in or across the end of all sanitary sewer lines when construction is stopped at the end of each day's work or for any other cause. When work is stopped temporarily on sanitary sewers, the end of the pipe shall be closed to prevent trash or debris from entering the pipe. Such stoppers need not be water tight.
- 17.3.6 Sewer Grades – The grade line shown on the plans is the elevation of the invert or flow line of the sewer. The grade line shall be established in the trench by the use of batterboards set at grade stakes not farther than fifty (50) feet apart. Not less than three (3) batterboards shall be maintained in correct position continuously during the construction of the sewer. Batterboards shall be of good, straight, sound material, fastened to substantial stakes or uprights. Batterboards ten (10) feet or less in length shall not be smaller than 1" x 4", and when longer than ten (10) feet shall not be smaller than 1" x 6" or 2" x 4". Stakes shall not be smaller than 2" x 4". Steel stakes may be used when approved by the Engineer. Suitable fine cord or wire, shall be stretched tightly between batterboards over the exact centerline of the sewer. A graduated pole or rod shall be provided for measuring from the cord stretched between batterboards to the bottom of the trench while the trench is being prepared, and to the sewer invert while the sewer is being placed.
- 17.3.6.1 Laser Level – The use of a laser level to establish sewer grade and alignment is permitted as an alternate to the use of batterboards, at the contractor's option.
- 17.3.7 Excavation and Backfill – Excavation and backfill shall include all excavation, backfilling, compacting, disposal of surplus material, restorations of all disturbed surfaces, and all other work incidental to the construction of trenches, including any additional excavation which may be required for manholes or other structures forming a part of the pipe line.

17.3.7.1 Surface Removal – along the proposed pipe lines as indicated on the plans, the Contractor shall remove the surface materials only to such widths as will permit a trench to be excavated which will afford sufficient room for proper efficiency and proper construction. Where sidewalks, driveways, pavements and curb and gutter are encountered, care shall be taken to protect such against fracture or disturbance beyond reasonable working limits. In areas specified on the plans, the top twelve (12) inches shall be piled separately and preserved so that it may be restored after the remainder of the backfill is replaced.

17.3.7.2 Excavation by Hand or Machine – Where working space will permit, trenches may be excavated by machine, provided that by so doing, public and private improvements will not be subjected to an unreasonable amount of damage, otherwise hand excavation shall be employed.

17.3.7.3 Width of Excavation – The bottom width of the trench at and below the top of the pipe, and inside any sheeting and bracing used, shall not be less than the widths shown in the following tables:

17.3.7.3.1 When construction is under an unimproved surface the following table shows the minimum trench widths:

Table 17-3. Unimproved Surface Minimum Trench Width

Pipe Size	Width	Paper Size	Width	Paper Size	Width
6"	2'6"	27"	4'3"	66"	9'1"
8"	2'6"	30"	4'7"	72"	9'8"
10"	2'6"	33"	5'4"	78"	10'3"
12"	2'8"	36"	5'8"	84"	10'10"
15"	2'10"	42"	6'3"	90"	11'5"
18"	3'2"	48"	6'10"	96"	12'0"
21"	3'8"	54"	7'11"	102"	12'7"
24"	4'0"	60"	8'6"	108"	13'2"

17.3.7.3.2 When construction is under an improved surface, the following table shows the minimum trench widths:

Table 17-4. Improved Surface Minimum Trench Width

Pipe Size	Width	Paper Size	Width	Paper Size	Width
6"	3'0"	27"	4'9"	66"	9'7"
8"	3'0"	30"	5'0"	72"	10'2"
10"	3'0"	33"	5'9"	78"	10'9"
12"	3'0"	36"	6'1"	84"	11'4"
15"	3'0"	42"	6'9"	90"	11'7"
18"	3'5"	48"	7'4"	96"	12'6"
21"	3'9"	54"	7'11"	102"	13'1"
24"	4'6"	60"	9'0"	108"	13'8"

17.3.7.3.3 The strength or class of pipe shall be as indicated on the plans or Special Provisions.

- 17.3.7.3.4 Trench sheeting and bracing or a trench shield shall be used when required by the rules and regulations of O.S.H.A. The bottom of the trench excavation shall conform to the details shown on the plan.
- 17.3.7.4 Excavation Below Grade – Where the excavation is carried beyond or below the lines and grades given by the Engineer, the Contractor shall, at his expense, refill all such excavated space with suitable material as approved by the Engineer.
- 17.3.7.5 Rock Excavation - Rock excavation shall consist of igneous, metamorphic and sedimentary rock, concrete or masonry which cannot be excavated without blasting or the use of rippers, hoe-rams, or pavement breakers and all boulders or other detached stones each having a volume of ½ cubic yard or more as determined by physical or visual measurement. If there is not a bid item listed in the proposal form for this excavation, it shall be measured and paid for as Unclassified Excavation.
- 17.3.7.5.1 Rock shall be excavated to a depth of 6 inches below the bottom of the pipe subgrade elevation as shown on the plans or as directed by the Engineer. The Contractor shall backfill to the subgrade elevation with material approved by the Engineer. Such material shall be properly compacted and shaped into the required elevation and cross-section.
- 17.3.7.5.2 Before payment is allowed for rock excavation, the Contractor shall be required to demonstrate that the material cannot be removed “by hand pick” or by power operated excavator or shovel. No payment will be made for Rock Excavation unless the Engineer determines that the material meets the above criteria, and gives written approval for payment prior to excavation.
- 17.3.7.5.3 Should the Contractor elect to use explosives to loosen rock or any other purposes in the prosecution of the work, he shall obtain the required permits and written permission of the Engineer. The City Fire Chief and Police Chief shall be notified. If construction is outside the City limits, the Contractor shall be responsible for determining whether a County permit is required and for obtaining any permit so required. The Contractor’s methods and procedures in the transportation, handling, storage and use of explosives shall comply with requirements of Federal and State laws, County regulations, if applicable, City regulations, the Standard Fire Prevention Code and O.S.H.A. Rules and Regulations. The Contractor shall be responsible for and shall repair at his own expense any damage caused by blasting or accidental explosions.
- 17.3.7.5.4 Blasting for excavation will be permitted only after securing the approval of the Engineer and only when proper precautions are taken for the protection of persons and property. The hours of blasting will be fixed by the Engineer. The Contractor’s methods and procedures in blasting shall conform to requirements of laws and regulations listed in item 3.7.5.
- 17.3.7.6 Subsurface Exploration – All information available to the City, if any, on subsurface conditions will be made available for examination by prospective bidders. However, it is understood and agreed that the City shall in no way be held responsible for interpretation of this information, its accuracy or its thoroughness. Prospective bidders

shall made such subsurface explorations as they believe necessary to verify and supplement information received from the City.

- 17.3.7.7 Exploratory Excavation – Whenever, in the opinion of the Engineer, it is necessary to explore and excavate to determine the best line and grade for construction of the proposed pipe line, the Contractor shall make explorations and excavations for such purposes.
- 17.3.7.8 Braced and Sheeted Trenches – Open-cut trenches shall be sheeted and braced or otherwise protected as required by any governing Federal or State laws and municipal ordinances, and as may be necessary to protect life, property, or the work. In any event, the minimum protection shall conform to the recommendations in O.S.H.A. Safety and Health Standards for Construction. A sand box or trench shield may be used in lieu of sheeting when permitted by O.S.H.A. and approved by the Engineer. When close-sheeting is used, it shall be so driven as to prevent adjacent soil from entering the trench either below or through such sheeting.
 - 17.3.7.8.1 Where sheeting and bracing are used, the trench width shall be increased as directed by the Engineer. The Engineer may order the sheeting driven to the full depth of the trench or to such additional depth as may be required for the protection of the work. Where soil in the lower limits of the trench has the stability to meet the O.S.H.A. standards, the Engineer at his discretion may permit the Contractor to stop the driving of sheeting at such designated elevation above the trench bottom. The granting of permission by the Engineer, however, shall not relieve the Contractor in any degree from his full responsibility under the contract. Sheeting and bracing which have been ordered left in place shall be cut off at the elevation ordered by the Engineer. Trench bracing, except that ordered left in place, may be removed when the backfilling has reached the respective levels of such bracing. Sheeting, except that ordered left in place, may be removed after the backfilling has been completed or has been brought to an elevation that permits its safe removal.
- 17.3.7.9 Trenches With Sloping Sides, Limited – The Contractor may, at his option, where working conditions and rights-of-way permit (as determined by the Engineer), excavate pipe line trenches with sloping sides, but with the following limitations:
 - 17.3.7.9.1 In general, only braced and vertical trenches will be permitted in traveled streets, alleys or narrow easements.
 - 17.3.7.9.2 Where trenches with sloping sides are permitted, the slopes shall not extend below the top of the sewer. Trench excavations below this point shall be made with vertical sides, with widths meeting those specified hereinbefore for the various sizes of pipe.
- 17.3.7.10 Short Tunnels – In some instances, the proximity of trees, fire hydrants, sidewalks and other obstructions may be a hindrance to open-cut excavation. In such cases, the Contractor shall excavate by means of short tunnels in order to protect such obstructions against damage. Such short tunnel work shall be considered incidental to the construction of the pipe line and shall not be grounds for extra payment or payment for

tunnel work. Where such obstructions are shown on the plan, payment will be made at the contract unit price or as extra work in accordance with Item 5.0.

- 17.3.7.11 Piling Excavated Material – All excavated material shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways. Fire hydrants under pressure, valve pit covers, valve boxes, curb stop boxes, or other utility controls shall be left unobstructed and accessible. Gutters shall be kept clear or other satisfactory provisions made for street drainage. Natural watercourses shall not be obstructed.
- 17.3.7.12 Removal of Water – The Contractor shall at all times during construction provide and maintain ample means and devices with which to promptly remove and properly dispose of all water entering and excavations or other parts of the work until all work to be performed therein has been completed. No sanitary sewer shall be used for disposal of trench water, unless specifically approved by the Engineer and then only if the trench water does not ultimately arrive at existing pumping or sewage treatment facilities.
- 17.3.7.13 Structure Protection – Temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers and other obstructions encountered in the progress of the work shall be furnished by the Contractor at his expense and under the direction of the Engineer. The structures which may have been disturbed shall be restored upon completion of the work.
- 17.3.7.14 Deviations Occasioned by Other Structures or Utilities – Wherever obstructions are encountered during construction that require alteration of a plan, the Engineer shall change the plans and order a deviation from the line and grade or arrange with the owners of the structures for the removal, relocation or reconstruction of the obstructions. Where gas, water, telephone, electrical, hot water, steam or other existing utilities are an impediment to the alignment of the proposed pipe line, the Engineer shall order a change in grade or alignment or shall arrange with the owners of the utilities for their removal. If a change in line or grade of a sanitary sewer is necessary, the Engineer will order the addition of any manholes needed. Cost of removal, modification and/or replacement of existing structures or utilities shall be borne by the City.
- 17.3.7.15 Protection of Utilities and Structures – The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures may be determined. Prior to proceeding with trench excavation the Contractor shall contact all utility companies in the area to aid in locating their underground services.
- 17.3.7.15.1 The Contractor shall take all reasonable precautions against damage to existing utilities. However, in the event of a break in an existing water main, gas main, sewer or underground cable, he shall immediately notify the responsible official of the organization operating the utility interrupted. The Contractor shall lend all possible assistance in restoring services and shall assume all cost, charges or claims connected with the interruption and repair of such services if the location of said utility was marked by the owner thereof prior to excavation.

- 17.3.7.15.2 Contractor shall protect all structures from damage during construction.
- 17.3.7.16 Backfill – All sanitary sewer pipe and services shall be bedded on a minimum of 4” of gravel and backfilled with gravel up to the spring line.
 - 17.3.7.16.1 Backfill material above the granular cradle to a point twelve (12) inches above the top of the pipe shall be placed in layers of six (6) inches thickness, loose measure, and each in such manner as not to disturb or injure the pipe. The balance of the backfill material shall be placed in uniform layers of twelve (12) inches thickness, loose measure, and each layer shall be compacted by ramming or tamping with tools approved by the Engineer. All compaction shall not be less than 95% standard proctor, for the soil.
 - 17.3.7.16.2 Where called for on the plans, those areas where sewers are crossing open areas where early settlement is not critical, backfill from 12” from the top of the pipe to the surface, shall be made by any acceptable method which will not dislodge or damage the pipe or cause bridging action in the trench. Only selected excavated material free from clods or stones shall be used in backfilling up to twelve (12) inches above the top of the pipe. Water-soaking or other methods of trench settlement will not be required in this case. Excess material shall be neatly rounded over the top of the trench as directed by the Engineer to allow reshaping of the surface to level out any uneven settlement that may occur.
- 17.3.7.17 Selected Granular Backfill – Where called for on the plans, material conforming to this specification for selected granular backfill shall be laced and compacted in those locations shown on the plans. Where sewers, water mains, or other pipe conduits are constructed under permanent type pavements, driveways or sidewalks, selected granular backfill shall be used to fill the trench to the bottom of the permanent type surface to be reconstructed and shall be compacted by either water jetting or mechanical methods before the permanent surface is constructed.
 - 17.3.7.17.1 Materials for selected granular backfill shall consist of sand, stone sand, crushed stone, pit run or crushed gravel, or crushed boiler slag well graded within the following limits. Selected granular backfill shall be reasonably free from an excess of soft and unsound particles and other objectionable matter.

17.3.7.17.1.1 Selected Granular Backfill

Table 17-5. Granual Backfill Percent Passing by Sieve Size

Sieve Size	Percent Passing							
	1-1/2"	1"	½"	#4	#8	#16	#100	#200
A	100	90-100	60-100	40-80	25-60	20-45		0-15
B		100	60-95	40-60		15-45		5-15
C				84-100			0-40	0-10
D			100	94-100		45-85	0-10	

- 17.3.7.17.1.2 Granular materials from local deposits, graded reasonably close to the limits specified above, and approved by the Engineer, may be used for selected granular backfill.

17.3.7.17.2 At the time of use, the selected granular backfill shall be free of frozen lumps and foreign materials that may have become mixed with it during handling.

17.3.7.18 Granular Cradle – Granular cradle shall be required only where indicated on the drawings or special provisions, or where ordered by the Engineer. Material fro granular cradle shall be stone screenings, crushed stone, pit run gravel, washed gravel, crushed boiler slag or other granular materials approved by the Engineer. Granular cradle shall be well graded within the limits stated below and shall be free from excess of soft or unsound particles or other objectionable matter. The type of granular cradle to be used in specific location will be designated by the Engineer.

17.3.7.18.1 For reasonably good non-granular foundation conditions, Type A, or Type C granular cradle will be designated. Where, in the opinion of the Engineer, the foundation conditions are not suitable for use of one of the above types of granular cradle then Type B granular cradle or concrete cradle may be used. The actual selection is to be made by the Engineer. Granular cradle shall be allowed for separate payment only in the locations where the use of these items is specified or ordered by the Engineer. A change in type of cradle material shall not be made unless a minimum of two (2) cubic yards of material is allowed for payment.

17.3.7.18.1.1 Granular Cradle Gradations

Table 17-6. Granular Cradle Gradations Percent Passing by Sieve Size

Sieve Size	Percent Passing							
	1-1/2"	1"	1/2"	#4	#8	#16	#100	#200
A	100	90-100	60-100	40-80	25-60	20-45	0-15	
B	100	60-95			10-30		0-5	
C	100	60-95	40-60		15-45		5-15	

17.3.7.18.1.2 Granular materials, from local deposits, graded reasonably close to the limits specified above and approved by the Engineer for use as granular cradle may be used.

17.3.7.18.2 Where the natural foundation soil, on which sewer pipes are to be bedded, consists of material suitable in its natural state for shaping and bedding a sewer, no granular cradle will be required. Where granular cradle is not required, the trench ahead of the pipe shall not be excavated below a plane one-twelfth (1/12) the inside diameter of the pipe above the flow line of the sewer. The pipelayer shall excavate the remainder of the trench to conform to the outside of the bottom of the pipe in order that the barrel of the pipe will have a bearing of not less than one-fourth (1/4) of its circumference and for not less than three-fourths (3/4) of its length. Bell holes shall be dug for bell and socket around the pipe from the outside. Under no condition shall they be so shallow that the pipe will be supported by the bell. After the joint is made, the bell hole shall be carefully filled with sand, fine earth or clay without tamping.

17.3.7.19 Unsuitable Soil – When soil conditions require the removal of unsuitable materials below the depth of the bedding shown on the plan, the Contractor shall replace the materials removed with granular cradle of the grade approved by the Engineer.

- 17.3.7.20 Concrete Cradle – Where subgrade conditions, in the opinion of the Engineer, warrant extra precautions for the bedding of pipe the Engineer may order the construction of a concrete cradle in conformance with the size and dimensions indicated on standard detail SSC-4. All concrete used in concrete cradle shall have a minimum compressive strength of twenty-five hundred (2,500) psi at twenty-eight (28) days.
- 17.3.7.21 Compacting Backfill – When called for on the plans, trench backfill shall be compacted by jetting the water-soaking in the manner described below. The trench compaction shall be started at the point of lowest elevation of the trench and worked up along the trench. Jetting and water-soaking shall not begin until the trench has been backfilled to within six (6) inches of the finished surface.
- 17.3.7.21.1 Jet Holes – The holes through which water is injected into the backfill shall be centered over the trench backfill and at longitudinal intervals of not more than six (6) feet. Additional holes shall be provided if deemed necessary by the Engineer to secure adequate settlement. All holes shall be jetted and shall be carried to a point one (1) foot above the pipe. Drilling the holes by means of augers or other mechanical means will not be permitted. Care shall be taken in jetting so as to prevent direct contact with, or other disturbances of the pipe.
- 17.3.7.21.2 Water Soaking – Water required for jetting and water soaking shall be provided as set forth in Special Provisions. The water shall be injected at a pressure and rate just sufficient to sink the holes at a moderate rate. After a hole has been jetted to the required depth, the water shall continue to be injected until it begins to overflow the surface. An approved soil auger shall be used for boring test holes. As soon as the jetting and water soaking has been completed, all holes shall be filled with soil and compacted. Surface depressions resulting from backfill substance caused by jetting and water soaking shall be filled and recompactd by tamping or rolling to the satisfaction of the Engineer.
- 17.3.7.22 Unsuitable Backfill Material – Where there is a deficiency of suitable backfill material, due to a rejection of part or all of the excavated material as unsatisfactory for backfill purposes, and other bedding materials are not specified, the Contractor shall furnish satisfactory backfill material wasted from trench excavation in other locations or from other sources furnished by the Contractor. Backfill furnished and disposal of unsatisfactory material under these circumstances shall not be paid for directly, the cost of which is to be included in other bid items.
- 17.3.8 Tunnel – Where shown on the plans or where specifically authorized by the Engineer, pipe lines shall be constructed in tunnels. This work will be done in accordance with requirements of any permits obtained by the City from railroads or state or county highway departments, or in accordance with the following paragraphs.
- 17.3.8.1 Carrier Pipe materials shall be shown on the plans, in these specifications or as described in the special provisions.

- 17.3.8.2 Requirements for excavation and laying and for joints shall be those applicable for the type of pipe line involved, unless otherwise specified.
- 17.3.8.3 The tunnel shall be only of sufficient width and height to provide free working space. The sides and roof of the tunnel shall be braced sufficiently to support the external loads and to prevent caving, bulging, and settlement of the earth.
- 17.3.8.4 The Contractor shall backfill all tunnels with well compacted sand, fine gravel or stone screenings as rapidly as the conditions permit.
- 17.3.8.5 The backfill material shall be deposited in the tunnel in such a manner as not to injure or disturb the pipe. The filling of the tunnel shall be carried on simultaneously on both sides of the pipe in such a manner that injurious side pressures do not occur. Special care shall be taken to compact the backfill under the haunches of the pipe. The remainder of the tunnel, or such portion of the remainder as may be possible, shall then be backfilled by one of the following methods, at the option of the Contractor, if in the opinion of the Engineer, the method is practicable.
- 17.3.8.5.1 The material shall be deposited in uniform layers not to exceed twelve (12) inches thick (loose measure) and such layer either inundated or deposited in water.
- 17.3.8.5.2 The tunnel shall be backfilled with loose material or only partly backfilled at a time, if necessary, and settlement secured in either case by introducing water through holes jetted into the material to a point approximately two (2) feet above the top of the pipe.
- 17.3.8.5.3 If neither of the above methods is practicable or can be used for only a portion of the backfill, the remainder of the tunnel shall be completely backfilled with material carefully deposited in uniform layers and each layer compacted by ramming or tamping with tools approved by the Engineer.
- 17.3.8.6 When sheeting and bracing have been used, sufficient bracing shall be left across the trench as the backfilling progresses to hold the sides and top firmly in place without caving or settlement before the backfilling material shall be filled in a manner meeting the approval of the Engineer.
- 17.3.8.7 Any depressions which may develop within the area involved in the construction operations due to settlement of the backfilling material shall be filled in a manner meeting the approval of the Engineer.
- 17.3.8.8 Use of Casing Pipe – The Contractor may, subject to the approval of the Engineer, use metal casing pipe as a tunnel liner in place of timber shoring. The diameter, gauge and type of such pipe, method of placing and method of installing carrier pipe within it shall be subject to the approval of the Engineer. The entire void space between tunnel liners and the pipe shall be filled with compacted sand or other approved material if such method of construction is used.
- 17.3.8.9 Jacking or Boring of Pipe – The Contractor may, subject to the approval of the Engineer, use special cast iron pipe bored into position with or without tunnel liners, for tunneled

sections of pipe. In such cases all conditions of performance of the work shall be subject to the approval for the Engineer.

- 17.3.8.10 Restoration of Surfaces – Restoration of surfaces shall include the removal of the existing surface, the disposal of surplus material, and the construction of new surfaces as indicated on the plans or special provisions. The type of surface restoration required shall be shown on the plans or described in the special provisions.
- 17.3.9 Temporary Surface Over Trench – Wherever conduits are constructed under traveled roadways, driveways, sidewalks, or other traveled surfaces, a temporary surface may be placed over the top of the trench as soon as possible after compaction, when approved by the Engineer. The temporary surface shall consist of a minimum of six (6) inches of coarse aggregate conforming to the current specifications of the SCDOT.
 - 17.3.9.1 The top of the temporary surface shall be smooth and meet the grade of the adjacent undisturbed surface. The temporary surface shall be maintained at the Contractor’s expense until final restoration of the street surface is completed as specified. No permanent restoration of street surface shall be initiated until authorized by the Engineer. The temporary surfacing shall be required over the entire width of the trench.
 - 17.3.9.2 Where ordered by the Engineer, dust control over temporary surfaces shall be accomplished by the Contractor.
 - 17.3.9.3 Payment for temporary surface over trench will not be paid for directly, the cost to be included in the items Remove and Replace Pavement, Remove and Replace Driveways and Remove and Replace Sidewalks.
- 17.3.10 Removal of Pavement, Sidewalk, Driveway and Curb – Wherever the pipe is located along or across an improved surface, the width of the trench shall be held as nearly as possible to the width specified. Where brick or concrete pavement, sidewalk, driveway or curbing is cut, the width of the cut will exceed the actual width of the top of the trench, in accordance with Standard Detail SSC-5. Exposed surfaces of Portland cement or asphaltic concrete shall be cut with a pavement saw before breaking. Care shall be taken in cutting to insure that a straight joint is sawed.
- 17.3.11 Replacement of Permanent Type Pavement, Sidewalks, Driveways, Curbs, Gutters and Structures – The Contractor shall restore (unless otherwise specified or ordered by the Engineer) all permanent type pavements, sidewalks, driveways, curbs, gutters, shrubbery, fences, poles and other property and surface structures removed or disturbed during or as a result of construction operations to a condition which is equal in appearance and quality to the condition that existed before the work began. The surface of all improvements shall be constructed of the same material and match in appearance the surface of the improvement which was removed. All work shall be in accordance with applicable details shown on the plans and in these specifications. Any sidewalk or driveway crossing a sidewalk is removed, it shall be replaced in accordance with latest version of ADA requirements.

- 17.3.11.1 Materials shall conform to SCDOT Standard Specifications for Highway Construction, latest edition.
- 17.3.12 Sewer Pipe Laying – Laying of sewer pipe shall be accomplished to line and grade in the trench only after it has been dewatered and the foundation and/or bedding has been prepared. Mud, silt, gravel and other foreign material shall be kept out of the pipe and off the jointing surfaces.
- 17.3.12.1 All pipe laid shall be retained in position so as to maintain alignment and joint closure until sufficient backfill has been completed to adequately hold the pipe in place. All pipe shall be laid to conform to the prescribed line and grade shown on the plans, within the limits that follow. At least three batterboards shall be maintained in position during all pipe laying operations, unless a laser beam is used.
- 17.3.12.2 Variance from established line and grade shall not be greater than one thirty-second ($1/32$) of an inch, per inch of pipe diameter and not to exceed one-half ($1/2$) inch provided that any such variation does not result in a level or reverse sloping invert; provided also, that variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed one sixty-fourth ($1/64$) inch per inch of pipe diameter, or one-half ($1/2$) inch maximum.
- 17.3.12.3 The sewer pipe, unless otherwise approved by the Engineer, shall be laid up grade from point of connection on the existing sewer or from a designated starting point. The sewer pipe shall be installed with the bell end forward or upgrade, unless approved otherwise. When pipe laying is not in progress the forward end of the pipe shall be kept tightly closed with an approved temporary plug.
- 17.3.13 Sewer Pipe and Water Main Separation – Sanitary sewers, house sewers or storm drains that are laid in the vicinity of pipe lines designated to carry potable water shall meet the following conditions:
- 17.3.13.1 Parallel Installation – Sewers and Water Mains – Normal Conditions – Any sanitary sewer, storm sewer or sewer manhole shall be located at least ten feet horizontally from water mains, whenever possible; the distance shall be measured from edge to edge.
- 17.3.13.2 Unusual Conditions – When local conditions prevent a horizontal separation of ten feet, a storm or sanitary sewer may be laid closer to a water main provided that:
- 17.3.13.2.1 The bottom of the water main is at least 18 inches above the top of the sewer.
- 17.3.13.2.2 Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction.
- 17.3.13.3 Crossing – Sewers and Water Mains – Normal Conditions – Water mains crossing house sewers, storm sewers or sanitary sewers shall be laid to provide a separation of at least 18 inches between the bottom of the water main and the top of the sewer.

- 17.3.13.4 Unusual Conditions – When local conditions prevent a vertical separation of 18”, the sanitary sewer shall be constructed of cast iron pipe meeting water main specifications.
- 17.3.14 Sewer Line Connections – No existing sewer shall be connected to a sanitary sewer unless specifically authorized in each instance by the Engineer. Storm drains and drain tiles shall not be connected to a sanitary sewer.
- 17.3.15 Service Wyes and Risers – Where the depth of the sewer invert is greater than twelve (12) feet below the surface of the ground, a service riser shall be constructed to an elevation as shown in the plans or as directed by the Engineer.
 - 17.3.15.1 The service riser shall be constructed with a minimum six (6) inch wye branch as shown on the standard detail No.SSC-7, or as shown in the plans.
 - 17.3.15.2 The riser pipe shall extend to the proper elevation and shall terminate with a manufactured plug.
 - 17.3.15.3 Extreme care shall be taken in backfilling around risers. Where the excavated material is not suitable for this purpose in the opinion of the Engineer, granular material shall be placed around the riser.
- 17.3.16 Sewer Manholes – Sewer manholes shall be constructed so that no water pipe or other conduit is in contact with or enclosed by any part of a sewer or sewer manhole.
 - 17.3.16.1 Manholes shall be leak-tight and may be constructed of precast units, Portland cement concrete brick or cast-in-place concrete, all in accordance with plans and these specifications.
 - 17.3.16.2 Strength – All concrete used in manhole construction shall have a minimum compressive strength of thirty-five hundred (3,500) psi at twenty-eight (28) days. Strength determination shall be in accordance with ASTM C39, unless otherwise approved by the Engineer.
 - 17.3.16.3 Steps – Manhole steps shall be furnished and installed as shown on the plans.
 - 17.3.16.4 Cast-in-Place Bases – Unless otherwise specified, cast-in-place bases shall be at least six (6) inches in thickness and shall extend at least six (6) inches radially outside of the outside dimension of the manhole section.
 - 17.3.16.5 Brick Manholes – Brick manholes are not approved for sanitary sewer construction.
 - 17.3.16.6 Precast Manholes – Precast manholes shall be constructed with a cast-in-place base as specified.
 - 17.3.16.6.1 Precast base sections are not approved.
 - 17.3.16.6.2 All lift holes in precast elements for sanitary sewer manholes shall be completely filled with an approved bitumastic material. All joints between precast elements on sanitary

sewer manholes shall be made with an approved bitumastic material with a minimum 12" width or an approved rubber gasket.

- 17.3.16.6.3 The first precast section shall be placed on the monolithic base structure before the base has taken initial set, and shall be carefully adjusted to true grade and alignment with all inlet pipes properly installed so as to form an integral watertight unit; or the section shall be mortared into a suitable groove provided in the top of the monolithic base. The first section shall be uniformly supported by the base concrete, and shall not bear directly on any of the pipes.
- 17.3.16.6.4 Precast sections shall be placed and aligned to provide vertical sides and vertical alignment of the ladder rungs. The completed manhole shall be rigid, true to dimensions, and be watertight. In areas where the ground water table is expected to reach above the invert of the sanitary sewer manholes, the exterior of the manhole shall be sealed with bitumastic material if called for in the special provisions.
- 17.3.16.7 Inlet and Outlet Pipe – Pipe or tile placed in the masonry for inlet or outlet connections shall extend through the wall and beyond the outside surface of the wall a sufficient distance to allow for connections, and the masonry shall be carefully constructed around them so as to prevent leakage along the outer surfaces. Openings must be core-drilled in the wall of the manhole.
- 17.3.16.8 Excavating and Backfilling Manholes – In order to permit the joints to be mortared properly and also to permit proper compaction of the backfill material, the excavation shall be made to a diameter of at least six (6) inches greater than the diameter of the structure.
- 17.3.16.9 Placing Castings – Castings placed on concrete or masonry shall be bolted to the manhole and set in full mortar beds. The mortar shall be mixed in proportion of one (1) part cement to three (3) parts sand, by volume, based on dry materials. Castings shall be set accurately to the finished elevation so that no subsequent adjustment will be necessary.
- 17.3.16.10 Manholes in Paved Streets – Where work is in paved streets or areas which have been brought to grade, not more than sixteen (16) inches shall be provided between the top of the cone or slab and the underside of the manhole casting ring for adjustment of the casting ring to street grade.
- 17.3.16.11 Streets or Alleys With No Established Grade – The top of the manhole casting shall be flush with the street surface unless otherwise directed by the Engineer.
- 17.3.17 Fittings – Service sewers shall be connected to the wye, or riser provided in the public sewer where such is available, utilizing approved fittings or adapters. Where no wye, or riser is provided or available, connections shall be made by machine-made tap and suitable saddle, or other method approved by the Engineer.
- 17.3.18 Cleanouts – Cleanouts are not approved for construction on the Columbia Sewer System.

- 17.3.19 Pipe Covering and Embankment – This section of the specifications applies to the construction of pipe covering and embankment. Pipe covering shall be constructed where the invert of the pipe is so shallow that placing of earth over the pipe becomes necessary to provide a minimum depth of cover. Pipe cover and embankment shall be constructed where the invert of the pipe is above the existing ground and it becomes necessary to construct an embankment upon which the pipe and pipe covering is to be placed. The embankment and cover shall be constructed to lines shown on the drawings.
- 17.3.19.1 Pipe Bed – The area upon which the embankment for the pipe bed is to be placed shall be stripped to the extent the Engineer directs to provide a firm bedding.
- 17.3.19.1.1 The embankment upon which the pipe is to be installed shall be constructed up to the springing line in six (6) inch lifts, each lift being compacted to a density equal to ninety-five percent (95%) of AASHTO T99 density. The material used in constructing the embankment shall be such that it will readily compact to required density. The Contractor may use any type of compacting equipment he wished provided the required end result is obtained, and provided no damage occurs to surface or subsurface improvements.
- 17.3.19.1.2 Pipe Cover – The pipe cover material above compacted embankment shall be placed without compaction, and shall be shaped to the required section.
- 17.3.19.1.3 Source of Material – The source of material shall be that which is specified in the special provisions.

17.4 Testing for Acceptance of Sanitary Sewers

- 17.4.1 Testing sanitary sewers for acceptability shall be conducted by the infiltration testing technique, as specified or approved by the Engineer.
- 17.4.2 Test Sections – Unless otherwise specified or directed by the Engineer the first section of sanitary sewer constructed of approximately 1,200 feet in length or the entire length of the sewer if it is less than 1,200 feet shall be tested by the infiltration method before additional excavation is permitted.
- 17.4.2.1 The Contractor may, at his option, divide the first section of sewer into subsections of more convenient length for testing. If the section or subsection tested does not pass the leakage tests it shall be repaired and the test repeated until a satisfactory test is obtained. Excavation shall not proceed beyond the first 1,200 feet test section until test results for the entire 1,200 feet are satisfactory.
- 17.4.3 Allowable Leakage for Sanitary Sewer – Infiltration flow shall be measured by a 90 degree V notch weir with free fall discharge or other means acceptable to the Engineer. All gravity sewer shall be designed and specified such that the leakage outward (exfiltration) or inward (infiltration) shall not exceed two hundred (200) gallons per inch of pipe diameter per mile per day.
- 17.4.3.1 The result in infiltration tests shall be certified by a registered professional engineer.

17.5 Measurement and Payment

- 17.5.1 Work under this section will be measured and paid for as specified below. Wherever units of measure, i.e., lineal feet, each, and similar units of measurement are mentioned in the proposal, it shall be interpreted to mean the unit installed in accordance with the plans and specifications, and ready for use.
- 17.5.2 Sewer Pipe – Sewer pipe will be measured from center to center of manholes and depth of cut from invert to original ground line at centerline. The original ground line will be determined immediately prior to the beginning of trench excavation. It is the Contractor’s responsibility to notify the Engineer 24 hours in advance so that the Engineer may take measurements.
- 17.5.2.1 Payment will be made at the unit prices per lineal foot as stated in the proposal for the type of pipe specified, including pipe placed in steel casing pipe, and shall include cost of all necessary materials, tools, equipment, excavation, bedding, backfilling, cleanup, testing, etc.
- 17.5.3 Ductile Iron Sewers – Where ductile iron pipe is shown in lieu of vitrified clay sewer pipe, measurement and payment will be made in accordance with Item 5.2.
- 17.5.3.1 Cast Iron Sewers in Steel Casing Pipe – Where PVC and/or ductile iron pipe is placed in steel casing pipe, measurement will be along the centerline of the pipe.
- 17.5.3.1.1 Payment will be made at the unit bid price per lineal foot and shall include all necessary materials, tools and equipment necessary to install and grout the ductile iron carrier pipe inside the casing. The unit bid price does not include the casing pipe. See Sections 2.1 and 2.2.
- 17.5.3.2 Ductile Iron Sewers in Tunnels – When ductile iron pipe is placed in tunnels, measurement will be along the centerline of the pipe.
- 17.5.3.2.1 Payment will be made at the unit bid price per lineal foot and shall include all necessary materials, tools and equipment necessary to install and grout the cast iron carrier pipe inside the tunnel lining. Unit bid price does not include the tunnel. See Section 5.8.
- 17.5.4 Service Sewers – Measurement shall be along the pipe from the outside surface of the main sewer to the extreme end of the last pipe or fitting placed. Measurement shall be to the nearest one (1) foot.
- 17.5.4.1 Measurement for service risers shall be from invert of the service wye to the top of the riser fitting along the centerline of the pipe. Measurement shall be to the nearest one (1) foot.
- 17.5.4.2 Payment for SERVICE SEWERS shall be at the unit contract price per lineal foot for SERVICE SEWERS of the size indicated. Payment for WYES shall be at the unit contract price per each. Payment for SERVICE RISERS shall be at the unit contract price per foot for SERVICE RISERS of the size indicated. Bends, adapters and plugs shall be considered

as incidental to the construction and all costs thereof shall be included in other pay items of the proposal.

- 17.5.4.3 Payment for cut-in connections to main sewers where no wye branch exists shall be at the contract unit price for wye branches.
- 17.5.5 Manholes – Manholes more than six (6') feet in depth shall be measured to the nearest one-tenth (0.10) of a foot, from invert of the outlet pipe vertically to the top of the casting, for the purpose of determining the additional depth of manhole to be paid for at the unit bid price per vertical foot in addition to the base price for each.
 - 17.5.5.1 Drop manhole connections shall be measured to the nearest one-tenth (0.10) of a foot, from invert of the inlet pipe to the invert of the manhole.
 - 17.5.5.2 Payment for each MANHOLE shall consist of a basic price per each, complete with frame, cover, base and steps, plus a unit price per foot, for all depth in excess of six (6') feet, plus a unit price per vertical foot for each DROP MANHOLE CONNECTION where they occur. Where more than one (1) type or size designation is shown on the drawings or called for in the special provisions, each shall be covered by a separate bid item of the following form:
 - 17.5.5.2.1 "Type------(or size) MANHOLE, each.
 - 17.5.5.2.2 ADDITIONAL DEPTH OF MANHOLE, per vertical foot.
 - 17.5.5.2.3 DROP MANHOLE CONNECTION, per vertical foot.
 - 17.5.5.3 The unit contract prices shall be full compensation for furnishing and constructing manholes, complete in place, including excavation and connection to existing sewers.
- 17.5.6 Watertight Manhole Frame and Cover – The unit bid price for the item WATERTIGHT MANHOLE FRAME AND COVER shall include all labor, tools, materials and equipment for furnishing and installing this lid in lieu of a standard manhole ring and cover.
- 17.5.7 Steel Casing Pipe – The payable boring footage will be the distance shown on the plans or as specified by the Engineer. The unit bid price per lineal foot of STEEL CASING PIPE shall include all labor, materials, tools, and equipment necessary to install the casing. (See Section 2.8). Unit bid price does not include the carrier pipe.
- 17.5.8 Tunnel – TUNNEL will be paid for at the unit prices bid per lineal foot for TUNNEL for the various type and sizes for the actual length of tunnel work as shown on the plans. Payment shall include all labor, materials and equipment necessary to construct the tunnel, complete in place, including excavation and backfill, shoring and bracing, furnishing and laying casing pipe where required and all other work necessary for a complete installation. Unit bid price does not include the carrier pipe.
- 17.5.9 Concrete Cradle – Measurement shall be made along the centerline of the pipe and the pay quantity shall be determined from Standard Detail SSC#6 attached.

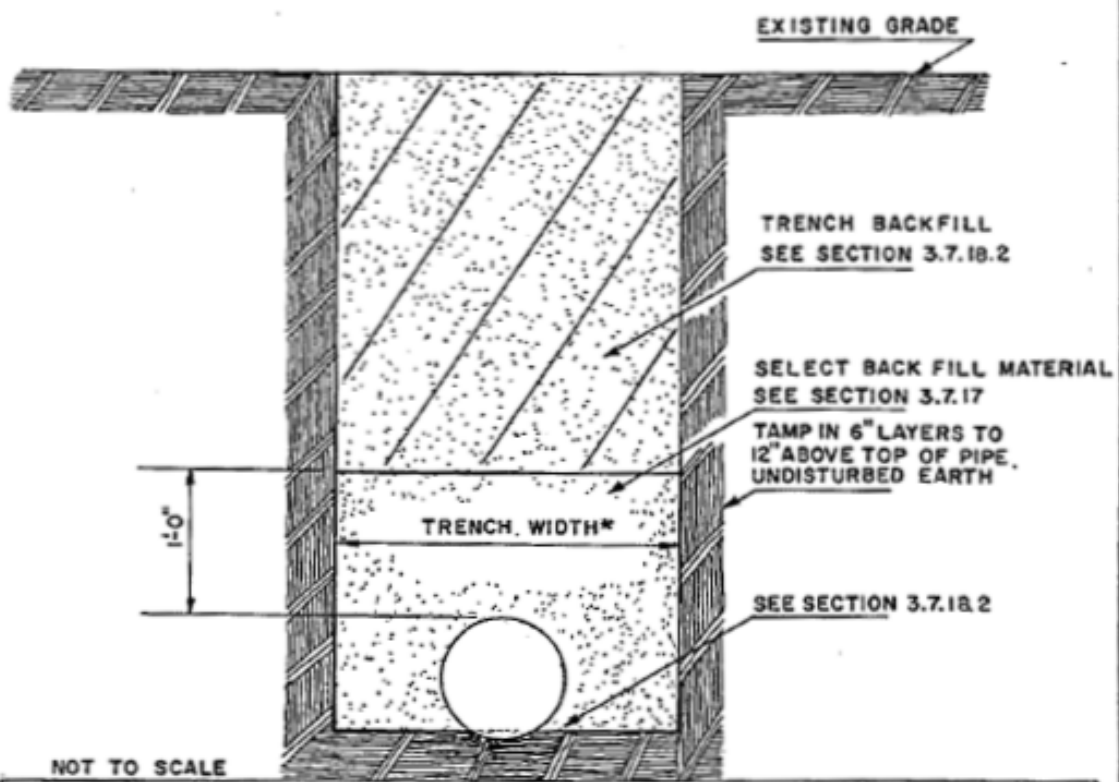
- 17.5.9.1 Payment for furnishing CONCRETE CRADLE shall be made at the contract unit price per cubic yard for CONCRETE CRADLE. The contract price for CONCRETE CRADLE shall also include the cost of removing and disposing of the material replaced by the CONCRETE CRADLE. Unit price does not include the pipe.
- 17.5.10 Concrete Encasement – Measurement shall be made along the centerline of the pipe and the pay quantity shall be determined from Standard Detail SSC #6 attached.
- 17.5.10.1 Payment for furnishing CONCRETE ENCASEMENT will be at the unit price per cubic yard of class of concrete stated in the proposal, such price to be paid in addition to that paid per foot of sewer for the various depths encountered. The unit price stated in the proposal shall include the cost of additional depth of excavation, the furnishing and placing of concrete and laying of pipe to line and grade on bricks. See Standard Detail SSC #2.
- 17.5.11 Granular Cradle – Measurement of GRANULAR CRADLE shall be made by the cubic yard in place, based on the quantities per lineal foot for the respective size of conduit, as shown on Standard Detail SSC #6.
- 17.5.11.1 Payment for GRANULAR CRADLE shall be made at the contract unit price per cubic yard for the type of GRANULAR CRADLE used. The contract unit price for GRANULAR CRADLE shall also include the cost of removing and disposing of the materials replaced by the GRANULAR CRADLE.
- 17.5.11.2 When ordered by the Engineer, payment for additional depth of GRANULAR CRADLE shall be made at the contract unit price per cubic yard for GRANULAR CRADLE measured in place.
- 17.5.12 Selected Granular Backfill – Measurement shall be made along the centerline of the pipe and the pay quantity shall be determined from Standard Detail SSC #6 attached.
- 17.5.12.1 Payment shall be made at the contract unit price per cubic yard for SELECTED GRANULAR BACKFILL. SELECTED GRANULAR BACKFILL in excess of the maximum quantity as herein specified shall be furnished and placed by the Contractor at his own expense.
- 17.5.13 Crushed Stone – CRUSHED STONE, to be used in stabilizing the bottom of trenches, etc., will be measured and paid for per ton at the unit priced bid by the Contractor for CRUSHED STONE, which price shall include the material and the labor incident to the placing of the stone and any additional extra depth of trench or excavation necessary to accommodate the CRUSHED STONE.
- 17.5.14 Unclassified Excavation – UNCLASSIFIED EXCAVATION will not be paid for separately, the cost of which shall be included in the unit price for other items of work.
- 17.5.14.1 When the removal of existing structures or materials is classified separately as a contract pay item, payment will be made in accordance with the contract price; otherwise such work will be considered as incidental work and will not be paid for directly, but its cost

shall be included in the unit price for other items of work. In either case, such price or prices shall be full compensation for all labor, materials, tools, equipment and incidentals necessary to complete the work and in the case of pavement cut and removal, shall include the cost of the required permit for cutting pavement, unless cost of permit fees are included as a bid item in the proposal.

- 17.5.15 Exploratory Excavation – The cost of such excavation, where ordered by the Engineer, will be paid at the contract unit price per cubic yard for “EXPLORATORY EXCAVATION”.
- 17.5.16 Rock Excavation – Where ROCK EXCAVATION is to be measured for payment, quantities will be determined by the Engineer. Rock required to be removed shall be computed by the cubic yard. Dimensions for pay purposes shall be the difference in elevation between the top and bottom of the rock as determined by the Engineer and the specified ditch width for the pipe size being laid. Where rock is encountered in the bottom of the trench, the maximum depth for payment purposes will be six (6) inches below the bottom of the pipe.
 - 17.5.16.1 Payment shall be made at the contract unit price per cubic yard for ROCK EXCAVATION. These process shall be full compensation for furnishing all materials, for all preparation and excavation of rock, for backfilling the excavated trench to the bottom of the pipe which selected backfill material (3.7.22), and for all labor, equipment, tools and incidentals necessary to complete the item.
- 17.5.17 Remove and Replace Paving – Where excavation in pavement is required the work will be paid for at the unit bid price per lineal foot for REMOVE AND REPLACE PAVEMENT and shall be measured along the centerline of construction. Extra width will not be measured for payment.
 - 17.5.17.1 The unit bid price for this time includes all labor, tools, equipment and materials necessary to complete the work. The unit bid price shall also include the cost of using flowable fill as backfill material and/or compaction to 95% maximum density as determined by AASHTO T-9 procedures. All compaction testing shall be certified by an approved laboratory. The unit bid price shall also include the cost of removing all paving materials which are not suitable for backfilling the trench from the job. There will be no extra payment for any of the above work, the cost of which shall be included in the unit bid price for “Remove and Replace Paving”.
- 17.5.18 Remove and Replace Asphalt Drive and Remove and Replace Concrete Drive – This work will be paid for at the unit bid price per lineal foot for REMOVE AND REPLACE ASPHALT DRIVEWAY or REMOVE AND REPLACE CONCRETE DRIVE. Measurement for payment will be along the centerline of construction. Extra width will not be measured for payment.
 - 17.5.18.1 The unit price bid for this item shall include all labor, tools, equipment and materials necessary to accomplish the work and shall include the cost of removing all paving materials which are not suitable for backfill in the trench from the job.

- 17.5.19 Resurface Existing Pavement – Payment for RESURFACING EXISTING PAVEMENT will be made at the unit bid price per square yard in accordance with field measurements of area made by the City Engineer. The Contactor shall furnish the Engineer all asphalt weight tickets at the time the work is accomplished. The computed yield, arrived at by dividing the weight of asphalt used by the measured area shall be a minimum of 150 pounds per square yard. In those areas where the work is acceptable to the State Department of Public Transportation and the City Engineer, yet the computed yield is less than 150 pounds per square yard, payment will be made for the item in direct ratio of the square of the actual yield to the square of 150 pounds per square yard.
- 17.5.20 PC Concrete Sidewalk – Concrete sidewalk shall be measured for payment based on the amount of sidewalk ordered removed and replaced by the Engineer. The width used for computing quantities shall be the actual width of the sidewalk unless specified otherwise by the Engineer. The unit bid price per square foot for this item will be complete payment for the above work.
- 17.5.21 Sheeting and Bracing – Payment for SHEETING AND BRACING, except when ordered left in place, and all other work incidental to SHEETING AND BRACING shall not be made separately unless specified or as shown on the plans or as directed by the Engineer, but shall be included in the contract price for other items.
- 17.5.21.1 Payment for timber sheeting ordered left in place shall be made at the contract unit price per 1,000 board feet of TIMBER SHEETING LEFT IN PLACE.
- 17.5.21.2 Payment for STEEL SHEET PILING when specified shall be made at the contract unit price per square foot for STEEL SHEET PILING.
- 17.5.21.3 Payment for STEEL SHEET PILING ordered left in place shall be made at the contract unit price per square foot for STEEL SHEET PILING LEFT IN PLACE.
- 17.5.22 Sodding, Fertilizing and Seeding – Measurement of surfaces to be sodded or seeded shall be made of the area within the rights-of-way designated by the Engineer for restoration. Payment shall be made at the contract unit bid price to the nearest one-tenth (0.10) acre, for FERTILIZING AND SEEDING of class specified. The cost of restoring areas beyond the right-of-way, designated by the Engineer, shall be borne by the Contractor.
- 17.5.23 Connections to Other Sewers or to Appurtenances – The lump sum price for making connections to other sanitary sewers and appurtenances shall be full compensation for removing, repairing and/or replacing pipe and/or structures and shall be full compensation for the completed work in place including all materials, labor, tools and equipment.

STANDARD DITCH BACKFILL DETAIL



NOT TO SCALE

	MIN. TRENCH WIDTH					
PIPE SIZE I.D.	6" THRU 10"	12"	15"	18"	21"	24"
TRENCH WIDTH*	2'-6"	2'-8"	2'-10"	3'-2"	3'-8"	4'-0"
TRENCH WIDTH WITH BRACING	3'-2"	3'-4"	3'-6"	3'-10"	4'-4"	4'-8"

TRENCH WIDTH DIMENSIONS ARE FROM THE INSIDE OF THE SHEETING AND BRACING AND AT AND BELOW THE TOP OF THE PIPE.

SEE SECT. 3.7.3 FOR PIPE OVER 24" DIA.



REVISED: 2-21-94

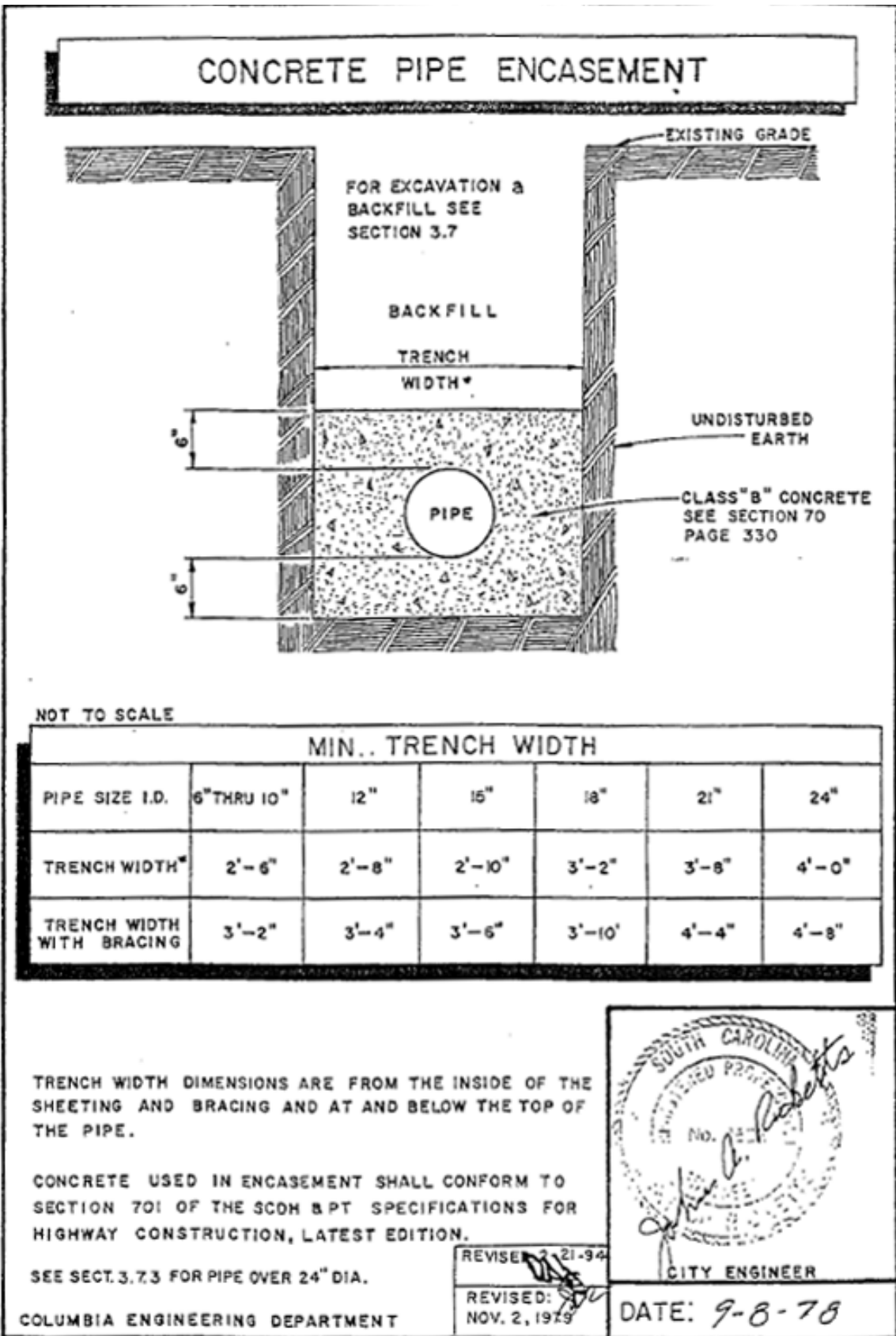
 REVISED:
 NOV. 2, 1979

CITY ENGINEER
 DATE: 9-8-78

COLUMBIA ENGINEERING DEPARTMENT

STANDARD DETAIL SSC # 1

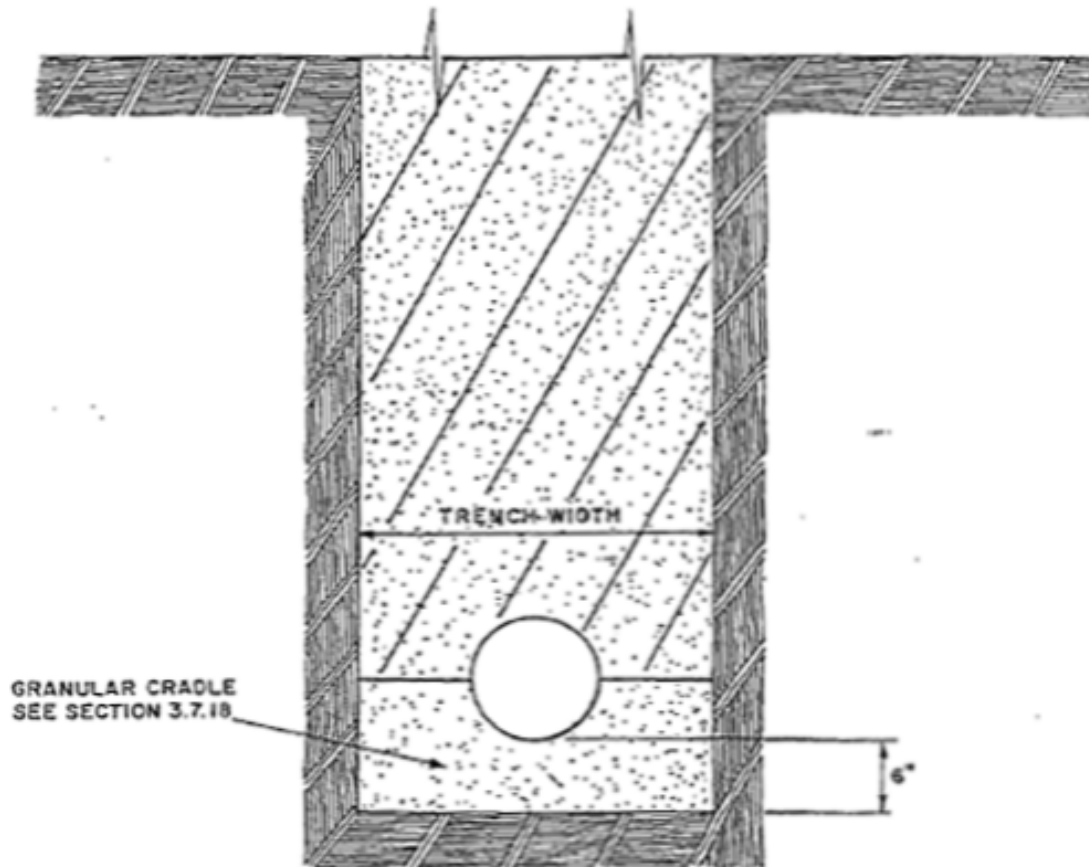
Figure 17-1. Standard Ditch Backfill Detail



STANDARD DETAIL #SSC 2

Figure 17-2. Concrete Pipe Encasement

GRANULAR CRADLE



LIMITS FOR EXCAVATING FOR PAYMENT PURPOSES ARE AS SHOWN IN TABLE I ANY EXCAVATION BEYOND THESE LIMITS WILL BE BACKFILLED WITH A SUITABLE MATERIAL AS APPROVED BY THE ENGINEER.

FOR MINIMUM TRENCH WIDTH SEE SECTION 3.7.3.

COLUMBIA ENGINEERING DEPARTMENT

REVISED: 2-21-94

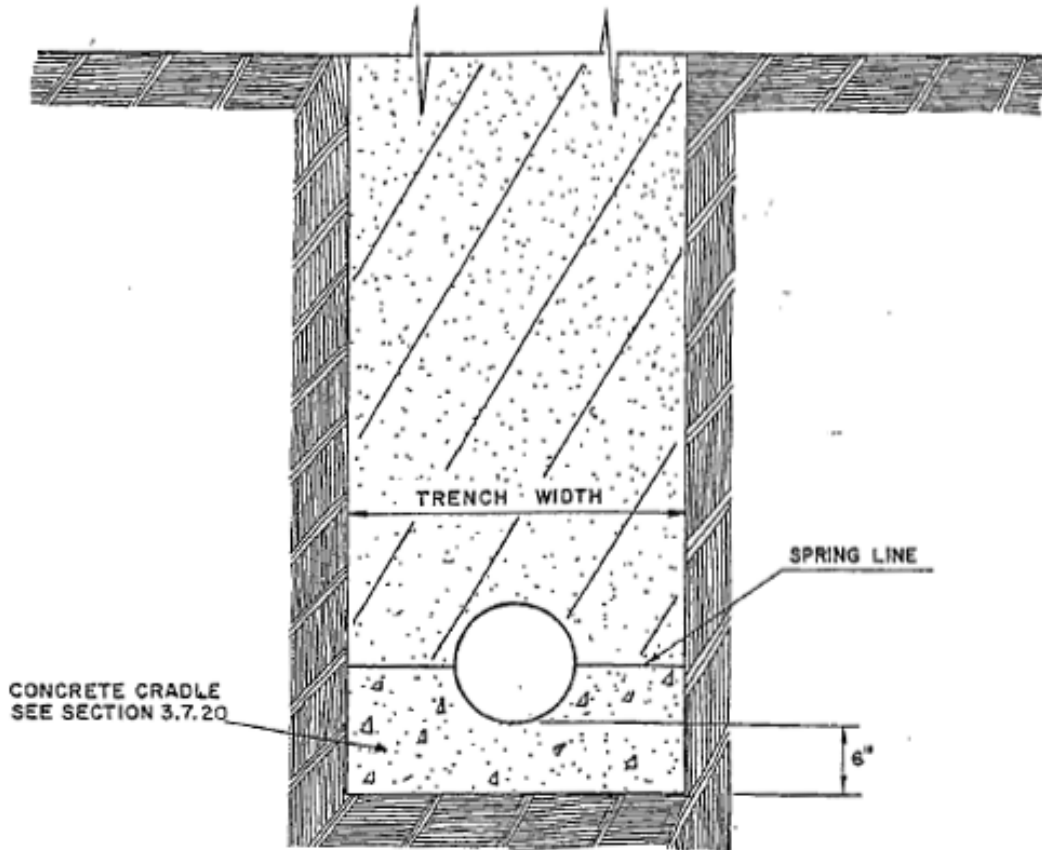


REVISED: *SP*
NOV. 2, 1979

DATE: 9-8-78

Figure 17-3. Granular Cradle

CONCRETE CRADLE



CONCRETE CRADLE
SEE SECTION 3.7.20

TRENCH WIDTH

SPRING LINE

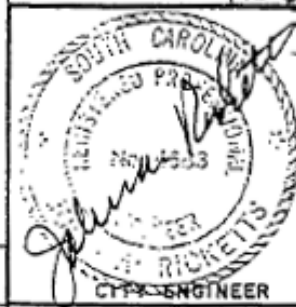
6"

LIMITS FOR EXCAVATING FOR PAYMENT PURPOSES ARE AS SHOWN
IN TABLE I ANY EXCAVATION BEYOND THESE LIMITS WILL
BE BACKFILLED WITH A SUITABLE MATERIAL AS APPROVED BY
THE ENGINEER.

FOR MINIMUM TRENCH WIDTH SEE SECTION 3.7.3

COLUMBIA ENGINEERING DEPARTMENT

REVISED: 2-21-94



REVISED: *[Signature]*
AUG. 15, 1990

REVISED: *[Signature]*
NOV. 2, 1977

DATE: 9-8-78

STANDARD DETAIL SSC#4

Figure 17-4. Concrete Cradle

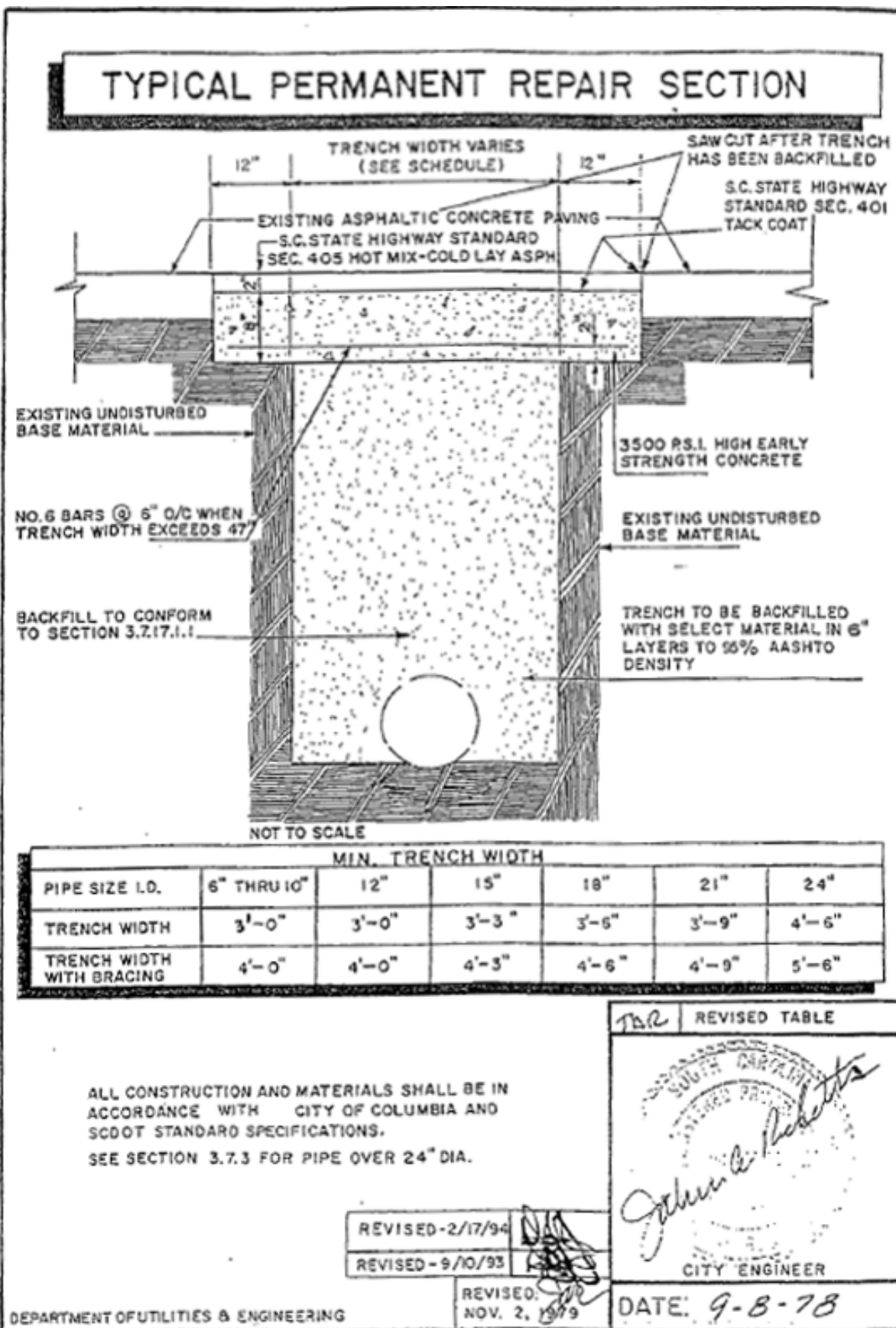


Figure 17-5. Typical Permanent Repair Section

GRANULAR/CONCRETE CRADLE VOLUMES

TABLE I

INSIDE DIAMETER OF CONDUIT IN INCHES "D"	MINIMUM TRENCH WIDTH AT TOP OF CONDUIT	PAYMENT QUANTITIES PER FOOT OF CONDUIT						
		GRANULAR CRADLE CONCRETE CRADLE CU. YDS./FT.	PERMANENT TYPE PAV'T REMOVAL AND REPLACEMENT SQ. YDS. PER FT.	CONCRETE FOR PERMANENT TYPE REPLACEMENT REPAIR CU. YDS. PER FOOT	CONCRETE PIPE PROTECTION CU. YDS./ FT.	SELECT BACKFILL CU. YDS./ FT. OF DEPTH	CONCRETE ENCASEMENT CU. YDS./ FT.	TEMPORARY COURSE AGGREGATE SURFACE CU. YDS./ FT.
6	2'-6"	0.07	0.56	0.13	0.07	0.09	0.14	0.05
8	2'-6"	0.07	0.56	0.13	0.07	0.09	0.14	0.05
10	2'-6"	0.08	0.56	0.13	0.08	0.09	0.16	0.05
12	2'-8"	0.09	0.57	0.13	0.09	0.10	0.18	0.05
15	2'-10"	0.09	0.61	0.13	0.09	0.10	0.18	0.05
18	3'-2"	0.12	0.64	0.14	0.12	0.12	0.24	0.06
21	3'-6"	0.15	0.69	0.15	0.15	0.14	0.30	0.07
24	4'-0"	0.17	0.73	0.16	0.17	0.15	0.34	0.07
27	4'-3"	0.19	0.75	0.17	0.19	0.16	0.38	0.08
30	4'-7"	0.21	0.80	0.18	0.21	0.17	0.42	0.09
33	5'-4"	0.27	0.88	0.20	0.27	0.20	0.54	0.10
36	5'-8"	0.29	0.92	0.20	0.29	0.21	0.58	0.11
42	6'-3"	0.35	0.98	0.22	0.35	0.23	0.70	0.12
48	6'-10"	0.40	1.05	0.23	0.40	0.25	0.80	0.13
54	7'-11"	0.51	1.17	0.25	0.51	0.29	1.02	0.15
60	8'-6"	0.58	1.23	0.27	0.58	0.31	1.16	0.16
66	9'-1"	0.65	1.30	0.29	0.65	0.33	1.30	0.17
72	9'-8"	0.72	1.30	0.30	0.72	0.36	1.44	0.18
78	10'-3"	0.79	1.43	0.32	0.79	0.38	1.58	0.19
84	10'-10"	0.86	1.49	0.33	0.86	0.40	1.72	0.20
90	11'-5"	0.94	1.56	0.35	0.94	0.42	1.88	0.21
96	12'-0"	1.02	1.64	0.36	1.02	0.44	2.04	0.22
102	12'-7"	1.10	1.68	0.38	1.10	0.47	2.20	0.24
108	13'-2"	1.19	1.75	0.39	1.19	0.49	2.38	0.25

PAVEMENT REPLACEMENT BASED ON 8" THICK CONCRETE SLAB. PIPE FROM 6" TO 36" IS DIMENSIONED FOR VCP.

PIPE FROM 42" AND LARGER IS DIMENSIONED FOR RCCP, CLASS III, WALL B.

CALCULATIONS BASED ON CITY OF COLUMBIA SPECIFICATIONS AND DETAILS FOR SANITARY SEWER CONSTRUCTION.

REVISED TABLE ON CONCRETE REPAIR



REVISED MAXIMUM TRENCH WIDTH CHANGED TO MINIMUM 2'-3" (REVISED TABLES ON) CONCRETE REPAIR AND PAVEMENT REPLACEMENT

DEPARTMENT OF UTILITIES & ENGINEERING

9/10/93

DATE: 9-12-78

STANDARD DETAIL SSC # 6

Figure 17-6. Granular/Concrete Cradle Volumes

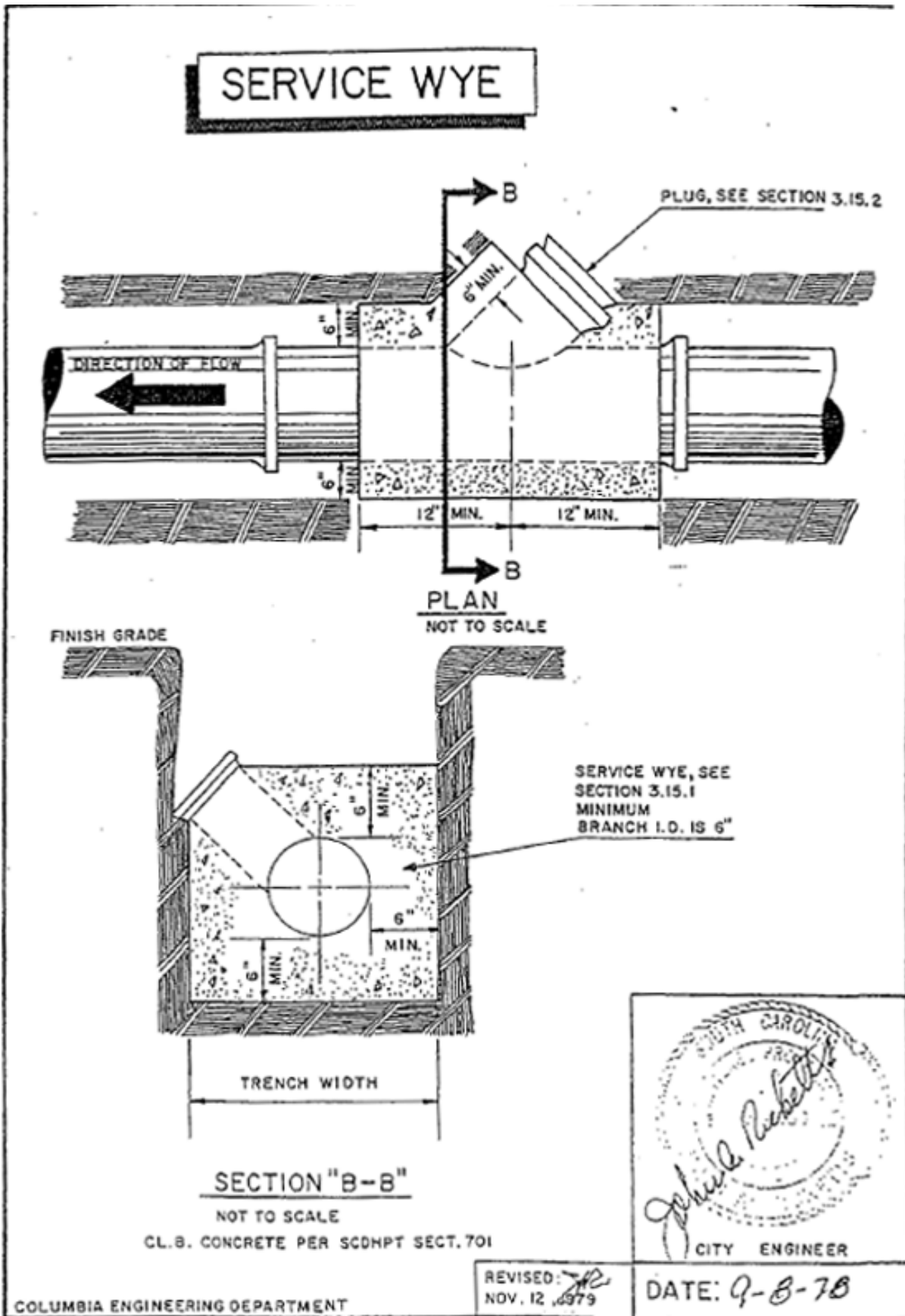


Figure 17-7. Service Wye

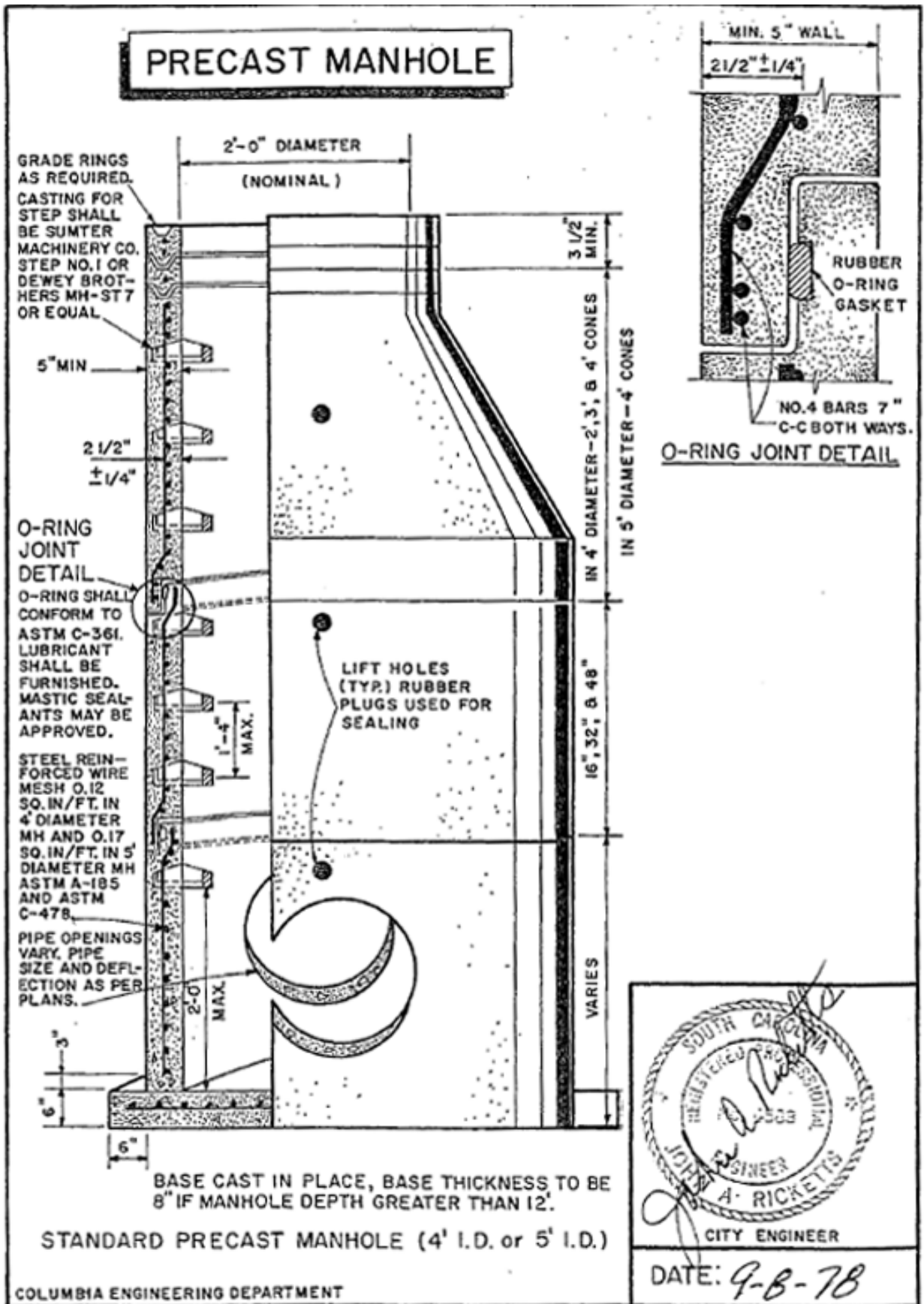


Figure 17-8. Precast Manhole

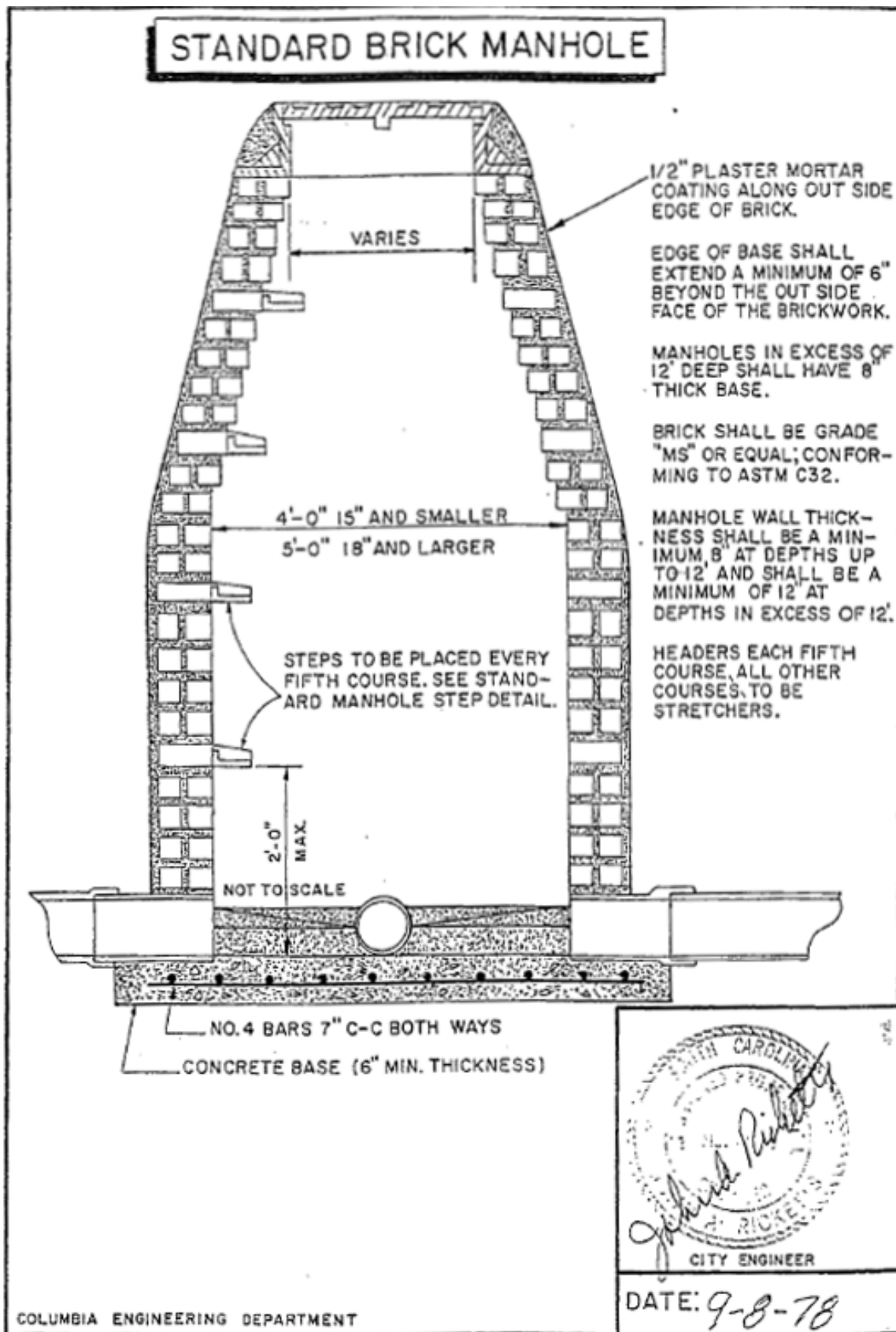


Figure 17-9. Standard Brick Manhole

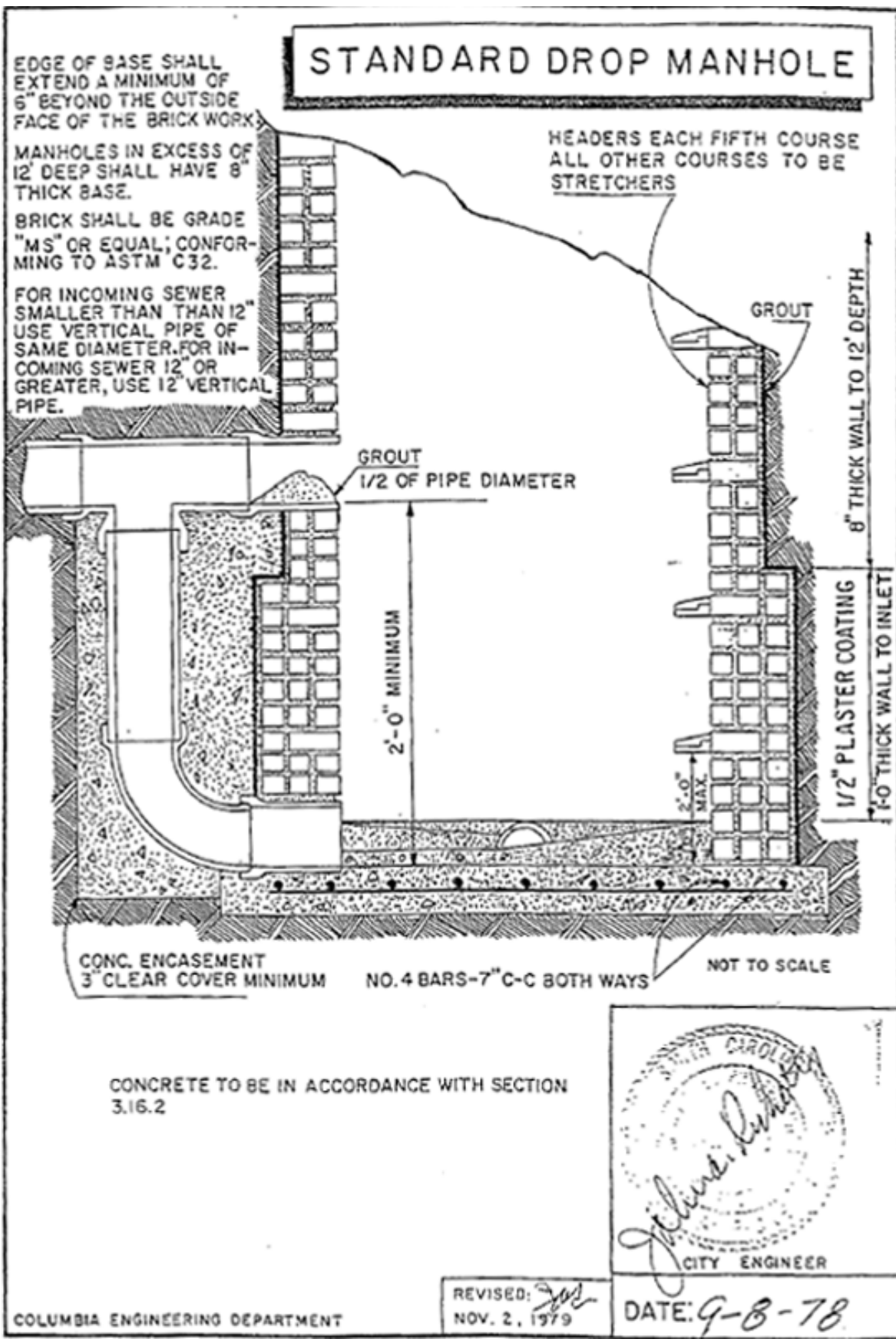


Figure 17-10. Standard Drop Manhole

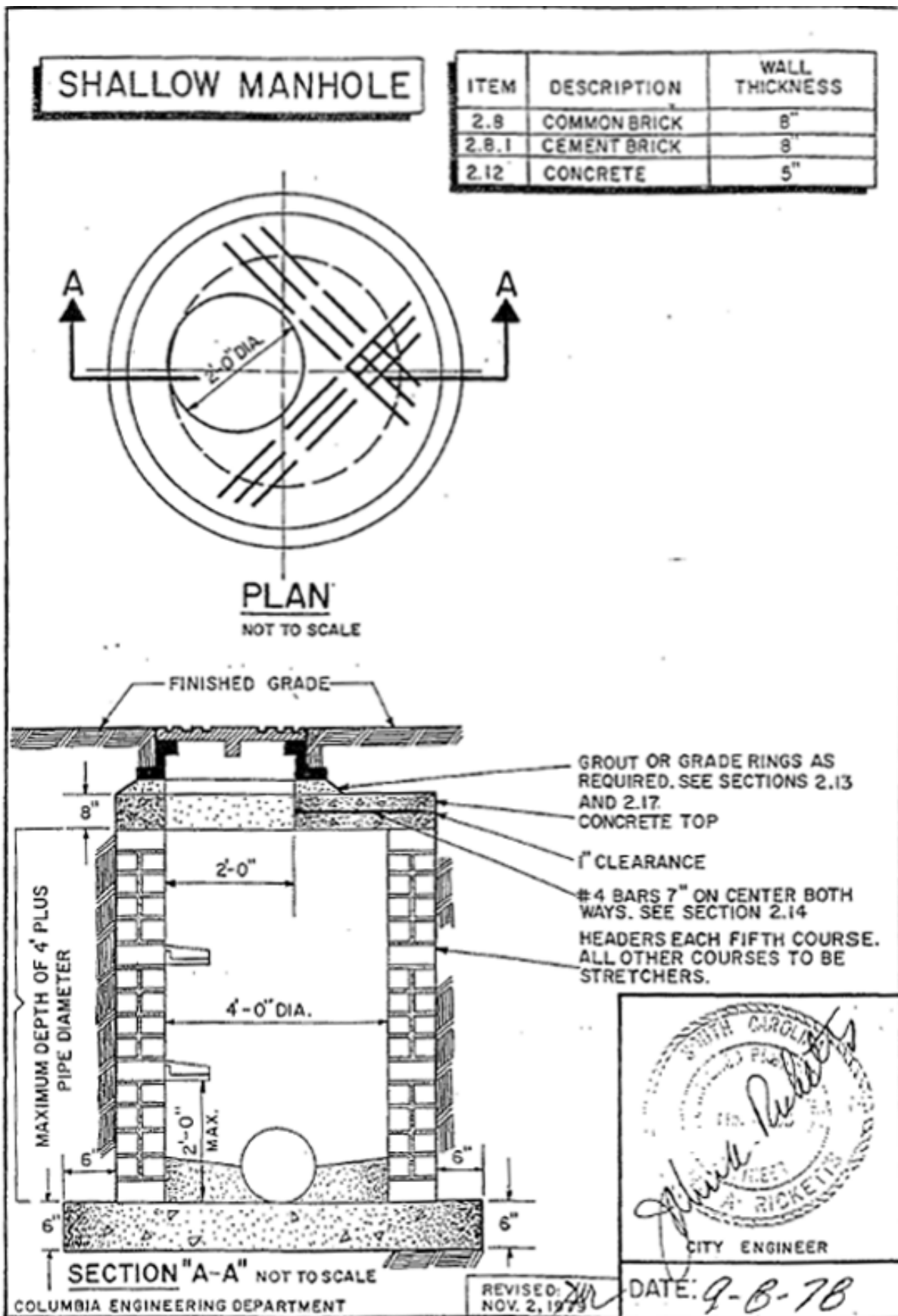
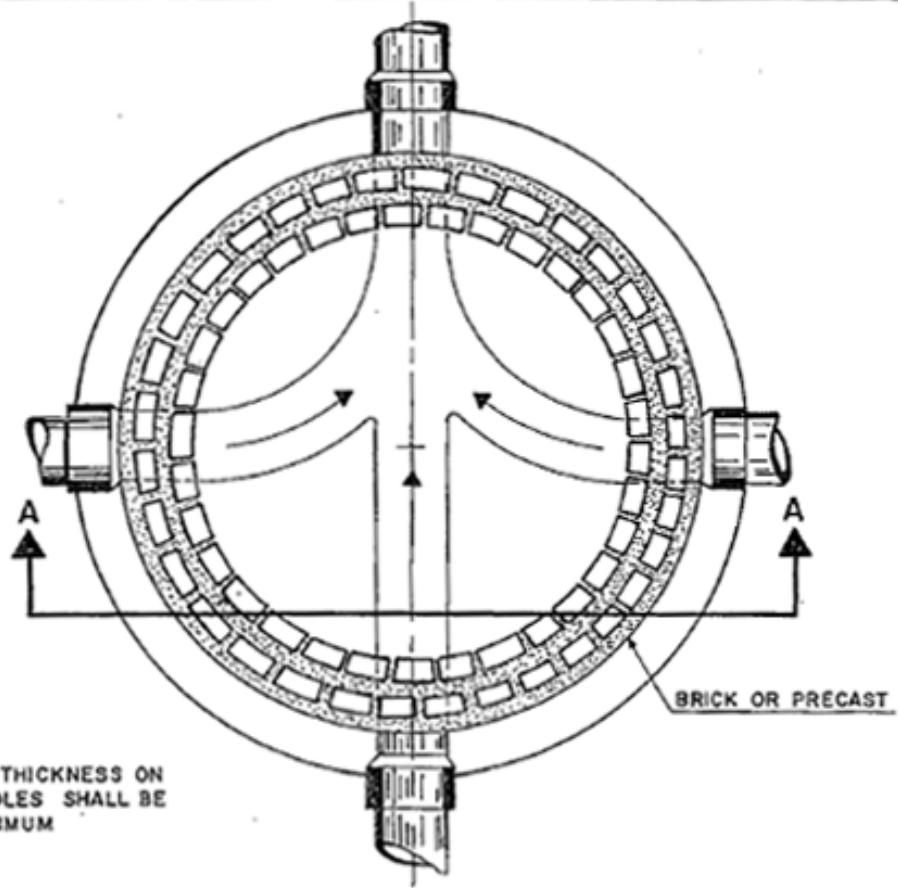


Figure 17-11. Shallow Manhole

TYPICAL SECTION SHOWING BOTTOM OF MANHOLE

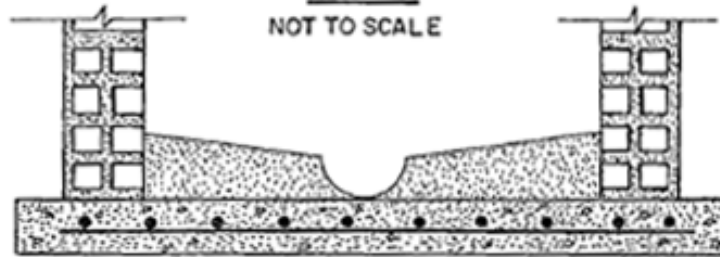


WALL THICKNESS ON
MANHOLES SHALL BE
5" MINIMUM

BRICK OR PRECAST

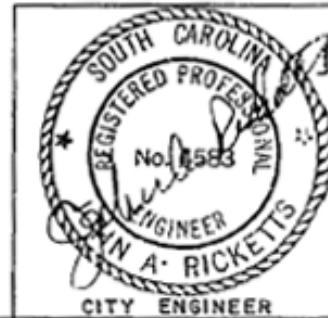
PLAN

NOT TO SCALE



SECTION A-A

NOT TO SCALE



COLUMBIA ENGINEERING DEPARTMENT

REVISED:

DATE: 11-6-79

STANDARD DETAIL SSC# 17

Figure 17-12. Typical Section Showing Bottom of Manhole

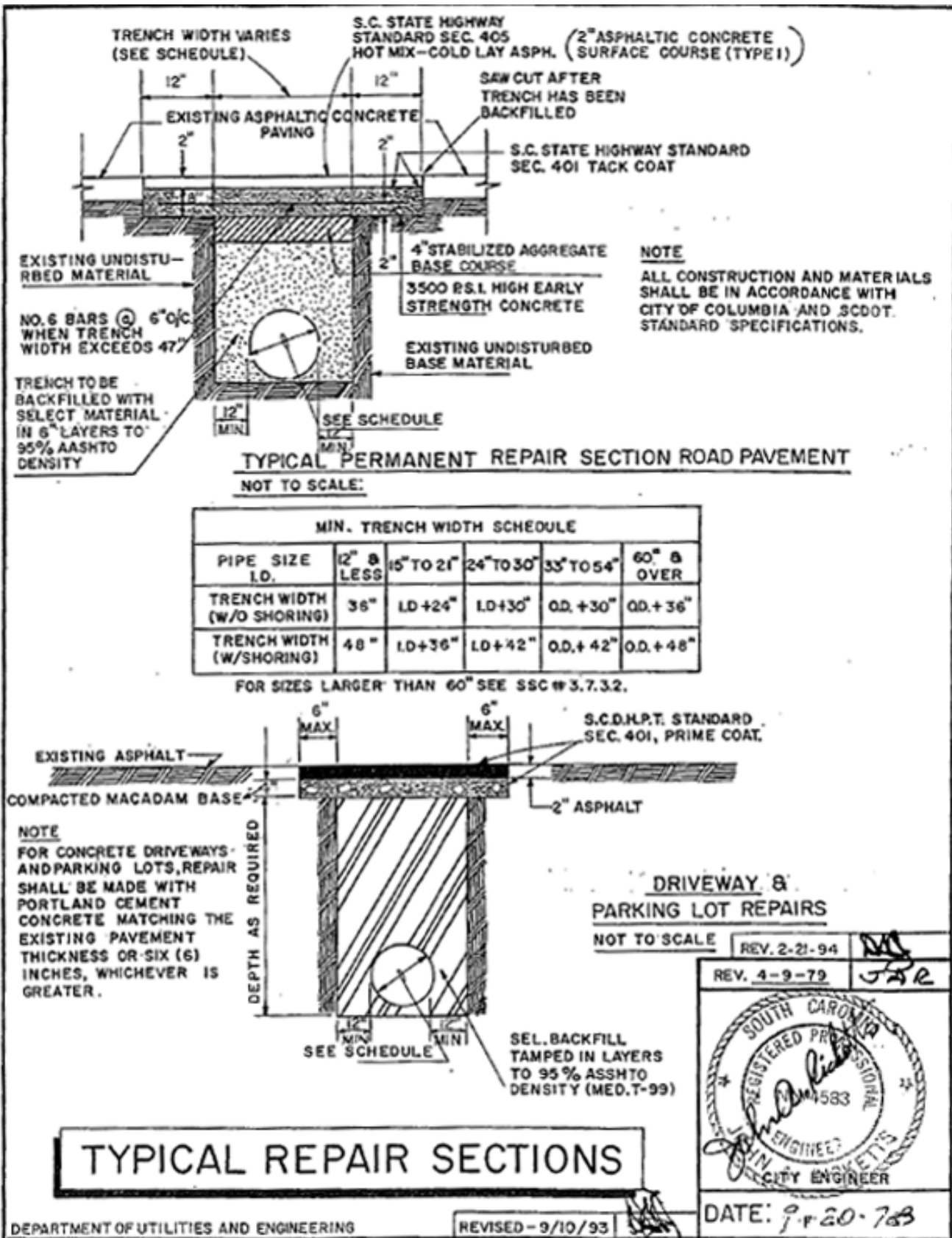
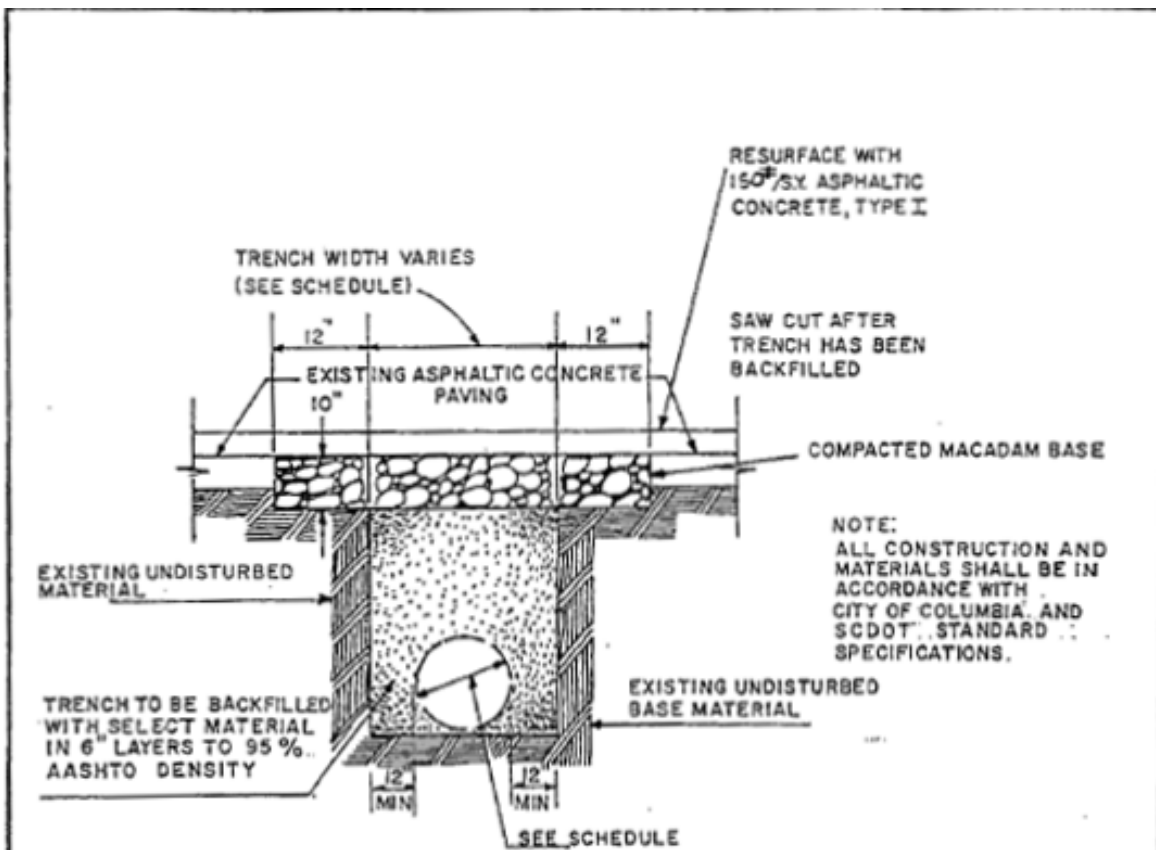


Figure 17-13. Typical Repair Sections - A



TYPICAL PERMANENT REPAIR SECTION ROAD PAVEMENT

NOT TO SCALE
 FOR USE ONLY ON SECONDARY ROADS WITH LOW VOLUME OF TRAFFIC WHERE CONSTRUCTION IS GENERALLY PARALLELING THE CENTERLINE OF THE PAVING AND EXISTING STREET DOES NOT HAVE CURB AND GUTTER

MIN. TRENCH WIDTH SCHEDULE					
PIPE SIZE I.D.	12" & LESS	15" TO 21"	24" TO 30"	33" TO 54"	60" & OVER
TRENCH WIDTH (W/O SHORING)	36"	I.D.+24"	I.D.+30"	O.D.+30"	O.D.+36"
TRENCH WIDTH (W/SHORING)	48"	I.D.+36"	I.D.+42"	O.D.+42"	O.D.+48"

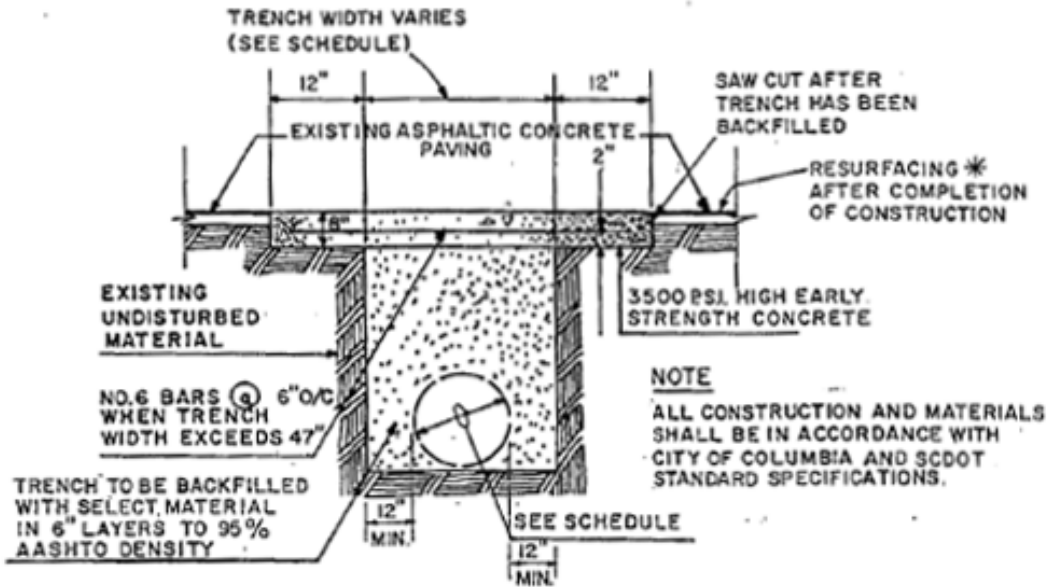
TYPICAL REPAIR SECTIONS



REVISOR: 2-21-94 REVISOR: 9/10/93 REVISOR: 8-20-79
 DEPARTMENT OF UTILITIES & ENGINEERING DATE: 8-16-79

Figure 17-14. Typical Repair Sections - B

TYPICAL REPAIR SECTION



TYPICAL PERMANENT REPAIR SECTION FOR ROAD PAVEMENT WHEN ROAD IS TO BE RESURFACED

(NOT TO SCALE)

MIN. TRENCH WIDTH SCHEDULE					
PIPE SIZE I.D.	12" & LESS	15" TO 21"	24" TO 30"	33" TO 54"	60" & OVER
TRENCH WIDTH (W/O SHORING)	36"	I.D. + 24"	I.D. + 30"	O.D. + 30"	O.D. + 36"
TRENCH WIDTH (W/SHORING)	48"	I.D. + 36"	I.D. + 42"	O.D. + 42"	O.D. + 48"

FOR SIZES LARGER THAN 60" SEE SSC # 3.7.3.2.

* ON STREETS WITH EXISTING CURB AND GUTTER, EXISTING ASPHALT PAVEMENT SHALL BE MILLED TO A UNIFORM DEPTH OF 1-1/4" BELOW EDGE OF GUTTER PRIOR TO RESURFACING.

(THIS SECTION TO BE USED ONLY WHEN SPECIFIED ON THE BID PROPOSAL FORM)
DEPARTMENT OF UTILITIES & ENGINEERING

REVISED: 2-21-94	
REVISED - 9/10/93	
REV.	3-22-88

- JPK
6-25-79

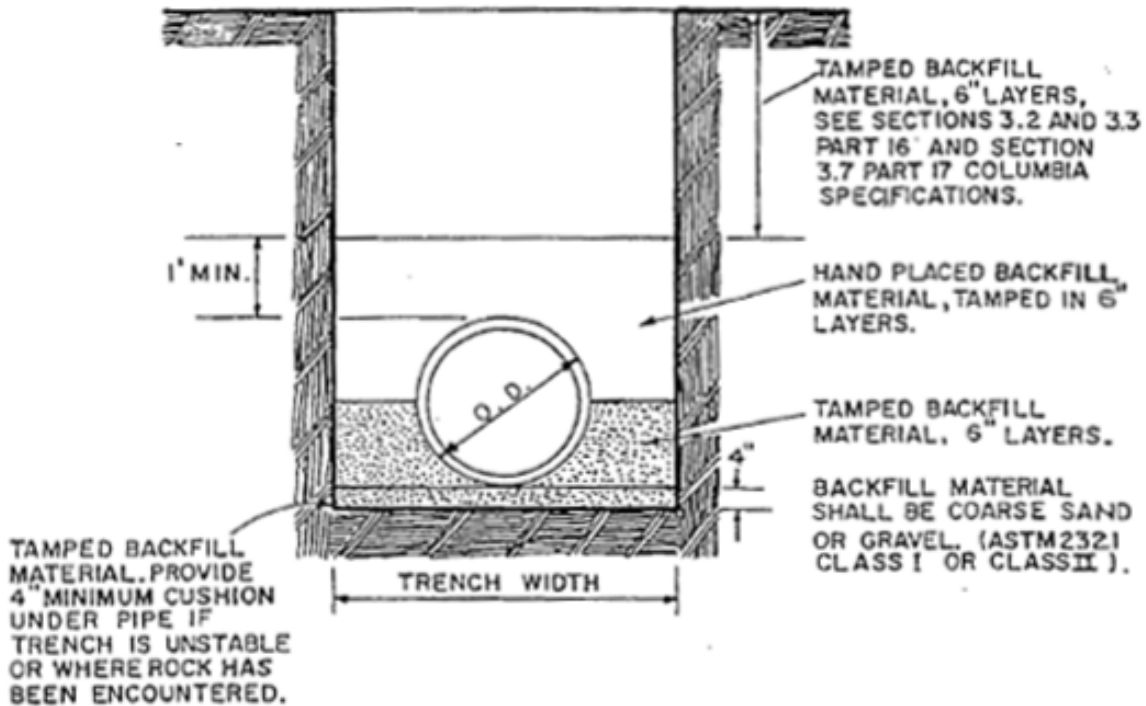
CITY ENGINEER

DATE: 6-25-79

STANDARD DETAIL WC # 13 & SSC # 19

Figure 17-15. Typical Repair Sections - C

STANDARD PIPE BEDDING AND BACKFILLING DETAIL PVC PIPE



THE PIPE IS TO BE BEDDED IN COMPACTED 6" LAYERS TO THE SPRINGING LINE FIRST, THEN BACK-FILLED WITH HAND PLACED MATERIAL COMPACTED IN 6" LAYERS TO A DEPTH OF 1' MINIMUM ABOVE THE PIPE. SEE SECTIONS 3.2 AND 3.3 (PART 16) AND SECTION 3.7 (PART 17) COLUMBIA SPECIFICATIONS FOR REMAINDER OF THE BACKFILL.



DATE: 11 - 25 - 91

DEPARTMENT OF UTILITIES AND ENGINEERING

STANDARD DETAIL WC#11 AND SSC#20

Figure 17-16. Standard Pipe Bedding and Backfilling Detail PVC Pipe