

OPEN CUT STORM DRAIN SPECIFICATIONS

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1. GENERAL

Storm Drains shall be considered to mean the pipes, conduits, or open channels between extreme ends of this project, including branch lines, but excluding special structures, as indicated on the Drawings.

All labor, tools and all materials necessary to excavate for, lay, join, backfill, and finish the storm drain shall be considered as part of the storm drain construction.

Unless otherwise allowed under specific specifications for a particular type of storm drain or unless permitted by the Engineer, construction shall begin at the outlet end of the storm drain and proceed upgrade.

This work shall be performed in accordance with the general conditions and general specifications unless otherwise noted in an addendum.

2. BASIS OF PAYMENT

Unless specified otherwise, storm drain of the diameter specified will be paid for at the contract unit price per lineal foot, measured in place, which price shall be payment in full for furnishing the materials, including stubs, connections, tees, wyes, or any other fittings shown on the drawings, all necessary excavation, removal of existing storm drains, sheeting or bracing, draining, well pointing, dewatering, sand cushion, porous gravel or slag under or around pipe bedding, laying jointing, new connections and connecting in of existing facilities, testing, backfilling, sand and gravel backfill, restoration of pavements, walks and drives, disposal of surplus excavated material, and all other work incidental to the construction of the storm drain. Measurements will be taken from the start of each section to its respective ends, including end sections, (center of end manholes, when they exist) with no reductions for intermediate manholes. The length of the special structures or special storm drain sections for which either lump sum or unit bids have been taken will be deducted from the total length of sewer and will be paid for at the prices bid therefor.

The Contractor may be required to submit to the Owner for approval, a breakdown of his price per lineal foot of storm drain showing a per foot cost for some or all of the foregoing incidental items of work. The sum of the individual items shall not exceed the total contract price per lineal foot of storm drain.

The breakdown, when approved, shall be used only as a basis for preparing estimates for progress payments and shall not be considered as overruling the contract unit price per lineal foot of storm drain.

Unless specified otherwise manholes and catch basins will be paid for at the contract unit price each, which price shall be payment in full for furnishing the materials, including the required fittings, frames and grates, steps, and for all labor, equipment and tools, all necessary excavation backfilling, disposal of surplus material, and all work incidental to the completed structure.

3. MATERIAL TESTING

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

4. EXCAVATION

- a. Excavation shall include clearing of the site and the removal and disposal of all materials necessary to be removed in the construction of all work under the Contract. Excavation shall be of sufficient widths and depths to provide adequate room for construction and installation of the work to lines, grades, and dimensions called for on the plans within the provided easements.
- b. Where the trench is excavated to a stable, foundation sub-grade for the bedding specified in Section 6 of this specification, the pipe shall be laid in accordance with OCSD, Section 5, LAYING PIPE. Where the depth of excavation exceeds such a limit, the Contractor shall fill the space with compacted angular-shaped, crushed stone containing sufficient smaller sized aggregate to provide proper "Keying" of the material to insure that the pipe, when laid, will maintain correct alignment and grade, and to prevent the migration of smaller-sized earth particles of bedding, trench wall or backfill material into voids of the stone. When crushed stone is used as a foundation material, it shall also be used as bedding material for pipe for the entire width of trench, and from sub-grade depth upwards to the top of the pipe. The remainder of bedding to a point twelve (12) inches above the top of the pipe shall be constructed as specified for Standard Pipe Bedding. Materials placed as foundation or bedding material shall be compacted in six (6) inch layers. Crushed stone shall not exceed one and one-half (1 1/2) inches in size and crushed stone shall be at least 85% angular-shaped crushed material. All such material shall be approved by the Engineer before use. "Pea" stone or uncrushed and ungraded "float" stone shall not be approved for use.

(1) Excavation to Eighteen (18) Inches below Invert of Pipe

Where through the Contractor's construction procedure, or where excavation has not uncovered stable foundation sub-grade for the bedding specified in Section 6 of this specification, the Contractor shall continue to excavate downward to a maximum distance of eighteen (18) inches below the specified pipe invert grade to reach stable foundation soil. The space resulting from such excavation and the pipe bedding shall be filled and constructed in the same manner and using the same materials specified above. All costs for such construction shall be borne by the Contractor.

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(2) Excavation Below Limits Specified in Paragraph (1)

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

(3) Special Excavation

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

- c. The widths of a trench from the bottom of the pipe to a height twelve (12) inches above the top of the pipe barrel shall not be greater than thirty (30) inches for pipe smaller than eighteen (18) inch diameter, not greater than eighteen (18) inches plus the outside diameter of the pipe barrel for concrete and CMP pipe eighteen (18) to twenty-four (24) inches in diameter and not greater than twenty-four (24) inches, plus the outside diameter of the pipe barrel for concrete and CMP pipe twenty-seven (27) inch diameter and larger. If such trench width is exceeded, unless otherwise shown on the contract plans, the Contractor shall install at his own expense such concrete cradle bedding, concrete arch bedding, or other bedding all as approved by the Engineer. The Contractor, as an alternative and with the approval of the Engineer, may construct such bedding of crushed stone as specified above, at no additional cost to the Owner.
- d. Excavated materials shall be removed from the site, transferred to the trench backfill or temporarily stored along the trench in a manner that will not cause damage to trees, shrubs, fences, or other property, nor that will endanger the bank of the trench by imposing too great a load thereon.
- e. Open cut excavation for shafts or other structures shall be adequately braced and/or sheeted to prevent caving or squeezing of the soil. Tunnels shall be sheeted, shored and/or braced, as necessary, to enable the work to be performed with safety to the men, the work, and neighboring structures. All excavations shall be completely dewatered prior to construction of the sewer or other structures; and adequate provisions shall be made to prevent water from flowing through or over newly placed concrete or masonry work. Drainage shall be carried to sumps from which the water may be pumped.

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5. LAYING PIPE

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

6. PIPE BEDDING

a. Concrete Pipe and Corrugated Steel Pipe

Bedding for concrete pipe is shown on the standard detail sheet for storm sewers. Standard pipe bedding is defined as the envelope surrounding the pipe and extending from a sub-grade of six (6) inches below the bottom of the pipe upwards, bearing laterally against the sides of the trench, to an elevation providing twelve (12) inches of cover over the pipe. If the contractor wishes to use a bedding material different than indicated on the standard detail sheet, prior approval regarding material and method of installation must be obtained from the engineer. If the trench is wet or unstable or an undercut is required, sand bedding will not be allowed. All costs for pipe bedding, including material, labor and equipment will be incidental to the contract unless otherwise indicated the proposal.

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b. Truss and Solid Wall Plastic Pipe Bedding

- (1) Bedding for ABS and PVC pipe shall be in accordance with ASTM D2321-00, except:
 - (a.) Only Class I and Class II materials having a maximum particle size of one and one-half (1 ½) inch may be used.
 - (b.) Class III materials may be used provided they are carefully and uniformly mechanically compacted to 95% Maximum dry density as determined by the ASTM D 1557 Compaction Standard in 6" maximum layers.
 - (c.) Standard pipe bedding is defined as the envelope surrounding the pipe and extending from a subgrade of three (3) to four (4) inches below the bottom of the pipe upwards, bearing laterally against the sides of the trench, to an elevation providing twelve (12) inches of cover over the pipe.
 - (d.) Flooding of the trench to consolidate bedding shall not be used.
- (2) It is essential that it be recognized that the successful use of flexible pipe requires bedding that provides unyielding side support and complete bedding contact under pipe haunches. Bedding material must be properly placed and compacted to provide lateral restraint against deflection in the pipe diameter. Pipe must be bedded to true line and grade throughout its length. Bell holes shall be provided where required.
- (3) Where unstable bottoms are encountered, the contractor shall provide a foundation consisting of an approved graded processed angular stone or filter fabric to act as an impervious mat to impede migration or vertical movement of unstable soils or bedding materials. Where trench sheeting, plates, or a trench box are used due to severe ground conditions, all voids to the side and below the top of the pipe caused by the sheeting, plates or box withdrawal shall be completely filled or the supports left in place below the top of the pipe.
- (4) Concrete cradle bedding shall not be used where allowable trench widths are exceeded. In lieu of concrete cradle bedding, standard pipe bedding shown shall be provided to the full width between undisturbed trench walls or at least to 2.5 pipe diameters on both sides of the pipe.
- (5) Due to potential damage to exterior walls of truss or plastic pipe, particularly under cold weather conditions, if rocks, frozen material or large objects strike the pipe, the contractor shall carefully avoid dumping any materials other than approved bedding sand or stone on the pipe until twelve (12) inches of cover is placed on it. Pipe walls and joints shall also be protected from abrasion and damage during handling, and shall be fully inspected just prior to placing in trench.
- (6) Care shall be taken during bedding compaction to avoid distorting the shape of the pipe or damaging its wall. Mobile equipment shall not be used over the pipe trench until forty-eight (48) inches of cover has been placed.
- (7) Bedding for sump lead connections shall be equal to that of the main line bedding. Risers in deep and unstable trenches should be bedded in Class I angular stone to avoid settlement. Concrete shall not be used for bedding. End caps or plugs shall be used with a 2 x 2 marker to with in 6" of ground surface.
- (8) Class I, II, IIA, III. grading requirements for granular materials are defined per ASTM C-136.

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7. CONCRETE CRADLE FOR PIPE

Where called for on the drawings, or otherwise required, pipe shall be installed with a concrete cradle of Grade "C" concrete, in accordance with the "Materials - Concrete" included herein or available and on file at the office of the Engineer.

Each pipe shall rest on a 6" minimum thickness bed of dry mix concrete, shaped to fit the bottom of the pipe. The dry mix concrete shall be Grade "C" concrete and shall be machine mixed. After setting the pipe, the space between the outside of the pipe and the undisturbed trench bank shall be filled to a level equal to a point 1/3 of the diameter above the pipe invert with Grade "C" concrete, having a 5" slump and mechanically vibrated to insure complete filling of the annular space between the excavated face of the original ground and the outside face of the pipe.

The cost of concrete cradle for pipe shall be included in the contract unit price bid per lineal foot of storm drain.

8. BACKFILL

Backfill is defined as that material placed into trench from the top of the standard pipe bedding (as previously defined) to the ground surface. Backfill shall be placed into the trench according to one of the following specified manners as determined by the location of the trench or the edge of trench nearest the existing pavement, roadway, sidewalk, driveway or parking area.

Selected excavated material for use in backfill is defined as soil that is capable of meeting identified compaction requirements and is free of large or frozen lumps, asphalt, concrete, rubble, boulders, blue clay, topsoil, peat, marl, wood, debris, vegetation, or other extraneous materials as determined by the Engineer.

Zone of influence is defined as a one to one (1 horizontal to 1 vertical) slope from the edge of pavement to the trench bottom.

Wherever compaction is required, it shall be by suitable mechanical compaction equipment approved by the Engineer. Initial compaction test will be made by a representative of the Owner and paid for by the Owner. However, if it is necessary to repeat compaction tests because initial compaction methods or construction procedures failed to produce required density, in place, the Contractor shall be billed for the cost of all repeat testing until material meets specifications.

- a. **Concrete and Asphalt** (Roads, Sidewalks, Driveways & Parking Areas) (No frozen materials permitted)

Trench Location

Backfill Requirements

- | | |
|---|---|
| (1) Under concrete and asphalt surfaces and within the zone of influence. | Backfill shall be in accordance with detail sheet with mechanically tamped Class II sand or stone in six (6) inch layers, loose measure, with each layer compacted to not less than 95% of the maximum dry density as determined by the ASTM D 1557 Compaction Standard. |
| (2) Outside the zone of influence and within road right-of-way. | Backfill material shall be placed into trench in six (6) inch layers, loose measure, each layer compacted to not less than 90% of maximum dry density as determined by the ASTM D 1557 Compaction Standard. Selected excavated material may be used, provided compaction requirements can be met. |

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b. **Gravel** (Roads, Driveways, and Parking Areas) (No frozen materials permitted)

- (1) Within the zone of influence and within road right-of-way.

Backfill material shall be placed into trench in six (6) inch layers, loose measure, with each layer compacted to not less than 90% of maximum dry density as determined by the ASTM D 1557 Compaction Standard. Selected excavated material may be used, provided compaction requirement can be met. The Contractor shall immediately restore all roads, driveways, and parking areas with MDOT 21AA gravel at least eight (8) inches thick and shall maintain them in good, dust-free condition during the life of the contract. Additional aggregate shall be added if settlement occurs. Before final acceptance of the road, driveways, or parking area, it shall be top-dressed with approved material to match the original surface treatment. Gravel shall be suitably stabilized with calcium chloride.

- (2) Outside the zone of influence and within the road right-of-way

Same as (b) (1) above.

c. **Open Fields and Lawn Areas**

Backfill material shall be placed into trench in 12" layers, loose measure, with each layer compacted to not less than 90% of maximum dry density as determined by the ASTM D 1557 Compaction Standard. Selected excavated material may be used provided compaction requirement can be met. Compaction will be tested at the inspector's discretion.

Contractor shall regrade as necessary during the life of the Contract. For restoring lawn and landscaped areas see Section GS-8, "Final Cleanup and Restoration". No frozen materials permitted.

d. **Special Backfill**

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

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

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

9. MANHOLES, CATCH BASINS AND INLETS

Manholes, catch basins and inlets shall be constructed at the locations shown on the drawings and unless otherwise specifically called for on the drawings, shall consist of brick masonry on a concrete base, solid concrete block on a concrete base or precast sections on a concrete base. The base can be cast in place or precast slab. In the case of 48" or larger storm drains, manholes shall be precast manhole tees, or as approved by the Engineer, provided there is no grade or alignment change. All manholes, catch basins, and accessories including steps, frames and covers, etc. shall be constructed in accordance with the details shown on the standard detail sheets.

Manhole steps shall be plastic coated steel meeting the requirements in ASTM D 2146, Type II, Grade 49108 or approved equal with foot recess, suitably scored to provide a non-slip surface and shall be on 16" centers, 21" maximum below casting elevation and 24" maximum above structure bottom or top of fillet.

The upper surface of the manhole bottom shall be slopes so as to provide positive drainage toward flow channels that are continuations of the storm drain pipes.

Sumps shall be 2 feet deep unless otherwise noted.

Manhole covers shall have OAKLAND COUNTY WATER RESOURCES COMMISSIONER lettered thereon.

Connections to manholes shall be properly supported and braced where not resting on original ground so that any settlement will not disturb the connection.

All storm manholes and inlets shall be constructed to include concrete flow channels.

Excavation shall be carried to the depth required to permit the construction of the specified depth of base in accordance with the requirements of the Standard Details. The excavation shall be sufficiently wide to allow for shoring, bracing, or form work, should any or all be necessary. Also, this is to allow for accessibility in plastering the exterior of all brick masonry. The bottom of the excavation shall be trimmed to a uniform horizontal bed to receive the concrete base. The excavated section shall be completely dewatered before any concrete is placed therein. Concrete shall be Grade "A", 3500 pounds per square inch compressive strength and shall be in accordance with the "Design and Classifications" section of the "Specifications-Concrete".

All brick shall be wetted immediately before being laid. Broken or chipped brick shall not be used in the face of the structure. The brick shall be laid radially in courses in a full bed of mortar with interior joints not more than 1/4" in width. Whole bricks only shall be used except to effect closures and to fill in the outside portion of the radial joints. Each seventh course shall be laid in "stretchers", the intervening courses being composed of "headers". Adjoining courses shall break joints by one-half the width of a brick as nearly as practicable. All joints shall be true and smooth. The upper section of the manhole shall be domed, as indicated on the drawings, to such diameter as will fit the iron casting.

Block work: Blocks shall not be wet before building into walls. Unless otherwise noted, all masonry block units shall be laid up in Plain Running or Stretcher Bond (with whole stretchers overlapping by half block). In general, joints of all Block work shall be approximately 3/8" wide, unless otherwise indicated on drawings. Tool all interior exposed joints of block walls with a concave jointer when mortar has partially stiffened, pressing mortar firmly against edges of block.

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Where blocks are exposed, the exposed faces shall be free from all broken corners and all joints shall be neatly tooled.

Lay up all masonry which is to remain exposed with particular care in coursing, jointing, etc., so that walls present a neat and workmanlike appearance.

All manholes, catch basins and inlets shall be backfilled with compacted sand to a distance of 3 feet of the outer periphery of the structure.

Bond the courses at corners and intersections. Provide closed-end block where necessary. No open cells will be permitted in finish work.

Block shall be of thickness indicated for respective locations, bonded in manner specified above.

All blocks shall be laid in full beds of mortar, with vertical joints well filled, and laid to line, plumb and true.

The upper section of the manhole shall be eccentrically domed, as indicated on the drawings to such diameter as will fit the casting.

All precast sections shall bear the stamp of an approved testing laboratory as having been tested and delivered from tested stock of the manufacturer, at the expense of the Contractor.

Tops shall be set in full bed of mortar or otherwise secured, as shown on the drawings, and to the required finished elevations.

When completed, manholes shall be cleared of scaffolds and cleaned of surplus mortar or other foreign materials. The interior joints shall be pointed and the entire exterior surface of brick and block manholes completely plastered with mortar.

10. STUBS, CONNECTIONS, BULKHEADS AND MISCELLANEOUS ITEMS OF WORK

- a. The Contractor shall furnish all material and labor and shall install and/or construct the stubs connections, bulkheads and miscellaneous items of work called for on the drawings and/or specifications.
- b. Unless otherwise noted on the drawings, stubs 12" or larger in diameter shall consist of one full length of concrete storm drain pipe, minimum length 8 feet, with watertight brick and mortar bulkhead. Unless otherwise noted on the drawings, stubs four inches (4") to ten inches (10") in diameter shall consist of one full length of plastic storm drain pipe, minimum length of 8 feet, with an expandable plug or removable cap.
- c. Where called for on the drawings, existing storm drains shall be connected in.
- d. Where called for on the drawings, bulkheads and stubs for future storm drain connections shall be provided.
- e. Where called for on the drawings, bulkheads shall be constructed or removed as called for.
- f. No separate payment will be made for such stubs, connections, bulkheads, and miscellaneous items of work covered in this section. The cost of this work, unless otherwise specified, shall be included in the unit price bids for manholes and/or drains.

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11. CAST-IN-PLACE CONCRETE STRUCTURES

The Contractor shall submit to the Engineer complete shop drawings of concrete structures including the size and spacing of reinforcing steel. The plans will be approved or corrected and returned to the Contractor who shall furnish three sets of approved or corrected plans to the Engineer, a minimum of three days prior to proceeding with the work.

Unless otherwise noted, structural concrete shall be Grade A ($f'_c = 3500$ p.s.i.), and reinforcing steel shall be Grade 60.

All exposed concrete edges shall have 3/4" chamfer.

The finish of concrete surfaces on inside walls and floor shall be made as smooth as possible, special consideration being given to those surfaces that will be exposed to the flow.

As soon as the forms are removed, the surface of the concrete shall be carefully examined and any irregularities of surface shall be treated as directed by the Engineer. Fins and irregular projections shall be removed in a workmanlike manner, care being exercised to prevent undue spalling of adjacent surfaces.

If, in the opinion of the Engineer, the defects in the concrete are of such a nature as to warrant condemnation, that portion of the pour may be ordered replaced in its entirety and the Contractor shall promptly replace it without additional compensation. The Contractor alone shall be responsible for the trueness of the surface of the concrete and shall correct any deviation in the manner ordered by the Engineer,

If due to weather conditions or unacceptable workmanship, exposed concrete surfaces cannot be satisfactorily finished as determined by the Engineer, the Contractor shall apply two coats of ThorosexI mixed with Acryl 60 (or approved equal) to all exposed concrete surfaces. Mixing and application of cement-based water proofing shall be in accordance with manufacturer's recommendations for "finishing concrete".

Rubbing with a carborundum stone and/or the use of grinding wheels to obtain a smooth finish will be required for exposed to view exterior concrete surfaces.

Floors, walkways and stairs of structures and buildings shall be given a steel trowel finish unless otherwise specified. Pavement and sidewalk shall be given a standard float finish.

In tunnel construction, in addition to the removal of fins and irregular projections, the entire interior surface shall be given a cement mortar brush coat.

Concrete placement at air temperatures below 40° F shall comply with WRC specifications for Materials-Concrete, Section 18, Winter Conditions.

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12. TUNNELING

The Contractor may at his option (and with the approval of the Owner), construct the work in tunnel, where it crosses existing roadways, public and private utilities, walks, or other structures. The work shall be constructed in tunnel where noted on the drawings or as may be required under road permits.

a. Bored and Jacked Pipe Storm Drains

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

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

THIS TABLE NOT APPLICABLE AT RAILROAD CROSSINGS

- (4) The Casing pipe shall be installed by a continuous boring-jacking operation. The boring auger shall not proceed ahead of the casing pipe. Water shall not be used in the boring operation.
- (5) The face of the jacking pits generally shall be located a minimum of ten feet (10') from the edge of the pavement and/or back of curb, and shall be sheeted and shored sufficiently to protect the pavement and/or track installations, existing underground utilities and the safety of the workman. Access pits shall be protected from vehicular traffic and shall be provided with suitable fencing and barricades to prohibit public access to the work site. Equipment shall not be used in lieu of fencing to protect access sites.

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- (6) The storm drain shall be supported within the casing pipe by means of construction grade (No. 2) 4" x 4" pressure preservative treated timber skids. Skids shall be continuous from bell to bell. A minimum of four (4) skids, positioned 45° each side of the top and bottom center lines of the storm drain are required. Skids are to be strapped to the storm drain by 1 1/8" wide, 12 gauge galvanized steel or stainless steel bands. A minimum of four (4) straps per pipe length are to be installed.
- (7) After the storm drain is pushed through the casing, masonry bulkheads shall be installed tight around the storm drain at both casing ends. Stand pipes suitable to receive pressure grouting shall also be installed.
- (8) The void between the storm drain and the casing pipe shall be pressure grouted using a concrete grout mix as approved by the Engineer.
- (9) If the Contractor proposes to employ a different method of tunnel crossing than the method described in these specifications, he shall obtain written approval from the Engineer.

b. Jacked-in-Place Pipe Storm Drains

- (1) Jacked-in-Place pipe tunnel storm drain shall be constructed of reinforced concrete pipe, ASTM C76 Class V with 2 rings of circular reinforcement with the outside extending into the pipe's bell and the inside cage extending into the spigot end within one inch (1") of the gasket groove. Elliptical reinforcement will not be allowed. In such construction, excavation shall not proceed ahead of the cutting edge of the pipe. Voids shall be filled by means of pressure grouting with 1:3 cement-sand mortar.
- (2) All pipe 42" diameter and larger shall have inside cement pointing with cement mortar compound of one (1) part of cement and two (2) parts of sand.

c. Monolithic Concrete Tunnel

- (1) Monolithic concrete tunnel storm drains as detailed on the Drawings.
- (2) All voids shall be filled by means of pressure grouting with 1:3 cement sand mortar.
- (3) Shaft locations shall be subject to the approval of the Owner and the Contractor shall submit a schedule of desired locations of shafts for approval.
- (4) The method of constructing the shafts and the type of support are at the option of the Contractor, but subject to approval by the Engineer. The size of shaft and method of support shall be such that plumb lines hanging freely from the surface on the centerline of the tunnel shall have not less than six feet (6') between them.
- (5) The Contractor will receive no extra compensation for constructing, maintaining, or removing shafts, but the cost of it shall be included in the prices bid for the storm drains.

13. ACCEPTANCE TESTS

All pipes shall be clean of any accumulated sediment. All visible pipe leaks shall be repaired by the Contractor prior to final acceptance.

All pipe shall be visually inspected for structural integrity prior to final acceptance. Repair or removal and replacement shall be as directed by the Engineer.

All pipe installed with protective coatings shall be visually inspected prior to final acceptance. Repair of damaged pipe and/or coatings shall be as directed by the Manufacturer and the Engineer.

OPEN CUT STORM DRAIN SPECIFICATIONS

Mandrel Testing

The Engineer may, at his discretion, require mandrel (go/no-go) gauging test run on all ABS and PVC pipes. Mandrels shall have nine (9) arms and dimensions shall be ninety-five percent (95%) less a statistical tolerance of ASTM average diameter (see table below). The completed installation shall at no point have out-of-round pipe deflections greater than five percent (5%).

Mandrel testing shall not take place until a minimum of thirty (30) days has elapsed since the trench was backfilled to final grade. Any pipe sections not passing the mandrel test as described above shall be uncovered and the Contractor shall replace and/or re-compact the embedment backfill material to the satisfaction of the Engineer. After another thirty (30) day period, the pipe section shall be re-tested with the mandrel as described above.

NOMINAL PIPE SIZE	ABS OR PVC TRUSS PIPE	PVC - SDR 35 D-3034
8"	7.36"	7.28"
10"	9.36"	9.08"
12"	11.16"	10.79"
15"	14.01"	13.20"

14. VIDEO INSPECTION

The Contractor shall inspect the inside of all storm drains by television inspection and provide related color videotapes.

This work shall include dewatering or diverting flow in storm drains to the degree necessary for video inspection and color videotaping.

Dewatering shall include necessary pumping equipment, plugs and temporary piping between manhole sections.

The Contractor shall, prior to starting work, furnish the Engineer for approval, his proposed method for dewatering storm drains.

The Contractor shall furnish all labor, electronic equipment and technicians to perform the closed-circuit television inspection of the storm drains. Operation of the equipment is to be controlled from above ground with a skilled technician at the control panel in the television studio, controlling the movement of the television camera. The technician shall have the capability to adjust the brilliance of the built-in lighting system and be able to change the focus of the television camera by remote control.

The view seen by the television camera shall be transmitted to a monitor of not less than 17 inches. The monitor shall be located inside a mobile TV studio. The stationing of the television camera shall be continuously displayed on the television monitor while the storm drain is inspected. The Contractor's mobile studio shall be large enough to accommodate up to three people for the purpose of viewing the monitor while the inspection is in progress. The Owner's representative shall have access to view the television screen at all times.

The electricity for all operations will be furnished by the Contractor. If required to improve the quality of the television inspection, a ventilating system shall be furnished and installed between manhole sections.

The inspection reports and television tapes shall become the property of the Owner.