

SECTION 601

SECTION 601 -- SANITARY SEWERS

Description

1.1 This work shall consist of furnishing and installing sanitary sewer pipes at the locations shown or ordered, including all necessary joints, fittings and connections as required.

1.1.1 Sanitary sewers shall conform to the requirements of the latest edition of the NHDES-DWSPC "Standards of Design for Sewage and Wastewater Treatment Facilities" and as set forth in these specifications.

Materials

2.1 Reinforced Concrete Pipe, Circular.

2.1.1 This pipe shall conform to the requirements of AASHTO M 170, except as follows: Wall A thickness will be allowed in Class III pipe only. When the plans call for reinforced concrete pipe capable of withstanding an ultimate load greater than 3750 D, the design requirements of Class V shall be met with further provision that the pipe will withstand the ultimate D-load of 4000D.

2.1.2 Basis of acceptance of concrete pipe shall conform to AASHTO M 170, Section 5.1.1. Test requirements shall be as provided in Section 10.3.1 and 10.5 with the further provision that the pipe will withstand an additional ten percent of the D-load specified or brought to destruction. Permissible variation in pipe tolerances shall conform to AASHTO M 170, Section 11.

Table 601-1 -- Minimum Strength Requirements

D-Load to produce the ultimate load = Class	D-Load to produce a 0.01 inch crack	AASHTO Designation Class
1500D	1000	II
2000D	1350	III
3000D	2000	IV
3750D	3000	V
4000D	----	---

2.1.3 Workmanship and finish shall conform to AASHTO M 170, Section 12. Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements of AASHTO M 170, Section 15. Individual sections of pipe may be rejected

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because of the following reasons:

- (a) Fracture or cracks passing through the wall, except for a single crack that does not exceed the depth of a joint.
- (b) Defects that indicate imperfect proportioning, mixing and molding.
- (c) Surface defects indicating honey-combed or open texture.
- (d) Damaged or cracked ends where such damage would prevent making a satisfactory joint.
- (e) Any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more, regardless of position in the wall of the pipe.
- (f) The exposure of any steel in the barrel or the outside of the pipe indicating the displacement of reinforcement. Steel exposed at the ends will not be cause for rejection if a satisfactory join can be made.

2.1.4 Markings on pipe shall conform to AASHTO M 170, Section 16 with the following information clearly marked on each section of pipe.

- (a) The pipe class and specification designation
- (b) The date of manufacture
- (c) The name or trademark of the manufacturer
- (d) Identification of plant

2.1.5 Concrete pipe shall be joined by using flexible water tight gaskets conforming to AASHTO M 198.

2.1.6 The interior of all reinforced concrete pipe for sanitary sewers shall have a coal-tar-epoxy coating.

2.1.6.1 The coal-tar-epoxy coating shall be applied in two coats to a sandblasted surface with a minimum dry film thickness of 8.0 mils per coat and in a manner consistent with the manufacturer's recommendations. Epoxy coatings shall only be applied after the pipe has cured sufficiently to obtain a dry surface for adequate coating bond.

2.1.6.2 The coal-tar-epoxy shall be Bitumastic No. 300- M as manufactured by Koppers Company, Inc. or Tneme-Tar Hi- Build Coal Tar Epoxy as manufactured by Tnemec Company, Inc. or approved equal.

2.2 Ductile Iron Pipe.

2.2.1 Ductile iron pipe and fittings shall conform to the following standards of the American Water Works Association:

- (a) AWWA C151 for ductile iron pipe, centrifugally cast in metal or sand lined molds, for water or other liquids;

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(b) AWWA C150 for thickness design of ductile iron pipe and with ASTM A 536 ductile iron castings.

2.2.2 Joints shall be mechanical type, push-on type, or ball-and-socket type.

2.2.3 The interior of all ductile iron pipe for sanitary sewer shall have a cement lining

2.2.3.1. The cement lining shall be to a double thickness and seal coated in accordance with ANSI Specification A21.4, Cement Mortar Lining for Cast-Iron and Fittings for Water.

2.2.4 The interior of all ductile iron pipe for sanitary sewers shall have a coal-tar-epoxy coating.

2.2.4.1 The coal-tar-epoxy coating shall be applied in two coats with a minimum dry film thickness of 8.0 mils per coat and in a manner consistent with the manufacturer's recommendations.

2.2.4.2 The coal-tar-epoxy shall be Bitumastic No. 300- M as manufactured by Koppers Company, Inc. or Tneme-Tar Hi- Build Coal Tar Epoxy as manufactured by Tnemec Company, Inc. or approved equal.

2.2.5 The exterior of all ductile iron pipe for sanitary sewer shall have a bituminous coating.

2.3 Plastic Pipe.

2.3.1 Plastic gravity sewer pipe and fittings shall comply with the standards listed in Table 601-2:

Table 601-2 -- Plastic Pipe

<u>ASTM Standard</u>	<u>Generic Pipe Material</u>	<u>Sizes Approved</u>
D3034	*PVC (solid wall)	8" through 15" (SDR 35)
F679	PVC (solid wall)	18" through 27" (T-1 & T-2)
F789	PVC (solid wall)	4" through 18" (T-1 to T-3)
F794	PVC (ribbed wall)	8" through 36"
D2680	*ABS (composite wall)	8" through 15"

*PVC: poly vinyl chloride

*ABS: acrylonitrile-butadiene-styrene

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2.3.2 Plastic sewer pipe shall have a pipe stiffness rating of at least 46 pounds per square inch at 5 percent pipe diameter deflection, as measured in accordance with ASTM D2412 during manufacturing.

2.3.3 Joint seals for PVC pipe shall be oil resistant compression rings of elastomeric material conforming to ASTM D3212 and shall be push-on, bell-and-spigot type.

2.3.4 PVC pipe used for force mains shall have a Standard Dimension Ratio (SDR) no higher than 26 and shall conform to ASTM D2241 and ASTM D1784.

2.3.5 Force mains shall be designed to withstand hydrostatic pressures of at least 2 ½ times the design total dynamic head.

2.3.1.2 Pipe and fittings for PVC gravity sewer pipe shall have a Standard Dimension Ratio (SDR) of 35 or equivalent in load carrying performance.

2.4 Fittings.

2.4.1 Unless otherwise specified or ordered, tees, wyes and others special shapes shall be equal to the type, diameter, class and joint of pipe with which they are used.

2.5 Concrete for encasements and chimneys shall conform to the requirements for Class A (3000 psi) concrete as specified in Section 520.

2.6 Bedding and backfill shall conform to the requirements of Section 209.

Construction Requirements

3.1 Sanitary sewers shall be constructed according to the requirements of 603 3.1, 3.2, 3.3 and 3.4 except as follows:

3.1.1 Plastic Pipe.

3.1.1.1 Special care shall be taken to ensure that the first two to three feet of backfill above the sand cushion over the pipe is placed carefully rather than dropped, so as to avoid damaging the pipe from impact during placement.

3.1.1.2 There shall be at least 30 inches of cover over the top of the pipe before the trench is wheel loaded. There shall be at least 48 inches of cover over the top of the pipe before mobile trench compactors of the hydro-hammer or impactor type are used.

3.1.1.3 All necessary precautions shall be taken to prevent flotation of the pipe in the trench.

3.1.1.4 The pipe shall not be driven down to the required grade by striking with a

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shovel handle, timber or other unyielding object.

3.1.1.5 Suitable devices shall be used to force the pipe units together. Care shall be taken not to split or otherwise damage the joints.

3.1.1.6 All plastic sewer pipe shall be deflection tested not less than 30 days following installation.

3.1.1.7 The maximum allowable deflection of flexible sewer pipe shall be 7 ½% of average inside diameter. Deflection shall be measured as the reduction in the vertical diameter of the pipe (diametrically). Deflection testing shall be performed on random manhole-to-manhole sections using either a mandrel (supplied or available from pipe supplier or manufacturer) through the pipeline on the basis of a "GO-NO-GO" condition or by an approved deflectometer. If the mandrel does not pass through the pipeline, the entire section shall be excavated and relayed; and after backfilling and adequate compaction is assured, the pipeline shall be re-tested.

3.2 Sanitary services shall be installed according to the latest edition of the New Hampshire Department of Environmental Services -- Division of Water Supply and Pollution Control, "House and Sewer Details" and the City of Manchester "Sewer Use Ordinance". If the New Hampshire Department of Environmental Services -- Division of Water Supply and Pollution Control, "House and Sewer Details" and the City of Manchester, New Hampshire "Sewer Use Ordinance" differ, the more stringent as interpreted by the Engineer, shall apply.

3.2.1 Connecting Sanitary Services.

3.2.1.1- Service connections shall use a sanitary tee or wye fitting for all new sewer construction. Whenever practical, sanitary service connections shall be made at the same time as the new sewer line is constructed

3.2.1.2 Building connections shall have the sewer fitting set at 45° to provide a gradual slope entry to the sewer.

3.2.1.3 If the vertical drop between the existing service pipe and the new sanitary sewer is greater than four (4) feet, a chimney shall be constructed (see Figure 601- 6)

3.2.1.4 Abandoned sanitary service pipes shall be removed and disposed of or plugged and sealed watertight as ordered by the Engineer.

3.2.1.5 All joints shall be properly matched with the pipe materials use with appropriate flexible joint adaptors and couplings.

3.2.1.6 For existing sewers where fittings cannot be installed, saddle connections shall be used. Saddle joints shall be encased in concrete.

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3.2.1.7 Where the distance between the building and the sewer main is greater than 75 feet, a sewer service cleanout shall be provided.

3.2.1.8 Gas traps and/or grease traps may be required at the discretion of the Director of Public Works or of the Building Commissioner. A detail of each is provided at the end of this section.

Leakage Testing

4.1 All new sewers and force mains shall be tested for watertightness by the use of either water or low- pressure air test. There shall be no more than 1000 feet of untested sewer constructed at any time. The Engineer shall decide which of the following test procedures to be used.

4.2 The rate of infiltration or exfiltration shall not be greater than 100 gallons per day per inch of pipe diameter per mile of pipe for sizes to 48 inches, and not greater than 200 gallons per day per inch of pipe diameter per mile for sizes over 48 inches.

4.3 Low pressure air testing shall be in conformance with ASTM C828.

4.4 Tables are provided at the end of this section as guidelines for testing sewer lines.

4.4 Sanitary Service Connections.

4.4.1 Prior to backfilling, the completed service connection shall be tested for leakage according to the procedures stated in the New Hampshire Department of Environmental Services -- Division of Water Supply and Pollution Control Specification "House Sewer Details", Item 7 "Testing".

4.5 Gravity Sewers.

4.5.1 When the groundwater level is at or above the crown of the pipe, the infiltration test may be used. The section being tested shall be isolated by watertight end. After conditions have stabilized, leakage shall be measured by collecting flow from a water pipe, through a clay dam or by measurement with a vee-notch weir or other acceptable means.

4.5.2 Where groundwater is below the crown of the pipe, the exfiltration test shall be used. The test section shall be isolated and filled with water to an elevation two feet above the crown of the pipe at the upstream manhole. The amount of water necessary to maintain the level in the manhole shall be measured (See Table 601-1).

4.6 Force Main.

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4.6.1 Force mains shall be tested in accordance with section 4 of AWWA C600 “Installation of Cast Iron Water Mains”, at a pressure equal to 150% of the design operating total dynamic head.

Method of Measurement

5.1 Sewer pipes will be measured by the linear foot to the nearest 0.1 of a foot, according to type, size, class and depth, as the horizontal projection of the distance between manholes, from inside face of manhole walls, or inside face of manhole wall to end of stub or connection. Measurement shall be made along the central axis of the pipe.

5.1.1 The depth for measurement shall be determined as the vertical distance, to the nearest 1.0 foot, between the original ground and the flow line of the pipe as installed.

5.2 Sanitary service connections will be measured by the linear foot, to the nearest 0.1 of a foot, along the central axis of the pipe, from the point of connection with the specified fitting at the sewer line, manhole or chimney to the upstream end of the fitting connecting the new with the existing service line.

5.3 Drop connections will be measured by the vertical foot, to the nearest 0.1 of a foot, between the invert of the higher pipe entering the manhole and the invert of the 90 degree bend at the bottom of the manhole.

5.4 Service chimneys will be measured by the vertical foot to the nearest 0.1 of a foot, from the centerline of the sewer to the top of the uppermost wye connection.

5.5 Adjusting existing service connections to avoid a conflict and/or reconnect with sewer, will be measured as a unit per service connection adjusted.

5.6 Sewer service cleanouts shall be measured by the number of units installed. One cleanout shall be a unit.

Basis of Payment

6.1 The accepted quantities of sewer pipe will be paid for at the contract unit price per linear foot of the type, size, class and depth specified complete in place, which price shall constitute full compensation for excavation (except rock), backfill, bedding and furnishing all materials including fittings, tools, equipment, labor and incidentals needed to complete the work, including those necessary to test and inspect the sewer line.

6.2 The Contractor shall be paid the contract unit price per linear foot of service connection, complete in place which price shall constitute full compensation for excavation (except rock), backfill, bedding and furnishing all materials including wyes, tees, saddles, fittings, tools, equipment, labor and incidentals needed to complete the work, including those necessary to test and inspect the sewer service line.

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6.3 The Contractor shall be paid the contract unit price per each adjusted service connection, complete in place which price shall constitute full compensation for excavation (except rock), backfill, bedding and furnishing all materials, including fittings, tools, equipment, labor and incidentals needed to complete the work, including those necessary to test and inspect the sewer service line.

6.4 The Contractor shall be paid the contract unit price per vertical foot of chimney, complete in place which price shall constitute full compensation for furnishing all materials, including pipe, fittings, sand, concrete, tools, equipment and labor and incidentals needed to complete the work.

6.5 The Contractor shall be paid the contract unit price per vertical foot of drop connection, of the size, type and class specified, complete in place which price shall constitute full compensation for furnishing all materials, including pipe, fittings, concrete, tools, equipment, labor and incidentals needed to complete the work.

6.6 Temporary diversion of groundwater, including trenching or pumping directly from the trench shall be subsidiary to the pipe installation. When well points or other specific dewatering devices are required or ordered, they will be paid as shown or as extra work.

6.7 Temporary diversion of sewer flows shall be subsidiary to pipe installation.

6.8 The accepted quantities of sewer service cleanouts will be paid for at the contract unit price for each, complete in place, which price shall constitute full compensation for excavation, backfill and furnishing all materials, tools, equipment, labor and incidental needed to complete the work.

KEY TO ITEM NUMBERS FOR SEWER PIPE

Item Number					Item Number	Unit
601	A	B	C	D	E	
601						Section Number
	.A					Material
		B				Class, thickness or other
			C			Depth range
				D	E	Diameter
.0						Reinforced Concrete Pipe (Circular)
						Linear Foot
		C				Class
		2				Class II
		3				Class III

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4	Class IV	
5	Class V	
.1	Reinforced Concrete Pipe (Arch)	Linear Foot
C	Class	
2	Class II	
3	Class III	
4	Class IV	
5	Class V	
.2	Ductile Iron	Linear Foot
C	ANSI Thickness Class	
1	51	
2	52	
3	53	
4	54	
5	55	
6	56	
.3	Plastic Pipe (PVC)	Linear Foot
1	SDR 26	
2	SDR 35	
.4	Plastic Pipe (ABS)	
1	SDR 26	
2	SDR 35	
C	Depth Range	
1	0-10 feet	
2	10-15 feet	
3	15-20 feet	
4	Over 20 feet	

All Items to Read:

"...Including Excavation, Bedding and Backfill"

Examples:

601.04118 18" Reinforced Concrete Sewer Pipe, Class IV (0'-10'Deep)
601.25118 18" Ductile Iron Pipe, Class 55 (0'-10' Deep)
601.32118 18" PVC Pipe, SDR 35 (0'-10' Deep)

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Additional Pay Items and Units:

601.4	Inside Drop Connection	Vertical Foot
601.5	Sanitary Service Connection	Linear Foot
601.6	Adjusting Existing Sanitary Service Connection	Each
601.7	Service Chimney	Vertical Foot
601.8	Saddle	Each
601.81	Concrete Encased Saddles	Each
601.9	Sanitary Service Cleanout	Each

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TABLE 601-3

HYDROSTATIC TESTING TABLE FOR FORCE MAINS

Allowable Leakage per 1000 ft of Pipeline*-gph

P#**	Nominal pipe Diameter (Inches)								
	2	3	4	5	6	8	12	14	16
450	0.32	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55
400	0.30	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40
350	0.28	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25
300	0.26	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08
275	0.25	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99
250	0.24	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90
200	0.21	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70
175	0.20	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59
150	0.19	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47
125	0.17	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34
100	0.15	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20

* For pipe with 18 ft nominal lengths. To obtain the recommended allowable leakage for pipe with 20 ft nominal lengths, multiply the leakage calculated from the table by 0.9. If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

** #P = Average Test Pressure, psi.

LOW PRESSURE AIR TEST FOR SANITARY SEWERS

Introduction

Numerous laboratory and field air tests have been devised over the years since the early 1960's. Much of the information contained in these tests was utilized by the American Society for Testing and Materials (ASTM) when preparing ASTM C 828, a low-pressure air test for sanitary sewers.

Described below is the procedure for air testing sewer lines to demonstrate the integrity of the installed material and the construction methods.

Summary of Method

The section of the sewer line to be tested is plugged. Low-pressure air is introduced into the plugged line. The amount and rate of air loss is used to determine the acceptability of the section being tested.

Preparation of the Sewer Line

Flush and clean the sewer line prior to testing, thus serving to wet the pipe surface as well as clean out any debris. A wetted interior pipe surface will produce more consistent results. Plug all pipe outlets to resist the test pressure. Give special attention to plugs.

Procedures

Determine the test duration for the section under test by computation from the applicable equations shown in ASTM C 828, or from prepared air test tables. The pressure-holding time is based on an average holding pressure of 3 psi (21 kPa) gage or a drop from 3.5 psi (24 kPa) to 2.5 psi (17 kPa) gage.

Add air until the internal air pressure of the sewer line is raised to approximately 4.0 psi (28 kPa) gage. After an internal pressure of approximately 4.0 psig is obtained, allow time for the air pressure to stabilize. The pressure will normally show some drop until the temperature of the air in the test section stabilizes.

When the pressure has stabilized and is at or above the starting test pressure of 3.5 psi (24 kPa) gage, commence the test. Before starting the test, the pressure may be allowed to drop to 3.5 psig. Record the drop in pressure for the test period. If the pressure has dropped more than 1.0 psi (7 kPa) gage during the test period, the line is presumed to have failed. The test may be discontinued when the prescribed test time has been completed even though the 1.0 psig drop has not occurred.

The test procedure may be used as a presumptive test which enables the installer to

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backfill and subsequent construction activities.

If the pipe to be tested is submerged in ground water, a water infiltration test should be used.

Safety

The air test may be dangerous if, because of lack of understanding or carelessness, a line is improperly prepared.

It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. Inasmuch as a force of 250lbf (112 N) is exerted on an 8-in. (203-mm) plug by an internal pipe pressure of 5 psi (34 kPa), it should be realized that sudden expulsion of a improperly installed plug could cause serious personal injury.

As a safety precaution, pressurizing equipment may include a regulator or relief valve set at perhaps 10 psi (69 kPa) to avoid over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

Table

The attached air test table (601-5) has been prepared utilizing applicable equations from ASTM C 828. It is based on an allowable air loss of $0.003 \text{ ft}^3/\text{min-ft}^2$ of internal pipe surface, a maximum air loss per test section of $3.5 \text{ ft}^3/\text{min}$ and a minimum significant air loss per test section of $2.0 \text{ ft}^3/\text{min}$ would be exceeded using the allowable loss of air per square foot of internal pipe surface may be tested in segments where total air loss would be between 2.0 and $3.5 \text{ ft}^3/\text{min}$.) It applies when testing one pipe diameter only and for convenience ignores 4" and 6" insignificant differences in test time.

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TABLE 601-5

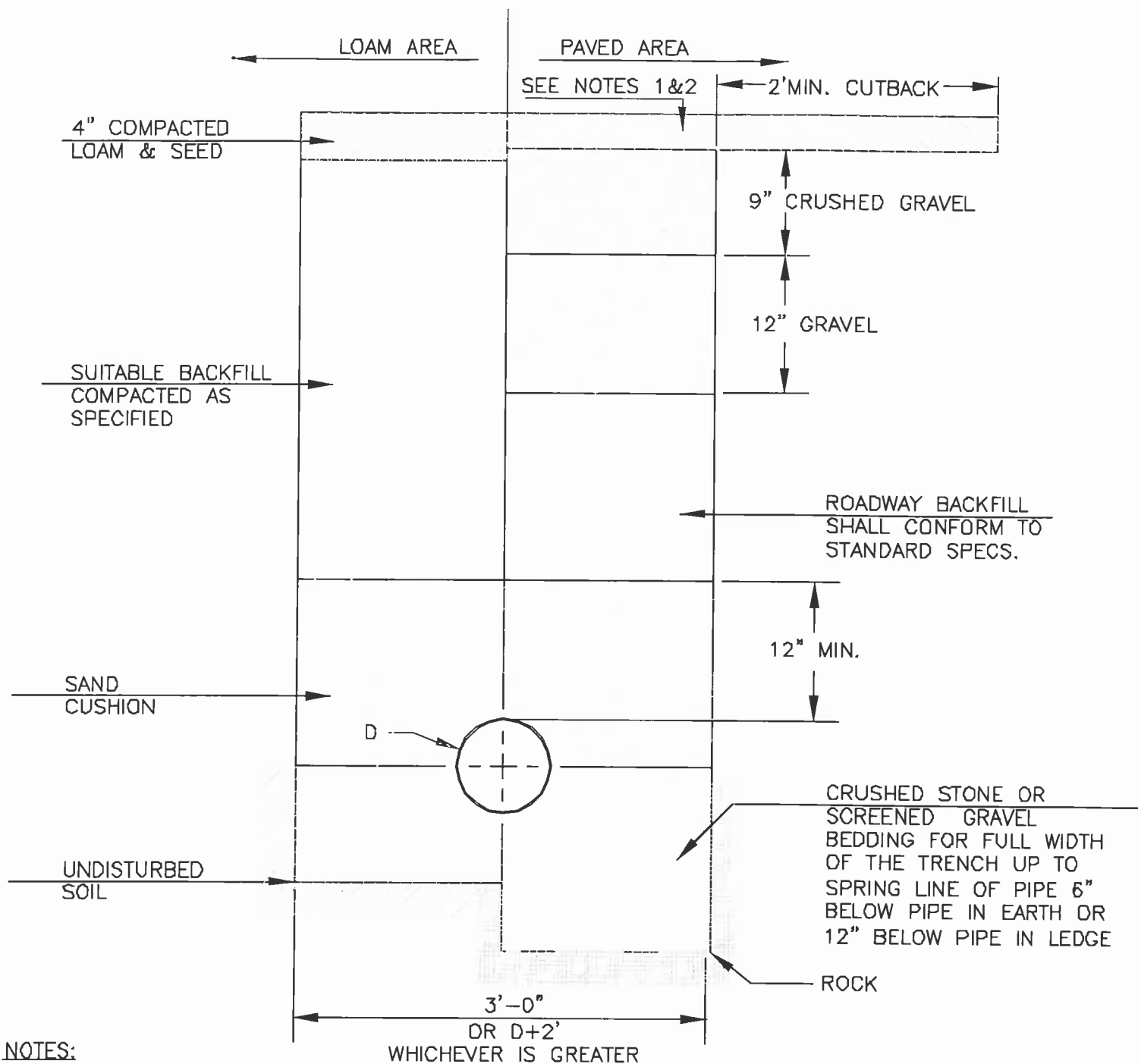
AIR TEST TABLE

Based on equations from ASTM C 828
 SPECIFICATION TIME (MIN:SEC) REQUIRED FOR PRESSURE DROP
 FROM 3-1/2 TO 2-1/2 PSIG
 WHEN TESTING ONE PIPE DIAMETER ONLY

	PIPE DIAMETER (INCHES)								
L*	4	6	8	10	12	15	18	21	24
25	0:04	0:10	0:18	0:28	0:40	1:02	1:29	2:01	2:38
50	0:09	0:20	0:35	0:55	1:19	2:04	2:58	4:03	5:17
75	0:13	0:30	0:53	1:23	1:59	3:06	4:27	6:04	7:55
100	0:18	0:40	1:10	1:50	2:38	4:08	5:56	8:05	10:34
125	0:22	0:50	1:28	2:18	3:18	5:09	7:26	9:55	11:20
150	0:26	0:59	1:46	2:45	3:58	6:11	8:30		
175	0:31	1:09	2:03	3:13	4:37	7:05			
200	0:35	1:19	2:21	3:40	5:17				12:06
225	0:40	1:29	2:38	4:08	5:40			10:25	13:36
250	0:44	1:39	2:56	4:35			8:31	11:35	15:07
275	0:48	1:49	3:14	4:43			9:21	12:44	16:38
300	0:53	1:59	3:31				10:12	13:53	18:09
350	1:02	2:19	3:47			8:16	11:54	16:12	21:10
400	1:10	2:38			6:03	9:27	13:36	18:31	24:12
450	1:19	2:50			6:48	10:38	15:19	20:50	27:13
500	1:28			5:14	7:34	11:49	17:01	23:09	30:14

*L = LENGTH OF LINE, FEET

NOTE: If the pipeline to be tested is beneath the groundwater level, the test pressure shall be increased 0.433 psi for each foot the groundwater level is above the crown of the pipe.



NOTES:

- 1.) PAVEMENT REPAIR IN EXISTING ROADWAYS SHALL CONFORM TO STREET OPENING REGULATIONS. DEPTH FOR BITUMINOUS PAVEMENT SHALL BE EQUAL TO EXISTING PAVEMENT WITH 3" MINIMUM. (1" WEARING, 2" BASE).
- 2.) NEW ROADWAY CONSTRUCTION SHALL CONFORM TO SUBDIVISION SPECIFICATIONS.
- 3.) IN LIEU OF THE 12" GRAVEL COURSE AND 9" OF CRUSHED GRAVEL, 18" OF CRUSHED GRAVEL OR RECLAIMED STABILIZED BASE MAY BE USED AS A BASE FOR THE PAVEMENT REPAIR.
- 4.) MATERIAL SHALL BE REPLACED IN KIND WHENEVER POSSIBLE.
- 5.) A MINIMUM 2' CUTBACK IS REQUIRED AT THE TOP OF THE TRENCH WALL OVER UNDISTURBED MATERIAL.

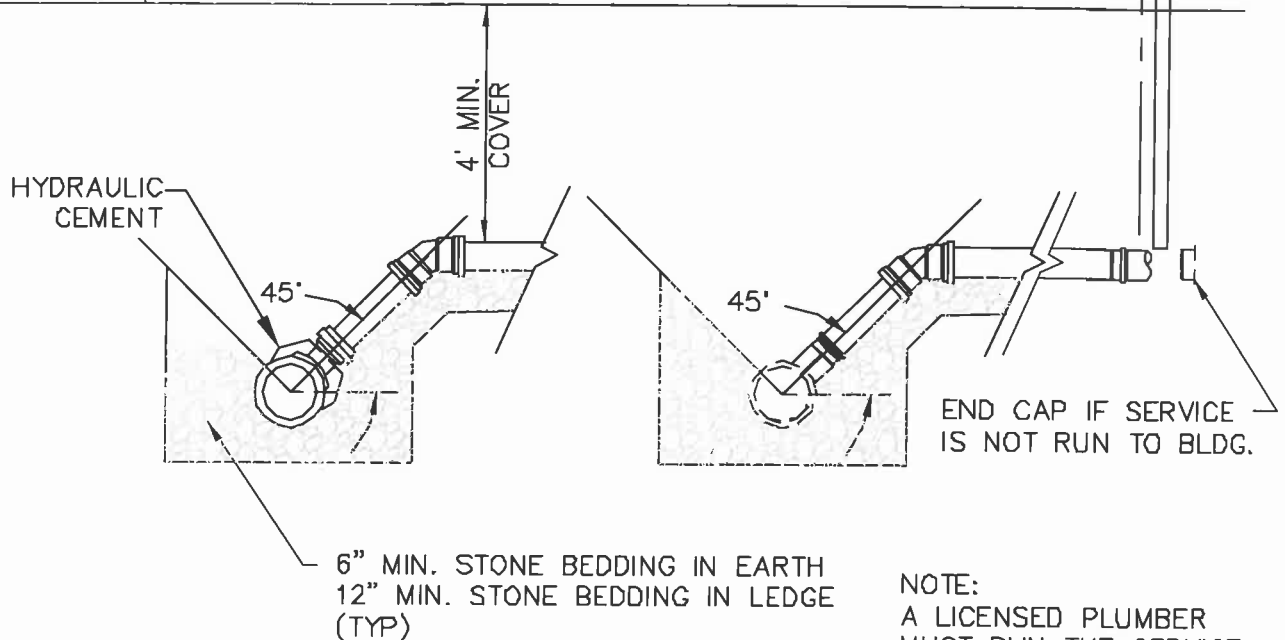
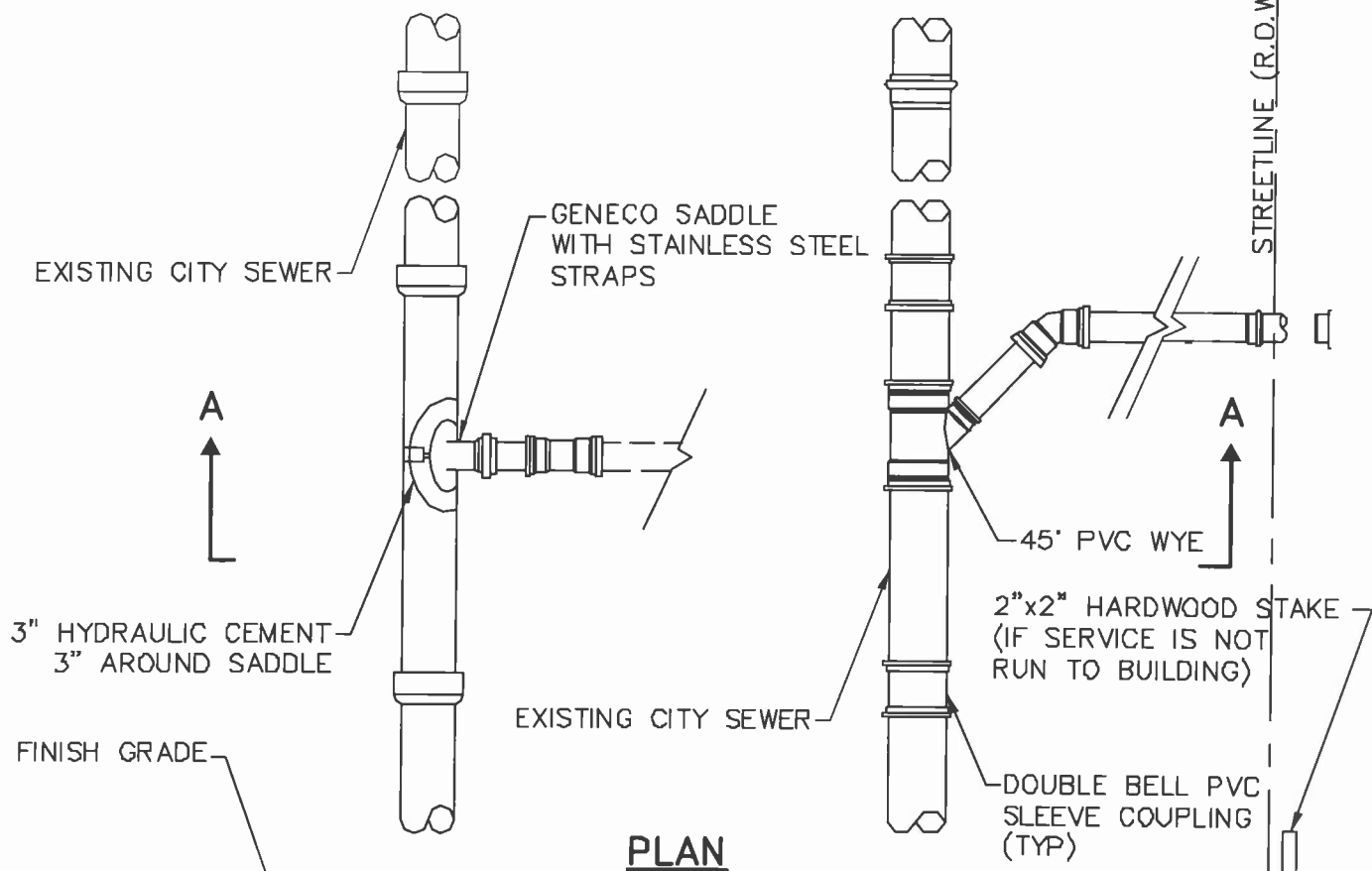
TYPICAL SEWER TRENCH DETAIL

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NOT TO SCALE
FIGURE 601-1

VITRIFIED CLAY PIPE

POLYVINYLCHLORIDE PIPE



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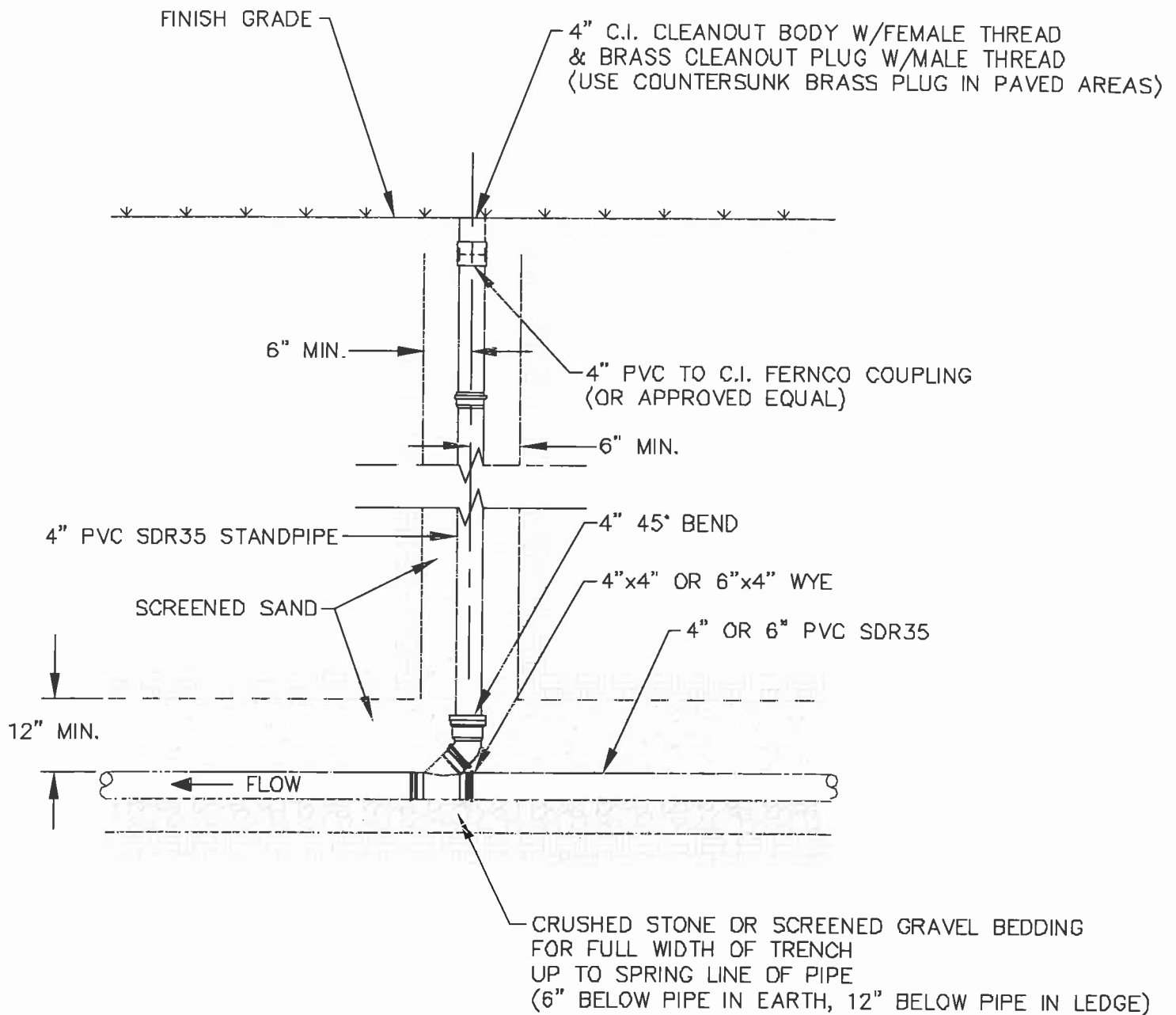
NOTE:
A LICENSED PLUMBER
MUST RUN THE SERVICE
TO THE BUILDING AFTER
OBTAINING A CLASS 'A' PERMIT

TYPICAL SEWER CONNECTION (TYING INTO EXISTING MAINS)

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NOT TO SCALE

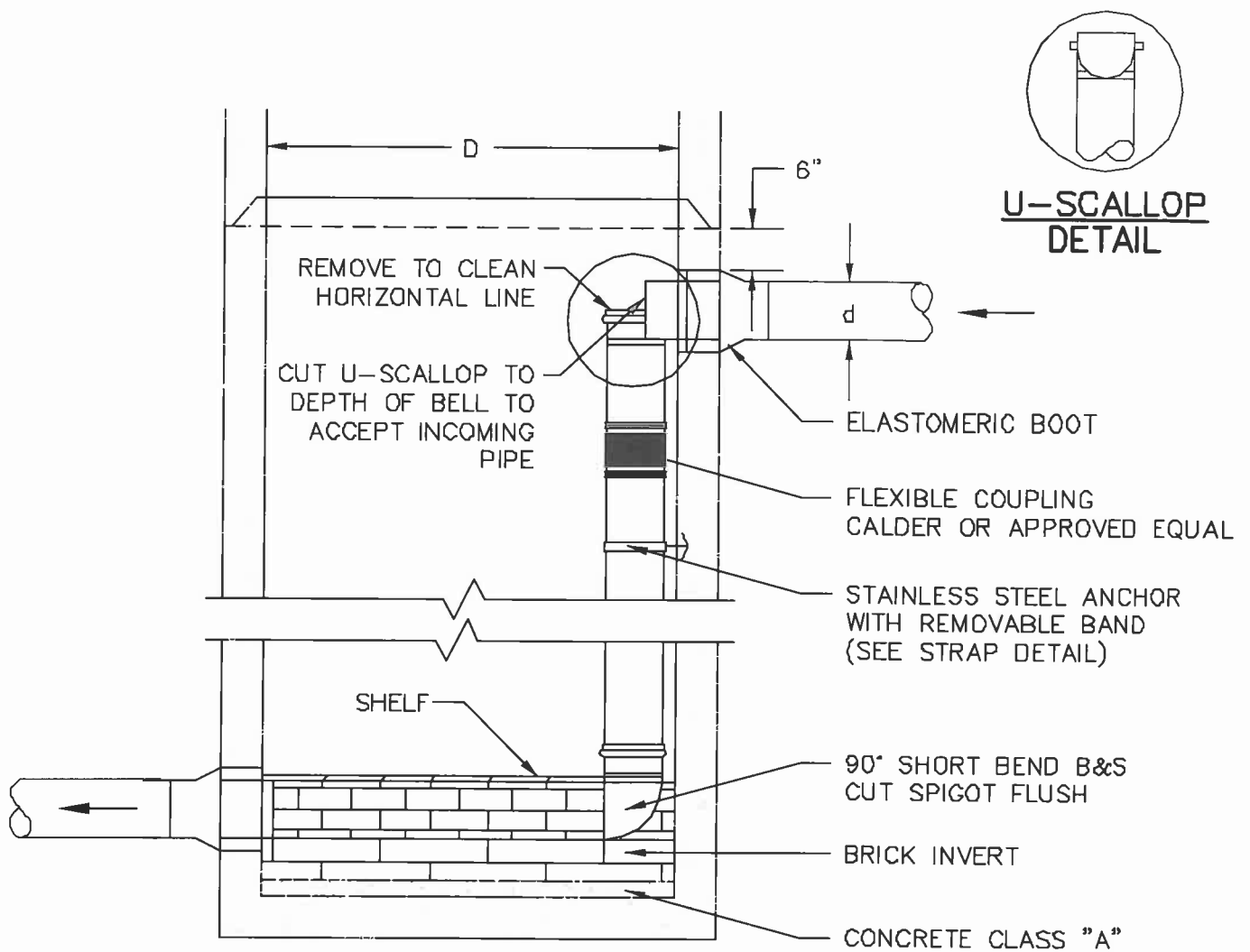
FIGURE 601-2



TYPICAL SEWER SERVICE CLEANOUT

S:\DWG\DETAILS\601-3 CLEANOUT.DWG

NOT TO SCALE
FIGURE 601-3

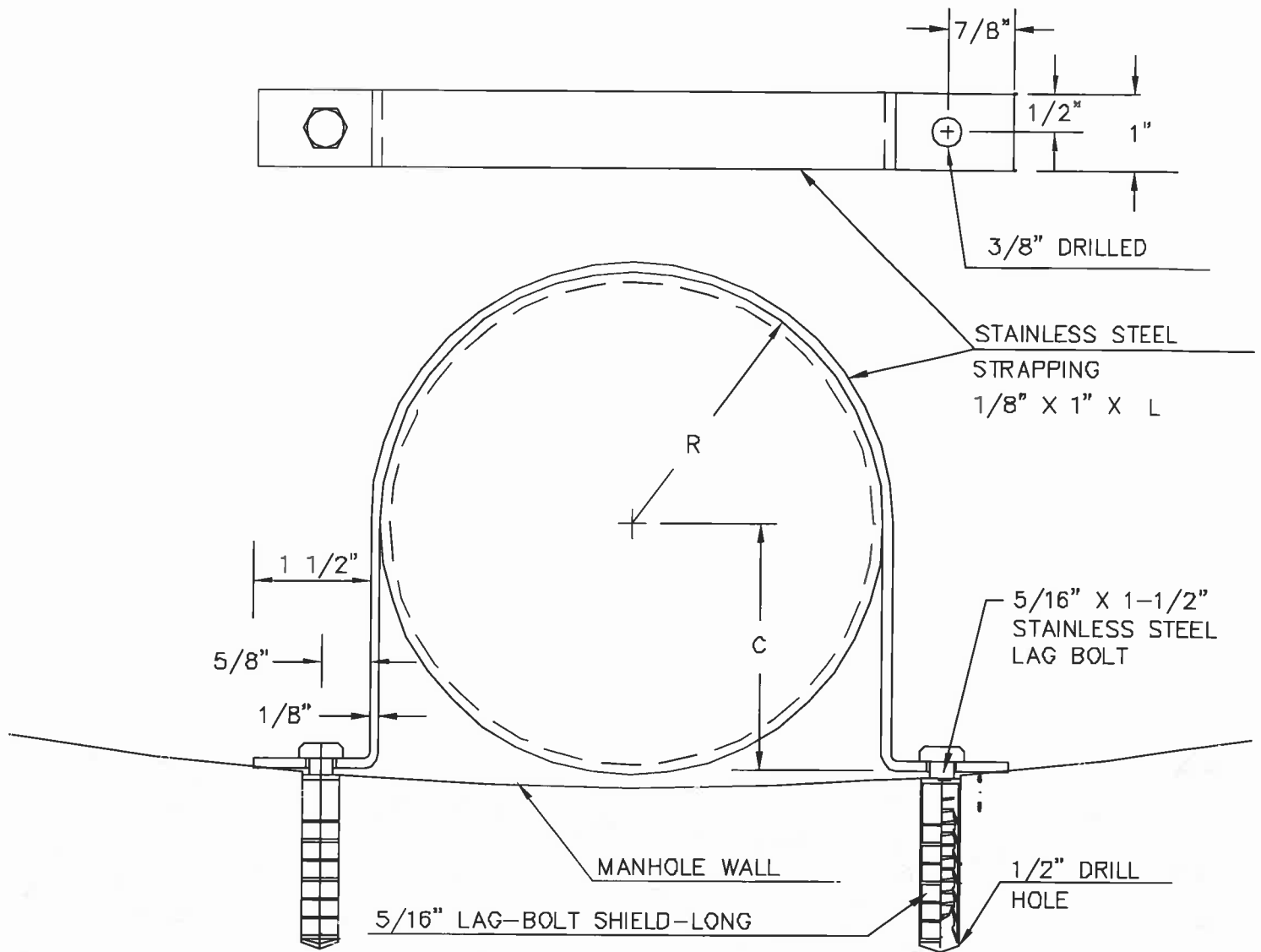


# OF DROPS	d	D
1	8"	4'
2	8" OR 10"	5'
1	12"	5'
1	15"	5'
1	18"	6'
1	24"	6'

INSIDE DROP CONNECTION FOR PVC PIPE

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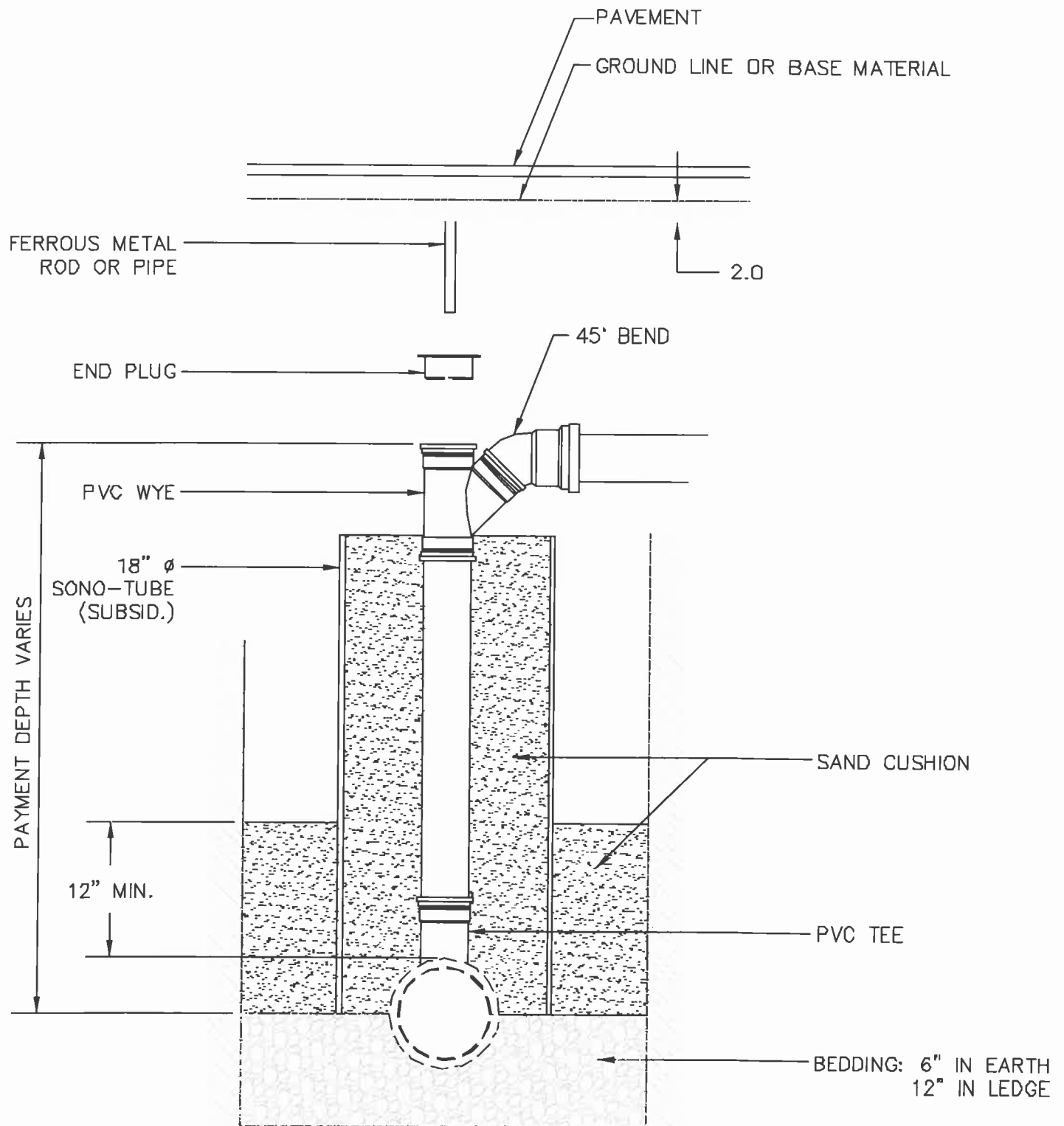
NOT TO SCALE
FIGURE 601-4



STRAP DETAIL FOR INSIDE DROP CONNECTION

NOT TO SCALE
FIGURE 601-5

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NOTE: FORMWORK OR SONO-TUBE SHALL BE LEFT IN PLACE.

SERVICE CHIMNEY FOR PVC PIPE

S:\DWG\DETAILS\601-6 CHIMNEY.DWG

NOT TO SCALE
FIGURE 601-6

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SECTION 602 -- SANITARY SEWER MANHOLES

Description

1.1 This work shall consist of furnishing and installing sanitary sewer manholes; furnishing and placing manhole covers, all as shown on the plans or as ordered.

1.1.1 Sanitary sewer manholes shall conform to the requirements of the latest edition of the New Hampshire Department of Environmental Services -- Water Division "Standards of Design and Construction for Sewerage and Wastewater Treatment Facilities" and as set forth in these specifications.

Materials

2.1 General.

2.1.1 Sanitary sewer manholes shall be precast concrete.

2.1.1.1 Cone and transition sections shall be eccentric in shape.

2.1.1.2 Base sections shall be monolithic construction to a point no less than 6 inches above the crown of the incoming pipe.

2.1.1.3 When manhole depth is less than 6 feet, a reinforced concrete slab cover may be used in lieu of a cone section. Such slab shall have an eccentric entrance opening and be capable of supporting H-20 loads.

2.1.1.4 Horizontal joints for all precast sections shall be tongue and groove.

2.1.1.5 The name of the manufacturer and the date of manufacture shall be clearly marked on each precast section.

2.1.1.6 Two coats of a bituminous waterproofing material shall be applied to the exterior surfaces by brush or spray and in accordance with the manufacturer's recommendations. The bituminous waterproofing material shall be Minwax Fibrous Brush Coat as manufactured by the Tremco Manufacturing Company, Bituminous Black Solution as manufactured by the Koppers Company, Inc., or an approved equal.

2.1.1.7 Manhole structures shall have a life in excess of 25 years.

2.2 Reinforcing steel shall conform to the requirements of 544.

2.3 Precast concrete sections shall conform to ASTM C478. The concrete shall be Class AA, meeting the requirements of 520.

SECTION 602

2.4 Clay brick shall conform to the requirements of ASTM C32 for Grade SS, hard brick.

2.5 Concrete masonry units shall conform to the requirements of ASTM C 139 and shall have a minimum compressive strength of 3000 pounds per square inch when tested by the method in AASHTO T 140.

2.6 Cement mortar shall conform to 707.

2.7 Non-shrinking mortar shall be Hallemite, Waterplug, Embecco or an approved equal.

2.8 The castings shall be of even-grained cast iron, smooth and free from scale, lumps, blisters, sand holes and defects. Castings shall be equal to class 30, conforming to ASTM A48.

2.9 The word "SEWER" in three inch letters shall be plainly cast in the center of each manhole cover.

2.10 Joints shall be sealed watertight with an approved rubber on bitumastic sealant conforming to ASTM C32.

2.11 Bedding and backfill material shall conform to the requirements of 209.

Construction Requirements

3.1 Excavation shall conform to the requirements of 206.

3.2 Bedding and backfill procedures shall conform to the requirements of 209.

3.3 Precast concrete sections shall be at least ten (10) days old when delivered to the construction site.

3.4 Sanitary manholes shall have a brick paved inverts and shelf constructed to conform to the size of pipe and flow. At changes in direction, the inverts shall be laid out in curves of the longest radius possible tangent to the center line of the sewer pipes. Shelves shall be constructed to the elevation of the highest pipe crown and sloped to drain towards the flow through the channel. Inverts and shelves shall be placed after testing.

3.4.1 All lifting holes and joints shall be filled with non-shrinking mortar and pointed as directed.

3.5 Concrete construction shall conform to the requirements for structural concrete. Masonry shall conform to the requirements for the respective type. Masonry shall fit neatly and tightly around the pipe.

SECTION 602

3.6 The Contractor shall provide for the temporary diversion of water in order to permit the installation of sanitary sewer manholes in a reasonably dry trench, unless otherwise permitted by the Engineer.

3.7 Prior to installation and adjustment of covers and frames, the top of the sanitary sewer manholes shall be temporarily covered to prevent accidental entry.

3.8 In accordance with the provisions of ASSHTO M105, 17.2, the following are the "other matters of workmanship and finish" required: Frames and covers shall be matched before being incorporated into the work. Covers shall make full and even bearing on the underlying surface to fit into the frames without rocking.

3.9 Structures within the limits of bituminous concrete pavement shall be temporarily set at the elevation of the bottom of the binder course or as ordered. Just prior to the placement of the wearing course, they shall be set at their final grade. Backfill necessary around such structures after the base course has been completed shall be made with Class "A" concrete unless otherwise ordered.

3.9.1 Brick or precast concrete rings shall be used to adjust manhole frames to grade. The maximum allowable adjustment shall be 12 inches.

3.9.2 Frames shall be set on a full bed of mortar to ensure a watertight fit. They shall be set true to grade and fully aligned with the masonry opening.

3.9.3 A mortar fillet extending to the outer edge of the masonry and a minimum of 1 inch thick shall be constructed around the frame in such a manner as to shed water.

3.10 Sanitary sewer manholes specified to be adjusted shall be built up to the required elevation according to the requirements of 3.8.

3.11 When connections to existing sanitary sewer manholes are required, the openings shall be cored and the pipe to manhole joints shall be neatly and tightly sealed with a Kor-N-Seal Joint Sleeve or approved equal. Inverts shall be modified to meet the requirements of 3.5.

3.12 Pipe to manhole joints shall be as follows:

- a) Elastomeric, rubber sleeve with watertight joints at the manhole opening and pipe surface;
- b) Cast into the wall or secured with stainless steel clamps;
- c) Elastomeric sealing ring cast in the manhole opening with seal formed on the surface of the pipe by compression of the ring; and
- d) Non-shrink grouted joints where watertight bonding to the manhole and pipe can be obtained.

SECTION 602

3.13 Upon completion, each sanitary sewer manhole shall be cleaned of silt, debris or other matter of any kind and shall be kept clean until final acceptance of the work.

Leakage Testing

4.1 General.

4.1.1. Manholes shall be tested for leakage using either a water infiltration test, exfiltration test or a vacuum test.

4.1.2 Whereas the tests are intended to verify watertightness of the precast concrete sections and joints, no adjustment to the leakage allowance will be made for any other cause.

4.1.3 The leakage test shall be performed prior to constructing the invert and shelf and before filling and pointing the interior horizontal joints.

4.1.4 The Contractor shall take all steps necessary to insure that the water table is below the bottom of the manhole throughout the test, except as provided in 4.4.

4.1.5 All pipes and other openings into the manhole shall be suitably plugged. The pipes shall be adequately braced to prevent blowouts.

4.1.6 Leakage tests may be performed either before or after backfilling around the manhole. It is recommended that the tests be performed prior to backfilling. If the Contractor elects to test after backfilling, he shall do so at his own risk.

4.2 Water Test.

4.2.1 Prior to performing the water test, all lifting holes and exterior joints shall be filled with non-shrinking mortar and pointed. The manhole shall then be filled to the top of the cone section with water.

4.2.2 Where the excavation has been backfilled and the exterior surface of the manhole cannot be observed, the test shall be continued as follows:

4.2.2.1 Prior to starting the test, the Contractor may be allowed to let the water stand in the manhole for a period of time to allow for absorption. At the end of that time, the water level shall be brought back to the top of the cone section and the measurement period begun.

4.2.2.2 The water shall be allowed to stand in the manhole for no less than eight hours. At the end of that time, the volume of water lost to leakage shall be computed and extrapolated to a 24 hour rate.

SECTION 602

4.2.2.3 The amount of leakage shall be determined on the basis of rate and depth and shall not exceed 1 gallon per vertical foot over a 24 hour period.

4.2.2.4 If the minimum leakage allowable cannot be met and the leakage does not exceed 3 gallons per vertical foot over a 24 hour period, the Contractor shall be allowed to make necessary repairs as approved by the Engineer. The manhole shall be re-tested.

4.2.3 The following conditions shall be cause for rejection of the manhole:

- (a) Failure to meet the minimum requirements after a repaired manholes has been re-tested.
- (b) Leakage exceeding 3 gallons per vertical foot over a 24 hour period as the result of the initial test.

4.2.3.1 If a manhole is rejected due to the failure of the leakage test, it shall be the Contractor's responsibility to either reconstruct or replace it as directed by the Engineer.

4.2.4 Upon completion of a successful water test, the interior joints shall be filled and pointed.

4.3 Vacuum Test.

4.3.1 Where the excavation has not been backfilled, the filling and pointing of exterior joints shall not be necessary prior to performing this test.

4.3.2 The vacuum test shall be conducted as follows:

4.3.2.1 The compression band shall be inflated to effect a seal between the vacuum base and the top of the manhole. The vacuum pump shall then be connected to the outlet port with the valve open and a vacuum of 10" Hg (20" of Hg absolute) drawn. The valve shall then be closed.

4.3.2.2 The following test criteria shall apply to 4 foot and 5 foot diameter manholes. The minimum acceptable test hold time for a 1" Hg pressure drop to 9" Hg shall be:

- (a) Not less than 2 minutes for manholes less than 10 feet deep;
- (b) Not less than 2-1/2 minutes for manholes 10-15 feet deep; and,
- (c) Not less than 3 minutes for manholes 15-25 feet deep.

4.3.2.3 If the pressure drop exceeds the acceptable limits the Contractor shall be allowed to make necessary repairs, as approved by the Engineer. The manhole shall then be re-tested.

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4.3.2.4 If the manhole fails to meet the minimum requirements of the vacuum test when re-tested, it may be water tested as outlined in 4.2.

4.3.3 Manholes shall be subject to rejection as outlined in 4.2.3.

4.3.4 Upon completion of a successful vacuum test, the interior and exterior joints shall be filled and pointed.

4.4 Infiltration Test.

4.4.1 If the water table is above the highest joint in the manhole, the infiltration test may be used to evaluate its watertightness.

4.4.1.1 The Engineer will check the interior of the manhole for leakage, and if in his opinion no serious leakage is observed, the watertightness of the manhole may be considered satisfactory.

4.4.1.2 If in the opinion of the Engineer, there is serious leakage the Contractor shall be required to perform the test in accordance with 4.3.

Method of Measurement

5.1 Sanitary sewer manholes will be measured by the vertical foot to the nearest 0.1 of a foot, from the bottom of the metal frame to the top of the base.

5.2 Connecting existing sanitary sewer manholes will be measured by the number of units connected.

5.3 Manhole covers will be measured by the number of units installed. A cover and frame will be a unit.

5.4 Adjusting covers and frames which have been set by others will be measured by the number of units adjusted.

Basis of Payment

6.1 The accepted quantities of sanitary sewer manholes, of the diameter specified, will be paid for at the contract unit price per vertical foot complete in place. This price shall constitute full compensation for excavation (except rock), backfill, bedding and furnishing all materials, tools, equipment, labor and incidentals needed to complete the work including those necessary to test the manholes.

6.1.1 All rock structure excavation and any excavation of unsuitable material ordered below the specified grade will be paid for as provided in 206.

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6.1.2 Granular backfill material necessary for the replacement of unsuitable material removed below the specified grade will be paid as provided in 209. Granular backfill necessary for the replacement of over-excavated ledge will be subsidiary.

6.1.3 No extra allowance will be made for structures adjusted in accordance with 3.5.9.

6.2 The accepted quantities of connecting existing manholes will be paid for at the contract unit price per each existing manhole connected complete in place which price shall constitute full compensation for furnishing all materials, tools, equipment, labor and incidentals needed to complete the work, including those necessary to test the connections.

6.3 The accepted quantities of manhole covers and frames or of adjusting covers and frames which have been set by others, will be paid for at the contract unit price per each, complete in place, which price shall constitute full compensation for excavation, backfill and furnishing all materials, tools, equipment, labor and incidentals needed to complete the work.

6.3.1 No payment will be made for reconstructing portions of the above manholes which are unnecessarily disturbed.

6.4 Temporary diversion of water including trenching or pumping directly from the trench shall be subsidiary to the sanitary sewer manhole installation. When well points or other specific dewatering devices are requested or ordered, they will be paid as shown or as extra work.

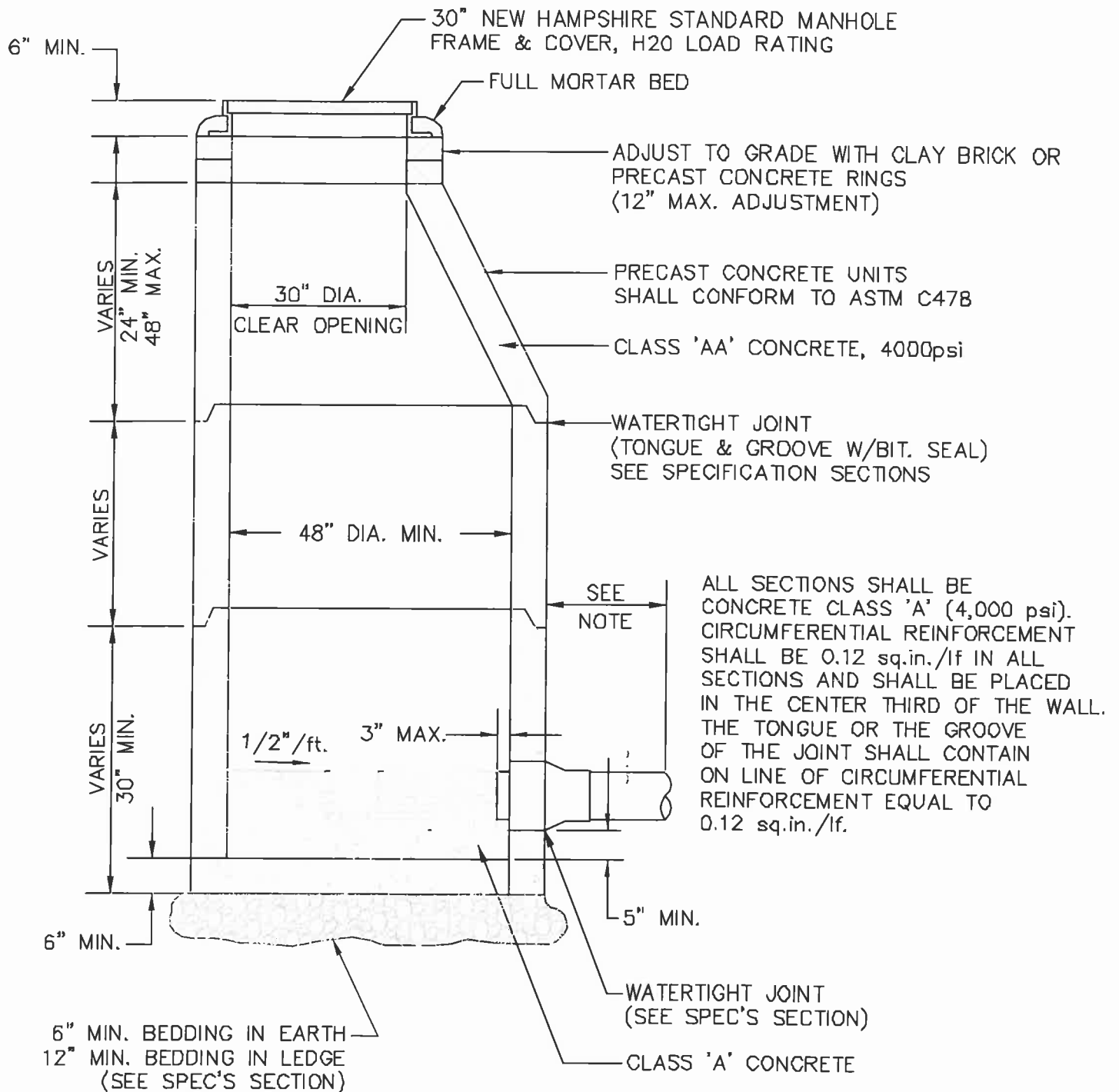
6.5 Temporary diversion of sewer flows shall be subsidiary to the sanitary sewer manhole installation.

Sanitary Sewer Manhole Items to Read:

"...Including Excavation, Bedding & Backfill"

Pay Items and Units:

602.3	Sanitary Sewer Manholes, __ Foot Diameter	Vertical Foot
602.5	Connecting Existing Sanitary Sewer Manholes	Each
602.55	Adjusting Manhole Covers & Frames set by others	Each
602.6	Sewer Manhole Covers and Frames	Each

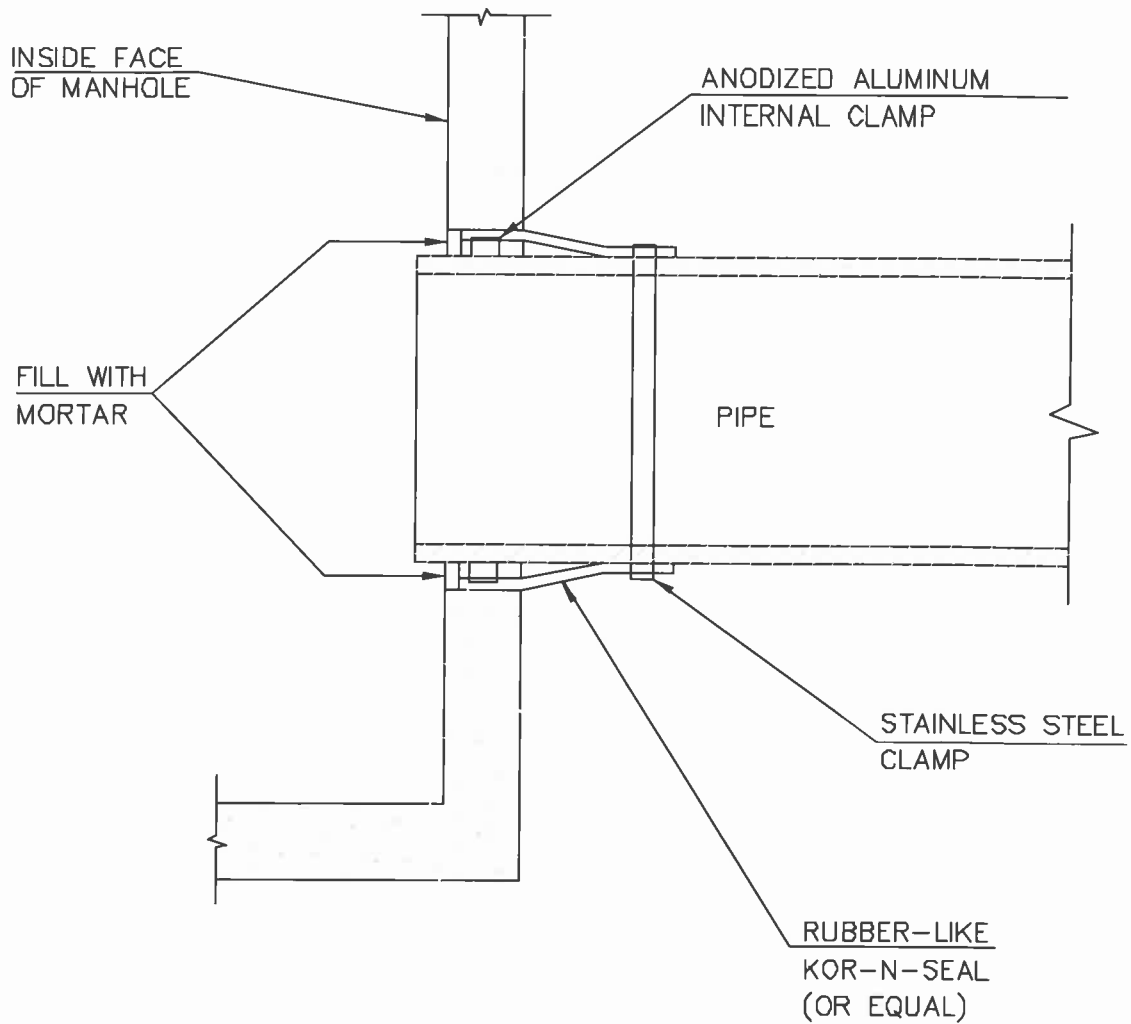


TYPE OF PIPE	SIZE	MAX. DIST. TO FIRST JOINT
R.C.P./C.I.	ALL	48"
C.I.P.	ALL	48"
P.V.C.	>15"	48"
V.C.P.	0-12"	18"
V.C.P.	>12"	36"

PRE-CAST REINFORCED SANITARY SEWER MANHOLE

NOT TO SCALE
FIGURE 602-1

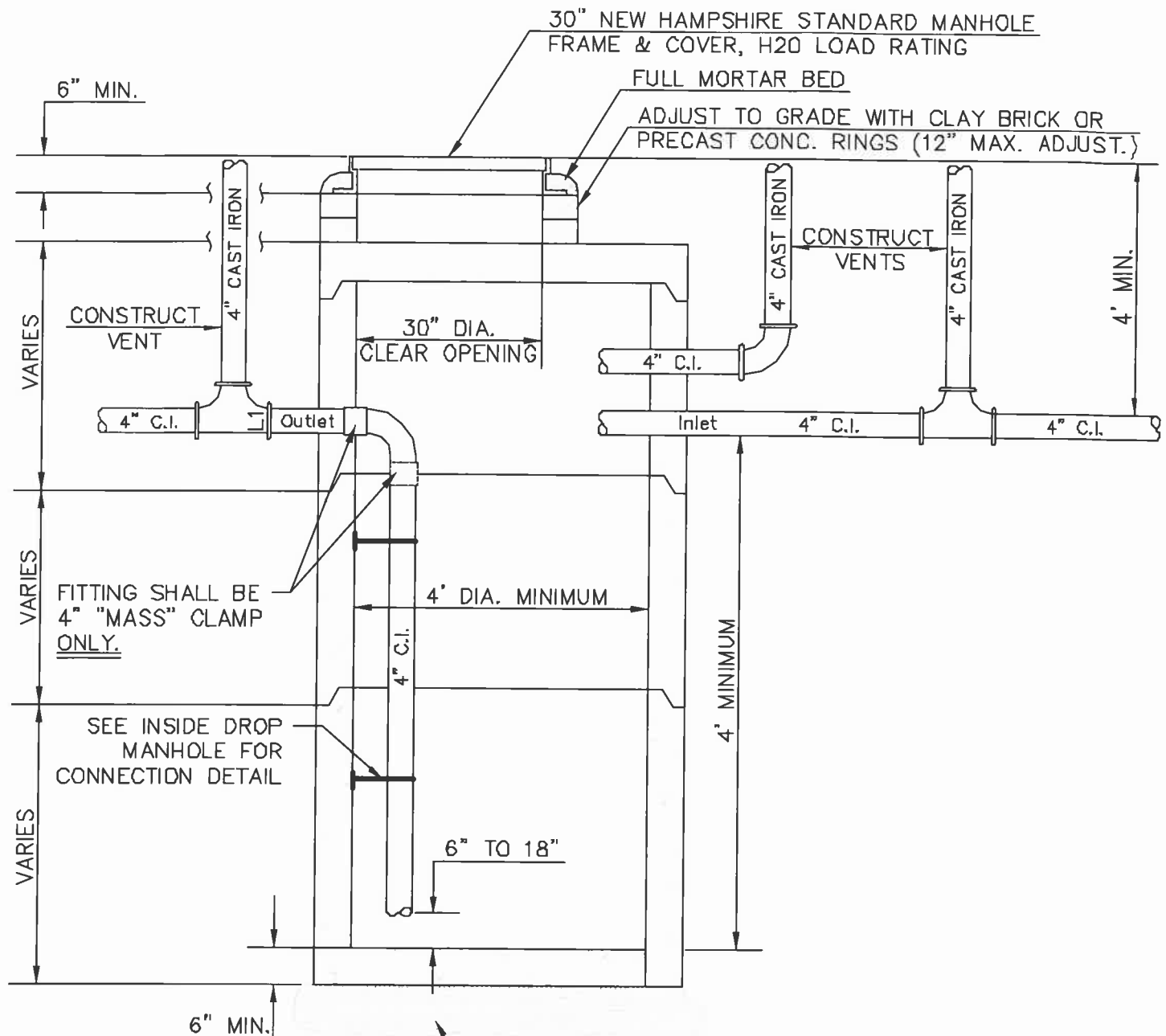
S:\DWG\DETAILS\602-1 SMH DETL.DWG



MANHOLE JOINT SLEEVE

S:\DWG\DETAILS\602-2 mthjointseal.dwg

NOT TO SCALE
FIG. 602-2



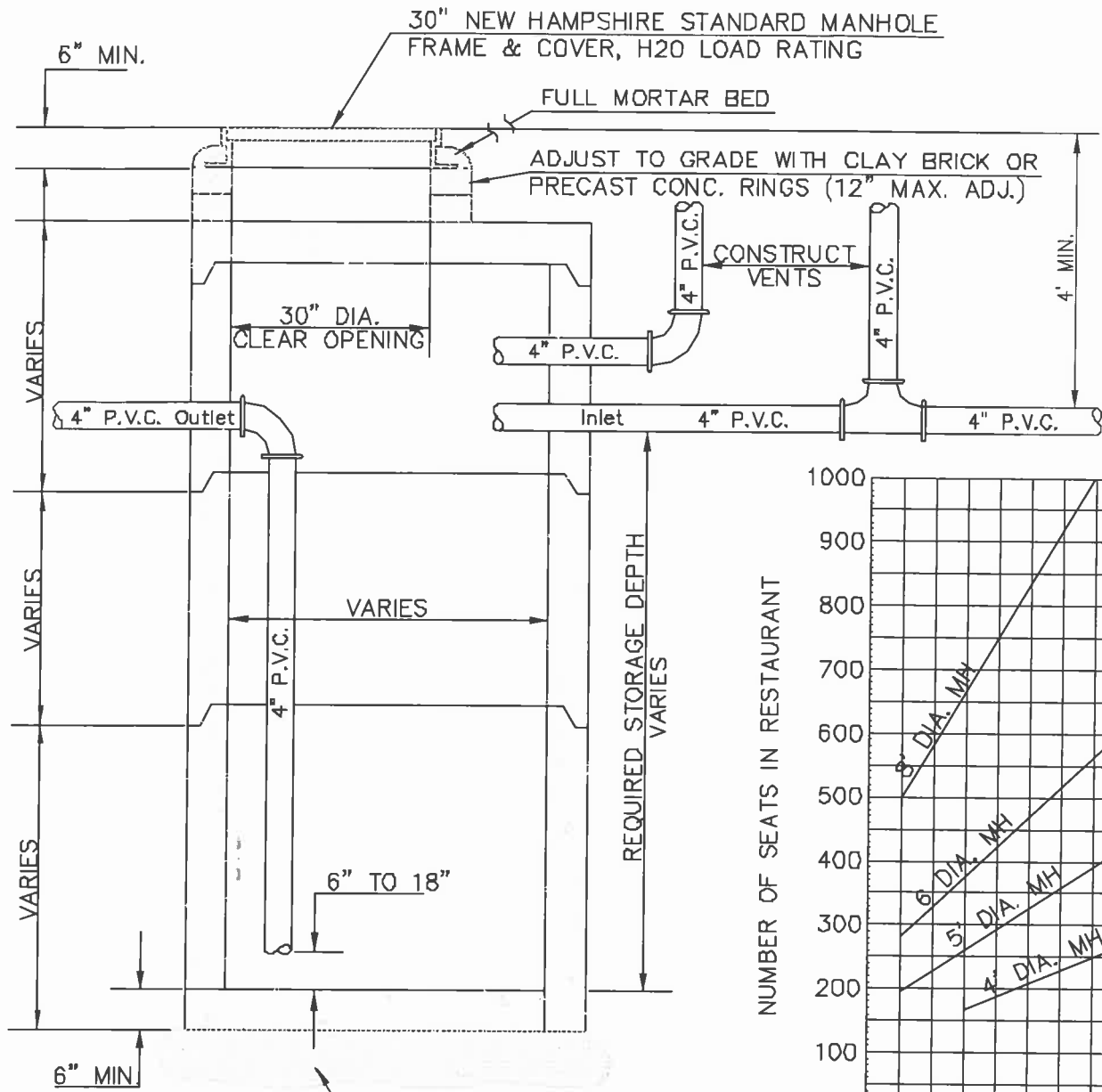
NOTES:

1. STEPS ARE NOT ALLOWED.
2. ALL SECTIONS SHALL BE CONCRETE CLASS AA (4,000 PSI) CIRCUMFERENTIAL REINFORCEMENT SHALL BE 0.12 SQ. IN. PER L.F. IN ALL SECTIONS AND SHALL BE PLACED IN THE CENTER OF THE WALL.
3. THE TONGUE OR THE GROOVE OF THE JOINT SHALL CONTAIN ONE LINE OF CIRCUMFERENTIAL REINFORCEMENT EQUAL TO 0.12 SQ. IN. PER L.F.
4. ALL CONCRETE SHALL BE CLASS AA (4,000 PSI).
5. WATERTIGHT JOINT (TONGUE & GROOVE W/ BIT. SEAL) SEE SPECIFICATION SECTIONS.
6. PRECAST CONCRETE UNITS SHALL CONFORM TO ASTM C478.

PRECAST REINFORCED CONCRETE GAS TRAP

NOT TO SCALE
FIGURE 602-3

S:\DWG\DETAILS\602-3 GAS-TRAP.DWG



NOTES:

1. STEPS ARE NOT ALLOWED.

2. ALL SECTIONS SHALL BE CONCRETE CLASS AA (4,000 PSI) CIRCUMFERENTIAL REINFORCEMENT SHALL BE 0.12 SQ. IN. PER L.F. IN ALL SECTIONS AND SHALL BE PLACED IN THE CENTER OF THE WALL.

3. THE TONGUE OR THE GROOVE OF THE JOINT SHALL CONTAIN ONE LINE OF CIRCUMFERENTIAL REINFORCEMENT EQUAL TO 0.12 SQ. IN. PER L.F.

4. ALL CONCRETE SHALL BE CLASS AA (4,000 PSI).

5. WATERTIGHT JOINT (TONGUE & GROOVE W/ BIT. SEAL) SEE SPECIFICATION SECTIONS.

6. PRECAST CONCRETE UNITS SHALL CONFORM TO ASTM C478

7. ALL OPENINGS TO STRUCTURE SHALL BE CORED, AND PIPE TO MANHOLE JOINT SHALL BE NEATLY AND TIGHTLY SEALED WITH A KOR-N-SEAL JOINT SLEEVE OR APPROVED EQUAL.

PRECAST REINFORCED CONCRETE GREASE TRAP

NOT TO SCALE
FIGURE 602-4

S:\DWG\DETAILS\602-4 GR5-TRAP.DWG

SECTION 603 -- STORM DRAINS**Description**

1.1 This work shall consist of furnishing and installing, or removing and relaying drain pipes and pipe end sections at the locations shown or ordered, including the necessary joints, fittings, and connections as required.

Materials**2.1 Reinforced Concrete Pipe, Circular.**

2.1.1 This pipe shall conform to the requirements of AASHTO M 170, except as follows: Wall A thickness will be allowed in Class III pipe only. When the plans call for reinforced concrete pipe capable of withstanding an ultimate load greater than 3750 D, the design requirements of Class V shall be met with further provision that the pipe will withstand the ultimate D-load of a 4000 D.

2.1.2 Basis of acceptance of concrete pipe shall conform to AASHTO M 170, Section 5.1.1. Test requirements shall be as provided in Section 10.3.1 and 10.5 with the further provision that the pipe will withstand an additional ten percent of the D-load specified or brought to destruction. Permissible variation in pipe tolerances shall conform to AASHTO M 170, Section 11.

Table 1 - Minimum Strength Requirements

D-Load to produce the ultimate load = Class	D-Load to produce a 0.01 inch crack	AASHTO designation Class
1500 D	100	II
2000 D	1350	III
3000 D	2000	IV
3750 D	3000	V
4000 D	----	---

2.1.3 Workmanship and finish shall conform to AASHTO M 170, Section 12. Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements of AASHTO M 170, Section 15. Individual sections of pipe may be rejected because of the following reasons:

- (a) Fracture or cracks passing through the wall, except for a single end crack that does not exceed the depth of a joint.
- (b) Defects that indicate imperfect proportioning, mixing, and molding.
- (c) Surface defects indicating honey-combed or open texture.

(d) Damaged or cracked ends where such damage would prevent making a satisfactory joint.

(e) Any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more, regardless of position in the wall of the pipe.

(f) The exposure of any steel in the barrel or the outside of the pipe indicating the displacement of reinforcement. Steel exposed at the ends will not be cause for rejection if a satisfactory joint can be made.

2.1.4 Markings on pipe shall conform to AASHTO M 170, Section 16 with the following information clearly marked on each section of pipe.

- (a) The pipe class and specification designation
- (b) The date of manufacture
- (c) The name or trademark of the manufacturer
- (d) Identification of plant

2.1.5 Concrete pipe shall be joined by using flexible water tight gaskets conforming to AASHTO M 198.

2.2 High Density Polyethylene (HDP) Pipe

2.2.1 Corrugated High Density Polyethylene (HDP) pipe shall conform to the requirements of AASHTO M 294, Type S, Or Type C as specified on the plans, and ASTM D2321 -Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.

2.2.2 Basis of acceptance and test requirements of HDP pipe shall conform to AASHTO M 294. A manufacturer's certificate of compliance, as required by 106.04, and certified laboratory test results for each shipment shall be provided. The certified test results shall also include pipe lot number, date produced, date test was completed, and a signature of the lab supervisor. For required frequency of laboratory testing see section 700 of the New Hampshire Department of Transportation Construction Manual.

2.2.4 Only soil tight pipe fittings supplied or recommended by the manufacturer shall be used.

2.2.5 Corrugated HDP pipe shall have an annular corrugated exterior and smooth inner wall.

2.2.6 Corrugated pipe, appurtenances, and all couplings shall be high density polyethylene of the size and type as shown on the Drawings, all manufactured by the same company and shall meet or exceed the following specifications: AASHTO M-294; ASTM F667 and ASTM D2321.

2.2.7 Backfilling over the pipe shall be to the pipe manufacturer's specifications. Cover shall be compacted to at least 92 percent of its maximum dry density as determined by ASTM Test D1557, Method D.

2.2.8 Split ring couplings or equal shall be utilized, no spring-on couplings will be allowed. One-half-inch wide self adhesive neoprene foam strips shall be applied on each inner rib of the coupling prior to installation on pipes to minimize any water leakage out of the joints.

2.2.9 Split ring couplings shall be connected with a minimum of six-gauge aluminum ties.

2.2.10 Bedding and backfill material shall conform to the requirements of 209.

2.3 End Sections and Headwalls.

2.3.1 End sections will be allowed at the discretion of the engineer.

2.3.2 Headwalls shall be installed per Figs. 603-1 thru 603-7 or as otherwise ordered.

2.3.3 Concrete for Headwalls shall conform to Section 520.

2.3.4 Child protective grates shall be provided for all headwalls per Fig. 603-8 or as ordered by the Engineer.

Construction Requirements

3.1 General.

3.1.1 All pipe shall be examined before laying and no piece shall be installed which is found to be defective.

3.1.2 Excavation for pipe construction shall conform to the requirements of 206.

3.1.3 Steam-cured or water-cured reinforced concrete pipe may be delivered to the project after 7 days from date of manufacture.

3.1.4 The Contractor shall provide for the temporary diversion of water in order to permit the installation of the pipe in a reasonably dry trench unless otherwise permitted.

3.1.5 Figures 603-9 to 12 have been made a part of these specifications for clarification.

3.1.6 Where soft or other unsuitable material is encountered, all of such unsuitable material, for the depth and width specified, shall be removed as shown in Figure 603-12.

3.1.7 Where bedrock or other incompressible material is encountered, it shall be removed as shown in Figure 603-11.

3.1.8 Granular backfill or other approved material shall be used to backfill the spaces left by the excavation of material removed in accordance with 3.1.4 and 3.1.5. The material shall be uniformly compacted.

3.1.9 The width of trenches shall be held to a minimum consistent with the space required to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Trenching below the top of the pipe shall as shown in figure 603-10. The width of the trench above the pipe may be at the Contractor's option as shown in Figure 603-10.

3.1.10 The pipe shall be placed at the designated location on a prepared foundation so that the flow line of the pipe will conform to the required grade.

3.1.11 Where the top of the pipe would lie above the natural ground, sufficient compacted fill shall be constructed at pipe locations to insure that the pipe is placed in a trench equal in depth to at least the height of the pipe. The fill shall be constructed on each side of the pipe for a distance equal to at least 5 times the diameter of the pipe. Refer to Figure 603-9

3.1.12 Bedding and backfill shall conform to the requirements of 209.

3.1.13 Corrugated HDP pipe handling, storage, and installation procedures will be supplied for each manufacturer with the first shipment to the project. Prior to any installation a manufacturer's representative will review these procedures with the installation Contractor and the Engineer. Installation shall conform to ASTM D 2321 or the manufacturer's procedures whichever is more stringent.

3.1.14 Unless deemed unsatisfactory, the backfill material above the pipe spring line shall be in-situ. If the in-situ material is found to be unacceptable as backfill, acceptable material with similar frost susceptible characteristics shall be used.

3.1.15 If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner.

3.1.16 Precautions shall be taken to prevent flotation of the pipe in the trench.

3.2 Laying and Joining Pipe.

3.2.1 Proper facilities shall be provided for lowering the sections of pipe into the trench. Each section shall be securely attached to the adjoining section by the approved method for the type of joint used.

3.2.2 All pipe laying shall start at the lowest point of each run and shall be laid with the bell end up grade.

3.2.3 Joints shall be made in accordance with the manufacturer's recommendations to form a watertight seal.

3.2.4 The pipe ends shall be thoroughly cleaned before the joint is made. When it is necessary to shorten a length of pipe, the pipe shall be sawed neatly using a masonry saw. The method of joining pipe sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even.

3.2.5 Joints between dissimilar pipes shall be made in accordance with the recommendations of the pipe manufacturer.

3.2.6 Pipes under construction shall not be used to carry ground water from the trenches, except as may be approved by the Engineer.

3.2.7 The CONTRACTOR shall place an adequate protecting cover of earth or other approved material over the pipe before allowing equipment or traffic to pass over it.

3.3 Workmanship.

3.3.1 Any pipe which is not true to alignment and grade or which shows any undue settlement after laying or is damaged shall be removed and relaid or replaced without extra compensation.

3.3.2 Deflection for Corrugated HDP pipe shall not exceed 5 percent in the first 90 days. When deflection verification is considered necessary by the Engineer, all necessary manpower and equipment, including mandrels for such tests, will be provided by the Contractor and shall be performed at least 30 days after installation. When mandrel testing is required the mandrel diameter shall be the Specified Pipe Diameter minus Inside Diameter Tolerance ($1.5\% \times \text{Specified Diameter Pipe}$; Maximum Allowable is 0.5") minus allowable deflection ($5\% \times \text{Specified Pipe Diameter}$). Any section of pipe not passing the mandrel shall be uncovered at no additional cost to the Owner and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested.

3.4 Removal of Pipe for Relaying.

3.4.1 Pipes shall be removed in accordance with 202.2 and 107.11.

3.4.2 Any pipe damaged shall be replaced with like material.

3.4.3 Any additional pipe needed shall be of like material.

Method of Measurement

4.1 Pipe will be measured by the linear foot to the nearest 0.1 of a foot according to size, class and depth. Measurement will be made between the ends of the pipe along the central axis as installed. In the case of twin pipes and other multiple pipe structures, each barrel will be measured separately.

4.1.1 The depth for measurement shall be determined by the vertical distance to the nearest 0.1 foot, between the original ground and the flow line of the pipe as installed.

4.2 Headwalls will be measured by the number of units installed.

Basis of Payment

5.1 The accepted quantities of pipe will be paid for at the contract unit price per linear foot of the size, type, and depth specified complete in place, with the following stipulations:

5.1.1 All rock structure excavation, and any excavation of unsuitable material required below the specified grade, will be paid as provided for in 206.

5.1.2 When the depth of excavation for a pipe is increased more than 1 foot by lowering the grade, additional excavation will be paid as provided in 206.

5.1.3 Granular backfill material necessary for the replacement of unsuitable material removed below the specified grade, will be paid as provided in 209.

5.2 Headwalls of the kind and size specified will be paid for at the contract unit price each complete in place.

5.3 The cost of furnishing and installing additional pipe for laying or relaying pipe, required through no fault of the Contractor, will be paid as provided in Extra Work (109.04) unless a bid item therefore is included in the contract.

5.4 Temporary diversion of water including trenching or pumping directly from the trench or sumps shall be subsidiary to the pipe installation. When well points or other specific de-watering devices are required or ordered, they will be paid as shown or as provided in Extra Work (109.04).

KEY TO ITEM NUMBERS FOR PIPES

SECTION 603

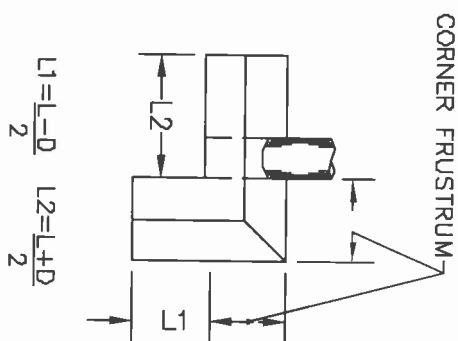
Item Number	A	B	C	D	E	Item Number	Unit
603.						Section Number	
.A						Material or Use	
	B					Type of Material, or Option	
		C				Class	
			D	E		Diameter	
.0						Reinforced Concrete Pipes	Linear Foot
0						Circular	
1						Arch	
		C				Class	
		2				Class II	
		3				Class III	
		4				Class IV	
		5				Class V	
.1						HDP Pipe	
1						Corrugated HDP	
.2						Headwalls	Each
0						Reinforced Concrete	
1						Mortar Rubble Masonry	
.3						Laying or Relaying Drainage Pipe (Furnished by the City or Salvaged)	Linear Foot
0						Unspecified	
1						Concrete	
<u>2</u>						HDP	

All items to Read:

“. . . Including Specified Excavation.”

Examples:

603.00415 15" Reinforced Concrete Pipe, Class IV
 603.32012 Laying or Relaying 12" Drainage Pipe
 603.11012 Laying or Relaying 12" HDP Pipe



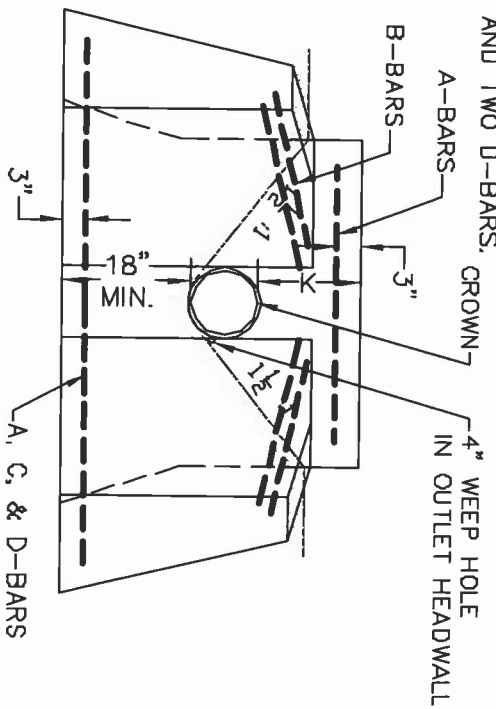
PLAN OF 'L' HEADWALL

[illegible]

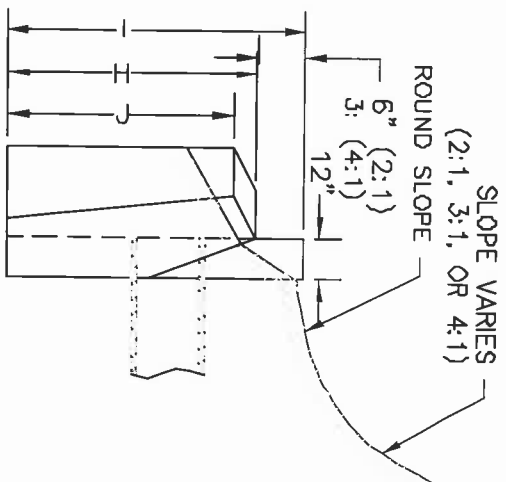
NOT TO SCALE
FIGURE 603-1

ALL LIKE BARS IN EACH HEADWALL ARE SAME SIZE. EACH STD. HEADER HAS 4A, B & C-BARS. AND TWO

EACH STD. HEADER HAS 4A, B & C-BARS, AND TWO D-BARS.



SLOPE VARIES
(2:1, 3:1, OR 4:1)



SYMMETRICAL ABOUT ϕ HALF PLAN SHWING TOP STEEL
HALF PLAN OF BOTTOM STEEL

END ELEVATION

SIDE ELEVATION

[illegible]

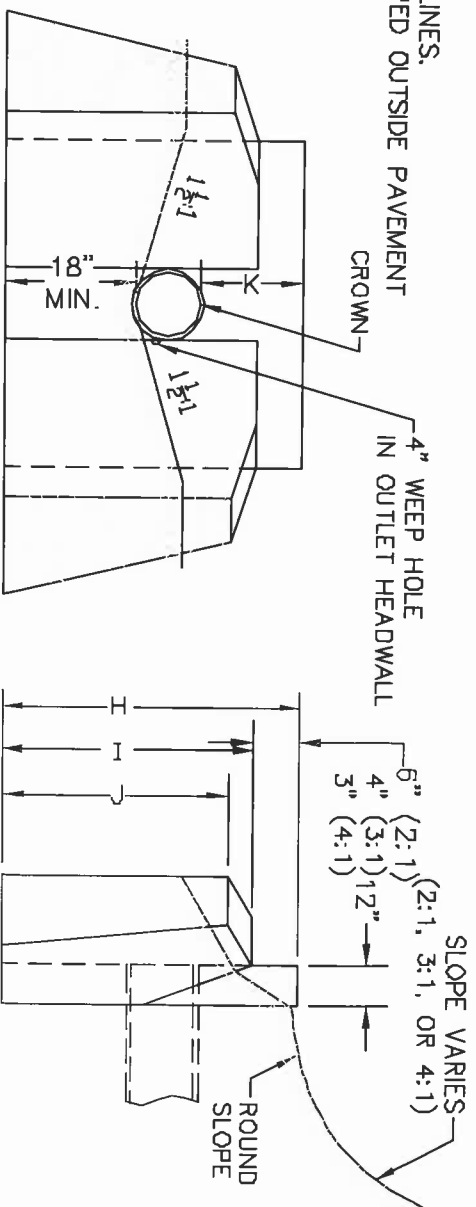
CONCRETE HEADWALLS W/45° WINGS FOR R.C. PIPE

NOT TO SCALE
FIGURE 603-2

S:\DWG\DETAILS\603-2 Comp Headwall Wings.DWG

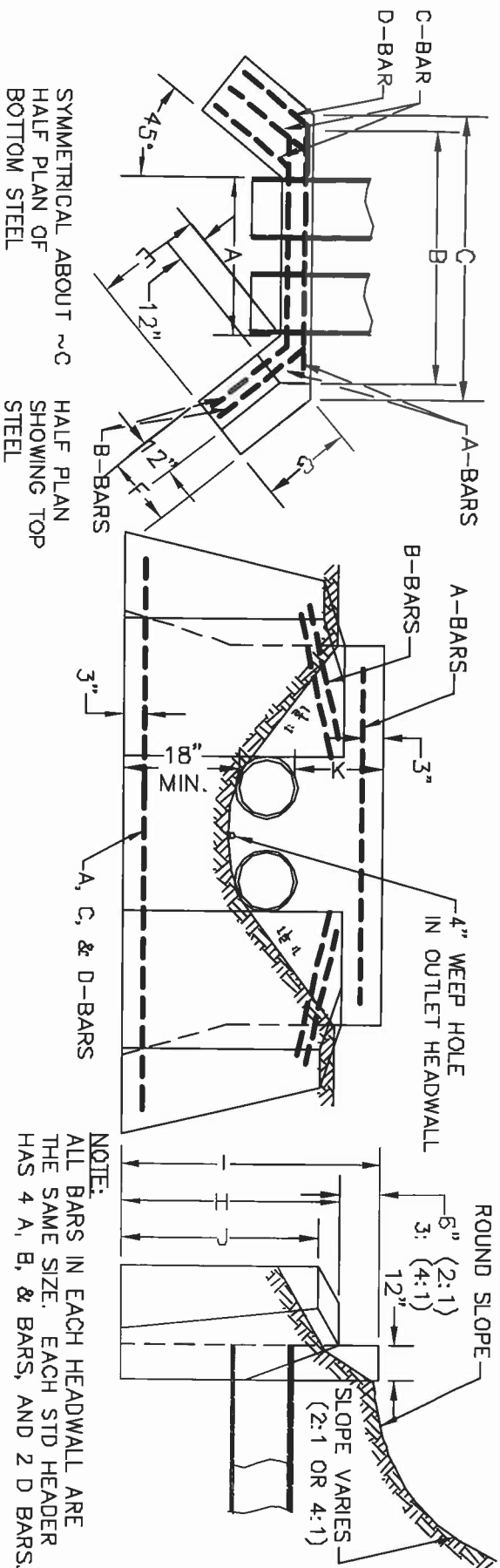
END ELEVATION

SIDE ELEVATION

[illegible]

MORTAR RUBBLE MASONRY HEADWALLS w/45° WINGS FOR R.C. PIPE

NOT TO SCALE
FIGURE 603-3



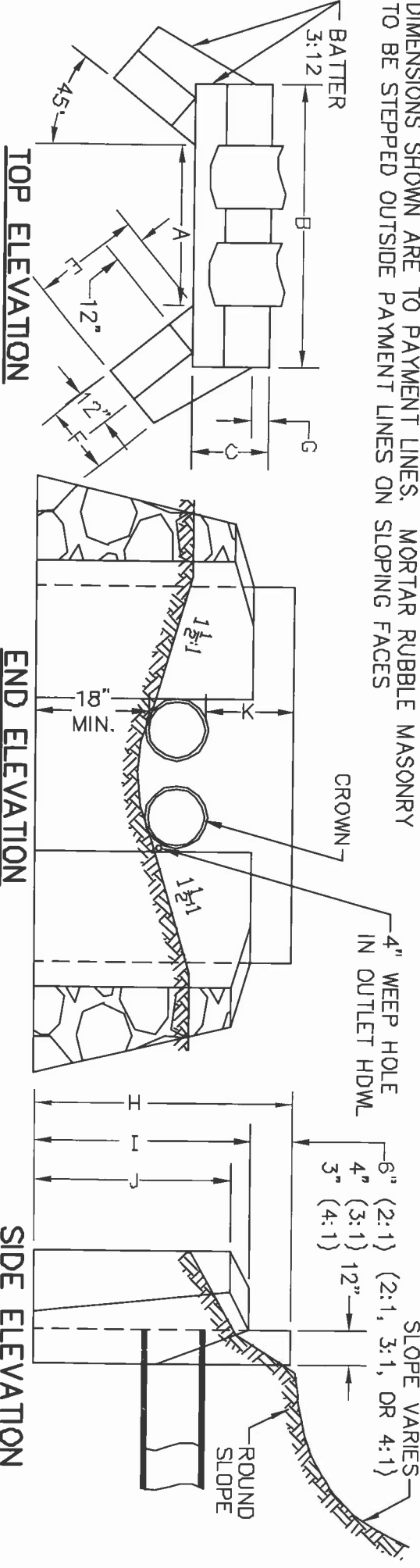
DIAM. D INCHES	AREA OF PIPE SQ. FT.	QUANTITIES			DIMENSIONS										REINFORCING STEEL									
		CONC. CU. YD.	PER HEADER		EXC. FOR 1' DEPTH CU. YD.	PIPE EXC. FOR 1' DEPTH CU. YD.	A	B	C	E	F	G	H	I	J	K	D/2	SIZE	LENGTH				D-BARS	
			STEEL LB.	STRENGTH CU. YD.															A BARS	B BARS	C BARS	D BARS	d	Qty.
24	5.28	2.44	46	1.86	0.278	5'-0"	8'-10"	10'-0"	3'-0"	1'-11"	2'-3"	5'-0"	4'-6"	3'-10"	1'-6"	1'-0"	1"	8'-6"	3'-2"	3'-0"	4'-8"	2'-5"	2'-3"	
30	8.82	3.18	53	2.28	0.345	7'-5"	10'-3"	11'-8"	3'-7"	2'-0"	2'-8"	5'-6"	5'-0"	4'-1"	1'-6"	1'-3"	1"	8'-11"	3'-8"	3'-7"	5'-10"	2'-6"	2'-8"	
36	14.14	3.98	61	2.69	0.414	8'-10"	11'-8"	13'-7"	4'-2"	2'-1"	3'-3"	6'-0"	5'-6"	4'-4"	1'-6"	1'-6"	1"	11'-4"	4'-3"	4'-1"	5'-10"	2'-8"	3'-2"	
42	18.24	5.43	161	3.22	0.482	10'-3"	13'-1"	15'-8"	5'-1"	2'-2"	4'-0"	6'-8"	6'-3"	4'-10"	1'-8"	1'-8"	1"	12'-8"	5'-3"	4'-11"	7'-10"	3'-10"	4'-0"	
48	25.13	6.53	180	3.64	0.548	11'-6"	14'-6"	17'-3"	5'-8"	2'-3"	4'-6"	7'-3"	6'-9"	5'-1"	1'-9"	2'-0"	1"	14'-2"	5'-11"	5'-7"	8'-6"	3'-10"	4'-7"	
54	31.81	7.76	197	4.00	0.618	13'-1"	15'-11"	18'-1"	6'-4"	2'-4"	5'-0"	7'-9"	7'-3"	5'-4"	1'-9"	2'-3"	1"	15'-7"	6'-7"	6'-1"	9'-9"	4'-1"	5'-1"	
60	39.27	9.10	214	4.45	0.685	14'-6"	17'-4"	20'-10"	6'-11"	2'-5"	5'-8"	8'-3"	7'-9"	5'-8"	1'-9"	2'-6"	1"	17'-0"	7'-1"	6'-8"	10'-5"	4'-2"	5'-6"	
66	47.52	10.58	232	4.84	0.752	15'-11"	18'-9"	22'-5"	7'-8"	2'-8"	6'-8"	8'-9"	8'-3"	5'-11"	1'-9"	2'-9"	1"	18'-5"	7'-8"	7'-3"	10'-5"	4'-2"	5'-6"	
72	56.55	12.28	249	5.25	0.821	17'-4"	20'-2"	24'-2"	8'-2"	2'-7"	6'-8"	9'-3"	8'-9"	5'-11"	1'-9"	3'-0"	1"	19'-10"	8'-3"	7'-10"	11'-0"	4'-3"	5'-6"	
24	5.28	3.05	53	2.29	0.278	5'-0"	8'-10"	10'-0"	3'-11"	2'-1"	3'-2"	5'-0"	4'-9"	4'-3"	1'-6"	1'-0"	1"	8'-8"	4'-3"	4'-0"	5'-8"	2'-8"	3'-0"	
30	8.82	3.92	61	2.70	0.345	7'-5"	10'-3"	11'-8"	4'-8"	2'-2"	3'-8"	5'-6"	5'-3"	4'-7"	1'-6"	1'-3"	1"	8'-11"	5'-0"	4'-8"	6'-3"	2'-8"	3'-7"	
36	14.14	5.09	70	3.15	0.414	8'-10"	11'-8"	13'-7"	5'-5"	2'-3"	4'-5"	6'-0"	5'-9"	5'-0"	1'-6"	1'-6"	1"	11'-4"	5'-8"	5'-4"	7'-1"	2'-10"	4'-3"	
42	18.24	6.97	185	3.78	0.482	10'-3"	13'-1"	15'-8"	6'-7"	2'-5"	5'-4"	6'-8"	6'-6"	5'-6"	1'-9"	1'-8"	1"	12'-8"	6'-11"	6'-5"	7'-1"	2'-10"	4'-3"	
48	25.13	8.44	204	4.24	0.548	11'-6"	14'-6"	17'-3"	7'-4"	2'-6"	6'-0"	7'-3"	7'-0"	5'-11"	1'-9"	2'-0"	1"	14'-2"	7'-8"	7'-1"	10'-1"	4'-2"	5'-11"	
54	31.81	10.13	225	4.74	0.618	13'-1"	15'-11"	18'-1"	8'-2"	2'-7"	6'-8"	7'-8"	7'-6"	6'-3"	1'-9"	2'-3"	1"	15'-7"	8'-6"	7'-10"	10'-11"	4'-3"	6'-8"	
60	39.27	11.90	245	5.23	0.685	14'-6"	17'-4"	20'-10"	8'-11"	2'-8"	7'-4"	8'-3"	8'-0"	6'-7"	1'-9"	2'-6"	1"	17'-0"	9'-3"	8'-8"	11'-9"	4'-4"	7'-5"	
66	47.52	13.87	266	5.74	0.752	15'-11"	18'-9"	22'-5"	9'-8"	2'-8"	8'-0"	8'-9"	8'-6"	7'-0"	1'-9"	2'-9"	1"	18'-5"	10'-0"	9'-5"	12'-8"	4'-7"	8'-1"	
72	56.55	16.13	283	6.29	0.821	17'-4"	20'-2"	24'-2"	10'-8"	2'-10"	8'-8"	9'-3"	8'-9"	7'-4"	1'-9"	3'-0"	1"	19'-10"	10'-10"	9'-9"	13'-5"	4'-8"	8'-9"	

CONCRETE HEADWALLS w/45° WINGS FOR TWIN R.C. PIPE

NOT TO SCALE
FIGURE 603-4

S:\DWG\DETAILS\603-4 Concrete Headwall With 45.DWG

NOTE:
DIMENSIONS SHOWN ARE TO PAYMENT LINES. MORTAR RUBBLE MASONRY
TO BE STEPPED OUTSIDE PAYMENT LINES ON SLOPING FACES



2:1 SLOPES

DIAM. D INCHES	AREA OF PIPE SQ. FT.	QUANTITIES IN CUBIC YARDS				DIMENSIONS										
		PER HEADER			PIPE EXC. PER 1' DEPTH 1' LENGTH	A	B	C	E	F	G	H	I	J	K	
		M.R.M. V = 5'	M.R.M./FT. ADD LENGTH	EXC. FOR 1' DEPTH V = 5'												EXC./FT. ADD LENGTH
24	6.28	4.40	.300	3.08	0.157	0.426	10'-0"	12'-10"	2'-3"	2'-11"	1'-11"	0'-6"	5'-0"	4'-6"	3'-10"	1'-6"
30	9.82	5.56	.348	3.60	0.163	0.485	11'-2"	14'-0"	2'-5"	3'-6"	2'-0"	0'-5"	5'-6"	5'-0"	4'-1"	1'-6"
36	14.14	6.71	.389	4.03	0.167	0.543	12'-4"	15'-2"	2'-6"	4'-1"	2'-1"	0'-4"	6'-0"	5'-6"	4'-4"	1'-6"
42	19.24	8.75	.458	4.68	0.173	0.602	13'-6"	16'-4"	2'-8"	5'-0"	2'-2"	0'-3"	6'-9"	6'-3"	4'-10"	1'-9"
48	25.13	10.43	.515	5.29	0.179	0.660	14'-8"	17'-6"	2'-10"	5'-8"	2'-3"	0'-2"	7'-3"	6'-9"	5'-1"	1'-9"
54	31.81	12.07	.562	5.85	0.182	0.719	15'-10"	18'-8"	2'-11"	6'-3"	2'-4"	0'-1"	7'-9"	7'-3"	5'-4"	1'-9"
60	39.27	14.09	.624	6.47	0.188	0.778	17'-0"	19'-10"	3'-1"	6'-10"	2'-5"	0'-1"	8'-3"	7'-9"	5'-8"	1'-9"
66	47.52	16.05	.675	7.03	0.191	0.836	18'-2"	21'-0"	3'-2"	7'-5"	2'-6"	0'-0"	8'-9"	8'-3"	5'-11"	1'-9"
72	56.55	18.41	.742	7.63	0.198	0.895	19'-4"	22'-2"	3'-4"	8'-1"	2'-7"	0'-1"	9'-3"	8'-9"	6'-3"	1'-9"

MORTAR RUBBLE MASONRY HEADWALLS W/45° WINGS FOR TWIN R.C. PIPE

NOT TO SCALE
FIGURE 603-5

5' (10M) DE TALLS 603-5 Mortar Rubble With 45° Wings

3:1 SLOPE

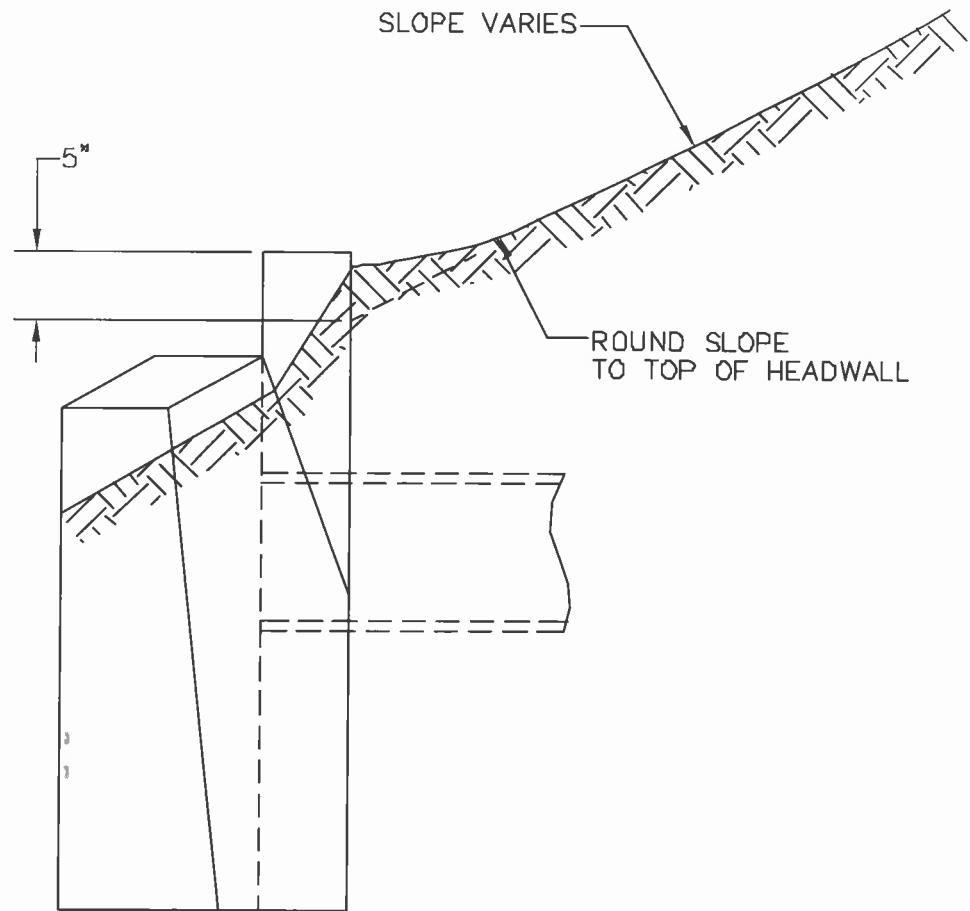
DIAM. D INCHES	AREA OF PIPE SQ. FT.	QUANTITIES IN CUBIC YARDS					DIMENSIONS									
		PER HEADER			PIPE EXC. PER 1' DEPTH 1' LENGTH	A	B	C	E	F	G	H	I	J	K	
		M.R.M. ADD LENGTH	EXC. FOR 1' DEPTH V = 5'	EXC./FT. ADD LENGTH												
24	6.28	4.77	.300	3.27	0.157	0.426	10'-0"	12'-10"	2'-3"	3'-6"	2'-1"	0'-6"	5'-0"	4'-9"	4'-3"	1'-6"
30	9.82	6.08	.348	3.83	0.163	0.485	11'-2"	14'-0"	2'-5"	4'-3"	2'-2"	0'-6"	5'-6"	5'-3"	4'-7"	1'-6"
36	14.14	7.38	.389	4.34	0.167	0.543	12'-4"	15'-2"	2'-6"	4'-11"	2'-3"	0'-4"	6'-0"	5'-9"	5'-0"	1'-6"
42	19.24	9.72	.458	5.06	0.173	0.602	13'-6"	16'-4"	2'-8"	6'-0"	2'-5"	0'-3"	6'-9"	6'-6"	5'-6"	1'-9"
48	25.13	11.59	.515	5.69	0.179	0.660	14'-8"	17'-6"	2'-10"	6'-8"	2'-6"	0'-3"	7'-3"	7'-0"	5'-11"	1'-9"
54	31.81	13.52	.562	6.27	0.182	0.719	15'-10"	18'-8"	2'-11"	7'-5"	2'-7"	0'-2"	7'-9"	7'-6"	6'-3"	1'-9"
60	39.27	15.80	.624	6.92	0.188	0.778	17'-0"	19'-10"	3'-1"	8'-1"	2'-8"	0'-1"	8'-3"	8'-0"	6'-7"	1'-9"
66	47.52	18.10	.675	7.58	0.191	0.836	18'-2"	21'-0"	3'-2"	8'-10"	2'-9"	0'-0"	8'-9"	8'-6"	7'-0"	1'-9"
72	56.55	20.80	.742	8.26	0.198	0.895	19'-4"	22'-2"	3'-4"	9'-6"	2'-10"	0'-0"	9'-3"	9'-0"	7'-4"	1'-9"

4:1 SLOPE

DIAM. D INCHES	AREA OF PIPE SQ. FT.	QUANTITIES IN CUBIC YARDS				DIMENSIONS										
		PER HEADER			PIPE EXC. PER 1' DEPTH 1' LENGTH	A	B	C	E	F	G	H	I	J	K	
		M.R.M./FT. ADD LENGTH	EXC. FOR 1' DEPTH V = 5'	EXC./FT. ADD LENGTH												
24	6.28	5.01	.300	3.39	0.157	0.426	10'-0"	12'-10"	2'-3"	3'-10"	2'-1"	0'-6"	5'-0"	4'-9"	4'-3"	1'-6"
30	9.82	6.37	.348	3.94	0.163	0.485	11'-2"	14'-0"	2'-5"	4'-7"	2'-2"	0'-6"	5'-6"	5'-3"	4'-7"	1'-6"
36	14.14	7.79	.389	4.47	0.167	0.543	12'-4"	15'-2"	2'-6"	5'-4"	2'-3"	0'-4"	6'-0"	5'-9"	5'-0"	1'-6"
42	19.24	10.30	.458	5.25	0.173	0.602	13'-6"	16'-4"	2'-8"	6'-6"	2'-5"	0'-3"	6'-9"	6'-6"	5'-6"	1'-9"
48	25.13	12.34	.515	5.90	0.179	0.660	14'-8"	17'-6"	2'-10"	7'-3"	2'-6"	0'-3"	7'-3"	7'-0"	5'-11"	1'-9"
54	31.81	14.46	.562	6.52	0.182	0.719	15'-10"	18'-8"	2'-11"	8'-1"	2'-7"	0'-2"	7'-9"	7'-6"	6'-3"	1'-9"
60	39.27	16.85	.624	7.23	0.188	0.778	17'-0"	19'-10"	3'-1"	8'-10"	2'-8"	0'-1"	8'-3"	8'-0"	6'-7"	1'-9"
66	47.52	19.41	.675	7.89	0.191	0.836	18'-2"	21'-0"	3'-2"	9'-7"	2'-9"	0'-1"	8'-9"	8'-6"	7'-0"	1'-9"
72	56.55	22.26	.742	8.62	0.198	0.895	19'-4"	22'-2"	3'-4"	10'-5"	2'-10"	0'-0"	9'-3"	9'-0"	7'-4"	1'-9"

MORTAR RUBBLE MASONRY HEADWALLS W/45° WINGS FOR TWIN R.C. PIPE

NOT TO SCALE
FIGURE 603-6

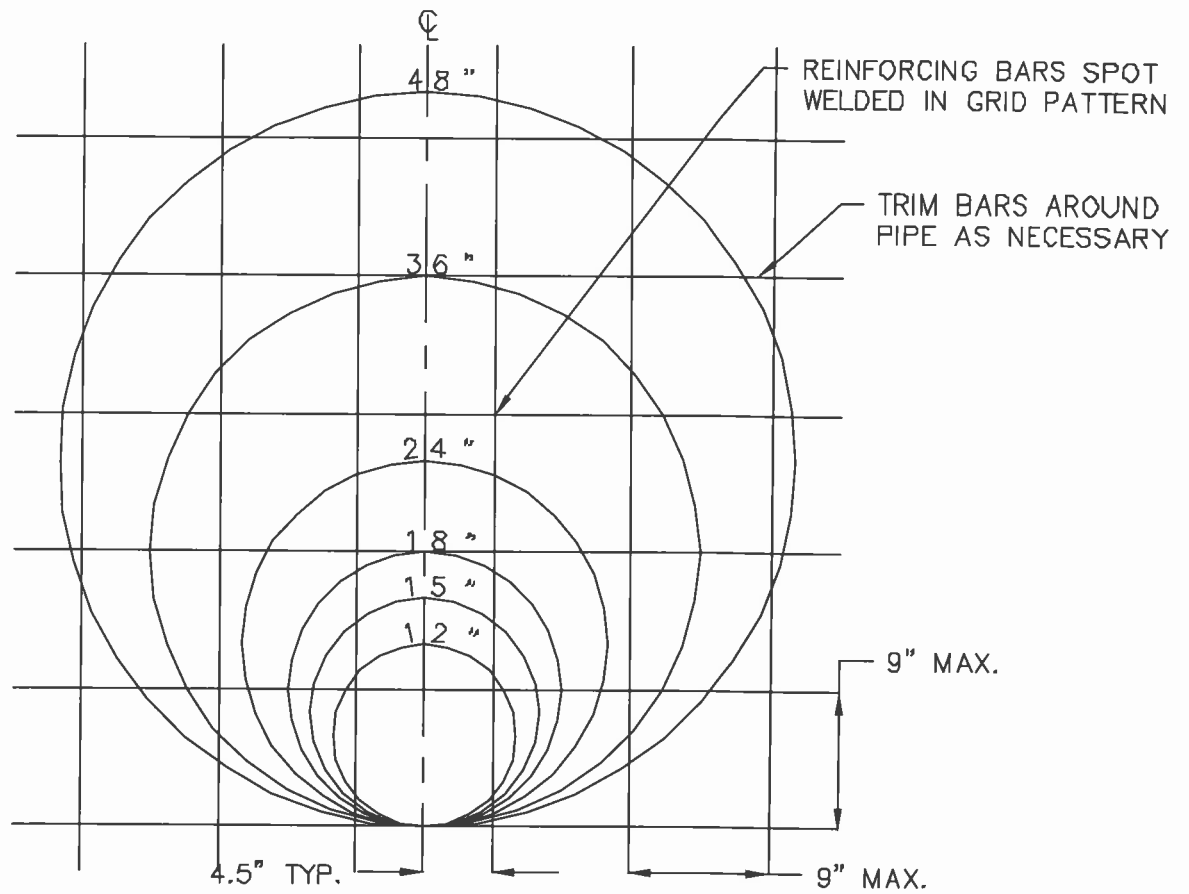


SIDE ELEVATION

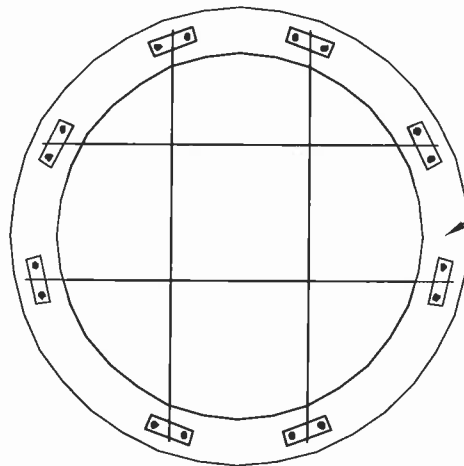
SLOPE ROUNDING AT TOP OF CULVERT HEADWALL

S:\DWG\DETAILS\603-6 Slope Rounding.DWG

NOT TO SCALE
 FIGURE 603-7



EXAMPLE:
(24" RCP)

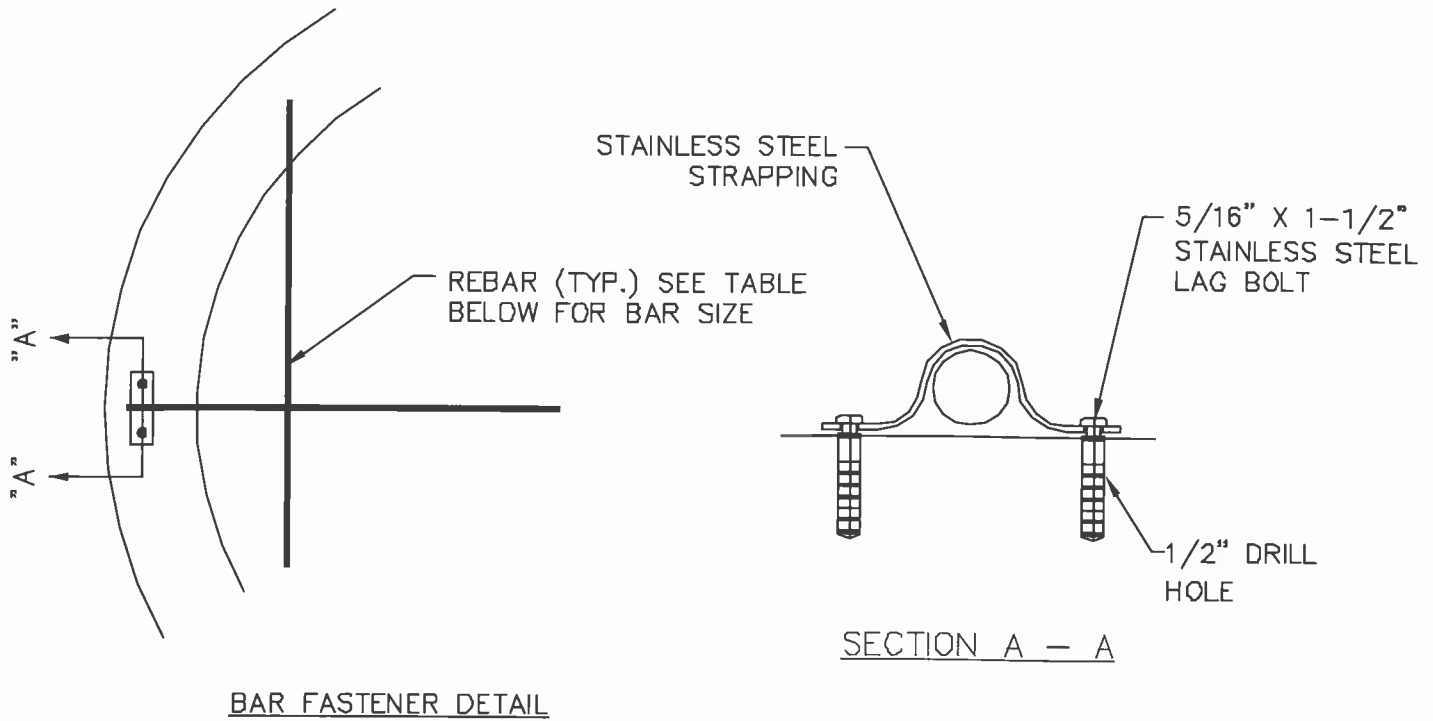


SEE DETAIL FOR BAR
FASTENER (FIG. 603-8b)
FOUR (4) CONNECTION
POINTS (MIN.)

PROTECTION GRATE FOR PIPE OUTLETS

S:\DWG\DETAILS\603-8 OUTLET.DWG

NOT TO SCALE
FIGURE 603-8a



PIPE DIAMETER	BAR SIZE
12"	#3 BARS FOR ALL BARS
15"	#4 BARS FOR ALL BARS CONNECTED TO PIPE, #3 BARS FOR OTHERS.
18"	#4 BARS FOR ALL BARS CONNECTED TO PIPE, #3 BARS FOR OTHERS.
24"	#5 BARS FOR ALL BARS CONNECTED TO PIPE, #3 BARS FOR OTHERS.
36"	#8 BARS FOR ALL BARS CONNECTED TO PIPE, #5 BARS FOR OTHERS.
48"	#11 BARS FOR ALL BARS CONNECTED TO PIPE, #8 BARS FOR OTHERS.

FOR CONNECTION TO REINFORCED CONCRETE PIPE OR HEADWALL:

FOR PIPE SIZES SIZES OF 24" OR SMALLER, USE 1/2" DIAMETER 1-1/2" LONG LAG BOLT EXPANSION SHIELDS.

FOR PIPE SIZES OVER 24", USE 1" DIA. 3" LONG LAG BOLT EXPANSION SHIELDS.

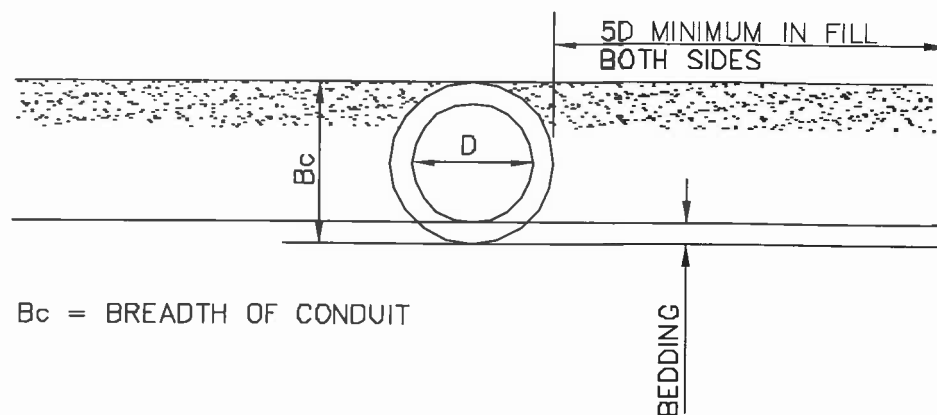
PROVIDE FOUR (4) CONNECTION POINTS (MIN.)

PROTECTION GRATE FOR PIPE OUTLETS

S:\DWG\DETAILS\603-8 OUTLET.DWG

NOT TO SCALE
FIGURE 603-8b

MINIMUM ELEVATION OF ORIGINAL GROUND
OR COMPACTED FILL PRIOR TO CONSTRUCTING
TRENCH AND INSTALLING PIPE



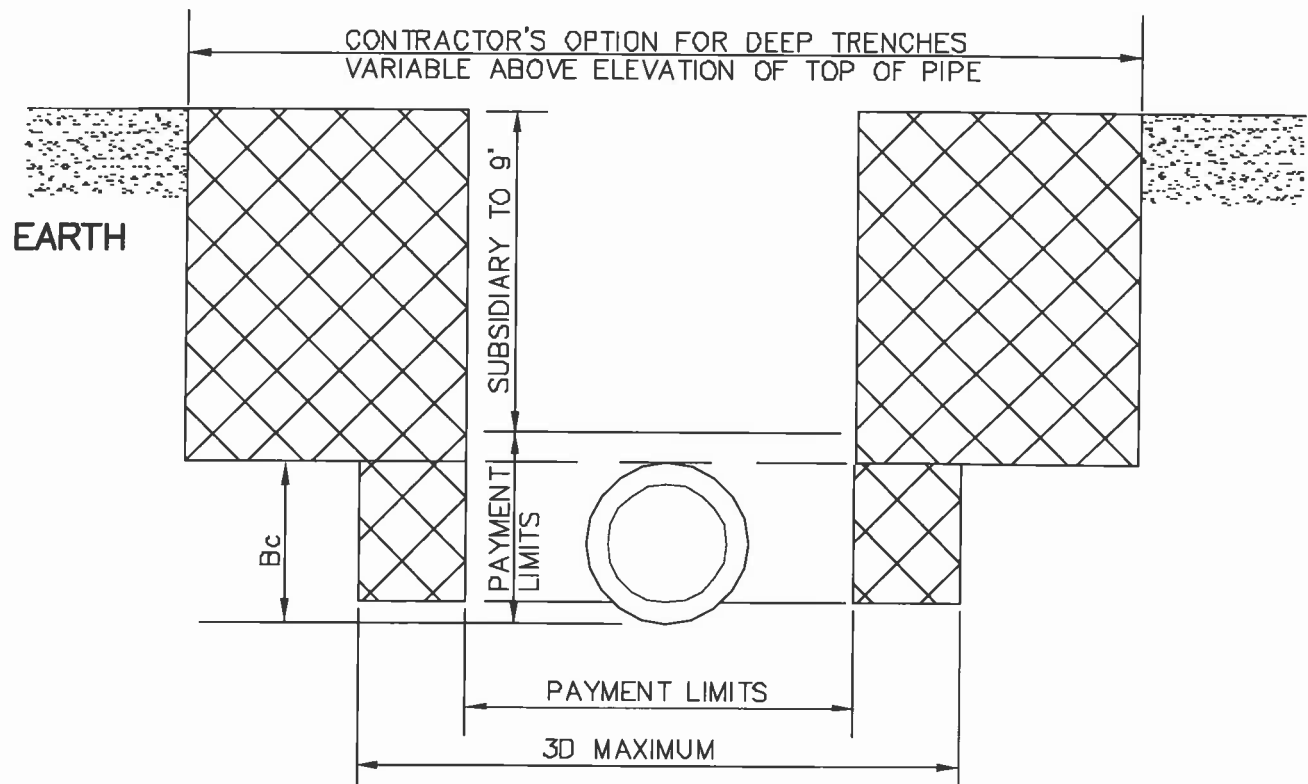
B_c = BREADTH OF CONDUIT

CULVERT DETAILS

S:\DWG\DETAILS\CLVRT-D1.DWG

NOT TO SCALE

FIG. 603-9



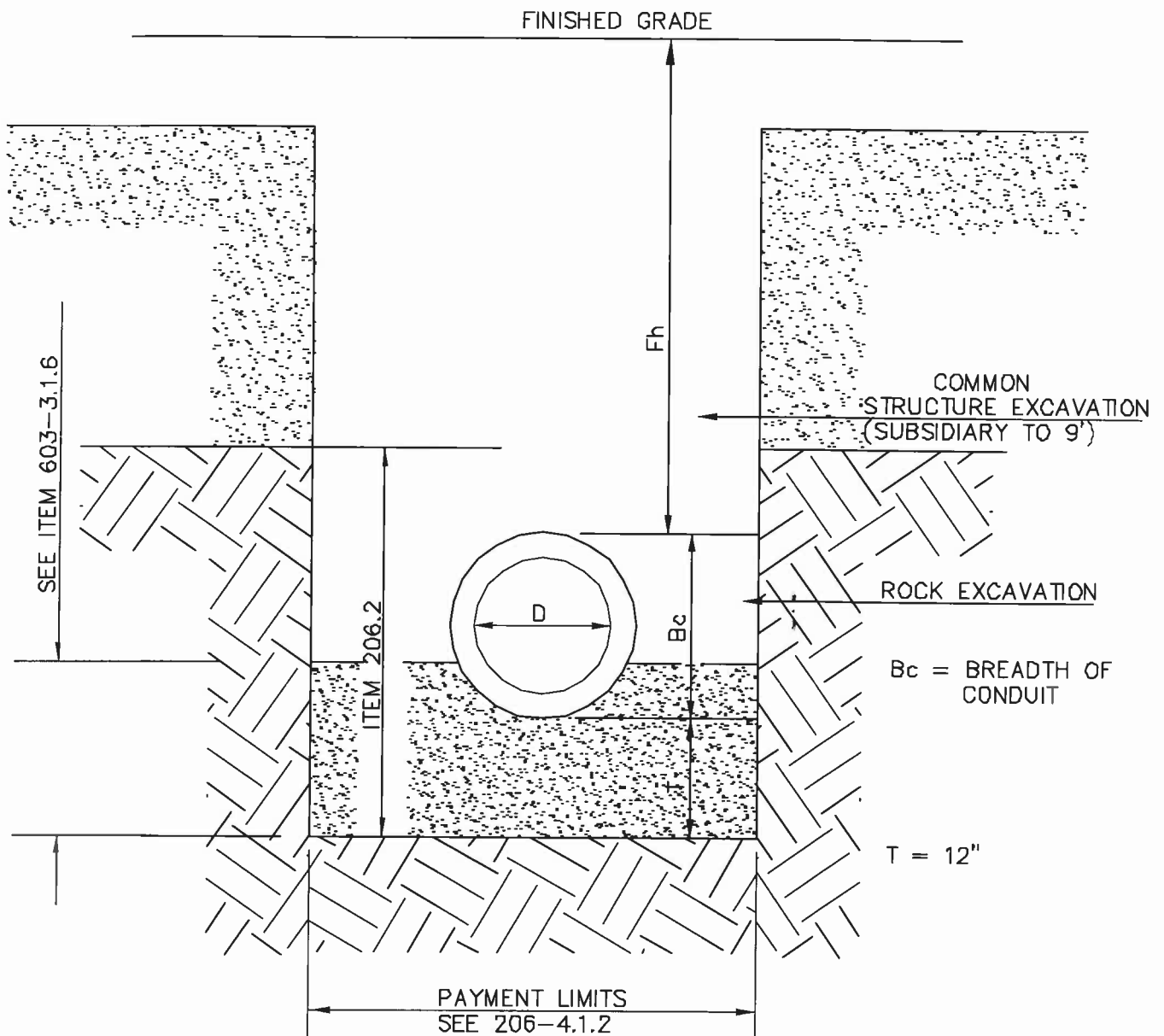
Bc = BREADTH OF CONDUIT

CULVERT DETAILS

NOT TO SCALE

FIG. 603-10

ROCK



CULVERT DETAILS

S:\DWG\DETAILS\CLVRT-D2.DWG

NOT TO SCALE

FIG. 603-11

SECTION 604 --CATCH BASINS, DROP INLETS AND DRAIN MANHOLES

Description

1.1 This work shall consist of furnishing and installing or reconstructing catch basins, drop inlets and drain manholes; and furnishing, placing or adjusting grates or manhole covers all as shown on the plans or as ordered. Common structure excavation to the depth specified in 206.4.1, bedding if required, and backfill shall be included in this work.

1.1.1 Surfaces of drainage structures shall be completely coated with water repellent inside and outside for new structures and existing structures shall be coated on the inside above the flow line unless directed otherwise.

Materials

2.1 General.

2.1.1 Catch basins, drop inlets and drain manholes and related appurtenances shall be precast concrete. Brick masonry and barrel block construction will not be allowed.

2.1.1.1 Cone and transition sections shall be of the eccentric type.

2.1.1.2 All catch basins shall have sumps 1.5 feet deep.

2.1.1.3 Base sections shall be monolithic to a point no less than 6 inches above the crown of the incoming pipe.

2.1.1.4 Joints shall be tongue and groove type and shall be sealed watertight with an approved rubber or bitumastic sealant.

2.1.1.5 The name of the manufacturer and the date of manufacture shall be clearly marked on each precast section.

2.2 Concrete shall be of the specified class and shall conform to the requirements of 520.

2.3 Reinforcing steel shall conform to the requirements of 544.

2.4 Precast concrete sections shall conform to AASHTO M 199. The concrete shall be Class AA, meeting requirements of 520.

2.5 Clay brick shall conform to the requirements of AASHTO M 91, Grade M5. The use of concrete brick will not be permitted.

2.6 Concrete masonry units shall conform to the requirements of ASTM C139 and shall have a minimum compressive strength of 3,000 psi when tested by the method of AASHTO T 140.

2.7 Cement mortar shall conform to the requirements of 707.

2.8 Non-shrinking mortar shall be Hallemite, Waterplug, Embecco or an approved equal.

2.9 Castings shall be gray iron conforming to AASHTO M105. Unless otherwise specified, all gray iron castings shall be Class 30.

2.10 Steel grates shall be of structural steel conforming to AASHTO M 183 (ASTM A 36). The grates shall be fabricated as shown on the plans or approved. All top edges shall be flush and all rivets shall be tight and properly headed. After fabrication, the grates shall be galvanized in accordance with AASHTO M 111 or ASTM A 153 as applicable.

2.11 The word "DRAIN" in 3 inch letters shall be plainly cast in the center of each cover.

2.12 Joints shall be sealed watertight with an approved rubber or bitumastic sealant conforming to ASTM C 32.

2.13 Bedding and backfill material shall conform to the requirements of Section 209.

2.14 Water repellent shall conform to 534.2.2

Construction Requirements

3.1 Excavation shall conform to the requirements of 206.

3.2 Bedding and backfill shall conform to the requirements of 209.

3.3 Precast concrete sections shall be at least 10 days old when delivered to the construction site.

3.4 Catch basins, drop inlets and drain manholes shall be placed at the designated locations on a prepared foundation so that the flow lines of the pipes entering and exiting, will conform to the required grades.

3.5 The Contractor shall provide for the temporary diversion of water in order to permit the installation of drainage structures in a reasonably dry trench unless otherwise permitted by the Engineer.

3.6 Drain manholes shall have concrete inverts and shelves conforming to one-half of

the diameter of the largest pipe. At changes in direction, the inverts shall be laid out in curves of the longest radius possible tangent to the center line of the drain pipes. Shelves shall slope towards the invert channels at a rate of 1/2 inch per foot.

3.7 Concrete construction shall conform to the requirements of structural concrete. Masonry shall conform to the requirements for the respective type. Masonry shall fit neatly and tightly around the pipe.

3.8 All lifting holes and pipe to drainage structure joints shall be neatly sealed watertight with non-shrinking mortar.

3.9 Prior to installation and adjustment of grates, covers and frames, the tops of drainage structures shall be temporarily covered to prevent accidental entry.

3.10 In accordance with the provisions of AASHTO M 105, 17.2, following are the "other matters of workmanship and finish" required: frames and grates or frames and covers shall be matched before being incorporated into the work. Grates and covers shall make full and even bearing on the underlying surface to fit into the frames without rocking.

3.11 Structures within the limits of bituminous concrete pavement shall be temporarily set at the elevation of the bottom of the binder course, or as ordered. After the binder course has been compacted, these structures shall be set at their final grade. Backfill necessary around such structures after the base course has been completed, shall be made with Class A concrete unless otherwise ordered.

3.11.1 Brick or precast concrete rings shall be used to adjust frames to grade. The maximum allowable adjustment shall be 12 inches.

3.11.2 Frames shall be set on a full bed of mortar to ensure a watertight fit. They shall be set true to grade and fully aligned with the masonry opening.

3.11.3 A mortar fillet extending to the outer edge of the masonry a minimum of 1 inch thick, shall be constructed around the frame in such a manner as to shed water.

3.12 When reconstruction of existing structures is specified, the frames, covers and gratings shall be removed and the walls reconstructed as required. The frames shall be cleaned and reset at the required elevations.

3.12.1 Structures specified to be adjusted shall be built up to the required grade according to the requirements of 3.8.

3.13 When connections to existing drainage structures are specified, the openings shall be cored and the pipe to structure joints neatly and tightly sealed.

3.14 Upon completion, each drainage structure shall be cleaned of silt, debris, or other matter of any kind and shall be kept clean until final acceptance of the work.

3.15 Surface preparation for drainage structures to be treated with water repellent shall be sufficient to remove dust, dirt, oil, wax, other coatings, efflorescence and other foreign materials. All surfaces shall be dry prior to the application of water repellent.

3.15.1 Treatment shall be performed in accordance with the other applicable provisions of 534.

Method of Measurement

4.1 Catch basins, drop inlets and drain manholes will be measured by the vertical foot to the nearest 0.1 of a foot, from the bottom of the metal frame (or the top of the concrete cover) to the top of the floor slab of the structure.

4.2 Reconstructing catch basins, drop inlets or manholes will be measured to the nearest 0.1 of a foot, vertically to the nearest 0.1 of a foot, between the bottom of the metal frame to the top of undisturbed portion of the existing structure. At least 0.5 feet of reconstruction will be allowed in all cases.

4.3 Grates or manhole covers will be measured by the number of units installed. A cover and frame will be a unit and a grate and frame will be a unit.

4.4 Adjusting grates or covers and frames or replacing rectangular concrete slab tops which have been set by others will be measured by the number of units adjusted.

4.5 Connecting existing drainage structures will be measured by the number of units connected.

4.6 Water repellent for existing drainage structures will be measured by the each for the number of drainage structures ordered to be treated.

Basis of Payment

5.1 The accepted quantities of catch basins, drop inlets and drain manholes of the diameter specified, will be paid for at the contract unit price per vertical foot. Which price shall constitute full compensation for excavation (except rock), backfill, bedding and furnishing all materials, tools, equipment, labor and incidentals needed to complete the work, with the following stipulations:

5.1.1 All rock structure excavation and any excavation of unsuitable material required below the specified grade will be paid for as provided in 206. Over excavation for bedding proposed in ledge and backfill for said over excavation will be subsidiary.

5.1.2 When the depth of excavation for a catch basin, drop inlet or manhole is increased more than one foot by lowering the grade, additional excavation will be paid for as provided in 206.

5.1.3 Granular backfill material necessary for the replacement of unsuitable material removed below the specified grade will be paid for as provided in 209. Granular backfill necessary for the replacement of overexcavated ledge will be subsidiary.

5.1.4 No extra compensation will be made for structures constructed in accordance with 3.11.

5.1.5 Water repellent for new drainage structures will be subsidiary.

5.2 The accepted quantities of connecting existing drainage structures will be paid for at the contract unit price per each existing structure connected complete in place, which price shall constitute full compensation for furnishing all materials, tools, equipment, labor and incidentals needed to complete the work.

5.2.1 No payment will be made for reconstructing portions of the above structures which are unnecessarily disturbed.

5.2.2 No separate payment will be made for excavation for reconstructing the above structures.

5.3 The accepted quantities of grates and frames or manhole covers and frames or of adjusting grates and covers and frames or of replacing rectangular concrete slab tops which have been set by others will be paid for at the contract unit price per each complete in place, which price shall constitute full compensation for excavation, backfill and furnishing all materials, tools, equipment, labor and incidentals needed to complete the work.

5.4 Temporary diversion of water including trenching or pumping directly from the trench or sumps shall be subsidiary to the drain structure installation. When well points or other specific dewatering devices are requested or ordered, they will be paid as shown or as extra work.

5.5 The accepted quantities of water repellent for existing drainage structures will be paid for at the contract unit price per each complete structure.

5.5.1 No separate payment will be made for surface preparation.

SECTION 604

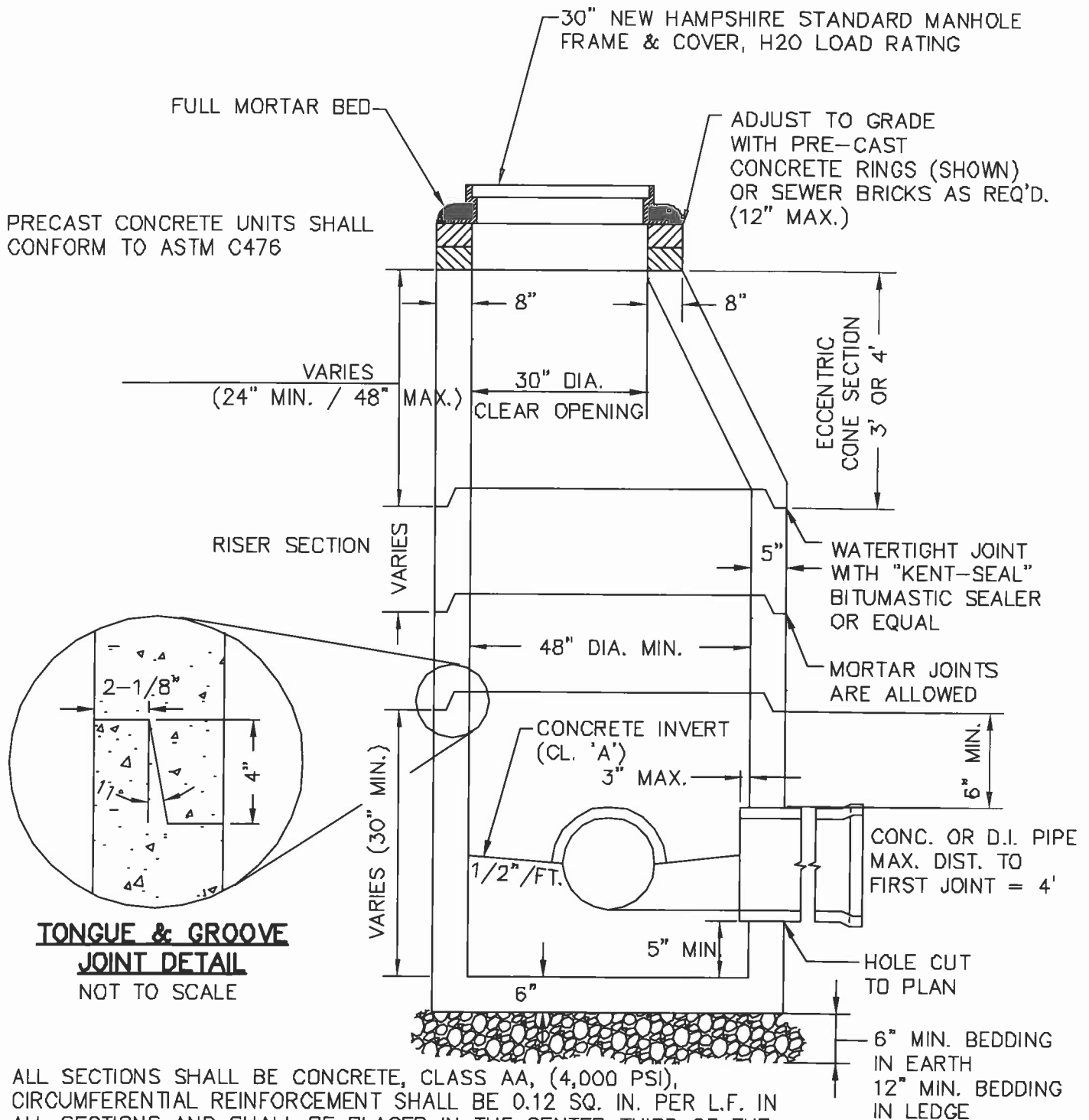
KEY TO ITEM NUMBERS FOR CATCH BASINS, DROP INLETS AND DRAIN MANHOLES

Item Number	Unit
604 .A B Item Number	
604 Section Number	
.A Structure	
B Diameter or Grate Type	
.1 Catch Basins, ____ ft Diameter	V.F.
.2 Drop Inlets, ____ ft Diameter	V.F.
.3 Drain Manhole, ____ ft Diameter	V.F.
.4 Reconstructing Catch Basins and Drop Inlets	V.F.
.45 Adjusting Catch Basins and Drop Inlet Grates and Frames	Each
.5 Reconstructing Drainage Manholes	V.F.
.55 Adjusting Drain Manhole Covers and Frames	Each
.6 Drain Manhole Covers and Frames	Each
.7 Concrete Rectangular Slab Top Replacement	Each
.8 Grates and Frames, Type ____	Each
1 Type A	
2 Type B	
3 Type C	
4 Blank	
5 Type E	
6 Type F	
7 Frames and Grates Furnished by Others	
8 Special	
.95 Water Repellent for Existing Catch Basins and Drop Inlets	Each

SECTION 604

Examples:

- 604.14 Catch Basin, 4 ft Diameter
- 604.24 Drop Inlet, 4 ft Diameter
- 604.35 Drain Manhole, 5 ft Diameter
- 604.6 Drain Manhole Covers and Frames
- 604.82 Grates and Frames, Type B



ALL SECTIONS SHALL BE CONCRETE, CLASS AA, (4,000 PSI), CIRCUMFERENTIAL REINFORCEMENT SHALL BE 0.12 SQ. IN. PER L.F. IN ALL SECTIONS AND SHALL BE PLACED IN THE CENTER THIRD OF THE WALL.

THE TONGUE OR GROOVE OF THE JOINT SHALL CONTAIN ONE LINE OF CIRCUMFERENTIAL REINFORCEMENT EQUAL TO 0.12 SQ. IN. PER L.F.

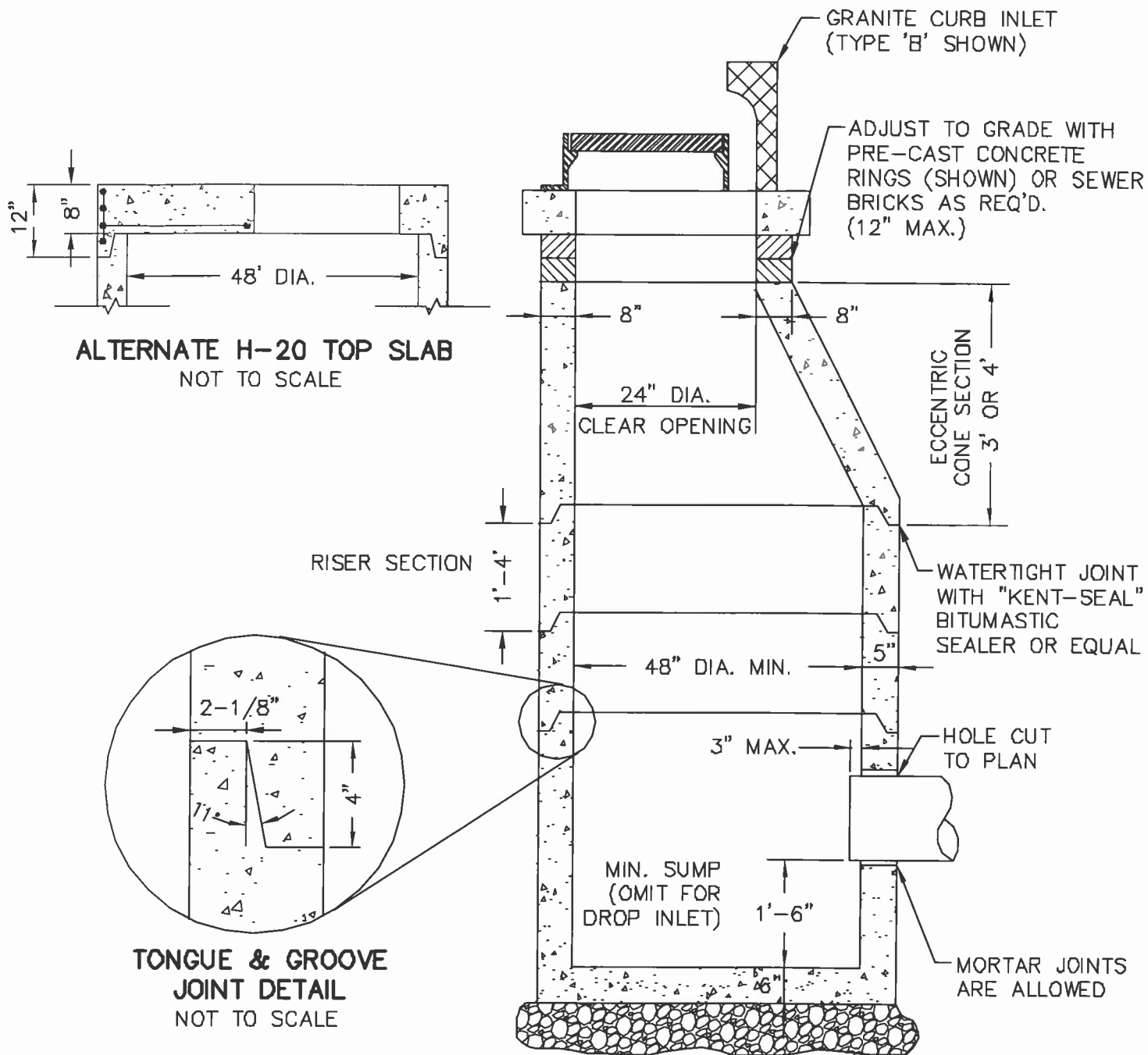
RISERS OF 1'-4" MAY BE USED TO REACH THE DESIRED ELEVATION.

STEPS ARE NOT ALLOWED.

PRE-CAST REINFORCED CONCRETE DRAIN MANHOLE

S:\DWG\DETAILS\604-1 DMH.DWG

NOT TO SCALE
FIGURE 604-1



ALL SECTIONS SHALL BE CONCRETE, CLASS AA, (4,000 PSI),
CIRCUMFERENTIAL REINFORCEMENT SHALL BE 0.12 SQ. IN. PER L.F. IN
ALL SECTIONS AND SHALL BE PLACED IN THE CENTER THIRD OF THE
WALL.

THE TONGUE OR GROOVE OF THE JOINT SHALL CONTAIN ONE LINE OF
CIRCUMFERENTIAL REINFORCEMENT EQUAL TO 0.12 SQ. IN. PER L.F.

RISERS OF 1'-4' MAY BE USED TO REACH THE DESIRED ELEVATION.

STEPS ARE NOT ALLOWED.

PRE-CAST REINFORCED CONCRETE CATCH BASIN & DROP INLET

NOT TO SCALE
FIGURE 604-2

S:\DWG\DETAILS\604-2 CB.DWG

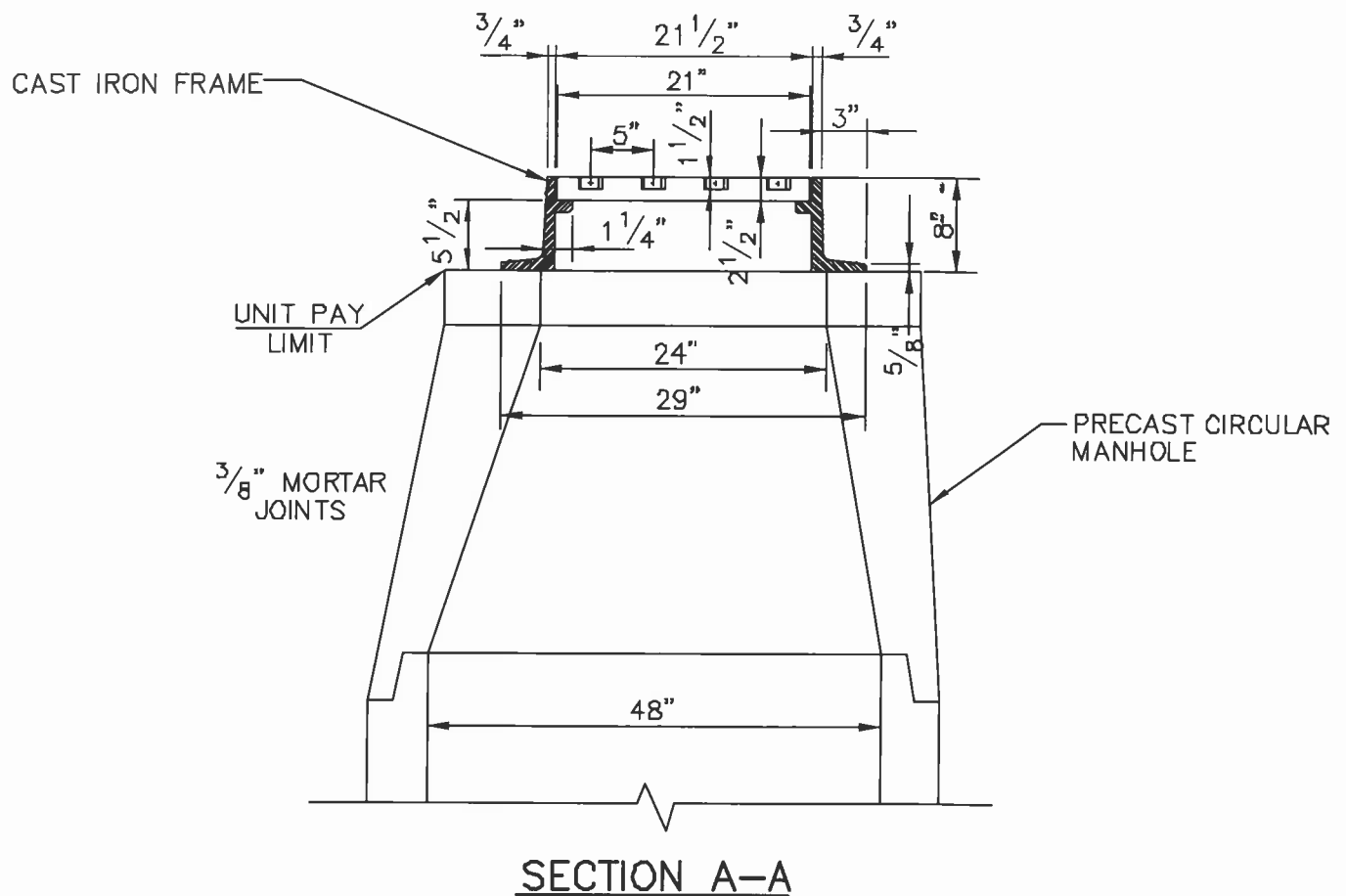
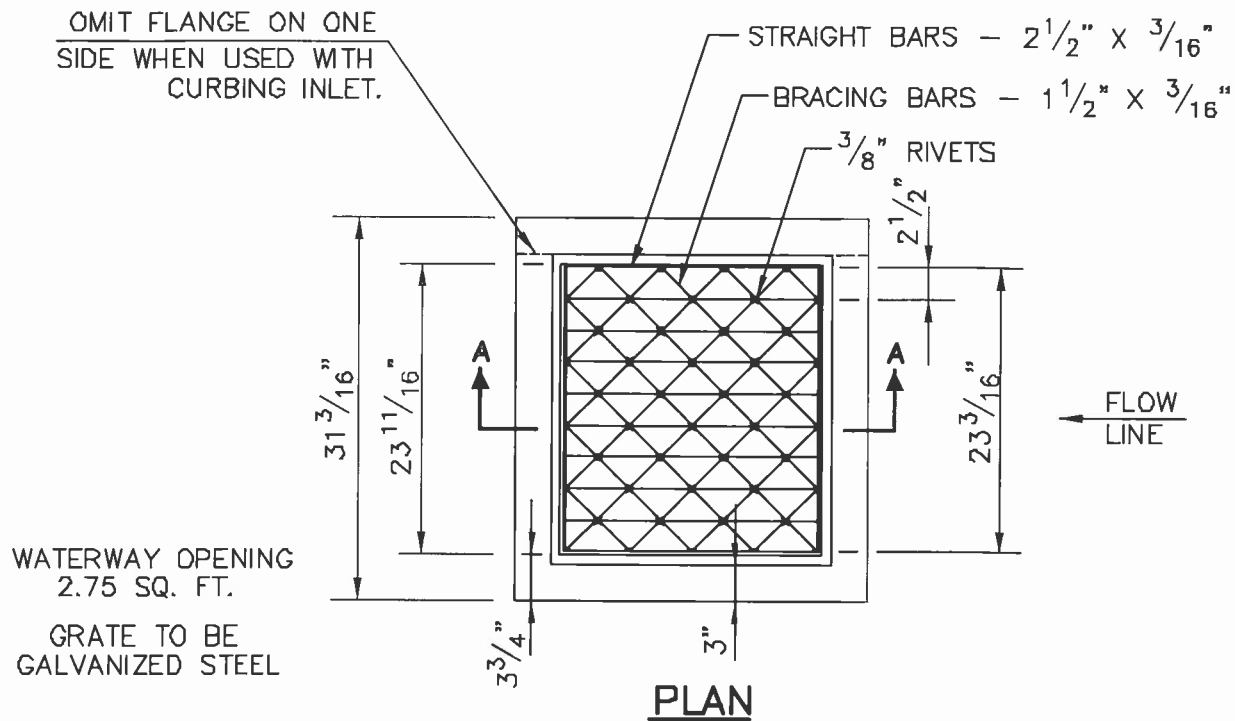
SQUARE GRATE & FRAME (CAST IRON)
HORIZONTAL BARS TO BE PARALLEL TO
FLOW LINE.

OMIT FLANGE ON ONE SIDE
WHEN USED WITH CURBING



S:\DWG\DETAILS\604-3 FRAGR-T-A.DWG

NOT TO SCALE
FIGURE 604-3



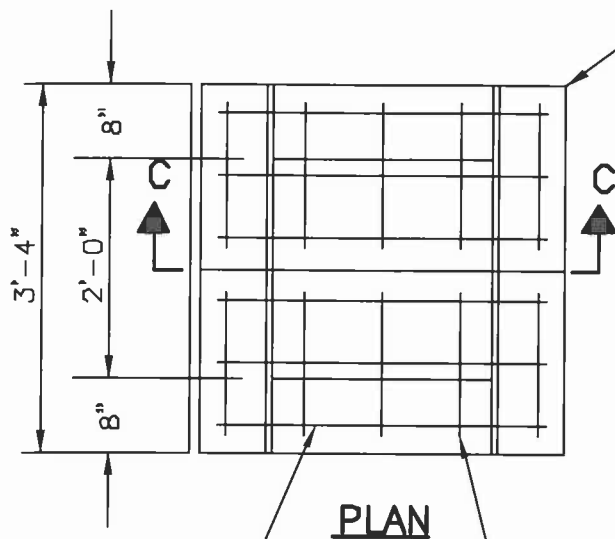
NOTE: USE WHERE BICYCLE AND/OR VEHICLE TRAFFIC CROSSES GRATE.

FRAME & GRATE TYPE 'B'

S:\DWG\DETAILS\604-4 FR&GR-EDWG

NOT TO SCALE
FIGURE 604-4

COVER IN 2
SECTIONS

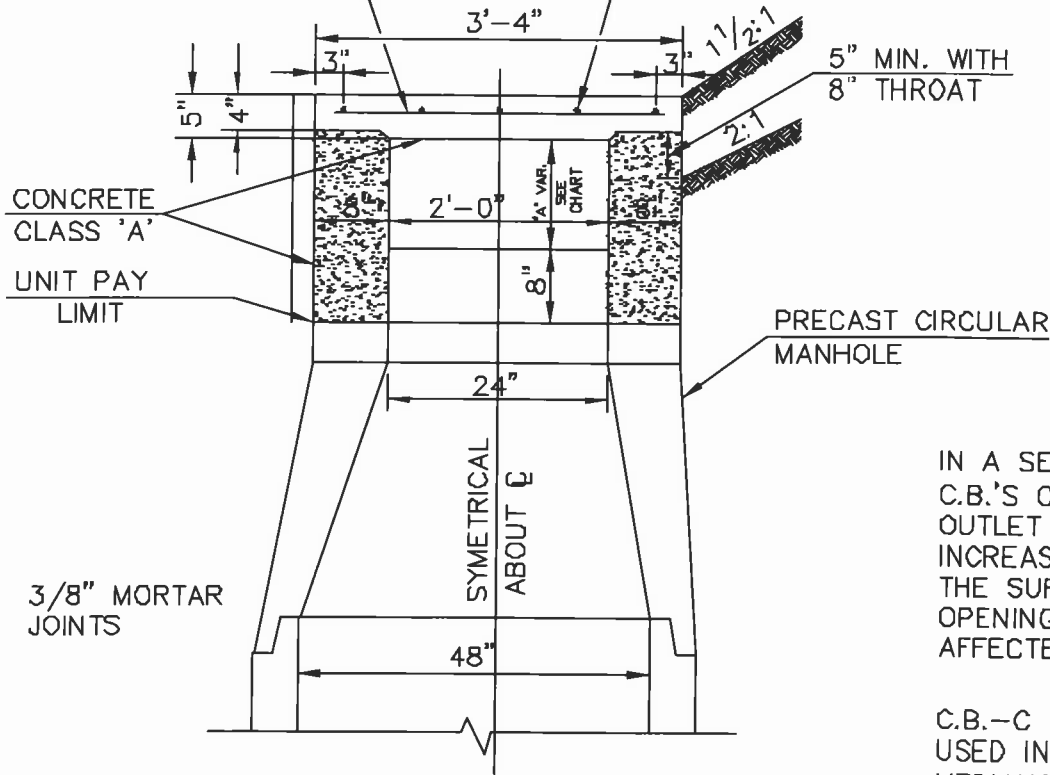


PIPE DIA. 'D' INCHES	THROAT DEPTH 'A' INCHES	
	ONE THROAT	TWO THROAT
12	8	8
14	8	8
15	8	8
16	8	8
18	16	8
20	16	9
24	18	16

PLAN

1/2"Ø BARS X 3'-0"
3 IN EACH SECTION

1/2"Ø BARS x 1'-4" @ 8 1/2" CTRS.
5 IN EACH SECTION



SECTION C-C

IN A SERIES OF CONNECTING
C.B.'S OR D.I.'S, THE
OUTLET PIPES MAY
INCREASE IN DIAMETER, BUT
THE SURFACE THROAT
OPENINGS ARE NOT
AFFECTED.

C.B.-C & D.I.-C NOT TO BE
USED IN DITCH LINES OR
MEDIANS WITHIN 30' FROM
EDGE OF PAVEMENT.
TO BE USED ONLY AT
LOCATIONS WHERE IT IS
IMPOSSIBLE TO BE HIT BY
VEHICLES.

CATCH BASIN TOP TYPE 'C'

S:\DWG\DETAILS\604-5 FR&GRT-C.DWG

NOT TO SCALE
FIGURE 604-5



S:\OWG\DETAILS\804-G FR&GRT-E.DWG

NOT TO SCALE
FIGURE 604-6

RIGHT HAND GRATE
AGONALLY OPPOSITE
(LEFT HAND GRATE)
TO FIT IN EXISTING
KEYED FRAMES.

CUT CORNER

23-3/4"

4-3/8"

2"

B

1/2"

23-3/4"

3/4"

A

1-1/2"

1/2"

CAST IRON GRATE

1"

5/16"

D

ERE
AND
ATED.

Q. FT.

GRATE TYPE 'F' TO BE USED
WITH CB TYPE 'A' FRAME.

USE ON STEEP GRADES WHERE
HIGH CAPACITY IS NEEDED AND
BICYCLE TRAFFIC IS ANTICIPATED.

WATERWAY AREA = 2.08 SQ. FT.

23-3/4"

1-3/8"

1/4" R

4 3/16"

1-1/2"

1-7/8"

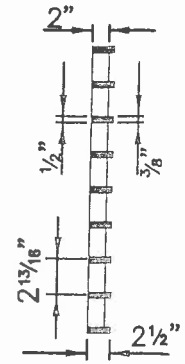
3/4"

SECTION A-A

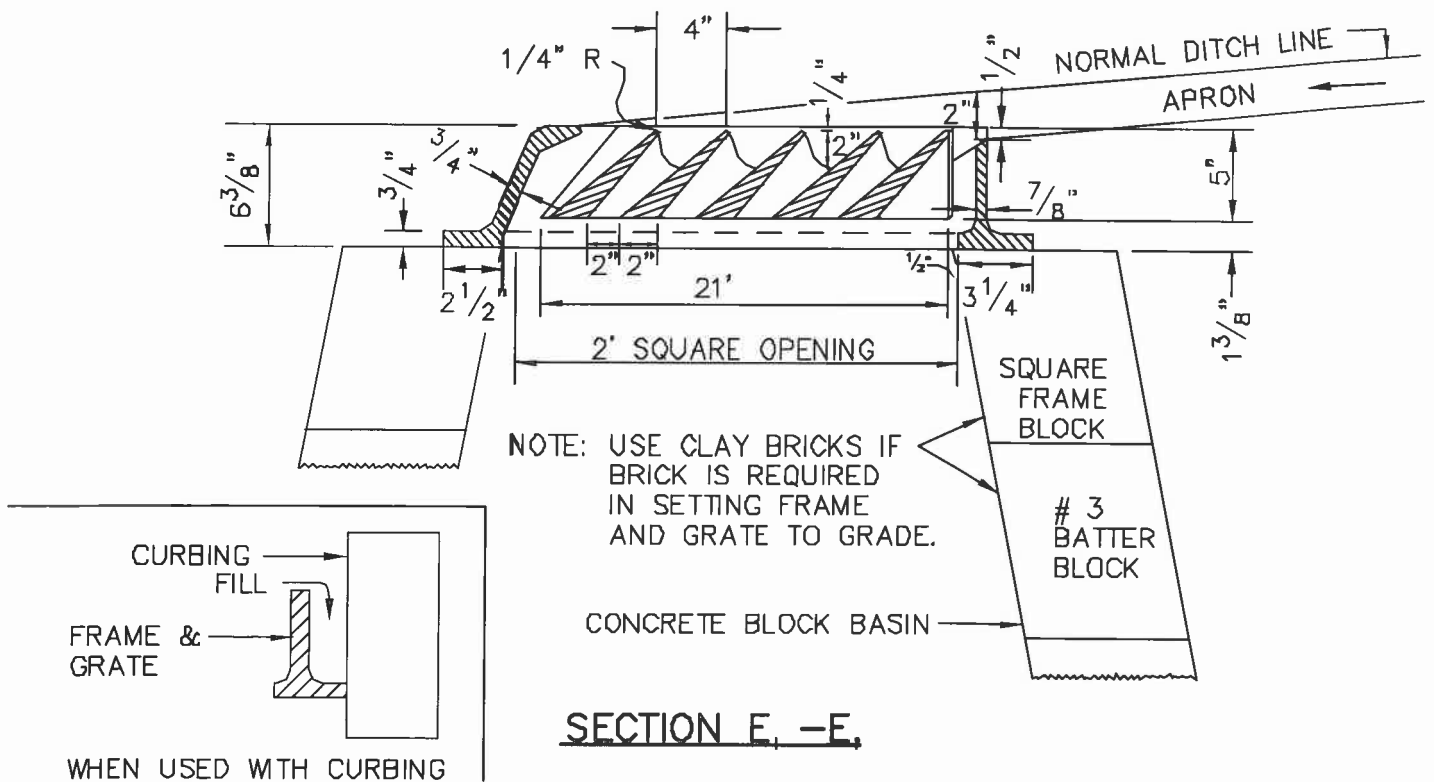
Technical drawing of a mechanical part, likely a propeller hub, showing a cross-section with dimensions. The part has a central shaft hole and a flange. Dimensions include: 1-7/8" for the flange thickness, 3-5/8" for the central hole diameter, 1/4" R for the fillet radius, 5-1/2" R for the outer radius, and 3" and 1" for the flange width segments. The section is labeled "SECTION B-B".

S: |DWG|DETAILS|604-7 FR&GRT-F.DWG

NOT TO SCALE
FIGURE 604-7



NOT TO SCALE
FIGURE 604-8

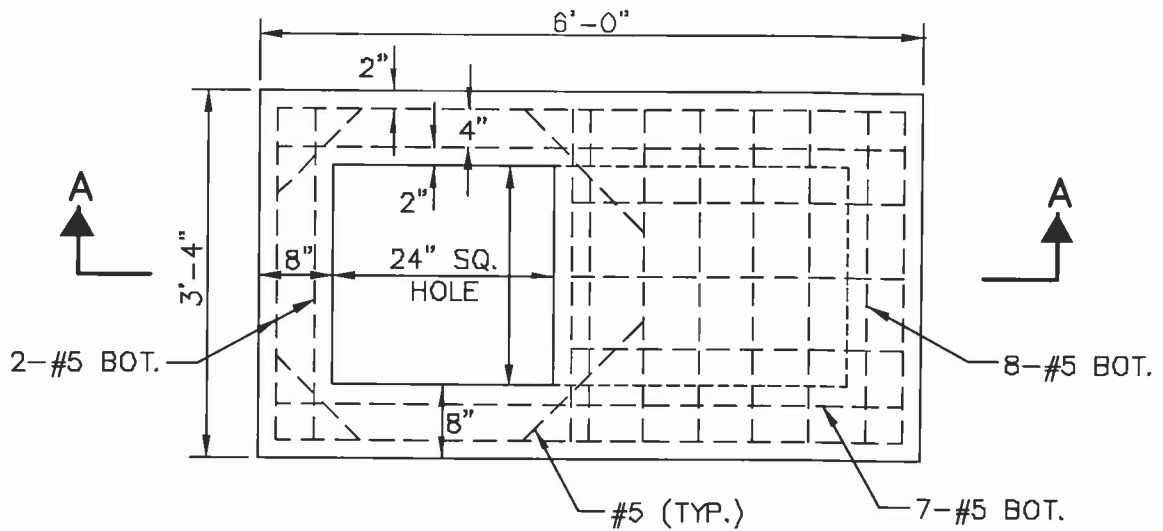
[illegible]

FRAME & GRATE TYPE 'E'—ALTERNATE 1

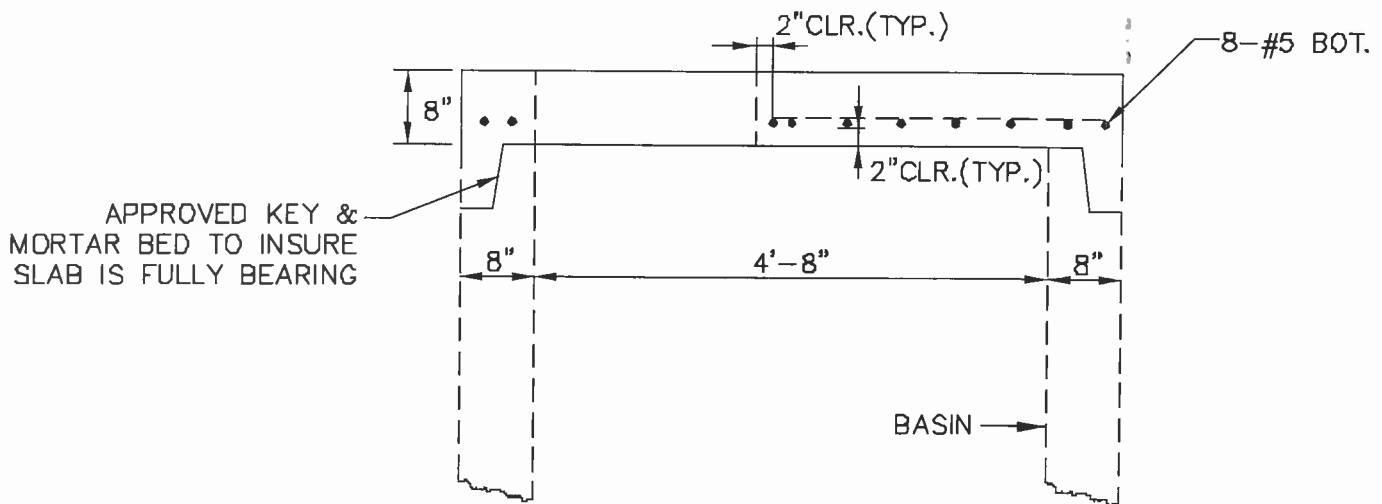
NOT TO SCALE
FIGURE 604-9

S:\DWG\DETAILS\BO4-8 FR&GR-EA.DWG

CONCRETE CLASS 'A' (4,000 LBS.
MIN. COMP. STRENGTH PER SQ. IN.)



ALL REBAR TO HAVE
MIN. 2" CLEAR COVER



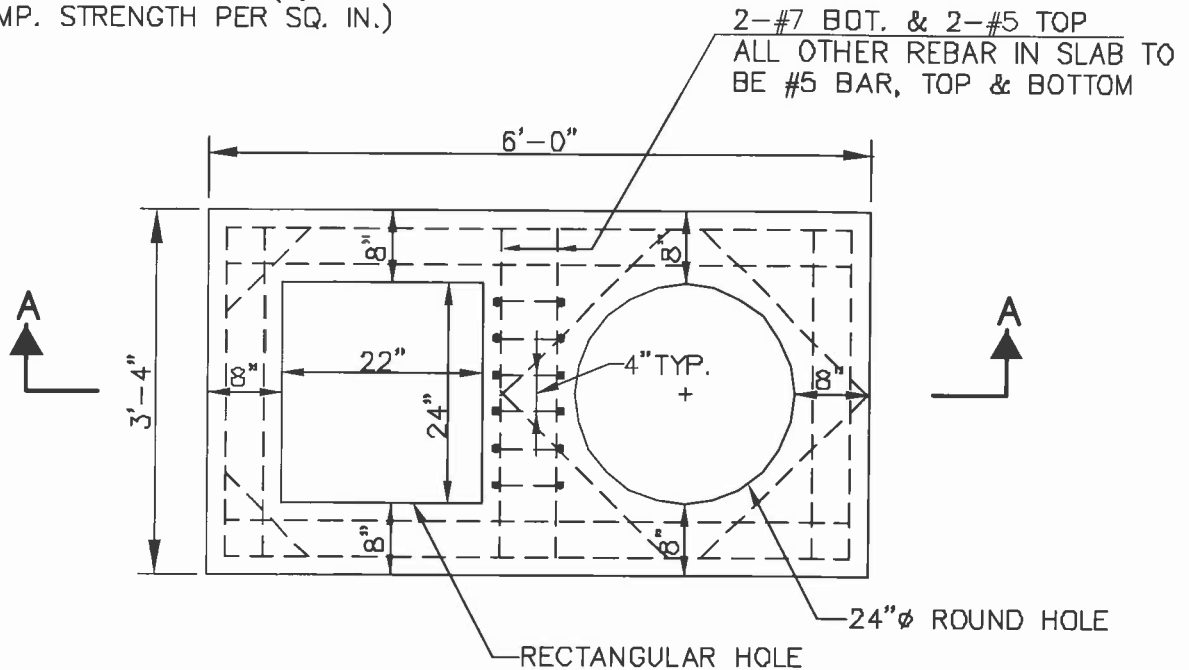
SECTION A-A

RECTANGULAR CATCH BASIN SLAB TOP - TYPE 'A'

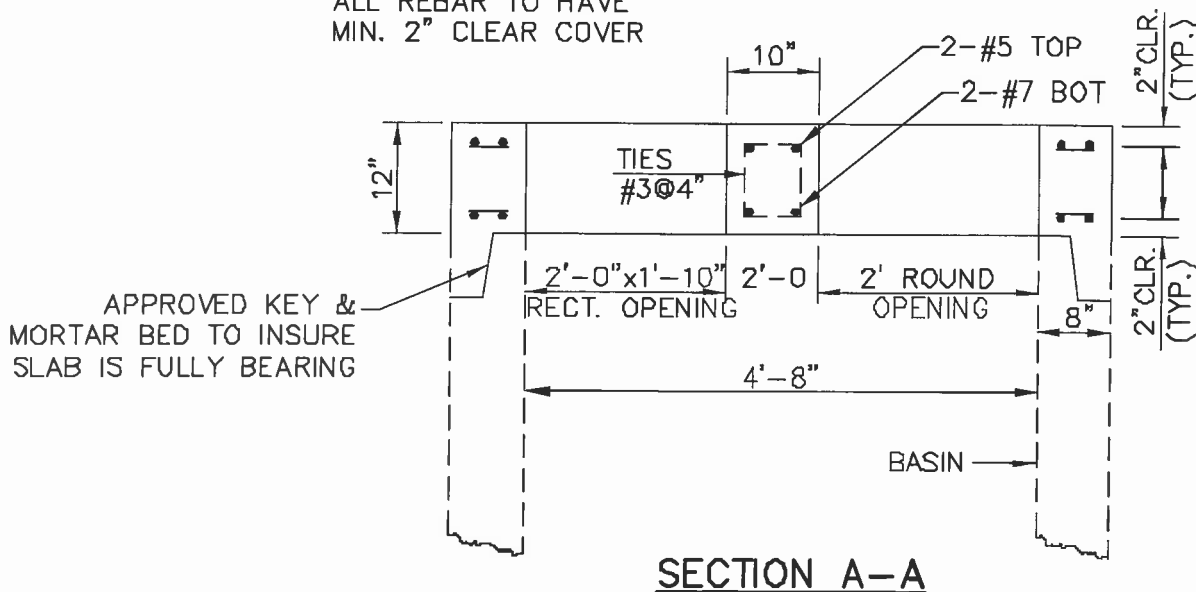
S:\DWG\DETAILS\604-10 CBREC-A.DWG

NOT TO SCALE
FIGURE 604-10

CONCRETE CLASS 'A' (4,000 LBS. MIN.
COMP. STRENGTH PER SQ. IN.)



ALL REBAR TO HAVE
MIN. 2" CLEAR COVER



RECTANGULAR CATCH BASIN SLAB TOP - TYPE 'B'

S:\DWG\DETAILS\604-11 CBREC-B.DWG

NOT TO SCALE
FIGURE 604-11

SECTION 605

SECTION 605 -- UNDERDRAINS

Description

1.1 This work shall consist of furnishing (unless pipe is provided) and installing underdrains at the locations shown or ordered. Pipe, common structure excavation, sand cushion, and backfill shall be included in this work.

1.1.1 Furnishing and installing underdrain flushing basins as shown on the plans or ordered shall also be included in this work.

1.2 Aggregate underdrain shall consist of furnishing and installing support membrane, graded aggregate, pipe, if ordered, and common structure excavation, and backfill as necessary.

Materials

2.1 Perforated corrugated steel pipe and coupling bands shall conform to the applicable requirements of AASHTO M 36M/M 36, Type III. The minimum allowable thickness of metal of 6 inch underdrain pipe shall be 0.052 inches; the minimum allowable thickness of metal in underdrain pipe larger than 6 inches shall be 0.064 inches.

2.2 Perforated corrugated aluminum pipe and coupling bands shall conform to the applicable requirements of AASHTO M 197.

2.3 Smooth-walled perforated polyvinyl chloride pipe shall conform to AASHTO M 278. Perforated polyvinyl chloride profile wall pipe shall conform to AASHTO M 304.

2.4 Corrugated polyethylene drainage tubing 6 inch diameter shall conform to AASHTO M 252, with class 2 perforations except that the required pipe stiffness shall be a minimum of 60 psi. Perforated corrugated polyethylene pipe of nominal sizes 12 to 36 inch diameter shall conform to AASHTO M 294, with Class 1 perforations. Pipe length for all sizes shall not exceed 20 feet.

2.5 Pipe Underdrain, Materials Per Contractor's Option.

2.5.1 When the item reads 6 inch pipe underdrain (contractor's option), it shall be the Contractor's option whether he furnishes perforated corrugated steel pipe, perforated corrugated aluminum pipe, perforated polyvinyl chloride pipe or perforated corrugated polyethylene drainage tubing.

2.6 Sand cushion shall be so graded that 90 to 100 percent by weight will pass a 1/2 inch sieve, and not more than 15 percent will pass a No. 200 sieve.

SECTION 605

2.7 Underdrain backfill shall meet the requirements of 209.2.1.

2.8 Flushing basin covers shall be gray iron conforming to AASHTO M 105, Class 30 unless otherwise specified.

2.9 Aggregate for aggregate underdrain shall conform to 703, AGGREGATES, TABLE 1 STANDARD SIZE #4.

2.10 Support membrane shall be nonwoven and conform to 593.2.1.

Construction Requirements

3.1 Trenches shall be excavated to the dimensions and grade shown or ordered. A minimum 2 inch sand cushion in common excavation and a 6 inch sand cushion in rock excavation shall be placed in the bottom of the trench for its full width and length to the grade of the bottom of the pipe.

3.2 Perforated pipe shall normally be placed with the perforations down, and sections shall be securely joined with the appropriate couplings, fittings, or bands.

3.3 After the pipe installation has been inspected and approved, underdrain backfill material shall be placed to a height of 12 inches above the top of the pipe, care being taken not to displace the pipe. The remainder of the backfill material shall then be placed to the required height and compacted in lifts not to exceed 12 inches.

3.4 Pipes shall be laid with 45 degree bends where changes in direction are indicated on the plans.

3.5 Except at structures, up grade ends of all underdrain pipe installations shall be closed with suitable plugs to prevent entry of soil material.

3.6 Flushing Basins.

3.6.1 Flushing basins shall be installed approximately 2 feet beyond the break in the shoulder and in such manner as to allow the basin cover to be set within the slope limits.

3.6.2 Any excavation required to install flushing basins shall be done in accordance with 3.1.

3.6.3 Additional 6 inch pipe shall be added to the elbow to bring the riser to the required elevation.

3.6.4 After the fitting and 6 inch riser pipe installation has been inspected and approved, underdrain backfill material shall be placed and properly compacted to a height which will allow for the proper installation of the 2 foot section of 8 inch riser and cover.

SECTION 605

The remainder of the backfill and base course necessary shall then be placed to the required height and compacted. Care shall be taken to prevent backfill material from entering the riser pipes.

3.6.5 Basin covers shall be press-fit onto the 8 inch riser pipe.

3.6.6 Flushing basins and the related underdrain system shall be tested prior to acceptance.

3.7 Aggregate Underdrains.

3.7.1 Trenches shall be excavated to the dimensions shown or ordered. Type 1 aggregate underdrain shall have a 6 inch by ten foot section of pipe at the outlet end of each section of underdrain. Type 2 shall include pipe of the specified diameter throughout.

3.7.2 Nonwoven support membrane shall be installed so as to minimize the number of fabric seams within the trench section. Seams shall be constructed by overlapping the fabric at least 12 inches and folding to create a joint which will ensure that soil infiltration will be retarded.

3.7.3 Aggregate shall be placed within the typical section as shown in a manner that will maintain the fabric integrity. Punctures created by aggregate, equipment, tools or improper handling shall be patched by placing fabric at least 12 inches beyond the puncture limits on the outside of the typical section.

3.7.4 Pipe, as required, shall be laid to grade as ordered.

3.7.5 Backfill shall be placed and tamped in the areas outside and adjacent to the aggregate underdrain so that the shape of the typical is maintained. Sharp pieces of rock shall not be placed immediately adjacent to the fabric.

3.7.6 When rock is encountered, sharp projections of solid rock shall be removed within the typical section, primarily at the bottom of the trench.

Method of Measurement

4.1 Underdrains will be measured by the linear foot to the nearest 0.1 of a foot along the centerline of the pipe.

4.1.1 Aggregate underdrain will be measured by the linear foot, to the nearest 0.1 of a foot along the centerline of the aggregate underdrain.

4.2 When the item of borrow is included in the contract, no deduction will be made from borrow for the quantity of backfill or cushioning material obtained from the

SECTION 605

sectioned area; the quantity of backfill or cushioning material furnished from nonsectioned areas will be added to borrow. When no quantity for borrow is included in the contract, backfill or cushioning material furnished will be subsidiary.

4.3 Underdrain flushing basins will be measured by the number of units installed.

4.3.1 Each unit shall include all required riser pipe, elbow or other fittings, cover and backfill material as required.

Basis of Payment

5.1 The accepted quantities of underdrain will be paid for at the contract unit price per linear foot complete in place, including common structure excavation, sand cushion and backfill.

5.1.1 Payment will not be made for 45 degree bends.

5.1.2 Rock excavation will be paid for under Item 206.2.

5.2 The accepted quantity of underdrain flushing basins will be paid for at the contract unit price per each complete in place, including common structure excavation and backfill.

5.3 The accepted quantities of aggregate underdrain of the type specified will be paid for at the contract unit price per linear foot in place, including common structure excavation and backfill.

5.3.1 Payment will not be made for fabric used for patching.

5.3.2 Excavation required will be paid for as provided in 5.1.2.

Pay items and units:

605.1	___ inch Perforated Corrugated Steel Pipe Underdrain	Linear Foot
605.4	___ inch Perforated Polyvinyl Chloride Pipe Underdrain	Linear Foot
605.5	___ inch Perforated Corrugated Polyethylene Pipe Underdrain	Linear Foot
605.79	Underdrain Flushing Basins	Each
605.81A	___ Aggregate Underdrain Type 1	Linear Foot
605.82ABC	___ Aggregate Underdrain Type 2, With _____ Pipe	Linear Foot
605.84015	1-1/2 inch PVC Plastic Horizontal Drains	Linear Foot
605.906	6 inch Pipe Underdrain (Contractor's Option)	Linear Foot

Notes:

SECTION 605

A = Width of Underdrain

1=18" 2=24" 3=30" 4=36"

B = Type of Material

- 1 = Perforated Corrugated Steel
- 2 = Blank
- 3 = Perforated Corrugated Aluminum
- 4 = Perforated Polyvinyl Chloride
- 5 = Perforated Corrugated Polyethylene

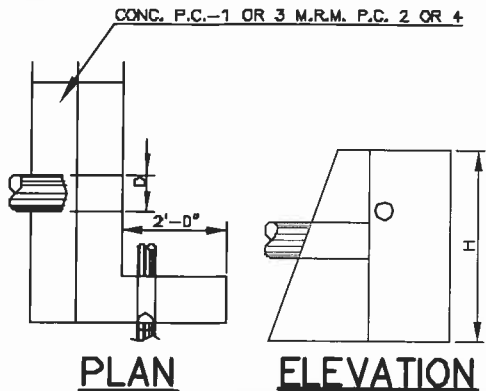
C = Diameter of Pipe

1=6" 2=12" 3=18" 4=24"

Examples:

- | | |
|-----------|---|
| 605.82311 | 30 inch Aggregate Underdrain Type 2, with Perforated Corrugated Steel
6inch Pipe |
| 605.906 | 6 Inch Pipe Underdrain (Contractor's Option) |

UNDERDRAIN
'L' HEADWALL



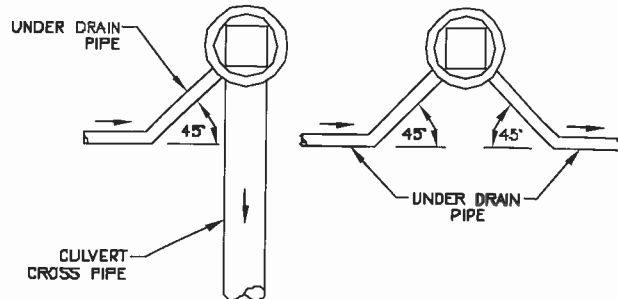
CONCRETE NO. U.L.-1
MOR.RUB.MAS. NO. U.L.-3

CONCRETE CLASS 'A'

D DIA. R.C.P. CULV.	H HEADER HEIGHT	MASONRY IN L' - C.Y. FOR 6" FOR 12"	UND.	UND.
15"	4'-3"	.30	.27	
18"	4'-6"	.32	.29	
24"	5'-0"	.36	.33	
30"	5'-6"	.40	.37	
36"	6'-0"	.43	.40	

C.B. (OR HEADER)

C.B.



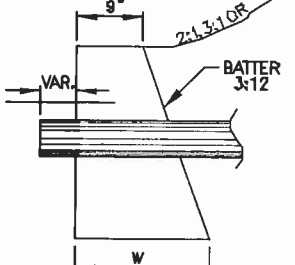
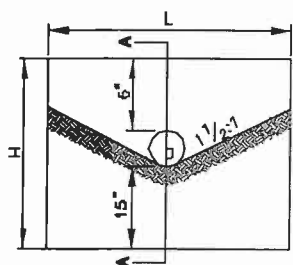
PLAN VIEWS

DETAIL FOR 45° BENDS
IN UNDERDRAIN PIPES

UNDERDRAIN
HEADWALL

DIMENSIONS SHOWN ARE TO PAYMENT LINES.
MORTAR RUBBLE MASONRY TO BE STEPPED
OUTSIDE PAYMENT LINES ON SLOPING FACE.
CONCRETE CLASS 'A'

CONCRETE NO. U.H.-1
MOR.RUB.MAS. NO. U.H.-2



D UND. DIA. IN.	PER HEADER MAS'RY C.Y.	EXC. PER 1' DEPTH C.Y.	L FT.-IN.	H FT.-IN.	W IN.
6	.17	.49	2-0	2-3	15 3/4
12	.32	.65	3-2	2-8	17 1/2
15	.43	.78	3-10	3-0	18

D UND. DIA. IN.	ANG. DEG.	PER HEADER MAS'RY C.Y.	EXC. PER 1' DEPTH C.Y.	L FT.-IN.	H FT.-IN.	W IN.
6	80	.30	.71	1-3	2-3	15 3/4
6	120	.26	.65	1-3	2-3	15 3/4
6	135	.25	.62	1-3	2-3	15 3/4
12	90	.54	.95	2-0	2-8	17 1/2
12	120	.49	.87	2-0	2-8	17 1/2
12	135	.47	.84	2-0	2-8	17 1/2
15	80	.72	1.10	2-6	3-0	18
15	120	.66	1.02	2-6	3-0	18
15	135	.84	.99	2-6	3-0	18
18	80	.85	1.20	2-8	3-3	18 3/4
18	120	.78	1.11	2-9	3-3	18 3/4
18	135	.77	1.01	2-9	3-3	18 3/4
24	90	1.25	1.46	3-6	3-9	20 1/2
24	120	1.18	1.37	3-6	3-9	20 1/2
24	135	1.14	1.39	3-6	3-9	20 1/2

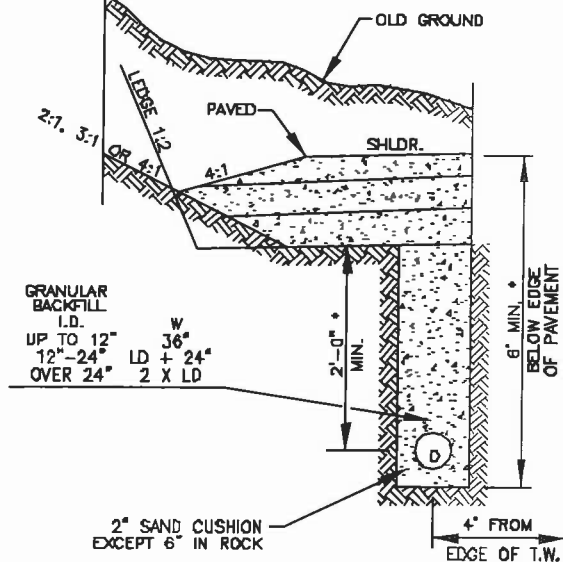
CONCRETE NO. U.L.-2
MOR.RUB.MAS. NO. U.L.-4

DIMENSIONS
SHOWN ARE TO
PAYMENT LINES.
MORTAR RUBBLE
MASONRY TO BE
STEPPED OUTSIDE
PAYMENT LINES
ON SLOPING
FACES.

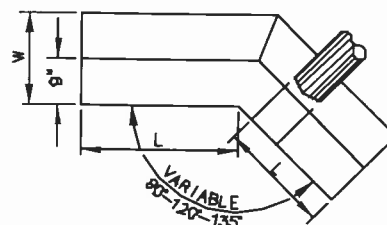
UNDERDRAIN

NO. U.D.-1

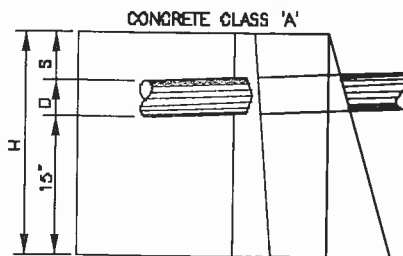
*WHICHEVER CONTROL
RESULTS IN THE GREATER
DEPTH WILL APPLY.



UNDERDRAIN
'L' HEADWALL



PLAN



ELEVATION

UNDERDRAIN HEADWALLS & UNDERDRAIN 'L' HEADWALLS

5: \DWG\DETAILS\605-1 UNDER-DRN.DWG

NOT TO SCALE
FIGURE 605-1