

The undersigned has approved this document for and on behalf of Carollo Engineers, P.C.

Patrick M. McCall

Partner

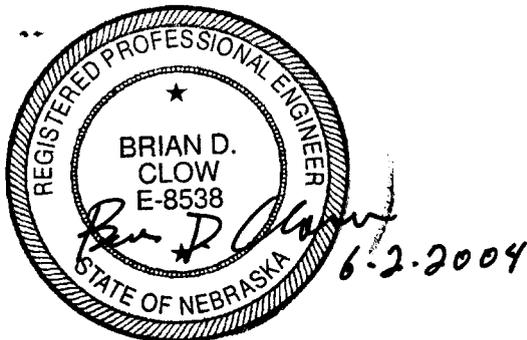
City of Lincoln, Nebraska

STEVENS CREEK BASIN TRUNK SEWER

**TECHNICAL MEMORANDUM NO. 2
STRUCTURES**

FINAL

June 2004



CITY OF LINCOLN, NEBRASKA
STEVENS CREEK BASIN TRUNK SEWER
TECHNICAL MEMORANDUM
NO. 2 - STRUCTURES

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1.0 MANHOLES

1.1 Manhole locations

Manholes will be located at various points along the trunk sewer, such as: angle points in the alignment, where the trunk sewer changes size, and where tributary flows enter the trunk sewer system. Additionally, manholes will be located where access to the system is desired, as determined by the City. Other locations will be determined on a case-by-case basis during the final design of the alignment. Permanent steps will not be incorporated into manholes except where specifically requested by City Staff.

1.2 Manhole Spacing

For sewer pipe sizes 30-inches and less in diameter the maximum manhole spacing shall be 400 to 600 feet. For sewer pipe that is 33-inches and larger in diameter the maximum manhole spacing shall be in the 800 to 1000 feet. The actual spacing of the manholes will be determined during the final design and may vary from the above stated values due to location of angle points, junction structures and other site specific features of the alignment.

1.3 Standard Manholes

For line manholes where the trunk sewer is from 18-inches to 48-inches in diameter, The manhole bases will be either cast in place or precast. The risers shall be constructed of precast concrete. A precast eccentric reducer shall be placed on top of the manhole riser sections. A heavy duty, H20 traffic rated, cast iron manhole frame and cover shall be utilized. See Drawings T-001 and T-002 (located at the end of this document) for preliminary standard manhole details.

For manholes where the size of the main line trunk sewer does not change, and the direction of flow either does not change or the change in direction is less than 45 degrees, the flow line shall be constant with the slope of the sewer. For main line manholes where the pipe size does change, and the direction of flow changes 45 degrees or greater there shall be a one-tenth foot drop across the manhole.

Where the main line pipe size increases, the crown elevation of the inlet and outlet pipes shall match. Likewise, for manholes that receive flow from a tributary sewer the crown elevation of the tributary, or smaller, sewer shall match the crown of the inlet main line. If both the inlet main line and tributary pipes are the same diameter as the main line outlet pipe, there shall be a one-tenth foot drop from the inlet to outlet invert elevations.

Where a tributary sewer of 15-inches or less in diameter enters the trunk line, the standard manhole details will be utilized. If the tributary pipe is 18-inches or larger a junction structure will be used in place of a manhole.

If drop manholes are required the manholes shall be constructed as shown in Drawings T-002. The same criteria will apply for inlet and outlet pipe size and manhole spacing as discussed above.

Standard manholes will be constructed on a reinforced, poured-in-place concrete base. Installed on top of the base, a pre-cast concrete manhole section with an eccentric reducer. Will be a heavy duty, traffic rated, cast iron manhole frame and cover will be utilized.

1.4 Tee-Base Manholes

“Tee-Base” manholes shall be used for sewers where the largest pipe is greater than 48-inch in diameter. Tee-base manholes are essentially a tee with the straight-through section the same diameter as the connecting main line sewer. The side outlet is installed in the vertical position and serves as an access shaft to the sewer. The diameter of the access hatch will vary depending on the actual installation, but for planning purposes 48-inches in diameter will be used.

Where required, the flow from a tributary or branch sewer can be directed into a tee-base manhole. Generally, for this type of connection the tee base manhole manufacturer shall fabricate the inlet of the appropriate size to allow the tributary pipe to enter the trunk sewer. If possible, the crown elevation of the tributary sewer shall match the crown of the trunk sewer. However, if this is not possible, the crown of the tributary sewer shall be installed as close to the crown of the main line sewer as possible. These connections will be designed on a case-by-case basis and the actual details will differ depending on the actual material used to manufacture the tee-base manholes and the size and piping material of the tributary pipe. If the tributary sewer is 18-inches in diameter or greater, a junction structure shall be used in lieu of a tee-base manhole.

As with the standard manholes discussed above, each tee-base manhole shall incorporate a riser and a heavy duty, traffic-rated, cast iron manhole frame and cover. Due to the size of piping in a Tee-Base manhole the one-tenth of a foot drop at an angle point is not required.

See Drawings T-002 and T-003 for preliminary Tee Base Manhole Details.

1.5 Corrosion Protection

Corrosion protection will be provided on larger manholes on a case by case basis. Factors that will be used in the decision process include location of the manhole in the system and the estimated turbulence of the flow at that manhole.

If corrosion protection is incorporated at a manhole it will consist of PVC sheet liner or other approved system. The corrosion protection will be installed to the concrete manhole sections riser section and the eccentric reducers. The installation of PVC lining on the manhole grade rings will be evaluated on a case by case basis.

1.6 Manhole Testing

All manholes shall be tested for potential infiltration by performing ex-filtration tests or by vacuum testing as described in Section 22.09 of the City Standard Specifications. All manholes shall be constructed so as to be free from infiltration. Holes in the walls of the precast concrete sections are not allowed. The manhole shall remain free from visible infiltration during the guarantee period. If any infiltration is observed during that period, the Contractor shall be required to make any necessary repairs.

2.0 JUNCTION STRUCTURES

2.1 General

Junction structures shall be used where an 18-inch diameter or greater branch sewer enters the main line or trunk sewer. Junction structures will be constructed from cast-in-place reinforced concrete and shall incorporate a removable reinforced concrete slab cover. Flow channelization will be provided to allow the flow from the tributary sewer to be directed into the main line with minimal turbulence and headloss. As a minimum, three feet of access space will be provided on one side of the trunk sewer within the junction structure. Junction structures will be equipped with two access shafts. The access shafts will be similar to the risers on the tee-base manholes and incorporate a heavy duty, traffic-rated, cast iron manhole frame and cover. Permanent steps will not be provided in the junction structures, however, access will be ladders or other temporary methods.

Drawings for the junction structures will be prepared during the final design phase of the project.

2.2 Access

The actual location of the structures will be determined during design phases of the project. Wherever possible the location of junction structures will be located where the City can access the structures with their maintenance vehicles.

2.3 Corrosion Protection

At junction structures the flows from one or more subbasins enters the main trunk basin sewer. Due to this turbulence the concrete must be protected from hydrogen sulfide attack. This attack is due to sulfides escaping the sewage as hydrogen sulfide gas and then reforming as sulfuric acid through bacterial action on the interior walls and suspended slabs of the structures. The degree of this problem is dependant on the amount of hydrogen sulfide forming in the sewage flows, the amount of hydrogen sulfide released, and the temperatures necessary to allow sulfuric acid formation. Therefore, acid attach is more significant in turbulent sections of sluggish sewers, such as junction structures.

The interior concrete walls and suspended slabs of the junction structures will be protected with PVC lining. The PVC lining will be installed on the interior forms of the structure. After

the forms are removed any holes or other irregularities in the PVC lining will be repaired with PVC welded patches. Full-time inspection and testing of the PVC lining is an important part of the construction quality control program.

Exposed metal will be protected from corrosion using epoxy coating or other systems as directed by the City. Once the geotechnical report has been finalized the need for external coating if any will be determined.

3.0 SIPHON STRUCTURES

3.1 Siphon or Depressed Sewer

A siphon, or depressed sewer, is used to direct a gravity flow sewer under an obstruction such as stream or depressed highway. A siphon incorporates two structures, an inlet and outlet structure. Generally, siphons for larger flows, such as the Stevens Creek Trunk Sewer, incorporate two or more pipes or barrels that run between the two structures. The pipes are sized to accommodate current flows as well as future peak flows. Self-cleaning velocity needs to be maintained in each barrel. The flow in the primary barrel needs to reach the self-cleaning velocity of 3 ft/sec or greater at least once per day. Weirs or other flow control devices will be used to direct higher flows into the other barrels. The sum of the barrel capacities need to match the ultimate peak flows expected to be carried through the siphon. Self-cleaning velocities should be achieved in the secondary barrels during high flow events to scour the pipes clean.

3.2 Structures

An inlet structure will be located on the upstream side of the siphon. Weirs or other devices are designed to split the flow into the multiple barrels as the liquid level rises in the inlet structure. The outlet, or downstream, structure is where flow from the siphon barrels will be combined into one main line sewer. The headloss through a siphon needs to be calculated to accurately locate the invert elevations on the downstream side of the siphon barrels.

Both the inlet and outlet structures will be constructed from reinforced cast-in-place concrete and shall incorporate a removable reinforced concrete slab cover, similar to that for junction structures. The access shafts will be similar to the risers on the tee-base manholes, and shall incorporate a heavy duty, traffic-rated, cast iron manhole frame and cover. As with junction structures, permanent stairs, ladders or steps will not be provided.

3.3 Air Jumper

Positive pressure develops in the atmosphere upstream of a siphon because of the downstream movement of air induced by the sewage flow. In extreme cases, this pressure may equal several inches of water. The air tends to vent from the inlet structure and upstream manholes. This venting of air is a potential cause for odor release, especially during lower flows when the formation of hydrogen sulfide is more prevalent. Likewise, there is a tendency for air to be pulled into the downstream or outlet structure.

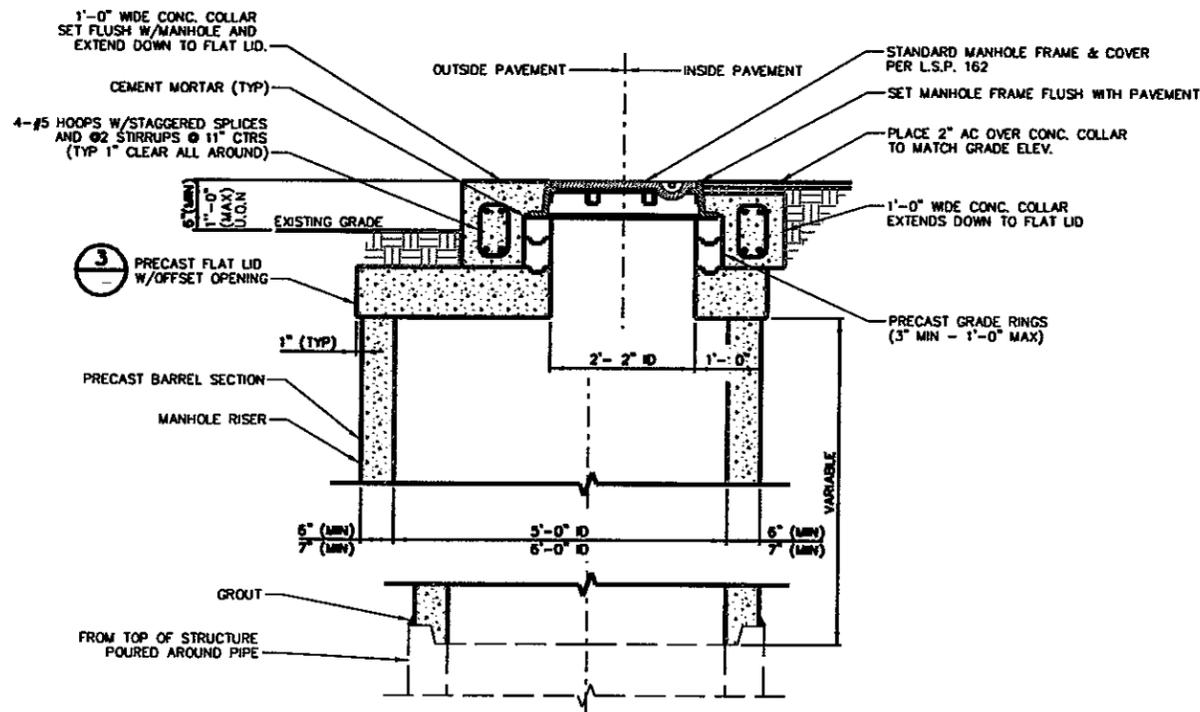
To overcome this phenomena, an air jumper will be used. An air jumper is a pipe that is usually installed with the siphon barrels. The air jumper directs the air from the inlet structure to the outlet structure. Condensate may collect in the lower elevations of the air jumper and provisions, such as a sump pump, are needed to remove the accumulated condensate. The size of the jumper pipe will be determined on a case- by-case analysis; however, it is generally one half of the diameter of the largest barrel of the siphon. Provisions for the addition of future odor control will be provided on both structures.

3.4 Corrosion Protection

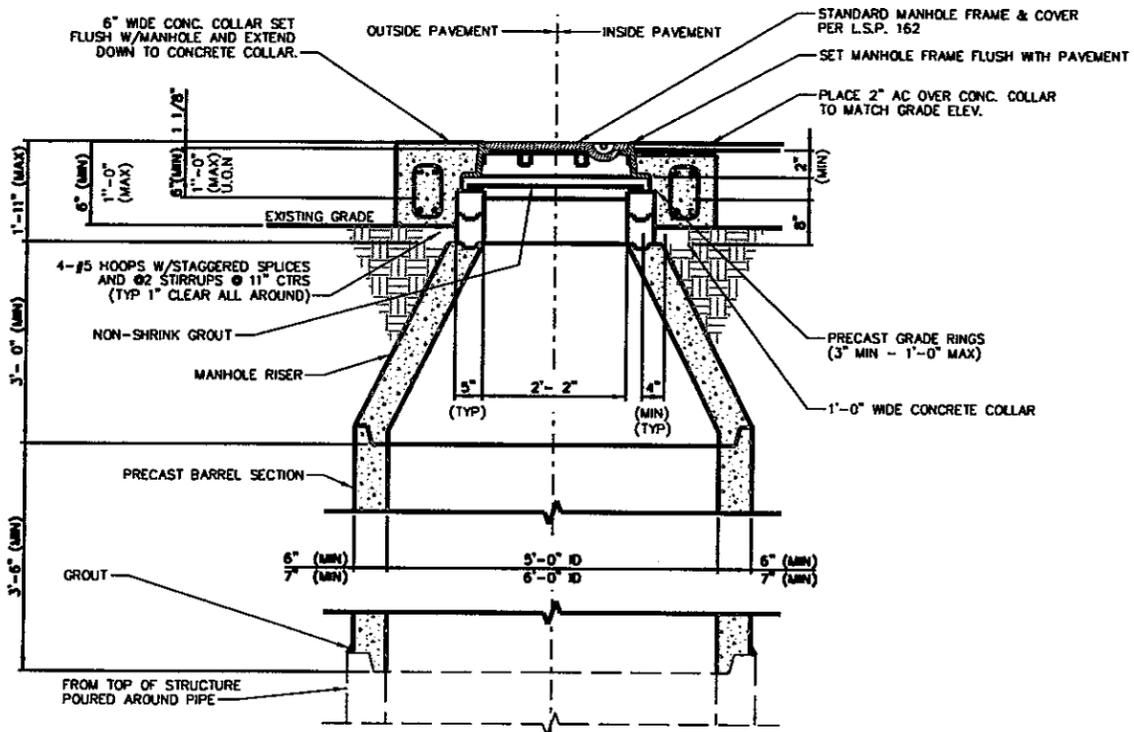
Siphon structures will incorporate the same corrosion protection as Junction Structures as discussed above.

3.5 Access

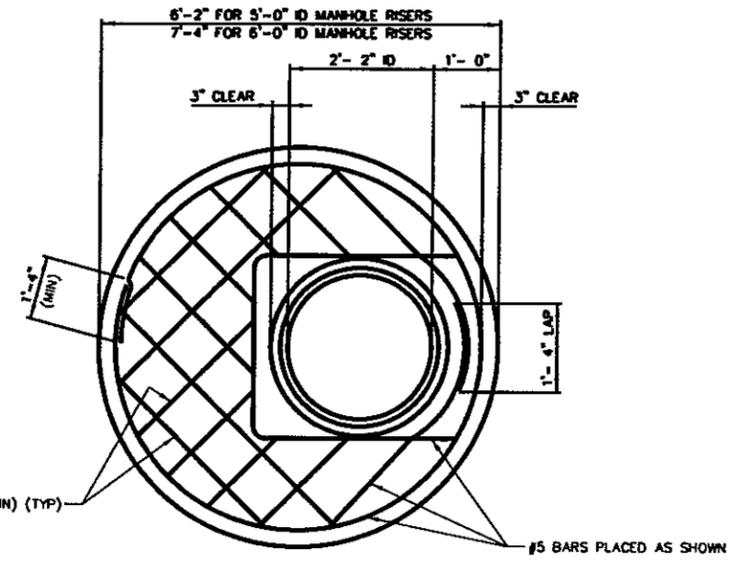
Siphons generally require more routine maintenance and cleaning than other structures in the collection system. For this reason it is desirable that siphons be located where vehicular traffic, such as sewer cleaning trucks, can easily access the structures. The actual location of the siphons will be determined as part of the final alignment selection.



1 SECTION - RISER W/ FLAT LID
SCALE: 3/4"=1'-0"



2 SECTION - RISER W/CONE
SCALE: 3/4"=1'-0"



3 PLAN - PRECAST FLAT LID
SCALE: 3/4"=1'-0"

- NOTES - MANHOLE RISER**
1. JOINTS FOR THE BARREL SECTION SHALL BE TONGUE AND GROOVE, OR EQUAL. ALL JOINTS MUST BE SEALED W/APPROVED JOINT COMPOUND.
 2. FOR ASPHALTIC CONCRETE OVERLAYS ONLY, MANHOLES W/DEPTHS OF 8'-0" AND GREATER (MEASURED FROM THE FLOW LINE TO THE TOP OF CASING) THE MAX. THROAT DEPTH IS 2'-0".
 3. ALL MANHOLE SECTIONS TO BE FITTED WITH EXTERNAL LIFTING PINS. NO THRU PENETRATION HOLES ALLOWED.
 4. VACUUM TESTING PER ASTM C 124493 IS REQ'D W/ADDITION OF THE FOLLOWING CONSTRAINT: A MIN OF 9" OF MERCURY SHALL BE HELD FOR A MIN OF ONE MINUTE.
 5. ALL CONES SHALL BE OF THE ECCENTRIC TYPE. ECCENTRICITY SHALL BE LOCATED ON THE DOWN STREAM SIDE AND IN LINE W/FLOW THRU THE PIPE.
 6. PRECAST MANHOLE RISERS, FLAT LIDS, FRAMES AND COVERS SHALL ALL BE DESIGNED FOR H2O LOADING.
 7. JOINTS SHALL BE MORTERED INSIDE AND OUT WITH 1/2" MIN. THICKNESS 6" ABOVE AND BELOW JOINTS.

REV	DATE	BY	DESCRIPTION

DESIGNED
CWV
DRAWN
CWV
CHECKED
BDC
DATE
11-11-04

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NEBRASKA
MAYOR COLLEEN J. SEHG

carollo
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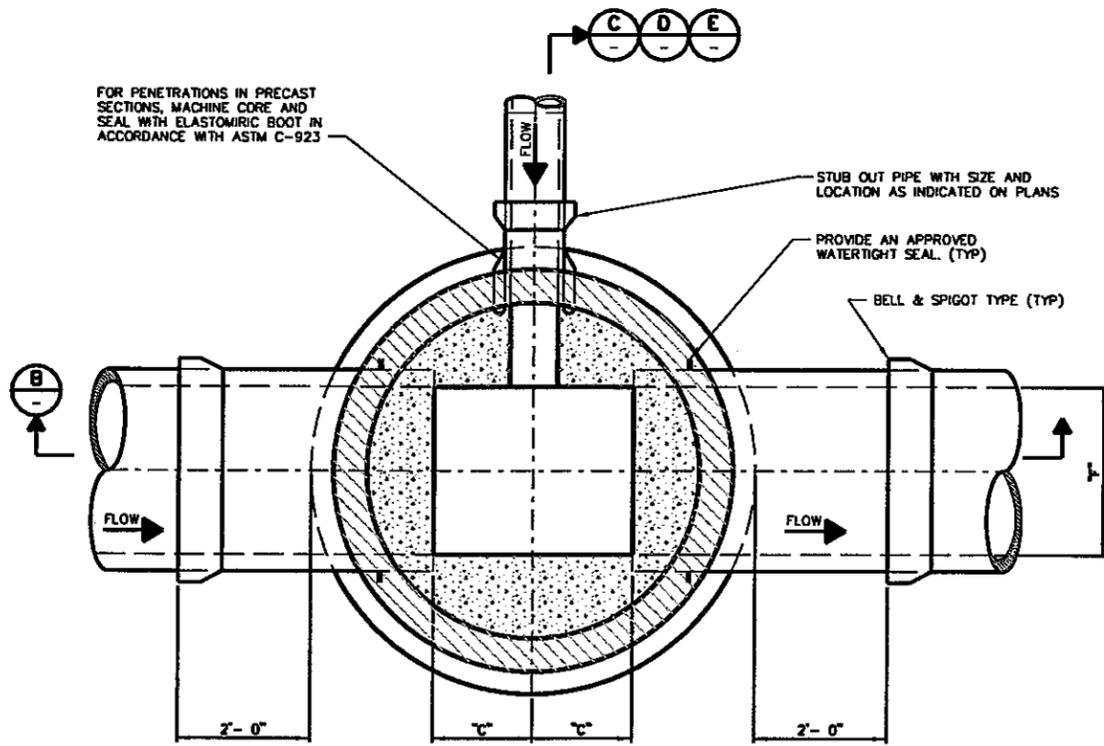
12001 O STREET
OMAHA, NE 68137-3542
PHONE: (402) 895-4700
FAX: (402) 895-3589

7130 S 29TH ST, STE D
LINCOLN, NE 68516-5841
PHONE: (402) 420-7217
FAX: (402) 420-7216

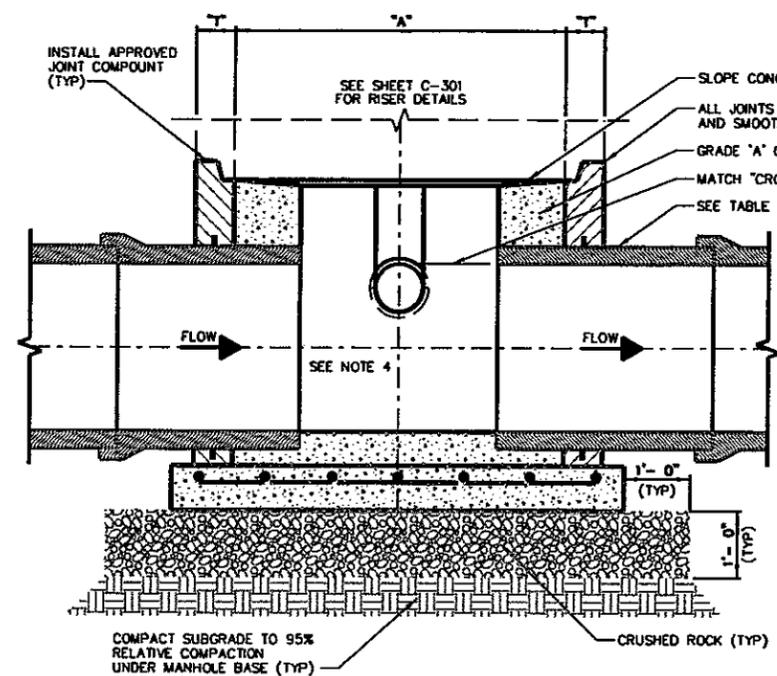
CITY OF LINCOLN, NEBRASKA
STEVENS CREEK BASIN TRUNK SEWER
CIVIL
SANITARY SEWER MANHOLE
RISER DETAILS

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0" = 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO.
6903A.10 (TM2)
DRAWING NO.
C-301
SHEET NO.
SHT 1 of 8



A PLAN - LINE MANHOLE BASE
SCALE: 3/4"=1'-0"

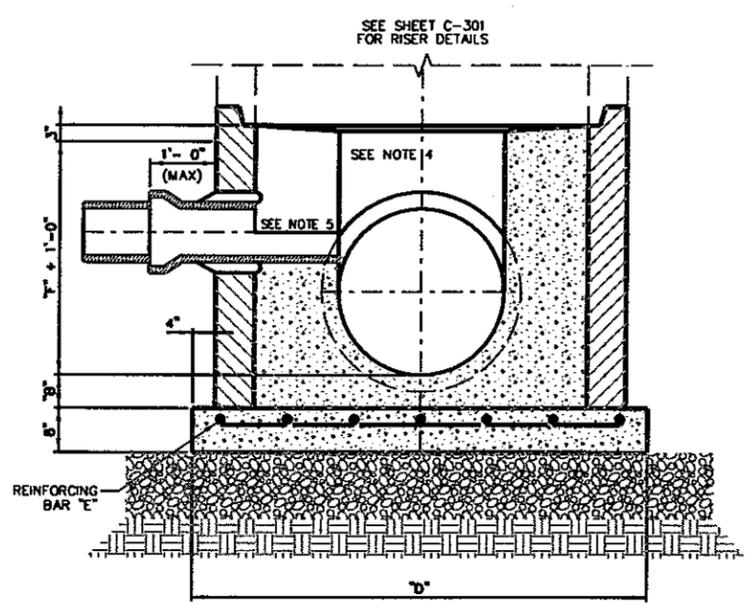


B SECTION - MANHOLE BASE
SCALE: 3/4"=1'-0"

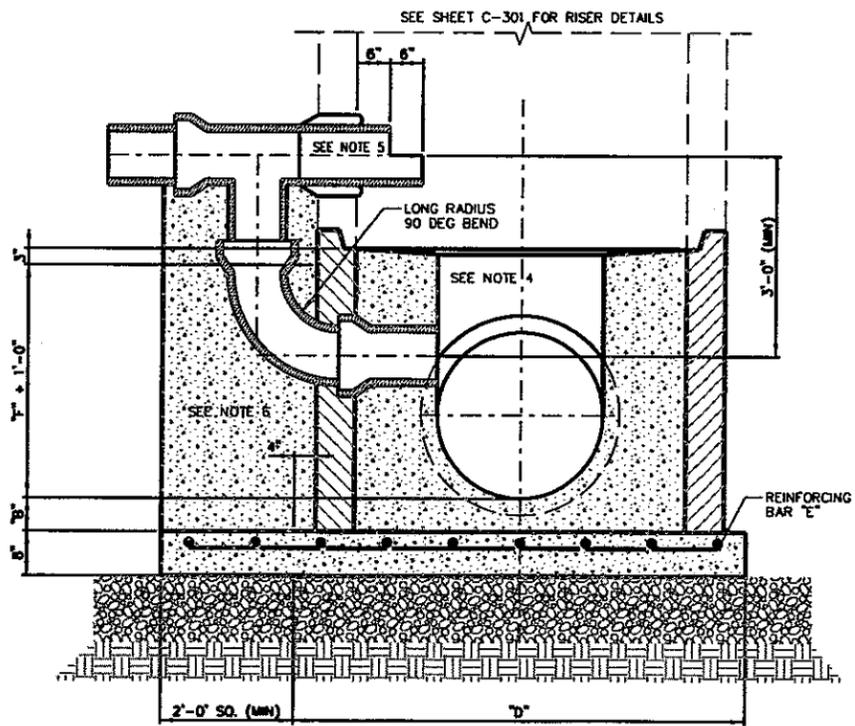
- NOTES - MANHOLE BASE**
1. MANHOLE BASES MAY BE PRE-CAST OR CAST IN PLACE. (PRECAST SECTIONS SHOWN).
 2. ALL PIPE PENETRATIONS SHALL BE SEALED WITH AN APPROVED SEALANT.
 3. ALL JOINTS SHALL BE GROUTED SMOOTH, INSIDE AND OUTSIDE.
 4. ALL CONCRETE SURFACES SHALL BE TROWELED SMOOTH TO MATCH THE FLOW LINES OF THE OUTFALL PIPE.
 5. REMOVE TOP SECTION OF PIPE EXTENSION OR TEE AS SHOWN.
 6. MIN. 2'-0" SQ. (MIN) CONC. ENCASEMENT TO SUPPORT DROP LEG AND FITTINGS.

TABLE 1 - MANHOLE BASE INFORMATION

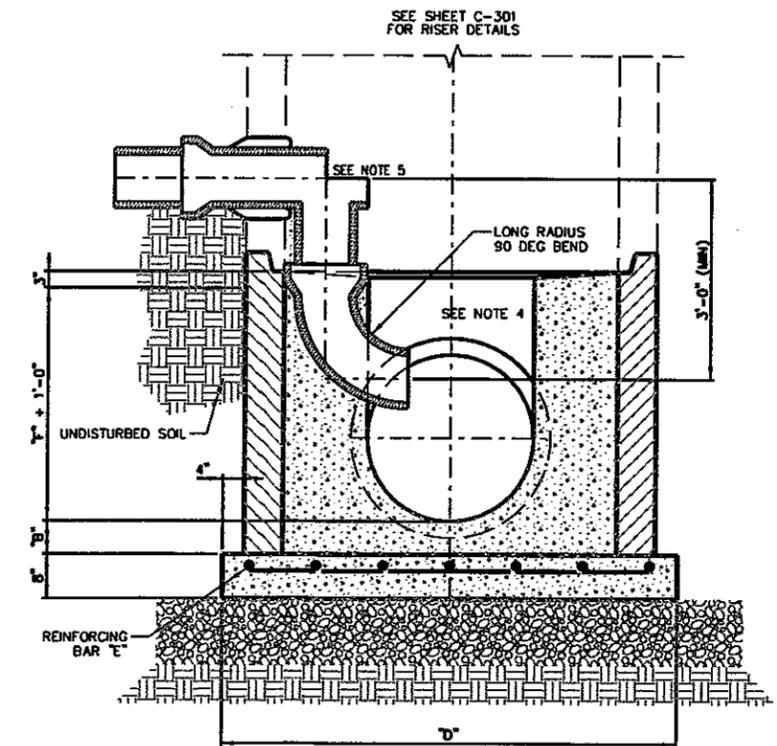
SANITARY SEWER MANHOLE	SANITARY TRUNK SEWER I.D. "T"	DIMENSIONS					REINFORCING BAR "E"
		"A" I.D.	"B"	"C"	"D" O.D.	"T"	
LINE	12" THRU 27" INCL	5'-0"	6"	1'-6"	6'-10"	6"	#5 BARS @ 12" EACH WAY
LINE	30" THRU 48" INCL	6'-0"	8"	1'-9"	7'-10"	7"	#5 BARS @ 9" EACH WAY
DROP	12" THRU 27" INCL	5'-0"	6"	1'-6"	6'-10"	6"	#5 BARS @ 12" EACH WAY
DROP	30" THRU 48" INCL	6'-0"	8"	1'-9"	7'-10"	7"	#5 BARS @ 9" EACH WAY



C SECTION - LINE MANHOLE BASE
SCALE: 3/4"=1'-0"



D SECTION - OUTSIDE DROP MANHOLE BASE
SCALE: 3/4"=1'-0"



E SECTION - INSIDE DROP MANHOLE BASE
SCALE: 3/4"=1'-0"

REV	DATE	BY	DESCRIPTION

DESIGNED
CWW
DRAWN
CWW
CHECKED
BDC
DATE
11-11-04

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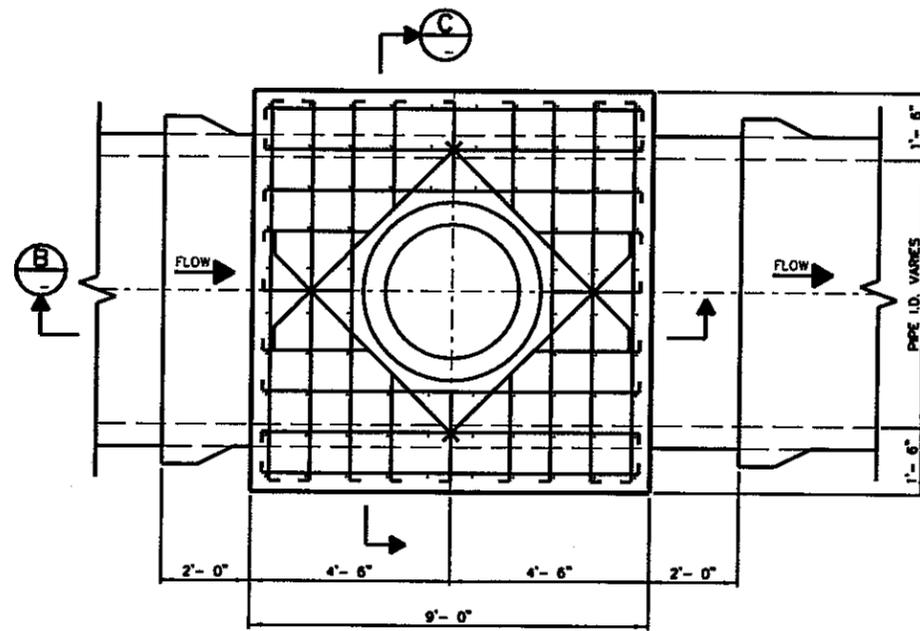
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STEVENS CREEK BASIN TRUNK SEWER
CIVIL
SANITARY SEWER MANHOLE
BASE DETAILS

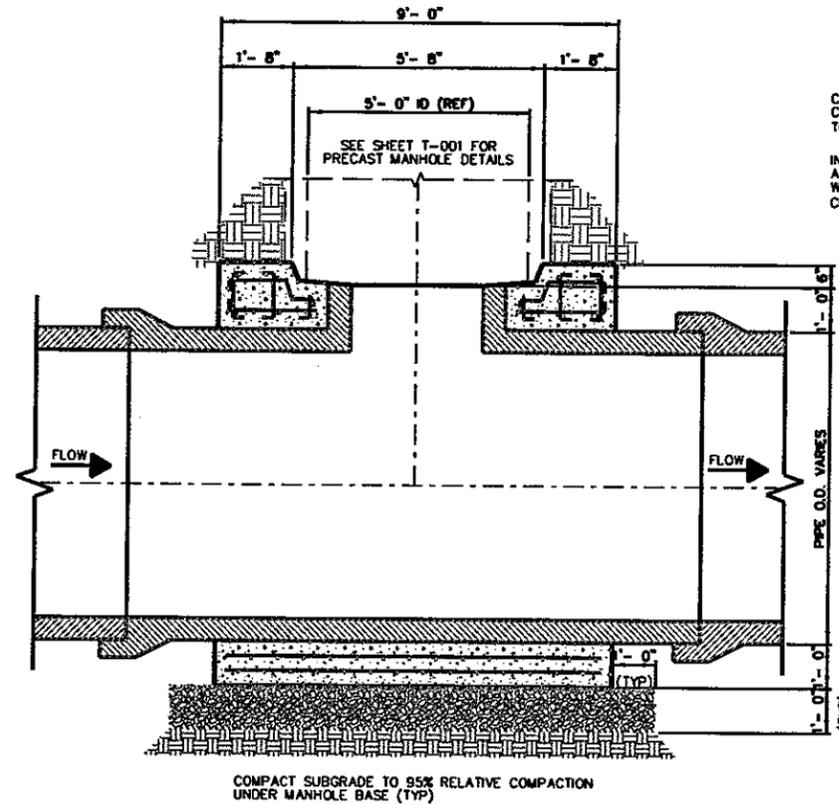
VERIFY SCALES
BAR IS ONE INCH ON
ORIGINAL DRAWING
0" = 1"
IF NOT ONE INCH ON
THIS SHEET, ADJUST
SCALES ACCORDINGLY

JOB NO.
6903A.10 (TM2)
DRAWING NO.
C-302
SHEET NO.
SHT 2 of 8

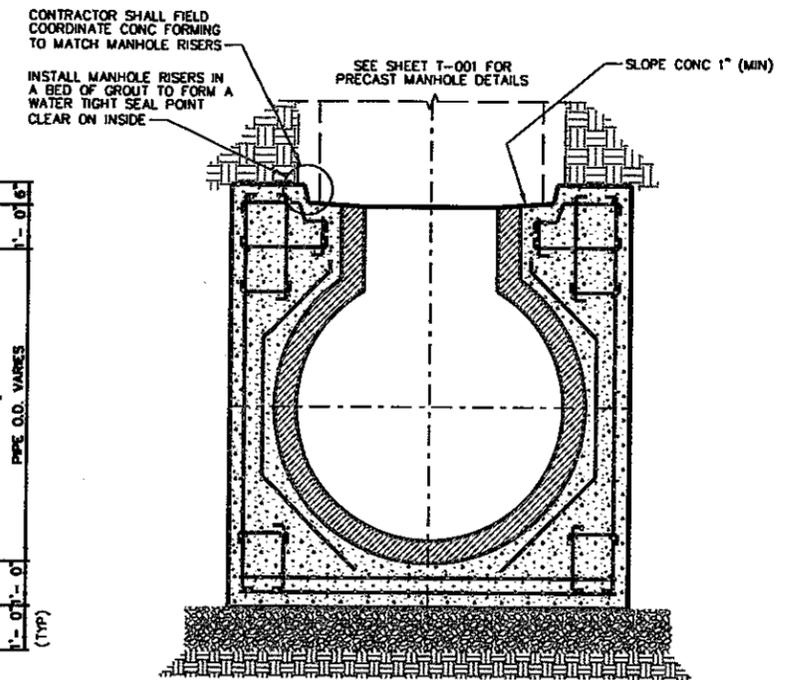
NOTES - MANHOLE BASE
 1. ALL REINFORCING BAR SHALL BE #5 @ 12" (MAX) U.O.N.



A PLAN - TEE MANHOLE BASE
 SCALE: 1/2"=1'-0"



B SECTION - TEE MANHOLE BASE
 SCALE: 1/2"=1'-0"



C SECTION - TEE MANHOLE BASE
 SCALE: 1/2"=1'-0"

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CWW
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CITY OF LINCOLN, NEBRASKA
 STEVENS CREEK BASIN TRUNK SEWER
 CIVIL
 SANITARY SEWER MANHOLE
 TEE BASE DETAILS

VERIFY SCALES
 BAR IS ONE INCH ON ORIGINAL DRAWING
 0 1"
 IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO.
6903A.10 (TM2)
 DRAWING NO.
C-303
 SHEET NO.
SHT 3 of 8