State of New Jersey
DEPARTMENT OF TRANSPORTATION
1035 PARKWAY AVENUE
CN 600
TRENTON, NEW JERSEY 08625

HAZEL FRANK GLUCK
COMMISSIONER

IN REPLY PLEASE REFER TO

Pipe Materials
and
Alternate Drainage Designs

December 10, 1986

MEMORANDUM
All Design Units

This memorandum contains a revised policy for Pipe Materials and a new policy for Alternate Drainage Designs. It is effective immediately on all Projects for which the estimated cost of the pipe is more than $50,000 and for which a Phase 3 Submission has not been made, except as follows: 1) If the Phase 3 will be significantly delayed, 2) If the cost to implement is high.

It has been determined that Corrugated Metal Pipe is an acceptable alternate to Reinforced Concrete Pipe under certain conditions as described in revised Section 10-06.1 of the Design Manual - Roadway which is attached hereto.

One of the factors in choosing a pipe material is cost. It is difficult for designers to predict accurately which pipe material will be the most economical, therefore, alternate drainage designs shall be shown on the plans. This will give contractors the opportunity to provide the most economical pipe material through competitive bidding, which will result in lower costs for the Department.

This memorandum supersedes the following:

SUBJECT	DATE
Plans and Specifications Culvert Pipe	Aug 13, 1964
Policy & Criteria for the Design of Highway Drainage Facilities	Aug 6, 1965
Plans & Specifications, Corrugated Metal Pipe, Elongated or Wire Strutted	Jul 30, 1969
Culvert Pipe	May 25, 1971
Reinforced Concrete Culvert Pipe	Mar 29, 1973
Drainage Culvert Pipe Size 21" x 27"	Sep 14, 1973
Phase II Review Drainage	Sep 19, 1973
Re: Design Policy for Culvert Pipes	Dec 2, 1974
Corrugated Metal Pipe and Pipe Arches	Nov 7, 1975
Roughness Coefficients	Aug 19, 1980

THE FOLLOWING HIGHLIGHTS THE MAIN CHANGES TO THE "DESIGN MANUAL - ROADWAY"

SECTION 10-06.1 CRITERIA FOR STORM DRAINS

Under certain conditions, the use of a reduced "n" for corrugated metal pipe is permitted.

Structural requirements are to be in accordance with current AASHTO Standard Specifications for Highway Bridges.

The following new criteria have been added:

Minimum gauges for durability of metal pipe
Guidelines for pipe materials
Requirements for alternate design

Attachment No. 1 includes new pages for Section 10-06.1 Criteria for Storm Drains. Old page 10-58 dated 3/1/84 is replaced by new pages 10-58, 10-58A and 10-58B dated 12/10/86. (No changes were made to page 10-57)..

SECTION 10-08.4 CULVERT SELECTION

Structural requirements are to be in accordance with current AASHTO Standard Specifications for Highway Bridges. ("n" values for Corrugated Metal Pipe have been deleted and replaced with a reference to Section 10-06.1(D))

Attachment No. 2 includes new pages for Section 10-08.4 Culvert Selection. Old page 10-68 dated 3/1/84 is replaced by new page 10-68 dated 12-10-86. (No changes were made to 10-67)

Attachment No. 3 includes new pages for Section 10-08.6 Culvert Hydraulics. Old page 10-88 dated 3/1/84 is replaced by new page 10-88 dated 12-10-86. (No changes were made to page 10-87)

THE FOLLOWING HIGHLIGHTS THE MAIN CHANGES TO THE SPECIFICATIONS

SECTION 602 - STORM DRAINS

Corrugated Metal Pipe has been added. Where corrugated Metal Pipe is called for, Corrugated Aluminum Alloy or Corrugated Steel Culvert pipe may be used. Also, Corrugated Steel Culvert Pipe, 15 inches in diameter or larger, shall be polymer coated. Bituminous Coated Corrugated Steel Culvert Pipe has been eliminated.

SECTION 913 - PIPE

Sections 913.06 and 913.08 - Only Helical corrugations will be permitted for Type I pipe, except that annular corrugations shall be used where called for. Corrugated Steel Culvert Pipe and Coupling Bands shall be polymer coating.

Section 913.10 - Gauges were added and the use of polymer coated underdrain pipe is allowed.

Attachment No. 4 includes Amendments to Sections 601, 602 and 913 of the 1983 Standard Specifications.

THE FOLLOWING ARE INSTRUCTIONS FOR ALTERNATE PIPE ITEMS ON THE PLANS

ESTIMATE OF QUANTITY SHEETS

See Figure 1 - Alternate Item groups shall be titled and follow one another.

DISTRIBUTION OF QUANTITIES SHEETS

See Figure 2 - Alternate Item groups shall be titled and follow one another.

CONSTRUCTION PLAN SHEETS

See Figure 3 - Inverts shall be shown for Concrete and Metal Pipe. Alternate items shall be clearly labeled on Construct notes. Alternate item groups shall be titled and follow one another in the To Be Constructed box.

Explanation of the examples shown on Figure 3 are as follows:

Example 1: In the upper right hand corner the Construct note indicates:

88 LF 15" CMCP (12 gauge steel or 14 gauge aluminum).

This is a situation where the designer has determined that the gauges required are heavier than the minimums specified for durability.

This item is shown on the Construct note and in the To Be Constructed box, however, when this item is forwarded to the Estimate sheet and Distribution sheet it is to be included in the item 15" Corrugated Metal Culvert Pipe. Payment for 15" Corrugated Metal Culvert Pipe, as indicated in the Supplementary Specifications, will include the cost of the heavier gauge.

Example 2: For design reasons, velocity etc., the 36" Corrugated Steel Pipe was not included with the alternates and is indicated as having Annular Corrugations.

Example 3: Because of the "n" value differential, the 87 LF of 24" Reinforced Concrete Culvert Pipe is hydraulically equivalent to 30" Corrugated Metal Pipe.

Example 4: The Asterisk indicating alternate items is clearly noted.

Example 5: The letter C should always be used for concrete pipe and M should always be used for metal pipe.

K. C. Afferton

Kenneth C. Afferton
Chief Engineer, Design

RRR:ab

ATTACHMENT No. 1

New pages for Design Manual-Roadway

10-57 no changes made

10-58, 10-58A, 10-58B dated 12-10-86

NOTE:

The Bureau of Design Standards and Economic Design Analysis will make a separate distribution of these revisions to all registered holders of the Design Manual.

10-05.7 Depressed Gutter Inlet

The depression of the inlet below the normal level of the gutter increases the cross-flow towards the opening, thereby increasing the inlet capacity. Also, the downstream transition out of the depression causes back-water which further increases the amount of water captured.

10-05.7.1 Locations of Depressed Inlets

a. All inlets in shoulders greater than 4'.

b. All inlets in one-lane, low speed ramps.

c. Inlets will not be depressed next to a riding lane, acceleration lane, deceleration lane, two-lane ramps, and direct connection ramps. Or, within the confines of a bridge approach and transition slab.

10-05.7.2 Limits of Depression

a. begin depression upgrade 4' from inlet

b. end depression 2' downgrade of inlet

c. begin depression 4' out from gutter line

d. depth of depression, 2" below projected gutter grade.

See NJDOT STANDARD DETAILS

10-05.7.3 Spacing of Depressed Inlets

Use the same procedure as described in section 10-05.5. This method will give a conservative distance between inlets, however, this will provide an added safety factor and reduce the number of times that water will flow on the highway riding lanes when the design storm is exceeded.

10-06 Storm Drains

The design of storm drains conforms to the principles of flow in open channels, when the system is not under pressure.

10-06.1 Criteria for Storm Drains

A. Minimum pipe size is 15".
B. Minimum pipe size is 18" @ main-line lowpoints
C. Should be designed to flow full, uniform flow.
D. "n" for concrete pipe is .012;

"n" for corrugated metal pipe:

	Annular	Helical									
Corrugations	2 2/3 X 1/2	2 2/3 X 1/2									
	All Diameters	15 in.	18 in.	21 in.	24 in.	30 in.	36 in.	48 in.	54 in.	60 in.	66 in. and Larger
"n"	0.024	0.013	0.014	0.015	0.016	0.017	0.018	0.020	0.021	0.022	0.024
Corrugations	3 X 1	3 X 1									
	All Diameters							48 in.	54 in.	60 in.	66 in.	72 in.	78 in. and Larger
"n"	0.027							0.023	0.023	0.024	0.025	0.026	0.027
Corrugations	5 X 1	5 X 1									
	All Diameters								54 in.	60 in.	66 in.	72 in. and Larger	
"n"	0.025								0.022	0.023	0.024	0.025	

The "n" values shown above for helical corrugations apply only when spiral flow can be developed. The designer must assure himself that spiral flow will occur in his design situation. Spiral flow will not occur when the following conditions exists, in which case the "n" value for annular corrugations is to be used:

1. Partly full flow
2. Non-circular pipes, such as pipe arches
3. When helical C.M.P. is lined or partly lined
4. Short runs less than 20 diameters long

E. Minimum self-cleaning velocity of 2.5'/sec should be maintained.

F. Maximum grade on which concrete pipe should be placed is 10%.

G. Flared end-sections should be used whenever and wherever possible, both for concrete and metal pipes.

H. Pipe sizes should not decrease in the downstream direction even though an increase in slope would allow a smaller pipe.

I. Pipe slopes should conform to the original ground slope so far as possible for minimum excavation.

J. Structural design (class or guage) of storm drains shall be in accordance with current AASHTO Standard Specifications for Highway Bridges.

K. For durability, the minimum thickness for steel pipe is 14 gauge and for aluminum alloy pipe is 16 gauge. In extremely corrosive areas and where high abrasion can be expected the designer shall contact the Department for a determination as to whether heavier gauges should be used.

L. Material types: See Figure 10-06C
   a. Concrete and Aluminim Alloy pipe are to be used in the shaded area
   b. Concrete, Steel and Aluminim Alloy pipe are to be used in the unshaded area

M. Alternate Items:
   a. When the estimated cost of the pipes is more than $50,000 alternate bid items are required. See All Design Unit memo dated 12-10-86.
   b. Some pipes may be eliminated as alternate items due to unstable support, high impact, concentrated loading, limited clearance, steep gradients, etc.

N. If a conflict with existing utilities can be avoided by the use of a different pipe material such as cast iron pipe, contact the Department for directions on how to proceed.

O. Separate hydraulic calculations must be developed and submitted for concrete and corrugated metal using their respective roughness coefficients.

P. Round corrugated metal pipe shall have helical corrugations, except that annular corruglated pipe may be used where velocity reduction is desired.

Q. Drainage structures must accommodate both corrugated metal and concrete pipe.

R. Aluminum alloy pipe shall not be used as a section or extension of a steel pipe.

10-06.2 Storm Drain Calculation Form

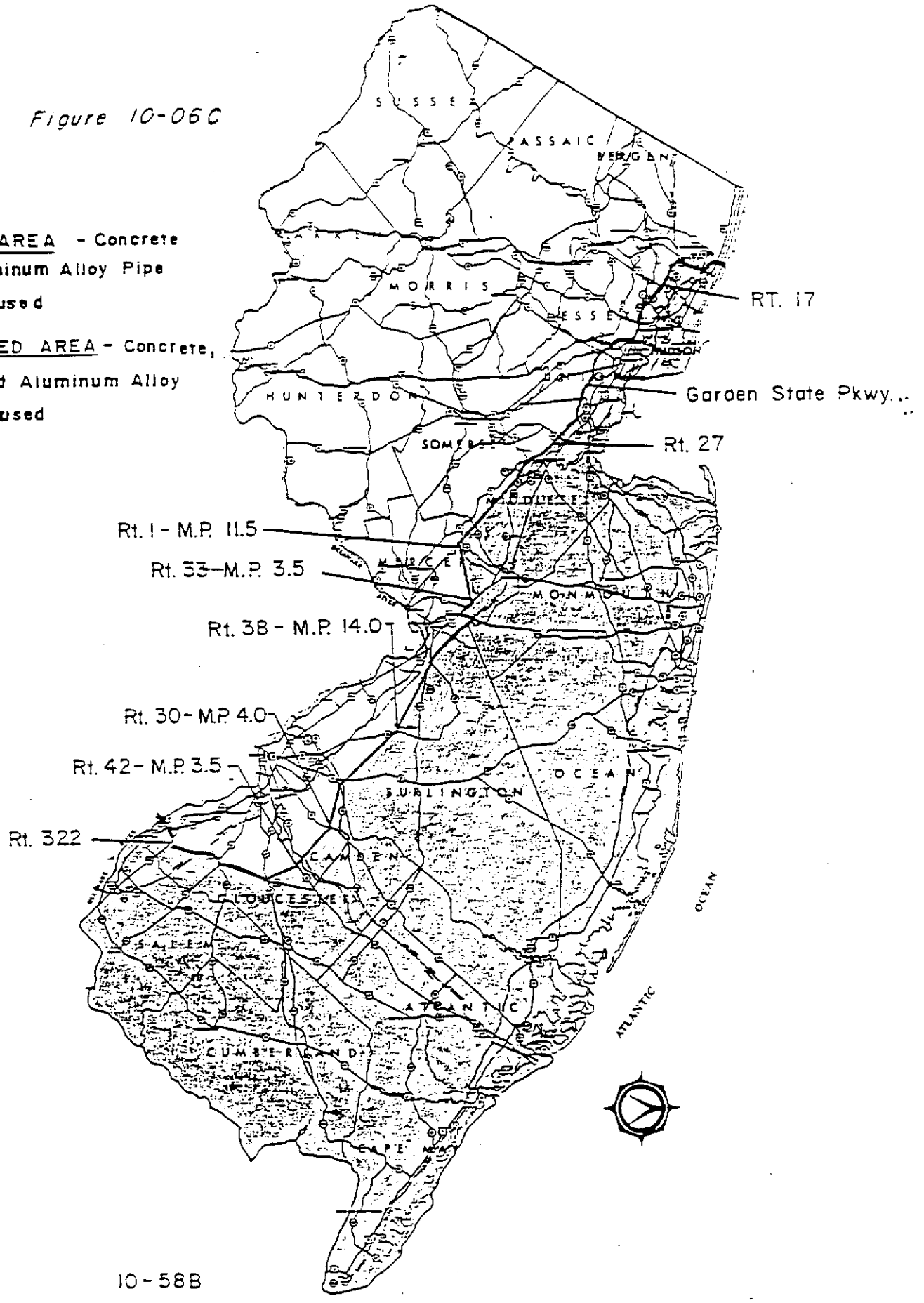
Form DC-46 is recommended for usage by the designer. A copy of that form and an explanation of the terms follows:

A. Line - each pickup or structure should be identified via a letter or number.
B. Length - distance between structures.
C. Type Structure - headwall, inlet, manhole, etc.
D. A - drainage area tributary to pickup.

Figure 10-06C

SHADED AREA - Concrete and Aluminum Alloy Pipe may be used

UNSHADED AREA - Concrete, Steel and Aluminum Alloy may be used



ATTACHMENT No. 2

New pages for Design Manual-Roadway

10-67 no changes made

10-68 dated 12-10-86

NOTE:

The Bureau of Design Standards and Economic Design Analysis will make a separate distribution of these revisions to all registered holders of the Design Manual.

The criteria given in Part 10-04, CHANNEL DESIGN, should be considered in the location of the culvert. Usually, the ideal location for the culvert is in the existing channel, with a slope the same as the existing channel.

10-08.4 CULVERT SELECTION:

1. New Culverts: Select a culvert type and size that is compatible with hydraulic performance, structural integrity and economics. The procedure for evaluating the hydraulic performance will be discussed in detail in section 10-08.6. The structural requirements shall be in accordance with current AASHTO Standard Specifications for Highway Bridges. A detailed cost study should be made for major culvert installations.

If concrete pipe or corrugated metal pipe is chosen, the criteria for storms drains in section 10-06.1 must also be complied with.

2. Existing Culverts: With regard to existing culverts under our highways, there are times when the construction of an "Improved Inlet" will transform an inadequate structure into one that is adequate. This design will work only if the existing culvert is under inlet control. Please refer to HEC No. 13[17]

10-08.5 INLET STRUCTURES: Inlet structures may be used for the following purposes:

1. To improve the hydraulic efficiency of the culvert.

2. To provide erosion protection and prevent flotation.

3. To retain the fill adjacent to the culvert.

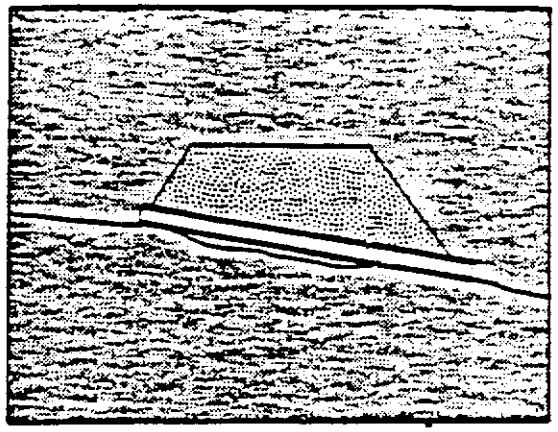
This chapter contains a description of inlet types.

A. Headwall: A headwall is a retaining wall attached to the end of a culvert or constructed monolithic with the culvert as in the case of RCB's. The alignment of the headwall should be normal to the centerline of the barrel to direct the flow into the barrel. The wingwalls should be long enough to prevent spillage of the embankment into the channel.

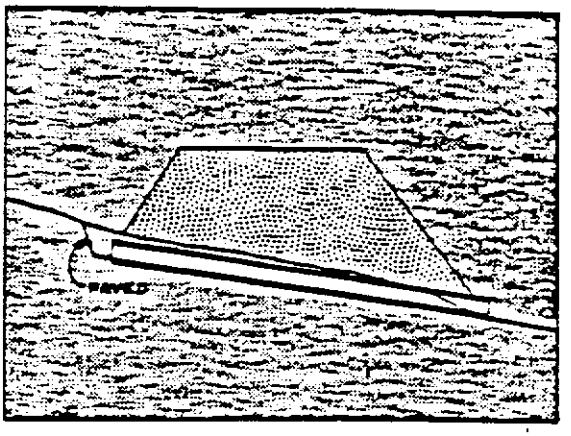
B. Concrete Flared End Sections. (See Figure 10-08C)

C. Corrugated metal end sections (See REFERENCE 2. for details)

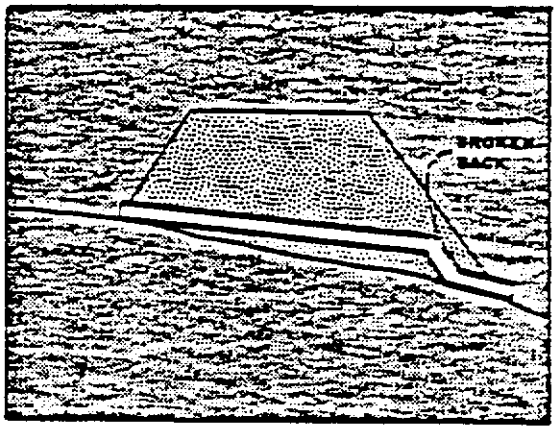
POSSIBLE CULVERT LOCATIONS

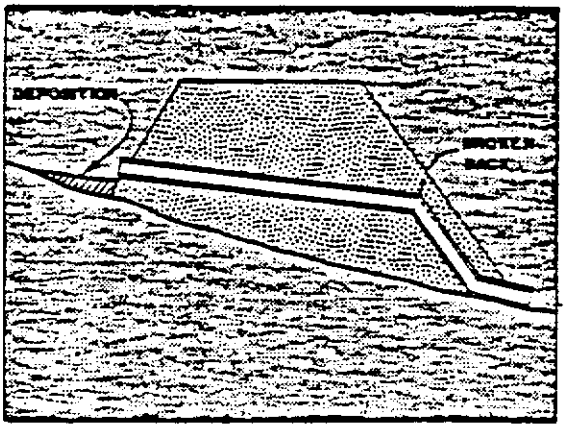


STREAMBED LOCATION

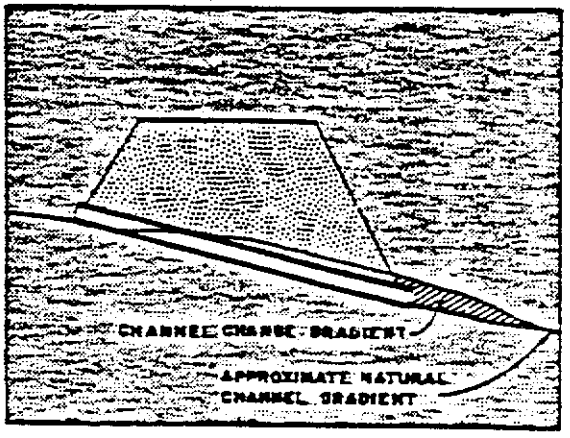


DEPRESSED INLET

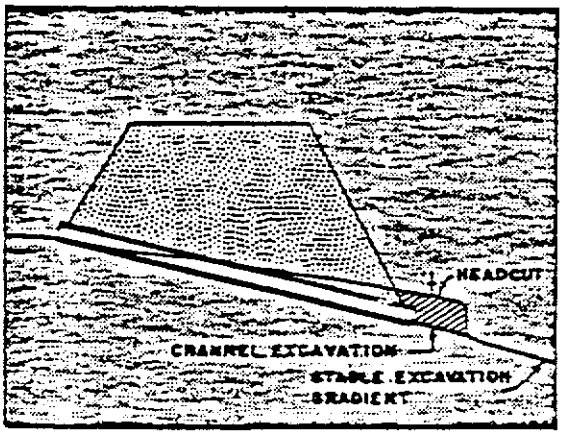




SIDEHILL LOCATION



CHANNEL CHANGE
GRADIENT MODIFICATION



DEGRADING CHANNEL

FIGURE: 10-08B

ATTACHMENT No. 3

New pages for Design Manual-Roadway

10-87 no changes made

10-88 dated 12-10-86

NOTE:

The Bureau of Design Standards and Economic Design Analysis will make a separate distribution of these revisions to all registered holders of the Design Manual.

OUTLET-CONTROL NOMOGRAPHS (Figures 10-08M THROUGH 10-08S).

Outlet control nomographs solve equation (2), for H when the culvert barrel flows full for its entire length. They are also used to determine H for some part-full flow conditions with outlet control. These nomographs do not give a complete solution for finding HW, since they only give H in the equation, $HW = H + h_o - LS_o$.

1. To determine H for a given culvert and discharge Q.

   a. Locate the appropriate nomograph for the type of culvert selected. Find k_e for the entrance type. (See Table 10-08A.)

   b. Begin the nomograph solution by locating the starting point on the length scale as follows:
      (1) If the n-value of the nomograph corresponds to that of the culvert being used, select the length curve for the proper k_e and locate the starting point at the given culvert length. If a k_e curve is not shown for the selected k_e, see (2) below. If the n-value for the culvert selected differs from that of the nomograph, see (3) below.

      (2) For the n-value of the nomograph and a k_e intermediate between the scales given, connect the given length on adjacent scales by a straight line and select a point on this line spaced between the two chart scales in proportion to the k_e values.

      (3) For a different roughness coefficient n' than that of the chart n, use the length scales shown with an adjusted length L', calculated by the formula

$$L' = L \left(\frac{n'}{n}\right)^2$$

      See instruction (2) for n values.

   c. Using a straightedge, connect the point on the length scale to the size of culvert barrel and mark the point of crossing on the "turning line". See instruction 3 below for size considerations for rectangular box culverts.

   d. Pivot the straightedge on this point on the turning line and connect the given discharge rate. Read head in feet on the head (H) scale. For values beyond the limit of the chart scales, find H by solving equation 2

2. Values of n for commonly used culvert materials.

	Concrete	
	Pipes	Boxes
	0.012	.015

	Corrugated Metal			
	Small Corrugations (2-2/3" x 1/2")	Medium Corrugations (3" x 1") (5" x 1")	Large Corr. Steel (6" x 2")	Large Corr. (Alum.) (9" x 2.5")
Unpaved	See Section 10-06.1.(D)		.033	.034

3. To use the box culvert nomograph, Figure 10-08M for full-flow for other than square boxes.

   a. Compute the cross-sectional area of the rectangular box.

   b. Connect the proper point (see instruction 1) on the length scale to the barrel area and mark the point on the turning line. (The area scale on the nomograph is calculated for barrel cross-sections with a span B twice the height D; its close correspondence with the area of square boxes assures it may be used for all sections intermediate between square and B=2D or B=5D. For other box proportions use equation (2) for more accurate results.)

   c. Pivot the straightedge on this point on the turning line and connect given given discharge rate. Read head in feet on the head (H) scale.

ATTACHMENT No. 4

Changes to the 1983 Standard Specifications

****
PROJECTS WITH UNDERDRAINS OR SUBBASE OUTLET DRAINS SHALL INCLUDE THE FOLLOWING AMENDMENT TO SUBSECTION 601.04 WHICH SHALL BE INSERTED AFTER LINE 1694 OF SI ROAD4
****

601.04 LAYING OF PIPE

THE FOLLOWING IS ADDED AFTER THE LAST PARAGRAPH:

ALL AREAS OF BITUMINOUS COATING WHICH HAVE BEEN DAMAGED SHALL BE PAINTED WITH TWO COATS OF ASPHALTIC PAINT.

ALL AREAS OF POLYMERIC COATING WHICH HAVE BEEN DAMAGED SHALL BE REPAIRED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.

****
PROJECTS WITH CORRUGATED STEEL CULVERT PIPE SHALL INCLUDE THE FOLLOWING AMENDMENT TO SUBSECTION 602.04 WHICH SHALL BE INSERTED AFTER LINE 1719 OF SI ROAD4
****

602.04 LAYING OF PIPE

THE THIRD PARAGRAPH IS CHANGED TO:

ALL AREAS OF POLYMERIC COATING WHICH HAVE BEEN DAMAGED SHALL BE REPAIRED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.

****
PROJECTS WITH CORRUGATED STEEL CULVERT PIPE AND/OR ALUMINUM ALLOY CULVERT PIPE SHALL INCLUDE THE FOLLOWING AMENDMENT TO SUBSECTION 602.08 WHICH SHALL BE INSERTED AFTER LINE 1727 OF SI ROAD4
****

602.08 BASIS OF PAYMENT

THE FOLLOWING IS ADDED AFTER THE LAST PARAGRAPH:

PAYMENT FOR PIPE WHICH IS SHOWN ON THE PLANS TO BE OF HEAVIER GAUGE THAN THAT SPECIFIED IN SUBSECTION 913 OF THE SUPPLEMENTARY SPECIFICATIONS WILL BE INCLUDED IN THE PAY ITEM FOR THAT PARTICULAR SIZE PIPE.

****
PROJECTS HAVING PIPE ALTERNATES SHALL ALSO INCLUDE THE FOLLOWING AMENDMENT TO SUBSECTION 602.02 WHICH SHALL BE INSERTED AFTER LINE 1714 OF SI ROAD4
****

WHERE CORRUGATED METAL PIPE IS CALLED FOR, CORRUGATED ALUMINUM ALLOY CULVERT PIPE OR CORRUGATED STEEL CULVERT PIPE MAY BE USED. WHERE CORRUGATED METAL PIPE ARCH IS CALLED FOR, CORRUGATED ALLUMINUM ALLOY PIPE ARCH OR CORRUGATED STEEL CULVERT PIPE ARCH MAY BE USED.

****
PROJECTS HAVING PIPE ALTERNATES SHALL ALSO INCLUDE THE FOLLOWING, AMENDMENT TO SUBSECTION 602.08 WHICH SHALL BE INSERTED AFTER THE PREVIOUS AMENDMENT TO SUBSECTION 602.08
****

THE FOLLOWING IS ADDED:

PAY ITEM	PAY UNIT
____" CORRUGATED METAL CULVERT PIPE	LINEAR FOOT
____" CORRUGATED METAL END SECTIONS	UNIT
____" X ____" CORRUGATED METAL CULVERT PIPE ARCH	LINEAR FOOT
____" X ____" CORRUGATED METAL SECTIONS	UNIT

****
PROJECTS HAVING PIPE ALTERNATES SHALL ALSO INCLUDE THE FOLLOWING AMENDMENT TO SECTION 913 WHICH SHALL BE INSERTED AFTER LINE 2147 OF SI ROAD4.
****

913.06 CORRUGATED ALUMINUM ALLOY CULVERT PIPE AND PIPE ARCHES

THE SECOND PARAGRAPH IS DELETED.

THE FOLLOWING IS ADDED AFTER THE THIRD PARAGRAPH:

CORRUGATED ALUMINUM ALLOY CULVERT PIPE AND PIPE ARCHES SHALL BE FABRICATED FROM 16 GAUGE SHEET METAL (0.064 INCH THICK) EXCEPT WHERE OTHER GAUGES ARE CALLED FOR ON THE PLANS.

ONLY HELICAL CORRUGATIONS WILL BE PERMITTED FOR TYPE I PIPE, EXCEPT THAT ANNULAR CORRUGATIONS SHALL BE USED WHERE CALLED FOR ON THE PLANS.

THE PIPE SHALL BE FIELD JOINTED WITH LOCKING BANDS CONFORMING TO AASHTO M 196, EXCEPT THAT COUPLING BANDS WITH PROJECTIONS (DIMPLES) ARE NOT ALLOWED FOR TYPE I PIPE.

913.08 CORRUGATED STEEL CULVERT PIPE AND PIPE ARCHES.

THE FOLLOWING IS ADDED AFTER THE FIRST PARAGRAPH:

CORRUGATED STEEL CULVERT PIPE AND PIPE ARCHES SHALL BE FABRICATED FROM 14 GAUGE STEEL METAL (0.079 INCH THICK) EXCEPT WHERE OTHER GAUGES ARE CALLED FOR ON THE PLANS.

THE FOLLOWING IS ADDED AFTER THE SECOND PARAGRAPH:

ONLY HELICAL CORRUGATIONS WILL BE PERMITTED FOR TYPE I PIPE, EXCEPT THAT ANNULAR CORRUGATIONS SHALL BE USED WHERE CALLED FOR ON THE PLANS.

THE PIPE SHALL BE FIELD JOINTED WITH LOCKING BANDS CONFORMING TO AASHTO M 36 EXCEPT THAT COUPLING BANDS WITH PROJECTIONS (DIMPLES) ARE NOT ALLOWED FOR TYPE I PIPE.

CORRUGATED STEEL CULVERT PIPE AND COUPLING BANDS SHALL HAVE A POLYMERIC COATING AS SPECIFIED IN AASHTO M 246, TYPE B (INTERIOR 0.010 INCHES AND EXTERIOR 0.003 INCHES).

THE THIRD PARAGRAPH IS DELETED.

THE FIRST AND SECOND SENTENCES IN THE FOURTH PARAGRAPH ARE DELETED.

THE FIRST SENTENCE IN THE FIFTH PARAGRAPH IS CHANGED TO:

SPECIAL SECTIONS, SUCH AS ELBOWS AND FLARED END SECTIONS, FOR THESE CONDUITS SHALL BE OF THE SAME GAUGE AS THE CONDUIT TO WHICH THEY ARE JOINED, AND SHALL CONFORM TO AASHTO M 246.

THE LAST PARAGRAPH IS DELETED.

913.10 CORRUGATED STEEL UNDERDRAIN PIPE.

THE FOLLOWING IS ADDED AFTER THE FIRST PARAGRAPH:

SIX INCH CORRUGATED STEEL UNDERDRAIN PIPE SHALL BE FABRICATED FROM 18 GAUGE SHEET METAL (0.052 INCH THICK).

ALL OTHER CORRUGATED STEEL UNDERDRAIN PIPE SHALL BE FABRICATED FROM 16 GAUGE SHEET METAL (0.064 INCH THICK).

CORRUGATED STEEL UNDERDRAIN PIPE SHALL BE BITUMINOUS COATED OR POLYMERIC COATED.

WHEN POLYMERIC COATING IS USED, THE PIPE AND COUPLING BANDS SHALL CONFORM TO AASHTO M 246, TYPE B (INTERIOR 0.010 AND EXTERIOR 0.003 INCHES).

THE FIRST SENTENCE IN THE SECOND PARAGRAPH IS CHANGED TO:

WHEN BITUMINOUS COATING IS USED, THE PIPE AND COUPLING BANDS SHALL CONFORM TO AASHTO M 190, TYPE A.

ESTIMATE OF QUANTITIES

ITEM NO.	DESCRIPTION	UNIT	CONTRACT QUANTITY	AS BUILT QUANTITY
1	INLETS, TYPE E	UNIT	3	
2	INLETS, TYPE B MODIFIED	UNIT	1	
3	6" CORRUGATED STEEL UNDERDRAIN	LF	6	
4	36" CORRUGATED STEEL PIPE	LF	128	
5	36" CORRUGATED STEEL HEADWALL	UNIT	1	
6	SUBBASE OUTLET DRAIN	LF	60	
7	CORE STONE	CY	9	
	ALTERNATE "C" ITEMS			
8	15" REINFORCED CONCRETE CULVERT PIPE	LF	232	
9	24" REINFORCED CONCRETE CULVERT PIPE	LF	87	
10	15" REINFORCED CONCRETE FLARED END SECTION	UNIT	1	
11	NO ITEM			
12	NO ITEM			
	ALTERNATE "M" ITEMS			
13	15" CORRUGATED METAL PIPE	LF	232	
14	30" CORRUGATED METAL PIPE	LF	87	
15	15" CORRUGATED METAL HEADWALL	UNIT	1	
16	NO ITEM			
17	NO ITEM			

Figure 1

DISTRIBUTION OF QUANTITIES

ITEM NUMBERS		1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16	17
STATION TO STATION	SHEET NUMBERS	INLET, TYPE E	INLET, TYPE B MODIFIED	6" CORRUGATED STEEL UNDERDRAIN	36" CORRUGATED STEEL PIPE	36" CORRUGATED STEEL HEADWALL	SUBBASE OUTLET DRAIN	CORE STONE		ALTERNATE "C" ITEMS	15" REINFORCED CONCRETE CULVERT PIPE	24" REINFORCED CONCRETE CULVERT PIPE	15" REINFORCED CONCRETE FLARED END SECTION	NO ITEM	NO ITEM	ALTERNATE "M" ITEMS	15" CORRUGATED METAL PIPE	30" CORRUGATED METAL PIPE	15" CORRUGATED METAL HEADWALL	NO ITEM	NO ITEM
UNIT		U	U	LF	LF	U	LF	CY			LF	LF	U				LF	LF	U		
		3	1	6	128	1	60	9			232	87	1				232	87	1		
FROM CROSS SECTIONS IF AND WHERE DIRECTED																					
TOTALS		3	1	6	128	1	60	9			232	87	1				232	87	1		
EXTRA WORK																					
REDUCTIONS																					
ADJUSTED PLAN TOTALS																					
AS BUILT TOTALS																					

Figure 2

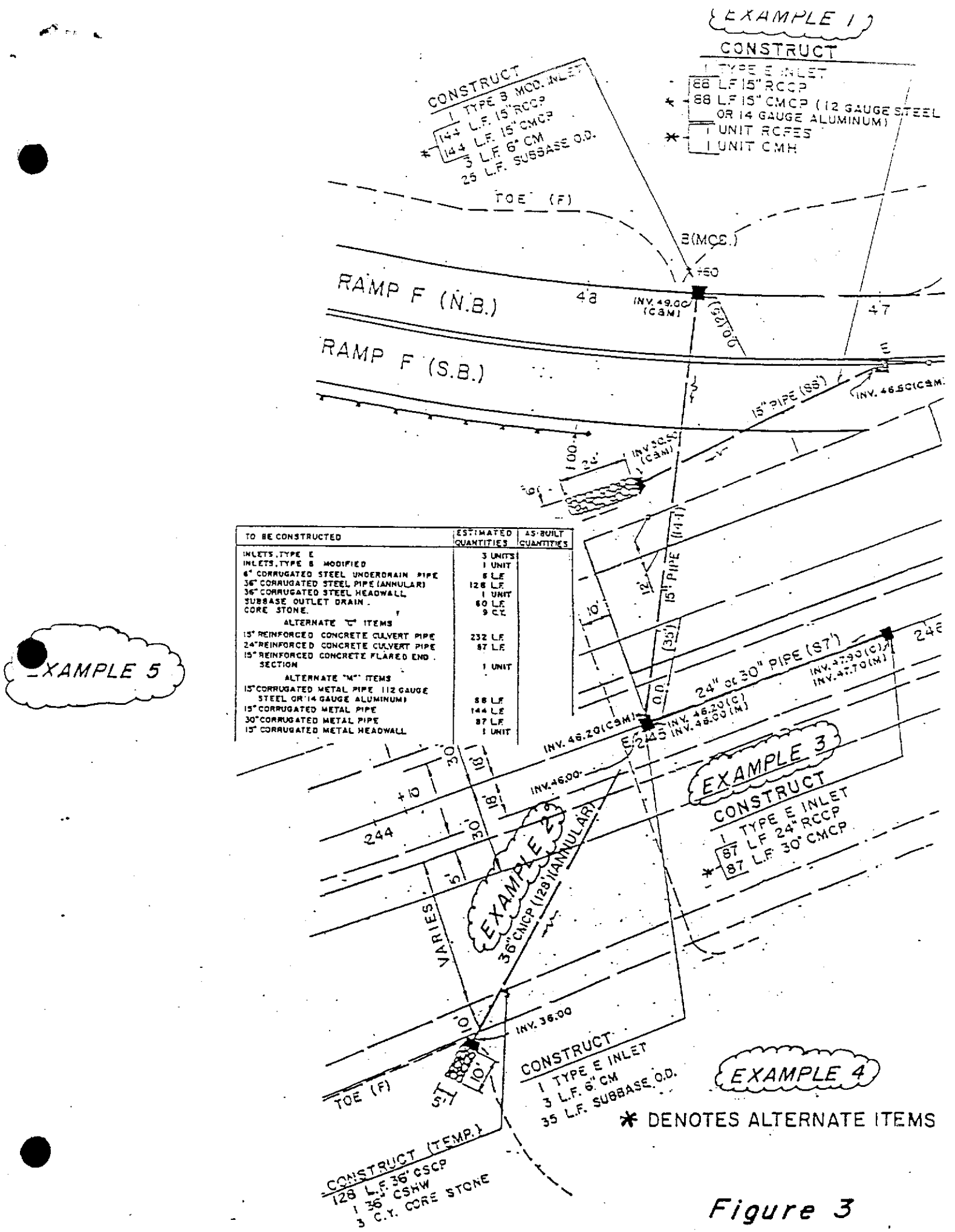

EXAMPLE 1
CONSTRUCT
1 TYPE E INLET
88 L.F. 15" RCCP
* 88 L.F. 15" CMCP (12 GAUGE STEEL OR 14 GAUGE ALUMINUM)
* 1 UNIT RCFES
1 UNIT CMH
CONSTRUCT
1 TYPE B MOD. INLET
144 L.F. 15" RCCP
* 144 L.F. 15" CMCP
3 L.F. 6" CM
25 L.F. SUBBASE O.D.
TOE (F)
B(MCE.)
RAMP F (N.B.)
RAMP F (S.B.)
INV. 49.00 (C&M)
15" PIPE (SS)
INV. 46.50(C&M)
INV. 50.50 (C&M)
TO BE CONSTRUCTED
ESTIMATED QUANTITIES
AS-BUILT QUANTITIES
INLETS, TYPE E 3 UNITS
INLETS, TYPE B MODIFIED 1 UNIT
6" CORRUGATED STEEL UNDERDRAIN PIPE 6 L.F.
36" CORRUGATED STEEL PIPE (ANNULAR) 128 L.F.
36" CORRUGATED STEEL HEADWALL 1 UNIT
SUBBASE OUTLET DRAIN 60 L.F.
CORE STONE 9 C.Y.
ALTERNATE "C" ITEMS
15" REINFORCED CONCRETE CULVERT PIPE 232 L.F.
24" REINFORCED CONCRETE CULVERT PIPE 87 L.F.
15" REINFORCED CONCRETE FLARED END SECTION 1 UNIT
ALTERNATE "M" ITEMS
15" CORRUGATED METAL PIPE (12 GAUGE STEEL OR 14 GAUGE ALUMINUM) 88 L.F.
15" CORRUGATED METAL PIPE 144 L.F.
30" CORRUGATED METAL PIPE 87 L.F.
15" CORRUGATED METAL HEADWALL 1 UNIT
EXAMPLE 5
15" PIPE
24" OR 30" PIPE (S7')
INV. 47.90 (C)
INV. 47.70 (M)
INV. 46.20(C&M)
INV. 46.20 (C)
INV. 46.00 (M)
INV. 46.00
EXAMPLE 3
CONSTRUCT
1 TYPE E INLET
87 L.F. 24" RCCP
* 87 L.F. 30" CMCP
EXAMPLE 2
36" CMCP (12 GAUGE) (ANNULAR)
VARIES
INV. 36.00
TOE (F)
CONSTRUCT
1 TYPE E INLET
3 L.F. 6" CM
35 L.F. SUBBASE O.D.
EXAMPLE 4
CONSTRUCT (TEMP.)
128 L.F. 36" CSCP
1 36" CSHW
3 C.Y. CORE STONE
* DENOTES ALTERNATE ITEMS

Figure 3