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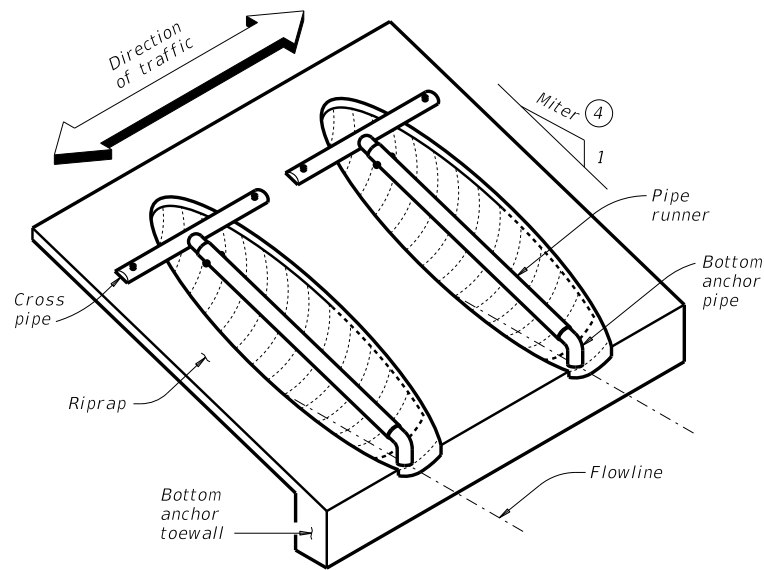
CROSS PIPE LENGTHS AND PIPE RUNNER LENGTHS ① ③

Corrugated Metal Pipe (CMP) Culverts

Design	Pipe Culvert Span	Pipe Culvert Rise	Pipe Culvert Spa ~ G	Cross Pipe Length	Pipe Runner Length												
					3:1 Side Slope				4:1 Side Slope				6:1 Side Slope				
					0° Skew	15° Skew	30° Skew	45° Skew	0° Skew	15° Skew	30° Skew	45° Skew	0° Skew	15° Skew	30° Skew	45° Skew	
1	17"	13"	1' - 0"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	21"	15"	1' - 2"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	28"	20"	1' - 5"	3' - 9"	N/A	N/A	3' - 5"	4' - 7"	N/A	N/A	4' - 11"	6' - 5"	N/A	N/A	7' - 11"	10' - 2"	
4	35"	24"	1' - 8"	4' - 4"	3' - 10"	4' - 0"	4' - 7"	6' - 0"	5' - 5"	5' - 8"	6' - 6"	8' - 4"	8' - 8"	9' - 1"	10' - 3"	12' - 11"	
5	42"	29"	1' - 11"	4' - 11"	5' - 1"	5' - 4"	6' - 1"	7' - 10"	7' - 2"	7' - 5"	8' - 6"	10' - 9"	11' - 2"	11' - 8"	13' - 2"	16' - 6"	
6	49"	33"	2' - 2"	5' - 6"	6' - 2"	6' - 5"	7' - 4"	N/A	8' - 6"	8' - 10"	10' - 0"	N/A	13' - 3"	13' - 9"	15' - 6"	N/A	
7	57"	38"	2' - 5"	6' - 2"	7' - 6"	7' - 9"	N/A	N/A	10' - 2"	10' - 7"	N/A	N/A	15' - 9"	16' - 4"	N/A	N/A	

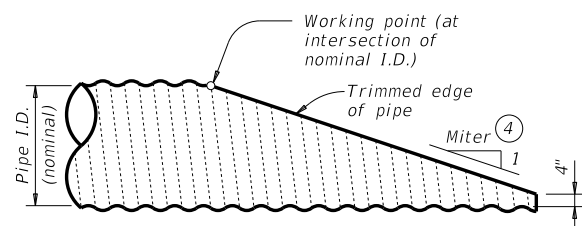
Reinforced Concrete Pipe (RCP) Culverts

Design	Pipe Culvert Span	Pipe Culvert Rise	Pipe Culvert Spa ~ G	Cross Pipe Length	Pipe Runner Length												
					3:1 Side Slope				4:1 Side Slope				6:1 Side Slope				
					0° Skew	15° Skew	30° Skew	45° Skew	0° Skew	15° Skew	30° Skew	45° Skew	0° Skew	15° Skew	30° Skew	45° Skew	
1	22"	13 1/2"	1' - 0"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	26"	15 1/2"	1' - 2"	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	28 1/2"	18"	1' - 5"	3' - 9 1/2"	N/A	N/A	2' - 10"	3' - 10"	N/A	N/A	4' - 2"	5' - 5"	N/A	N/A	6' - 9"	8' - 9"	
4	36 1/4"	22 1/2"	1' - 8"	4' - 5 1/4"	3' - 5"	3' - 7"	4' - 2"	5' - 6"	4' - 11"	5' - 1"	5' - 11"	7' - 7"	7' - 11"	8' - 3"	9' - 5"	11' - 11"	
5	43 3/4"	26 5/8"	1' - 11"	4' - 0 3/4"	4' - 6"	4' - 8"	5' - 5"	6' - 11"	6' - 4"	6' - 7"	7' - 6"	9' - 7"	10' - 0"	10' - 5"	11' - 9"	14' - 10"	
6	51 1/8"	31 5/16"	2' - 2"	5' - 8"	5' - 9"	6' - 0"	6' - 10"	N/A	7' - 11"	8' - 3"	9' - 4"	N/A	12' - 4"	12' - 10"	14' - 6"	N/A	
7	58 1/2"	36"	2' - 5"	6' - 3 1/2"	6' - 11"	7' - 3"	N/A	N/A	9' - 6"	9' - 11"	N/A	N/A	14' - 9"	15' - 4"	N/A	N/A	



ISOMETRIC VIEW OF TYPICAL INSTALLATION

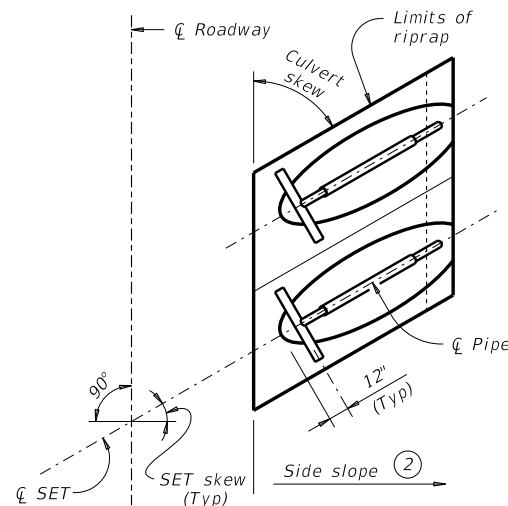
(Showing installation with no skew.)



NOTE: All pipe runners, calculations, and dimensions are based on the pipe culverts mitered as shown in this detail. Alternate styles of mitered ends will require that appropriate adjustments be made to the values presented on this standard.

SIDE ELEVATION OF TYPICAL PIPE CULVERT MITER

(Showing corrugated metal pipe (CMP) culvert. Details of reinforced concrete pipe (RCP) culvert are similar.)



PLAN OF SKEWED INSTALLATION

TYPICAL PIPE CULVERT MITERS ④

Side Slope	0° Skew	15° Skew	30° Skew	45° Skew
3:1	3:1	3.106:1	3.464:1	4.243:1
4:1	4:1	4.141:1	4.619:1	5.657:1
6:1	6:1	6.212:1	6.928:1	8.485:1

STANDARD PIPE SIZES AND MAX PIPE RUNNER LENGTHS ①

Pipe Size	Pipe O.D.	Pipe I.D.	Max Pipe Runner Length
2" STD	2.375"	2.067"	N/A
3" STD	3.500"	3.068"	10' - 0"
4" STD	4.500"	4.026"	19' - 8"
5" STD	5.563"	5.047"	34' - 2"

CONDITIONS WHERE PIPE RUNNERS ARE NOT REQUIRED ③

Design	Single Pipe Culvert	Multiple Pipe Culverts
1 and 2	Skews thru 45°	Skews thru 45°
3	Skews thru 35°	Skews thru 10°
4	Normal (no skew)	Always required
5 thru 7	Always required	Always required

MATERIAL NOTES:

Synthetic fibers listed on the "Fibers for Concrete" Material Producer List (MPL) may be used in lieu of steel reinforcing in riprap concrete unless noted otherwise.

Provide pipe runners, cross pipes, and anchor pipes that meet the requirements of ASTM A53 (Type E or S, Gr B), ASTM A500 Gr B, or API 5LX52.

Provide ASTM A307 bolts and nuts.

Galvanize all steel components, except concrete reinforcing, after fabrication. Repair galvanizing damaged during transport or construction in accordance with the specifications.

GENERAL NOTES:

Pipe runners are designed for a traversing load of 1,800 pounds at yield as recommended by Research Report 280-1, "Safety Treatment of Roadside Cross-Drainage Structures", Texas Transportation Institute, March 1981.

Safety end treatments (SET) shown herein are intended for use in those installations where out of control vehicles are likely to traverse the openings approximately perpendicular to the Pipe Runners.

Construct concrete riprap and all necessary inverts in accordance with the requirements of Item 432, "Riprap."

Payment for riprap and toewall is included in the price bid for each safety end treatment.

① Provide pipe runner of the size shown in the tables. Provide cross pipe of the same size as the pipe runner. Provide cross pipe stub out and bottom anchor pipe of the next smaller size pipe as shown in the Standard Pipe Sizes and Max Pipe Runners Lengths table.

② Recommended values of slope are 3:1, 4:1, and 6:1. All quantities, calculations, and dimensions shown herein are based on these recommended values. Slope of 3:1 or flatter is required for vehicle safety.

③ This standard allows for the placement of only one pipe runner across each culvert pipe opening. In order to limit the clear opening to be traversed by an errant vehicle, the following conditions must be met:

For Design 1 through 5 culvert pipe sizes, the skew must not exceed 45°.
 For Design 6 culvert pipes, the skew must not exceed 30°.
 For Design 7 culvert pipes, the skew must not exceed 15°.

If the above conditions cannot be met, the designer should consider using a safety end treatment with flared wings. For further information, refer to the TxDOT "Roadway Design Manual."

④ Miter = slope of mitered end of pipe culvert.

SHEET 1 OF 3



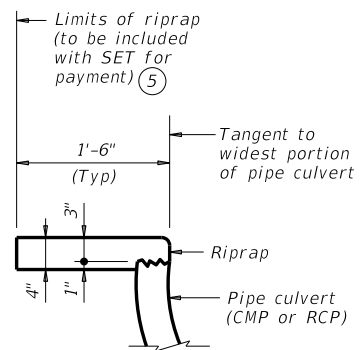
SAFETY END TREATMENT FOR DESIGN 1 TO 7 ARCH PIPE CULVERTS TYPE II ~ CROSS DRAINAGE SETP-CD-A

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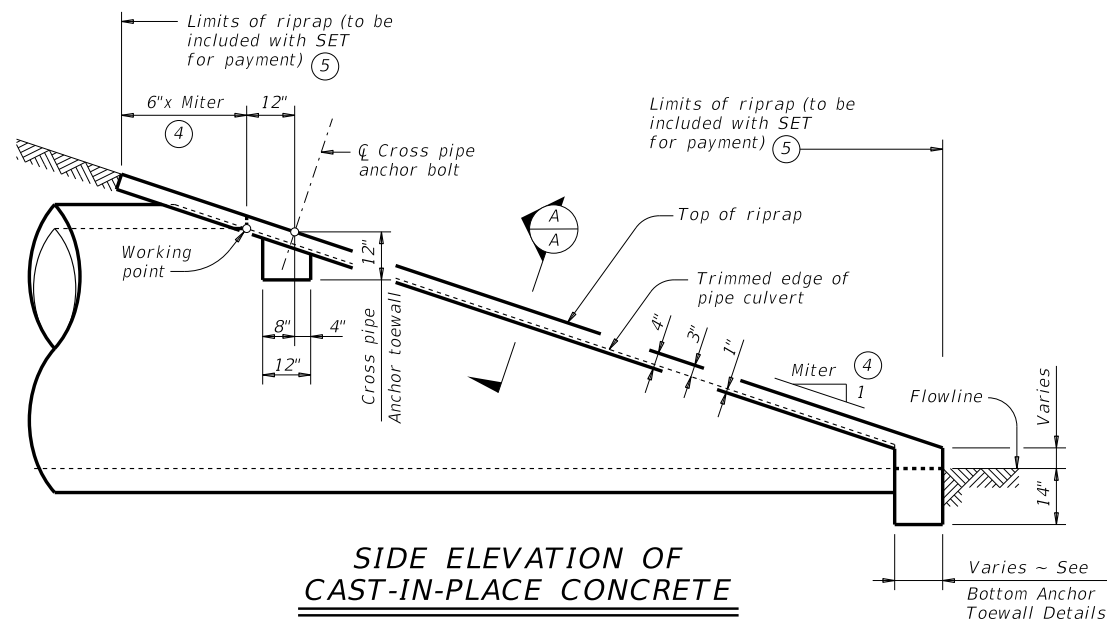
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SHOWING TYPICAL PIPE
CULVERT AND RIPRAP

SECTION A-A



**SIDE ELEVATION OF
CAST-IN-PLACE CONCRETE**

(Showing reinforced concrete pipe (RCP) culvert. Details of corrugated metal pipe (CMP) culvert are similar. Pipe runners not shown for clarity.)

ESTIMATED CONCRETE RIPRAP QUANTITIES (CY) ⑥
FOR BOTH CORRUGATED METAL PIPE CULVERTS AND CONCRETE PIPE CULVERTS

Design	3:1 Side Slope				4:1 Side Slope				6:1 Side Slope			
	0° Skew	15° Skew	30° Skew	45° Skew	0° Skew	15° Skew	30° Skew	45° Skew	0° Skew	15° Skew	30° Skew	45° Skew
1	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.9
2	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.8	1.0
3	0.6	0.6	0.7	0.8	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.2
4	0.7	0.7	0.8	0.9	0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.4
5	0.8	0.8	0.9	1.0	1.0	1.0	1.1	1.2	1.3	1.3	1.4	1.7
6	0.9	1.0	1.0	N/A	1.1	1.1	1.2	N/A	1.4	1.5	1.6	N/A
7	1.0	1.1	N/A	N/A	1.3	1.3	N/A	N/A	1.7	1.7	N/A	N/A

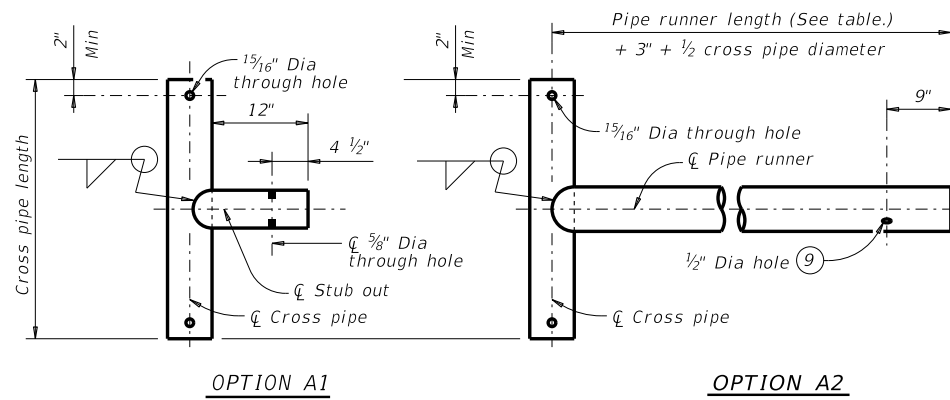
- ④ Miter = slope of mitered end of pipe culvert.
- ⑤ Riprap placed beyond the limits shown will be paid for as concrete riprap in accordance with Item 432, "Riprap."
- ⑥ Quantities shown are for one end of one pipe culvert. For multiple pipe culverts, quantities will need to be adjusted. Riprap quantities are for Contractor's information only.

**SAFETY END TREATMENT
FOR DESIGN 1 TO 7
ARCH PIPE CULVERTS
TYPE II ~ CROSS DRAINAGE
SETP-CD-A**

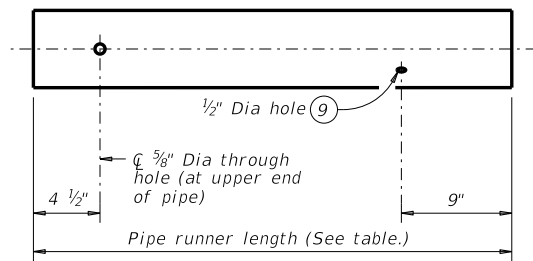
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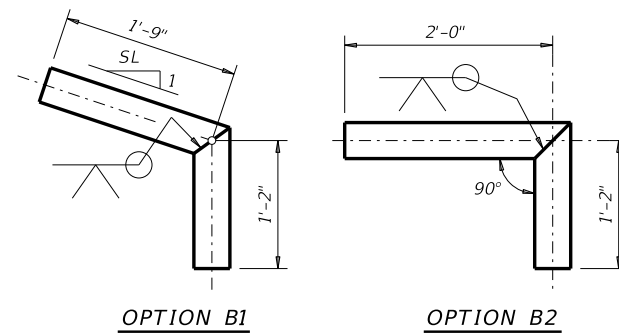


CROSS PIPE AND CONNECTIONS DETAILS

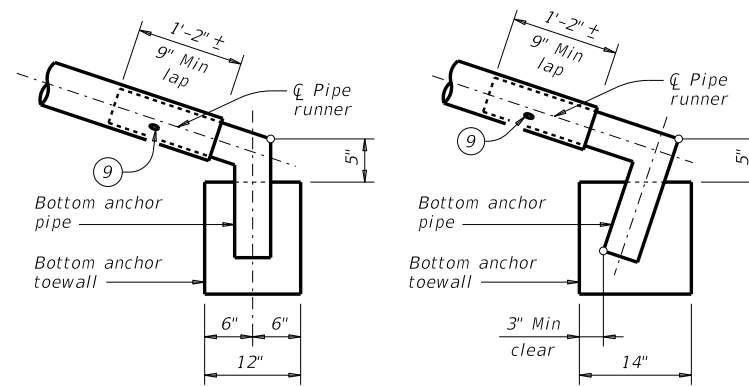


NOTE: The separate pipe runner shown is required when Cross Pipe Connection Option A1 is used.

PIPE RUNNER DETAILS

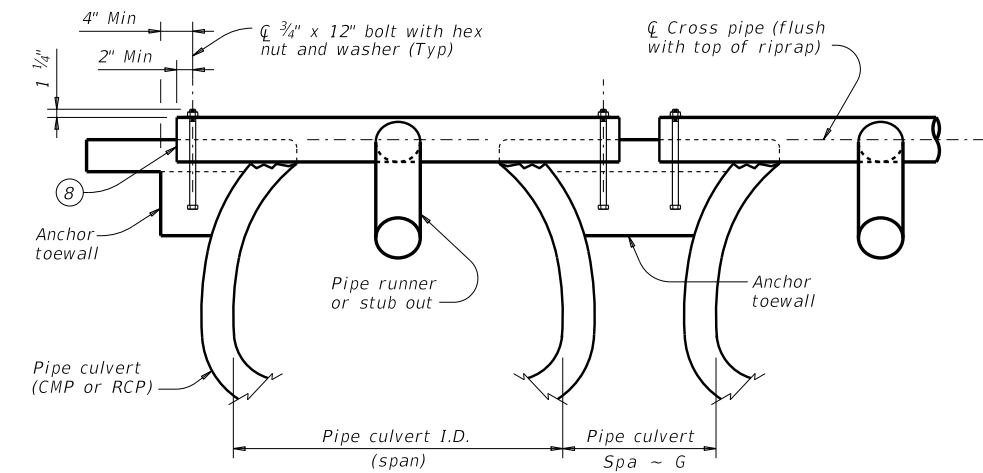


BOTTOM ANCHOR PIPE DETAILS



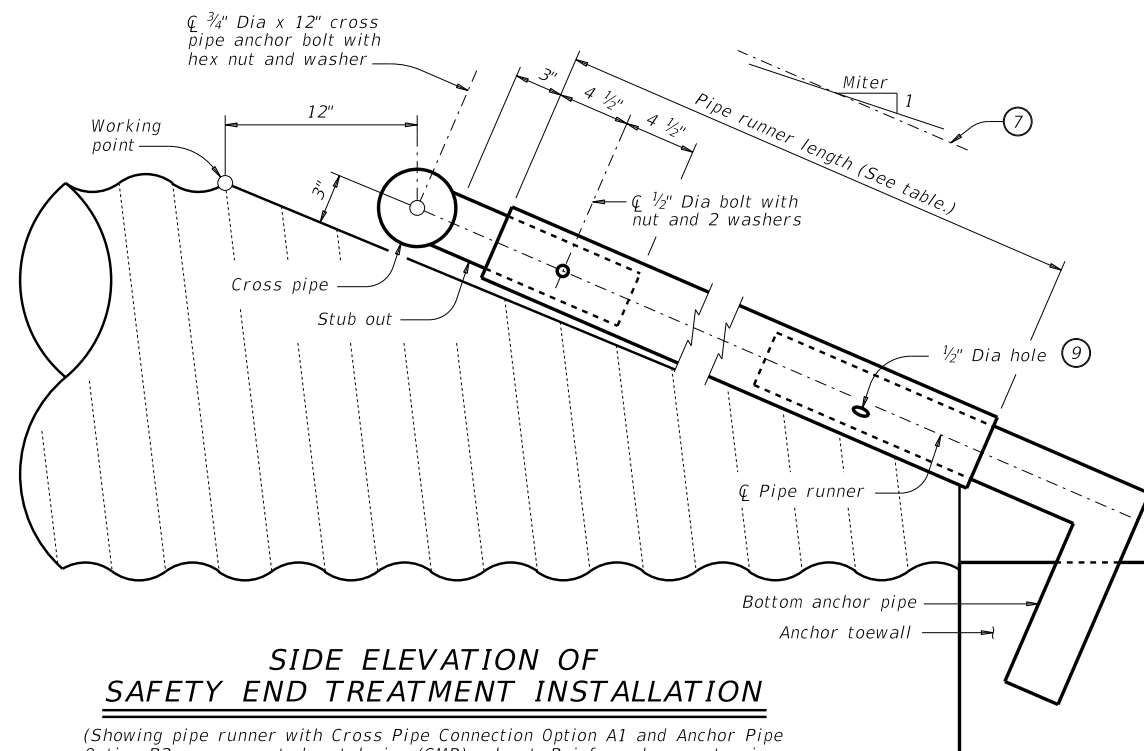
BOTTOM ANCHOR TOEWALL DETAILS

(Culvert and riprap not shown for clarity.)



SHOWING CROSS PIPE AND ANCHOR TOEWALL

SECTION A-A



SIDE ELEVATION OF SAFETY END TREATMENT INSTALLATION

(Showing pipe runner with Cross Pipe Connection Option A1 and Anchor Pipe Option B2 on corrugated metal pipe (CMP) culvert. Reinforced concrete pipe (RCP) culvert details are similar. Riprap not shown for clarity.)

- 7 Note that actual slope of pipe runner may vary slightly from side slope of riprap and trimmed culvert pipe edge.
- 8 Ensure that riprap concrete does not flow into the cross pipe so as to permit disassembly of the bolted connection to allow cleanout access.
- 9 After installation, inspect the 1#2" hole to ensure that the lap of the pipe runner with the bottom anchor pipe is adequate.
- 10 At fabricator's option, a heat bend to a smooth 5" radius or a manufactured elbow (of the same material as the runner) may be substituted for the mitered and welded joint in the bottom anchor pipe.

SHEET 3 OF 3



SAFETY END TREATMENT FOR DESIGN 1 TO 7 ARCH PIPE CULVERTS TYPE II ~ CROSS DRAINAGE

SETP-CD-A

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