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TABLE OF DIMENSIONS AND REINFORCING STEEL
(Wings for One Structure End)

Dimensions					Variable Reinforcing		Estimated Quantities per ft of wing length (Two-Wings)	
Maximum Wingwall Height Hw ^⑨	W	X	Y	Z	Bars J1		Reinf (Lb/Ft)	Conc (CY/Ft)
					Size	Spa		
2'-6"	2'-5"	1'-0"	9"	7"	#4	1'-0"	33.73	0.248
3'-0"	2'-5"	1'-0"	9"	7"	#4	1'-0"	37.07	0.261
3'-6"	2'-5"	1'-0"	9"	7"	#4	1'-0"	37.74	0.273
4'-0"	2'-5"	1'-0"	9"	7"	#4	1'-0"	38.41	0.285
4'-6"	3'-2"	1'-6"	1'-0"	7"	#4	1'-0"	41.75	0.330
5'-0"	3'-2"	1'-6"	1'-0"	7"	#4	1'-0"	45.09	0.343
5'-6"	3'-2"	1'-6"	1'-0"	7"	#4	1'-0"	45.75	0.355
6'-0"	3'-2"	1'-6"	1'-0"	7"	#4	1'-0"	46.42	0.367
7'-0"	3'-8"	1'-9"	1'-3"	7"	#4	1'-0"	52.77	0.414
8'-0"	4'-2"	2'-0"	1'-6"	8"	#5	1'-0"	60.19	0.486
9'-0"	4'-8"	2'-3"	1'-9"	8"	#4	6"	81.49	0.535
10'-0"	5'-2"	2'-6"	2'-0"	8"	#5	6"	97.25	0.584
11'-0"	5'-8"	2'-9"	2'-3"	8"	#6	6"	133.65	0.634
12'-0"	6'-2"	3'-0"	2'-6"	9"	#7	6"	162.29	0.721

TABLE OF WING WALL REINFORCING
(Two-Wings)

Bar	Size	No.	Spa
D	#5	~	1'-0"
E	#4	~	1'-0"
F	#4	~	1'-0"
G	#6	4	~
M	#4	4	~
P	#4	~	1'-0"
R	#5	6	~
V	#4	~	1'-0"

TABLE OF ESTIMATED CULVERT TOEWALL QUANTITIES

Bar	Size	No.	Spa
L	#4	~	1'-6"
Q	#4	1	~
Reinf (Lb/Ft)			2.45
Conc (CY/Ft)			0.037

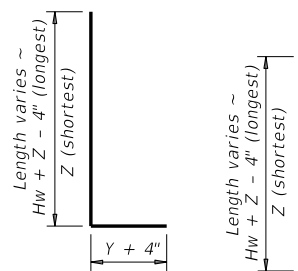
TABLE OF ESTIMATED ANCHOR TOEWALL QUANTITIES

Bar	Size	No.	Spa
K	#4	~	1'-0"
N	#5	6	~
OL	#4	6	~
Reinf (Lb/Ft)			9.82
Conc (CY/Ft)			0.074

- Extend Bars P 3'-0" Min into bottom slab of box culvert.
- Adjust to fit as necessary to maintain 1 1/2" clear cover and 4" Min between bars.
- Quantities shown are based on an average wing height for two wings (one structure end). To determine total quantities for two wings multiply the tabulated values by Lw.
- Recommended values of slope are: 3:1, 4:1, and 6:1. Provide 3:1 or flatter slope.
- When shown elsewhere on the plans, construct 5" deep concrete riprap. Payment for riprap is as required by Item 432, "Riprap." Unless otherwise shown on the plans or directed by the Engineer, extend construction joints or grooved joints, oriented in the direction of flow, across the full distance of the riprap, at intervals of approximately 20'. When such riprap is provided, the culvert toewall shown in SECTION B-B is not required.
- At Contractor's option, end the culvert toewall flush with wingwall toewall. Adjust reinforcing as needed.
- 3" Min to 5'-0" Max. Estimated curb heights are shown elsewhere in the plans. For structures without railing and curbs taller than 1'-0", refer to the Extend Curb Details (ECD) standard sheet.
- For vehicle safety, reduce curb heights, if necessary, to provide a maximum 3" projection above finished grade. No changes will be made in quantities and no additional compensation will be allowed for this work.
- See Table of Maximum Wing Heights for various slopes. Height is limited based on a 33'-6" maximum safety pipe runner length.

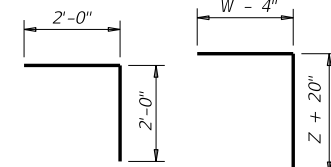
TABLE OF MAXIMUM WING HEIGHTS^⑨

Side Slope	Hw Max
3:1	11'-5"
4:1	8'-10"
6:1	6'-1"



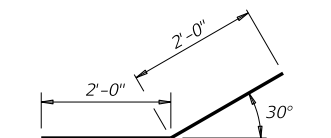
BARS J1

BARS V

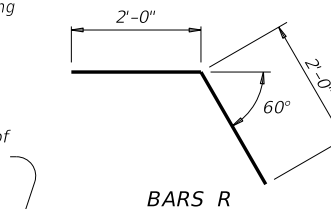


BARS L

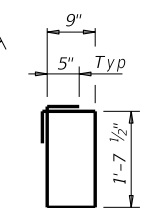
BARS J2



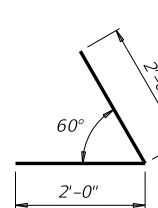
BARS D



BARS R



BARS K
(Length = 5'-5")



BARS OL

WING DIMENSION CALCULATIONS:

$$\begin{aligned} Hw &= H + T + C - 0.250' \text{ ⑨} \\ A &= (Hw - 0.333') (SL) \\ B &= (A) (\tan (30^\circ)) \\ Lw &= (A) \div \cos (30^\circ) \end{aligned}$$

For cast-in-place culverts:

$$Ltw = (N) (S) + (N + 1) (U)$$

For precast culverts:

$$Ltw = (N) (2U + S) + (N - 1) (0.500')$$

$$Lc = (Ltw) - (2U)$$

$$Atw = (Lc) + (2B)$$

$$\begin{aligned} \text{Total Wingwall Area (two wings ~ SF)} \\ &= (Hw + 0.333') (Lw) \end{aligned}$$

$$Hw = \text{Height of wingwall (feet)}$$

$$Atw = \text{Anchor toewall length (feet)}$$

$$Lw = \text{Length of wingwall (feet)}$$

$$N = \text{Number of culvert barrels}$$

$$SL:1 = \text{Side slope ratio (horizontal : 1 vertical)}$$

$$Ltw = \text{Culvert toewall length (feet)}$$

$$Lc = \text{Culvert curb between wings (feet)}$$

See applicable box culvert standard for H, S, T, and U values.
See Table of Maximum Wall Heights for limits on Hw.

MATERIAL NOTES:

Provide Grade 60 reinforcing steel.

Provide galvanized reinforcing steel if required elsewhere in the plans.

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 Class "C" concrete ($f'c = 3,600$ psi).

Adjust reinforcing as necessary to provide a minimum clear cover of 1 1/2".

Provide pipe runners and anchor pipes meeting the requirements of

ASTM A53 (Type E or S, Gr B), ASTM A500 Gr B, or API 5LX52.

Provide ASTM A307 bolts and nuts.

Provide ASTM A36 steel plates.

Galvanize all steel components, except reinforcing unless required elsewhere in the plans, after fabrication.

Repair galvanizing damaged during transport or construction in accordance with the Item 445, "Galvanizing."

For optional adhesive anchors, install adhesive anchorages in accordance with the manufacturer's instructions including hole size, drilling equipment and method, hole cleaning equipment and method, mixing and dispensing adhesive, and anchor insertion. Do not alter the manufacturer's mixing nozzle or dispenser. Provide anchorage rods that are clean and free of grease, oil, or any other foreign material. Demonstrate hole cleaning method to the Engineer for approval and continue the approved process for all anchorage locations. Test adhesive anchors in accordance with Item 450.3.3, "Tests." Test 3 anchors per 100 anchors installed.

GENERAL NOTES:

Designed according to AASHTO LRFD Bridge Design Specifications.

The safety end treatments 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.

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.

When structure is founded on solid rock, depth of toewalls for culverts and wingwalls may be reduced or eliminated as directed by the Engineer.

All bolts, nuts, washers, brackets, angles, and pipe runners are considered parts of the safety end treatment for payment.

The quantities for pipe runners, reinforcing steel, and concrete, resulting from the formulas given herein are for Contractor's information only.

See the Box Culvert Supplement (BCS) standard sheet for additional dimensions and information.

Cover dimensions are clear dimensions, unless noted otherwise.
Reinforcing dimensions are out-to-out of bars.

SHEET 1 OF 3



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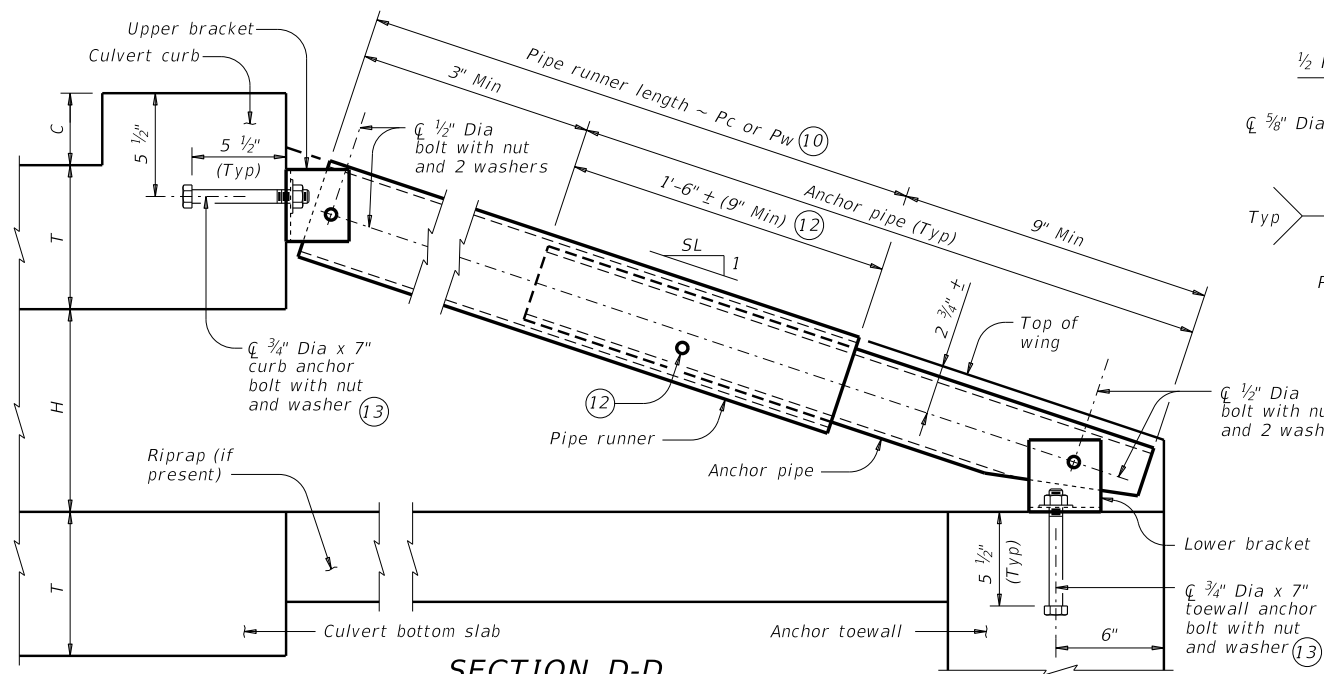
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SAFETY END TREATMENT WITH FLARED WINGS FOR 0° SKEW BOX CULVERTS TYPE I ~ CROSS DRAINAGE

SETB-FW-0

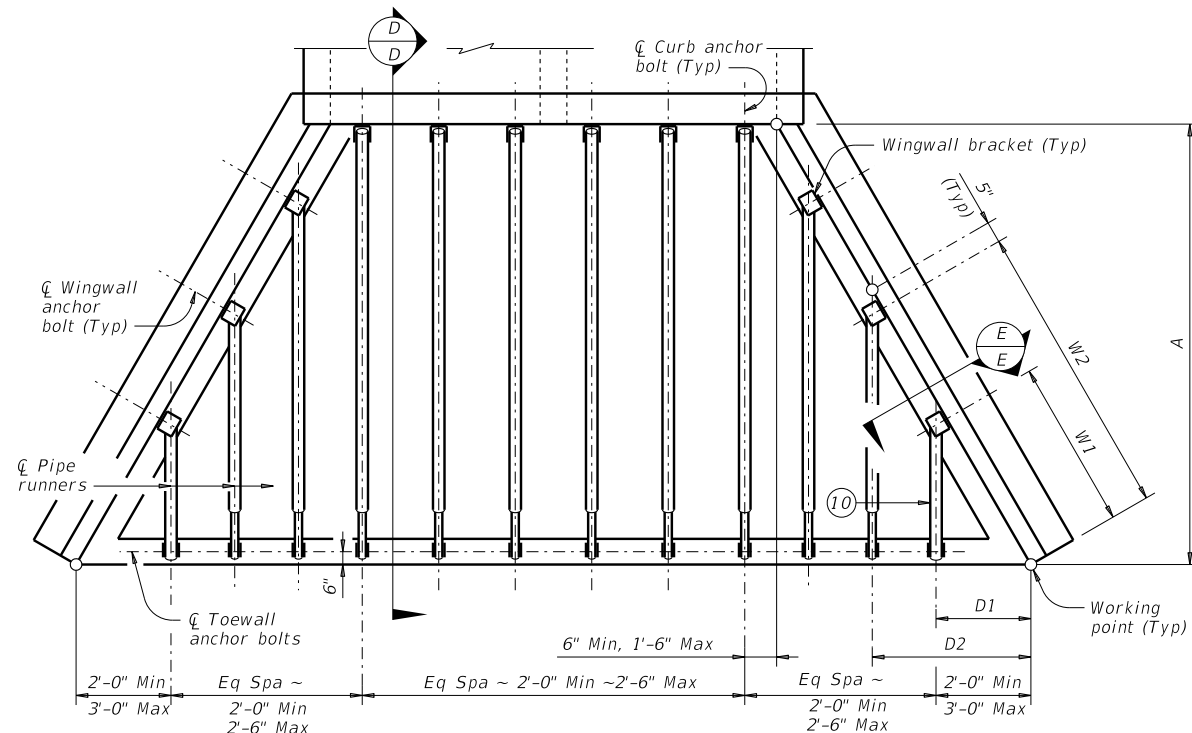
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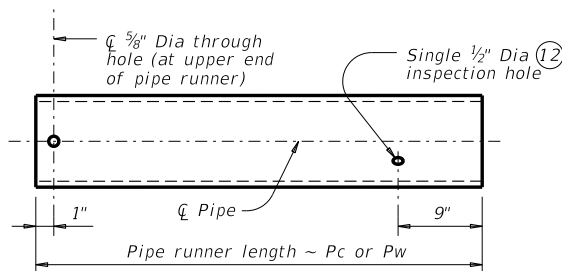


SECTION D-D

(Showing curb pipe runner. Except for upper bracket, wingwall pipe runners are similar.)

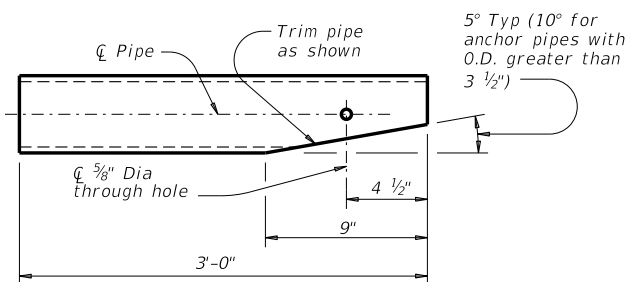


PIPE RUNNER PLAN

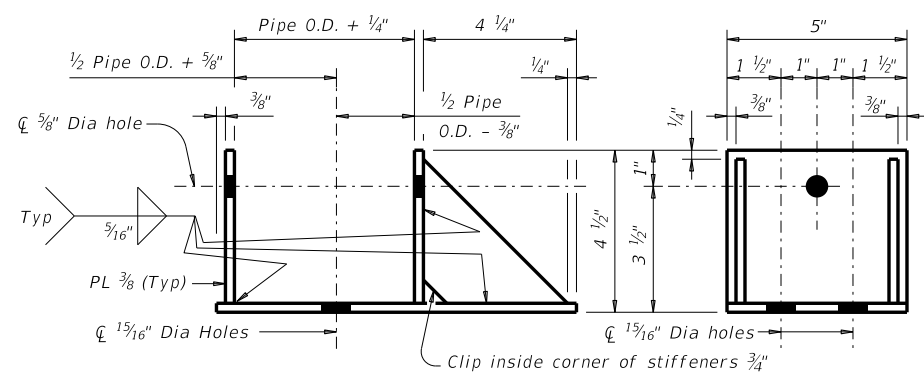


Note: Pipe diameter required for curb pipe runner is also used for wingwall pipe runner.

PIPE RUNNER DETAILS

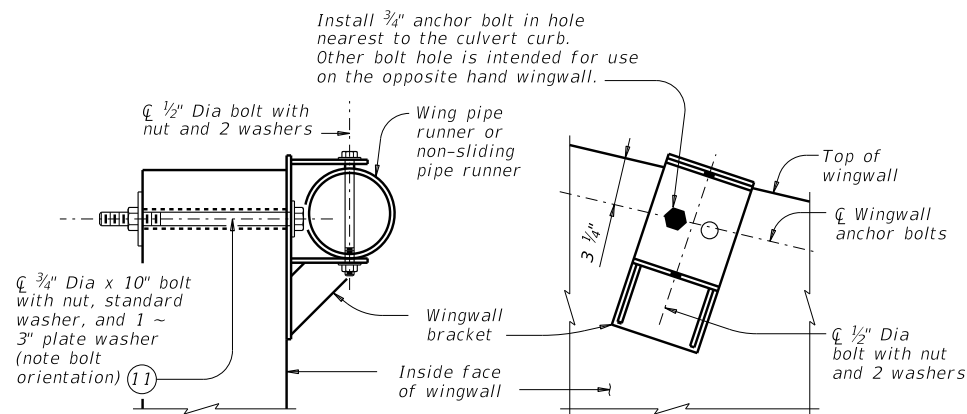


ANCHOR PIPE DETAILS



ELEVATION

SIDE VIEW



SECTION E-E

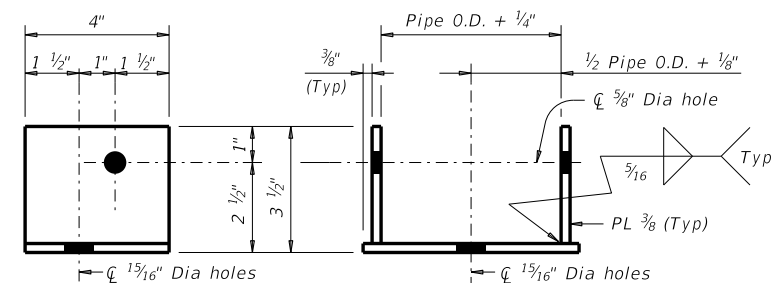
ELEVATION

(Showing installed bracket.)

(Showing installed bracket normal to wall. Pipe not shown for clarity.)

Note: Match wingwall bracket to the upper curb bracket size.

WINGWALL BRACKET DETAILS

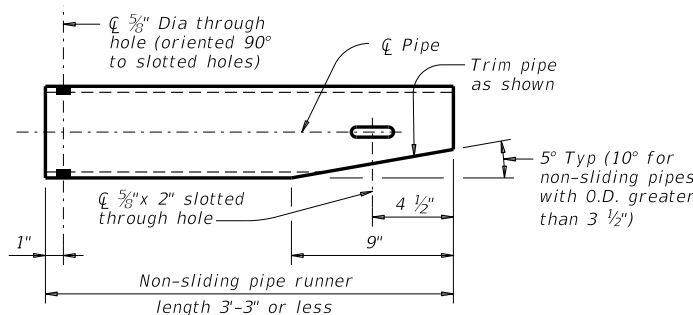


SIDE VIEW

ELEVATION

Note: Match upper and lower brackets, except for the brackets used with non-sliding pipe runners, to the required pipe diameters as shown in the table.

UPPER AND LOWER BRACKET DETAILS



Note: Pipe size is the same as required for curb pipe runner. Adjust the corresponding lower bracket accordingly.

NON-SLIDING PIPE RUNNER DETAILS

MAXIMUM PIPE RUNNER LENGTHS AND REQUIRED PIPE RUNNER SIZES						
Maximum Pipe Runner Length (Pc or Pw)	Required Pipe Runner Size			Required Anchor Pipe Size		
	Pipe Size	Pipe O.D.	Pipe I.D.	Pipe Size	Pipe O.D.	Pipe I.D.
9'-4"	3" STD	3.500"	3.068"	2" STD	2.375"	2.067"
19'-0"	4" STD	4.500"	4.026"	3" STD	3.500"	3.068"
33'-6"	5" STD	5.563"	5.047"	4" STD	4.500"	4.026"

- ⑩ If pipe runner length (Pw) is 1'-9" or less replace the normal pipe runner and anchor pipe with a single non-sliding pipe runner. See Non-Sliding Pipe Runner Details for additional information.
- ⑪ At Contractor's option, $\frac{7}{8}$ " diameter hole may be formed or cored drilled. Percussion drilling is not permitted. Adjust placement of reinforcing steel as necessary to avoid bolt holes.
- ⑫ After installation of pipe runner, use the $\frac{1}{2}$ " inspection hole to ensure that the lap of the anchor pipe with the pipe runner is adequate.
- ⑬ At Contractor's option, an adhesive anchor may be used. Provide $\frac{3}{4}$ " Dia adhesive anchors that meet the requirements of ASTM A307 Gr A fully threaded rods. Embed threaded rods into curb, wingwalls, and toewall using a Type III, Class C, D, E, or F anchor adhesive. Minimum embedment depth is 5 $\frac{1}{2}$ ". Provide anchor adhesive able to achieve a basic bond strength in tension, Nba, of 20 kips. Submit signed and sealed calculations or the manufacturer's published literature showing the proposed anchor adhesive's ability to develop this load to the Engineer for approval prior to use.

PIPE RUNNER DIMENSION CALCULATIONS:

$$\begin{aligned} W_n &= (2.000) (Dn) - (0.416') \\ P_{wn} &= (Dn) (K2) - (2.063') \\ P_{w1} \text{ Non-Sliding Pipe Runner (If required)} &= (D1) (K2) - (0.563') \\ P_c &= (A) (K1) - (1.688') \end{aligned}$$

W_n = Distance from working point to centerline anchor bolt measured along bottom inside face of wing (feet)

D_n = Distance from working point to centerline
pipe runner measured along outside face
of anchor toewall (feet)

P_w = Wingwall pipe runner length (feet)

P_c = Curb pipe runner length (feet)

K = Constant values for use in formulas

Slope SL:1 K1 K2

$$3:1 \quad \sim \quad 1.054 \quad \sim \quad 1.826$$
$$4:1 \sim 1.031 \sim 1.785$$
$$n = \text{Wing pipe runner number}$$


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*SAFETY END TREATMENT
WITH FLARED WINGS
FOR 0° SKEW BOX CULVERTS
TYPE I ~ CROSS DRAINAGE*

SETB-FW-0

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PIPE RUNNER LAYOUT

Quantities shown are for one structure end if Lt or Rt. Quantities shown are for two structure ends if Both.

If the outermost wing pipe runner is a non-sliding pipe runner, consider the next outermost wing pipe runner as the shortest.

SPECIAL NOTE:

This tabular sheet is to be filled out by the culvert specifier and provides information for the construction details and quantities of pipe runners.

An Excel 2010 spreadsheet to assist in completing this table can be downloaded from the Bridge Standards (English) web page on the TxDOT web site. The completed sheet must be signed, sealed, and dated by a licensed Professional Engineer.

Note that the tabular quantities are given for estimating purposes only. It is likely that these quantities will change due to field conditions. Therefore, all dimensions must be verified by the Contractor in the field prior to fabrication of the safety end treatment components.

SHEET 3 OF 3

**SAFETY END TREATMENT
WITH FLARED WING PIPE RUNNERS
FOR 0° SKEW BOX CULVERTS
TYPE I ~ CROSS DRAWING**

SETB-F

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