


# ORIGINATION FORM

Proposed Revisions to a Standard Plans Index  
(Please provide all information – Incomplete forms will be returned)

## Contact Information:

Date: May 7, 2018  
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## Standard Plans:

Index Number: 430-030  
Sheet Number (s): 1 of 1  
Index Title: Straight Concrete Endwalls - Single and Multiple  
Pipe 

## Summary of the changes:

Added Sheets and Reorganized Index. Moved payment and specification information to Specifications.  
Sheet 1: General Notes and overall view.  
Sheet 2: Concrete Endwall Details from old Sheet 1. Added Sta./Offset Location.  
Sheet 3: Quantities Tables from old Sheet 2. Elliptical Concrete and Elliptical/ Arched Corrugated Metal Pipe combined into one table.  
Sheet 4: Spacing for Multiple Pipes Details from old Sheet 1.

## Commentary / Background:

## Other Affected Offices / Documents: (Provide name of responsible personnel)

- | Yes                                 | No                                  |                             |
|-------------------------------------|-------------------------------------|-----------------------------|
| <input type="checkbox"/>            | <input checked="" type="checkbox"/> | Other Standard Plans –      |
| <input type="checkbox"/>            | <input type="checkbox"/>            | FDOT Design Manual –        |
| <input type="checkbox"/>            | <input type="checkbox"/>            | Basis of Estimates Manual – |
| <input checked="" type="checkbox"/> | <input type="checkbox"/>            | Standard Specifications –   |
| <input type="checkbox"/>            | <input type="checkbox"/>            | Approved Product List –     |
| <input type="checkbox"/>            | <input type="checkbox"/>            | Construction –              |
| <input type="checkbox"/>            | <input type="checkbox"/>            | Maintenance –               |

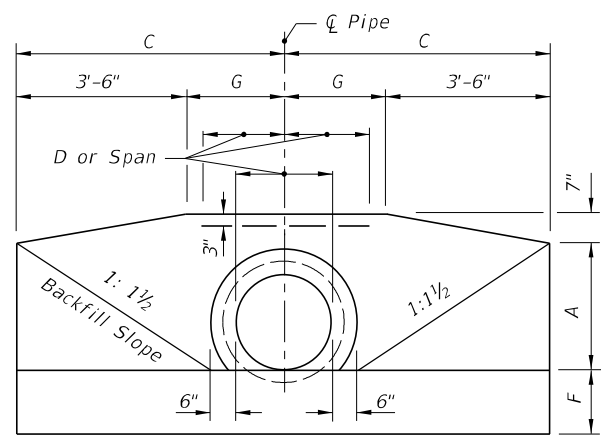
## Origination Package Includes: (Email or hand deliver package to Derwood Sheppard)

- | Yes                                 | N/A                      |   |
|-------------------------------------|--------------------------|---|
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | Redline Mark-ups                          |
| <input type="checkbox"/>            | <input type="checkbox"/> | Proposed Standard Plan Instructions (SPI) |
| <input type="checkbox"/>            | <input type="checkbox"/> | Revised SPI                               |
| <input type="checkbox"/>            | <input type="checkbox"/> | Other Support Documents                   |

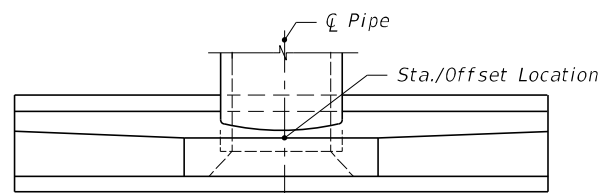
## Implementation:

- Design Bulletin (Interim)  DCE Memo  Program Mgmt. Bulletin  FY-Standard Plans (Next Release)

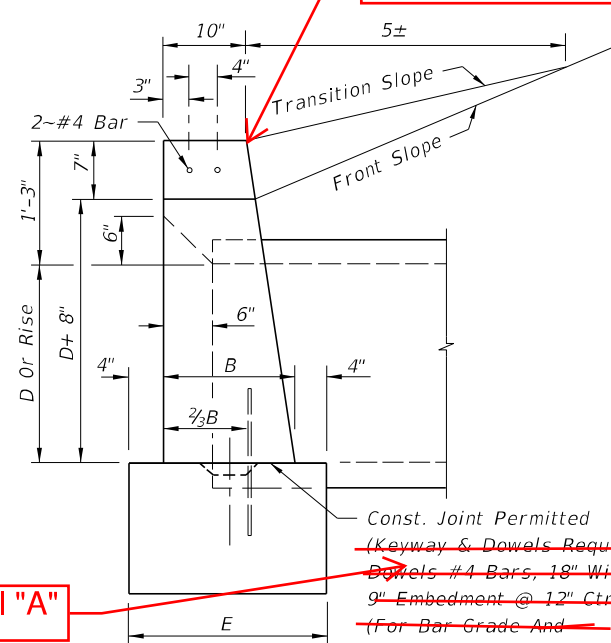
Contact the Roadway Design Office for assistance in completing this form



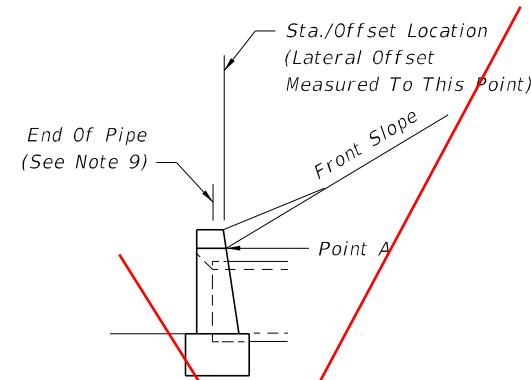
FRONT VIEW



TOP VIEW



END VIEW (ENLARGED)



END VIEW

1. Position is set by the intersection of the front slope and Point A where the intersection falls outside the clear zone.
2. Where the front slope falls inside the clear zone, the Station/Offset Location is at the clear zone limit. The front slope is transitioned to the endwall as shown in Index 430-001.

STANDARD LOCATION CONTROL

Notes Renumbered

GENERAL NOTES

1. Endwall dimensions, locations and positions are for round and elliptical concrete pipe and for round and pipe-arch corrugated metal pipe. Round concrete pipe shown.
2. Front slope and ditch transitions shall be in accordance with Index 430-001.
3. Endwalls may be cast in place or precast concrete. Reinforcing steel shall be Grades 40 or 60. Additional reinforcement necessary for handling precast units shall be determined by the Contractor or the supplier. Cost of reinforcement shall be included in the contract unit price for Concrete, (Endwalls).
4. All exposed corners and edges of concrete are to be chamfered 3/4".
5. Concrete shall be Class I, except ASTM C478 (4000 psi) concrete may be substituted for precast items manufactured in plants meeting the requirements of Section 449 of the Specifications.
6. On outfall ditches with side slopes flatter than 1:1 1/2 provide 20' transitions from the endwall to the flatter side slopes, right of way permitting.
7. For sodding around endwalls see Index 524-001.
8. Payment for concrete quantities for endwalls skewed to the pipe shall be made on the following basis:
 

Endwall Skew to Pipe	Use Tabulated Value
0° to 5°	0°
6°	15°
16°	30°
31° or over	45°
9. Pipe length plan quantities shall be based on the pipe end locations shown in the standard location control end view, or lengths based on special endwall locations called for in the plans.
10. Payment for pipe in pipe culverts shall be based on plan quantities, adjusted for endwall locations subsequently established by the Engineer.
11. Endwalls to be paid for under the contract unit price for Class I Concrete (Endwalls), CY.

See Detail "A"

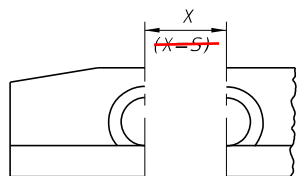
"Construct front slope and ditch transitions"

Moved to Specification

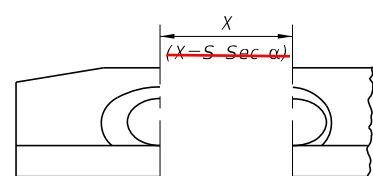
Details moved to new Sheet 2

"Use Class I concrete,"

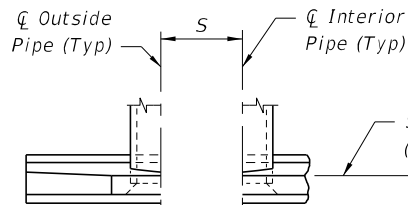
~~ENDWALL DIMENSIONS (EXCLUSIVE OF MULTIPLE PIPE SPACING)~~



FRONT VIEW

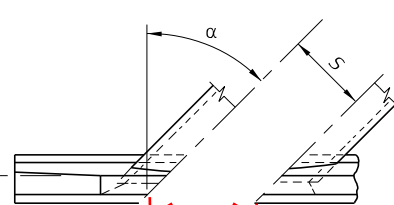


FRONT VIEW



TOP VIEW

NORMAL PIPE



TOP VIEW

SKEWED PIPE

LEGEND

- α Pipe Skew
- S Center To Center Pipe Spacing
- X Center Line To Center Line Dimension At Face Of Headwall

~~PIPE AND SPACING FOR MULTIPLE PIPE  
ENDWALL POSITIONS FOR SINGLE AND MULTIPLE~~

Moved to new Sheet 4

2" deep and 4" wide with 45 deg corners

#4 @ 12" Centers

2/3 B

Detail "A"

9"

Moved to Specification

between pipes

along

10/24/2018 8:58:44 AM

11/01/19

LAST REVISION 11/01/17	DESCRIPTION:		FY 2019-20 STANDARD PLANS	STRAIGHT CONCRETE ENDWALLS SINGLE AND MULTIPLE PIPE	INDEX 430-030	SHEET 1 of 2
						4

**DATA AND ESTIMATED QUANTITIES FOR ONE ENDWALL**

**ROUND CONCRETE AND CORRUGATED METAL PIPE**

D	Opening Area (SF)				Dimensions										Class I Concrete (CY)																D												
															Number And Type Of Pipe And Skew Angle Of Pipe																												
	Number Of Pipes				A	B	C	E	F	G	S	X				Single		Double				Triple				Quadruple																	
	1	2	3	4								0°	15°	30°	45°	Conc	Metal	0°	15°	30°	45°	0°	15°	30°	45°	0°	15°	30°	45°	0°		15°	30°	45°	0°	15°	30°	45°					
15"	1.23	2.46	3.69	4.92	1'-11"	1'-2"	4'-0"	1'-10"	1'-2"	0'-6"	2'-7"	2'-7"	2'-8"	3'-0"	3'-8"	1.23	1.24	1.59	1.60	1.65	1.74	1.62	1.63	1.68	1.78	1.94	1.96	2.05	2.23	1.99	2.02	2.11	2.30	2.30	2.34	2.47	2.74	2.37	2.41	2.75	2.84	15"	
18"	1.77	3.54	5.31	7.08	2'-2"	1'-3"	4'-6"	1'-11"	1'-3"	1'-0"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"	1.56	1.59	1.99	2.01	2.06	2.17	2.04	2.06	2.11	2.23	2.43	2.46	2.56	2.79	2.51	2.54	2.65	2.89	2.86	2.91	3.06	3.40	2.96	3.01	3.17	3.53	18"	
21"	2.41	4.82	7.23	9.64	2'-5"	1'-4"	5'-0"	2'-0"	1'-4"	1'-6"	3'-2"	3'-2"	3'-3"	3'-8"	4'-6"	1.97																											21"
24"	3.14	6.28	9.42	12.56	2'-8"	1'-4"	5'-6"	2'-0"	1'-4"	2'-0"	3'-5"	3'-5"	3'-6"	3'-11"	4'-10"	2.24	2.29	2.82	2.84	2.91	3.06	2.91	2.93	3.01	3.17	3.39	3.43	3.57	3.87	3.52	3.56	3.71	4.03	3.97	4.03	4.24	4.69	4.14	4.20	4.43	4.91	24"	
27"	3.98	7.96	11.94	15.92	2'-11"	1'-5"	6'-0"	2'-1"	1'-5"	2'-6"	3'-10"	3'-10"	4'-0"	4'-5"	5'-5"	2.73																											27"
30"	4.91	9.82	14.73	19.64	3'-2"	1'-6"	6'-6"	2'-2"	1'-6"	3'-0"	4'-3"	4'-3"	4'-5"	4'-11"	6'-0"	3.26	3.34	4.13	4.16	4.26	4.49	4.28	4.31	4.43	4.67	4.98	5.04	5.25	5.69	5.20	5.27	5.49	5.97	5.84	5.93	6.24	6.91	6.13	6.23	6.56	7.29	30"	
36"	7.07	14.14	21.21	28.28	3'-8"	1'-8"	7'-6"	2'-4"	1'-8"	4'-0"	5'-1"	5'-1"	5'-3"	5'-10"	7'-2"	4.53	4.64	5.73	5.77	5.92	6.23	5.95	6.00	6.15	6.49	6.92	7.00	7.29	7.91	7.25	7.34	7.65	8.33	8.13	8.26	8.69	9.62	8.57	8.71	9.18	10.20	36"	
42"	9.62	19.24	28.86	38.48	4'-2"	1'-10"	8'-6"	2'-6"	2'-0"	5'-0"	6'-0"	6'-0"	6'-3"	6'-11"	8'-6"	6.33	6.49	8.11	8.17	8.39	8.85	8.43	8.50	8.73	9.23	9.90	10.02	10.45	11.38	10.38	10.52	10.98	11.99	11.68	11.87	12.51	13.89	12.32	12.52	13.22	14.73	42"	
48"	12.57	25.14	37.71	50.28	4'-8"	2'-1"	9'-6"	2'-9"	2'-0"	6'-0"	6'-9"	6'-9"	7'-0"	7'-10"	9'-7"	8.15	8.38	10.40	10.48	10.75	11.33	10.85	10.94	11.23	11.87	12.64	12.80	13.34	14.50	13.34	13.51	14.11	15.39	14.89	15.13	15.93	17.68	15.82	16.08	16.97	18.90	48"	
54"	15.90	31.80	47.70	63.60	5'-2"	2'-6"	10'-6"	3'-2"	2'-3"	7'-0"	7'-8"	7'-8"	7'-11"	8'-10"	10'-10"	11.71	11.77	15.23	15.35	15.78	16.69	15.35	15.48	15.90	16.83	18.77	19.02	19.86	21.69	18.93	19.18	20.04	21.89	22.29	22.66	23.93	26.67	22.51	22.89	24.17	26.96	54"	

**CORRUGATED METAL PIPE ARCH**

Span	Rise	Opening Area (SF)				Dimensions										Class I Concrete (CY)																Span	Rise	Approx. Equiv. Round Pipe
																Number Of Pipe And Skew Angle Of Pipe																		
		Number Of Pipes				A	B	C	E	F	G	S	X				Single		Double				Triple				Quadruple							
		1	2	3	4								0°	15°	30°	45°	0°	0°	15°	30°	45°	0°	15°	30°	45°	0°	15°	30°	45°	0°	15°			
17"	13"	1.1	2.2	3.3	4.4	1'-9"	1'-2"	3'-10"	1'-10"	1'-2"	0'-4"	2'-6"	2'-6"	2'-7"	2'-11"	3'-6"	1.16	1.47	1.48	1.52	1.60	1.78	1.80	1.88	2.04	2.09	2.12	2.23	2.48	17"	13"	15"		
21"	15"	1.6	3.2	4.8	6.4	1'-11"	1'-2"	4'-3"	1'-10"	1'-2"	0'-9"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"	1.33	1.69	1.70	1.75	1.84	2.04	2.06	2.15	2.33	2.40	2.44	2.57	2.84	21"	15"	18"		
28"	20"	2.8	5.6	8.4	11.2	2'-4"	1'-3"	5'-2"	1'-11"	1'-3"	1'-8"	3'-5"	3'-5"	3'-6"	3'-11"	4'-10"	1.78	2.31	2.33	2.39	2.53	2.83	2.87	2.99	3.26	3.36	3.42	3.60	4.01	28"	20"	24"		
35"	24"	4.3	8.6	12.9	17.2	2'-8"	1'-4"	5'-11 1/2"	2'-0"	1'-4"	2'-5 1/2"	4'-0"	4'-0"	4'-2"	4'-7"	5'-8"	2.34	3.03	3.05	3.14	3.32	3.72	3.77	3.93	4.29	4.40	4.47	4.72	5.25	35"	24"	30"		
42"	29"	5.9	11.8	17.7	23.6	3'-1"	1'-5"	6'-10 1/2"	2'-1"	1'-5"	3'-4 1/2"	4'-9"	4'-9"	4'-11"	5'-6"	6'-9"	3.13	4.06	4.09	4.20	4.45	4.99	5.06	5.28	5.76	5.93	6.03	6.36	7.09	42"	29"	36"		
49"	33"	8.4	16.8	25.2	33.6	3'-5"	1'-6"	7'-8"	2'-2"	1'-6"	4'-2"	5'-6"	5'-6"	5'-8"	6'-4"	7'-9"	3.83	5.00	5.04	5.18	5.48	6.16	6.24	6.52	7.12	7.32	7.44	7.86	8.76	49"	33"	42"		
57"	38"	10.6	21.2	31.8	42.4	3'-10"	1'-7"	8'-7 1/2"	2'-3"	1'-7"	5'-1 1/2"	6'-4"	6'-4"	6'-7"	7'-4"	8'-11"	4.87	6.31	6.36	6.53	6.91	7.74	7.84	8.18	8.93	9.18	9.33	9.85	10.96	57"	38"	48"		
64"	43"	13.2	26.4	39.6	52.8	4'-3"	1'-8"	9'-6 1/2"	2'-4"	1'-8"	6'-0 1/2"	7'-1"	7'-1"	7'-4"	8'-2"	10'-0"	5.88	7.64	7.70	7.91	8.37	9.40	9.52	9.94	10.86	11.15	11.33	11.97	13.33	64"	43"	54"		
71"	47"	16.9	33.8	50.7	67.6	4'-7"	1'-10"	10'-4"	2'-6"	2'-0"	6'-10"	7'-10"	7'-10"	8'-1"	9'-1"	11'-1"	7.80	10.15	10.23	10.51	11.12	12.49	12.65	13.22	14.43	14.85	15.10	15.94	17.77	71"	47"	60"		

(a)

Note: Use the guidelines of General Note 8 for selecting tabular quantities.

**CONCRETE ELLIPTICAL PIPE**

Rise	Span	Opening Area (SF)				Dimensions										Class I Concrete (CY)																Rise	Span	Approx. Equiv. Round Pipe
																Number Of Pipe And Skew Angle Of Pipe																		
		Number Of Pipes				A	B	C	E	F	G	S	X				Single		Double				Triple				Quadruple							
		1	2	3	4								0°	15°	30°	45°	0°	0°	15°	30°	45°	0°	15°	30°	45°	0°	15°	30°	45°	0°	15°			
12"	18"	1.3	2.6	3.9	5.2	1'-8"	1'-2"	3'-9"	1'-10"	1'-2"	0'-3"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"	1.09	1.45	1.46	1.51	1.60	1.80	1.82	1.91	2.09	2.16	2.20	2.33	2.60	12"	18"	15"		
14"	23"	1.8	3.6	5.4	7.2	1'-10"	1'-3"	4'-2 1/2"	1'-11"	1'-3"	8 1/2"	3'-5"	3'-5"	3'-6"	3'-11"	4'-10"	1.36	1.82	1.84	1.89	2.01	2.29	2.32	2.43	2.68	2.75	2.80	2.97	3.33	14"	23"	18"		
19"	30"	3.3	6.6	9.9	13.2	2'-3"	1'-4"	5'-1 1/2"	2'-0"	1'-4"	1'-7 1/2"	4'-2"	4'-2"	4'-4"	4'-10"	5'-11"	1.89	2.55	2.57	2.65	2.82	3.22	3.27	3.43	3.77	3.88	3.95	4.19	4.70	19"	30"	24"		
24"	38"	5.1	10.2	15.3	20.4	2'-8"	1'-5"	6'-3"	2'-1"	1'-5"	2'-9"	5'-2"	5'-2"	5'-4"	6'-0"	7'-4"	2.64	3.55	3.58	3.69	3.93	4.48	4.54	4.77	5.24	5.39	5.49	5.82	6.53	24"	38"	30"		
29"	45"	7.4	14.8	22.2	29.6	3'-1"	1'-6"	7'-0"	2'-2"	1'-6"	3'-6"	6'-0"	6'-0"	6'-3"	6'-11"	8'-6"	3.32	4.48	4.52	4.66	4.96	5.64	5.72	6.00	6.60	6.80	6.92	7.34	8.24	29"	45"	36"		
34"	53"	10.2	20.4	30.6	40.8	3'-6"	1'-7"	7'-11 1/2"	2'-3"	1'-7"	4'-5 1/2"	7'-1"	7'-1"	7'-4"	8'-2"	10'-0"	4.24	5.76	5.81	6.00	6.39	7.29	7.40	7.76	8.55	8.81	8.97	9.52	10.70	34"	53"	42"		
38"	60"	12.9	25.8	38.7	51.6	3'-10"	1'-8"	8'-9"	2'-4"	1'-8"	5'-3"	7'-11"	7'-11"	8'-2"	9'-2"	11'-2"	5.22	7.16	7.23	7.46	7.96	9.10	9.24	9.70	10.71	11.05	11.25	11.95	13.46	38"	60"	48"		
43"	68"	16.6	33.2	49.8	66.4	4'-3"	1'-10"	9'-8 1/2"	2'-6"	1'-10"	6'-2 1/2"	8'-10"	8'-10"	9'-2"	10'-2"	12'-6"	6.63	9.01	9.09	9.38	10.00	11.39	11.56	12.13	13.36	13.77	14.02	14.88	16.73	43"	68"	54"		
48"	76"	20.5	41.0	61.5	82.0	4'-8"	2'-1"	10'-8"	2'-9"	2'-0"	7'-2"	9'-9"	9'-9"	10'-1"	11'-3"	13'-9"	8.66	11.74	11.85	12.22	13.02	14.82	15.04	15.77	17.37	17.91	18.23	19.34	21.74	48"	76"	60"		
53"	83"	24.8	49.6	74.4	99.2	5'-1"	2'-6"	11'-7"	3'-2"	2'-6"	8'-1"	10'-7"	10'-7"	10'-11"	12'-3"	15'-0"	12.50	16.98	16.98	17.67	18.83	21.47	21.78	22.86	25.18	25.97	26.44	28.06	31.55	53"	83"	66"		
58"	91"	29.5	59.0	88.5	118.0	5'-6"	2'-10"	12'-6 1/2"	3'-6"	2'-10"	9'-0 1/2"	11'-4"	11'-4"	11'-9"	13'-1"	16'-0"	16.46	22.26	22.46	23.16	24.66	28.05	28.46	29.85	32.85	33.85	34.46	36.55	41.05	58"	91"	72"		

Note 2, tabular quantities moved from old General Notes

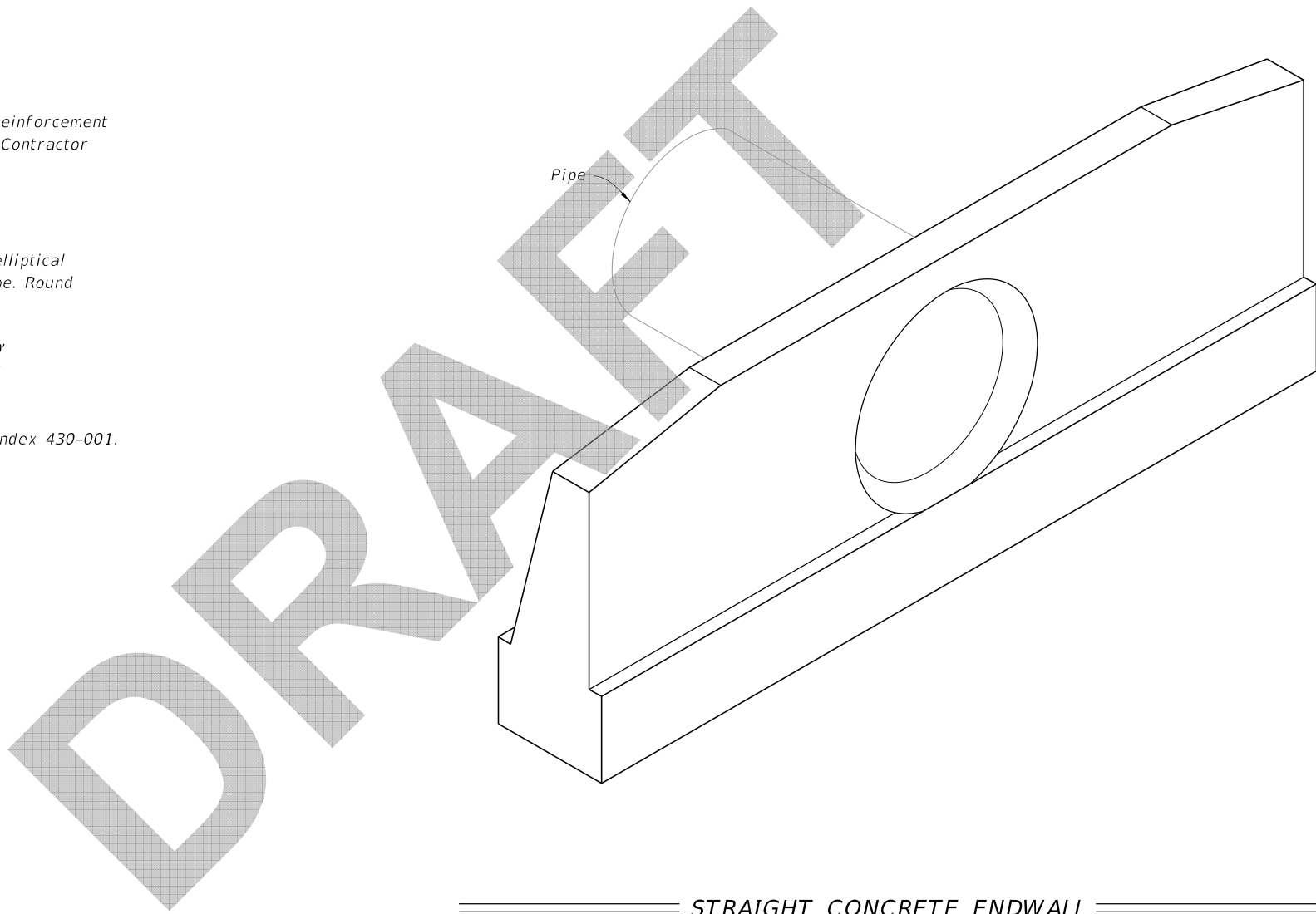
Notes:  
 1) Dimension X can be calculated as  $X = S * \text{SEC } \alpha$   
 2)

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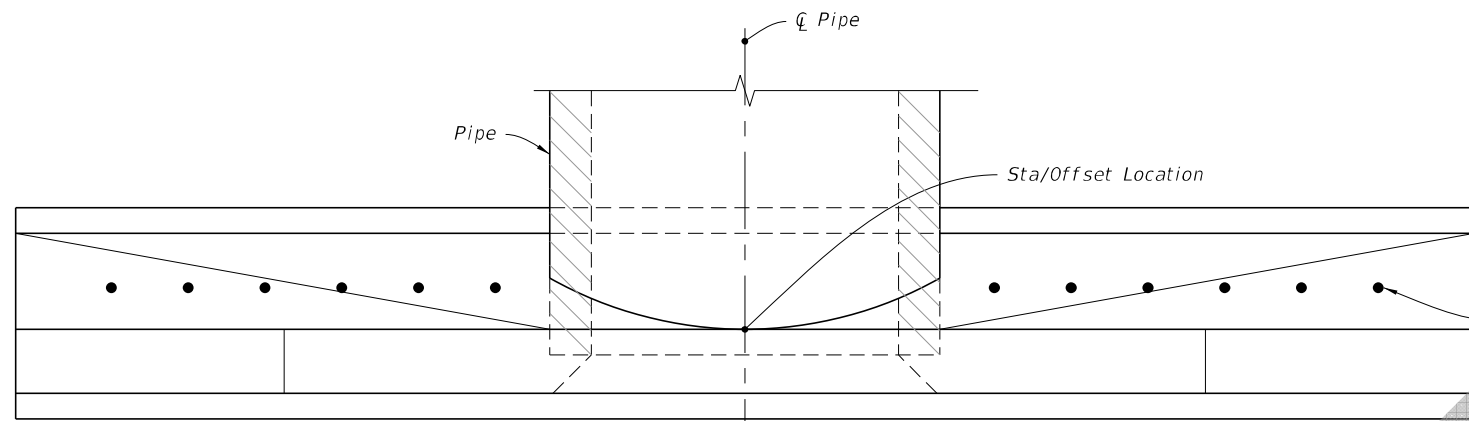
**GENERAL NOTES:**

1. Use Class I concrete.
2. Reinforcing steel is either Grade 40 or 60.
3. Endwalls may be cast in place or precast concrete. (Additional reinforcement necessary for handling precast units will be determined by the Contractor or the supplier).
4. Chamfer all exposed edges and corners to  $\frac{3}{4}$ ".
5. Endwall dimensions, locations and positions are for round and elliptical concrete pipe and for round and pipe-arch corrugated metal pipe. Round concrete pipe shown.
6. On outfall ditches with side slopes flatter than 1:1.5 provide 20' transitions from the endwall to the flatter side slopes, right of way permitting.
7. Construct front slope and ditch transitions in accordance with Index 430-001.
8. Quantities shown are for estimating purposes only.

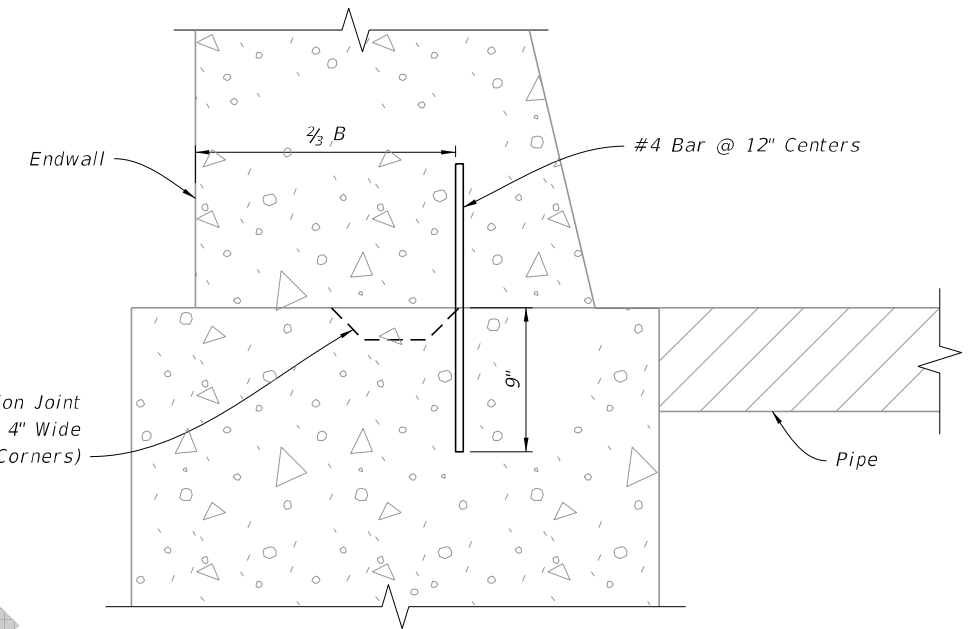
TABLE OF CONTENTS:	
Sheet	Description
1	General Notes and Contents
2	Concrete Endwall Details
3	Concrete and Metal Pipe Tables
4	Spacing For Multiple Pipes



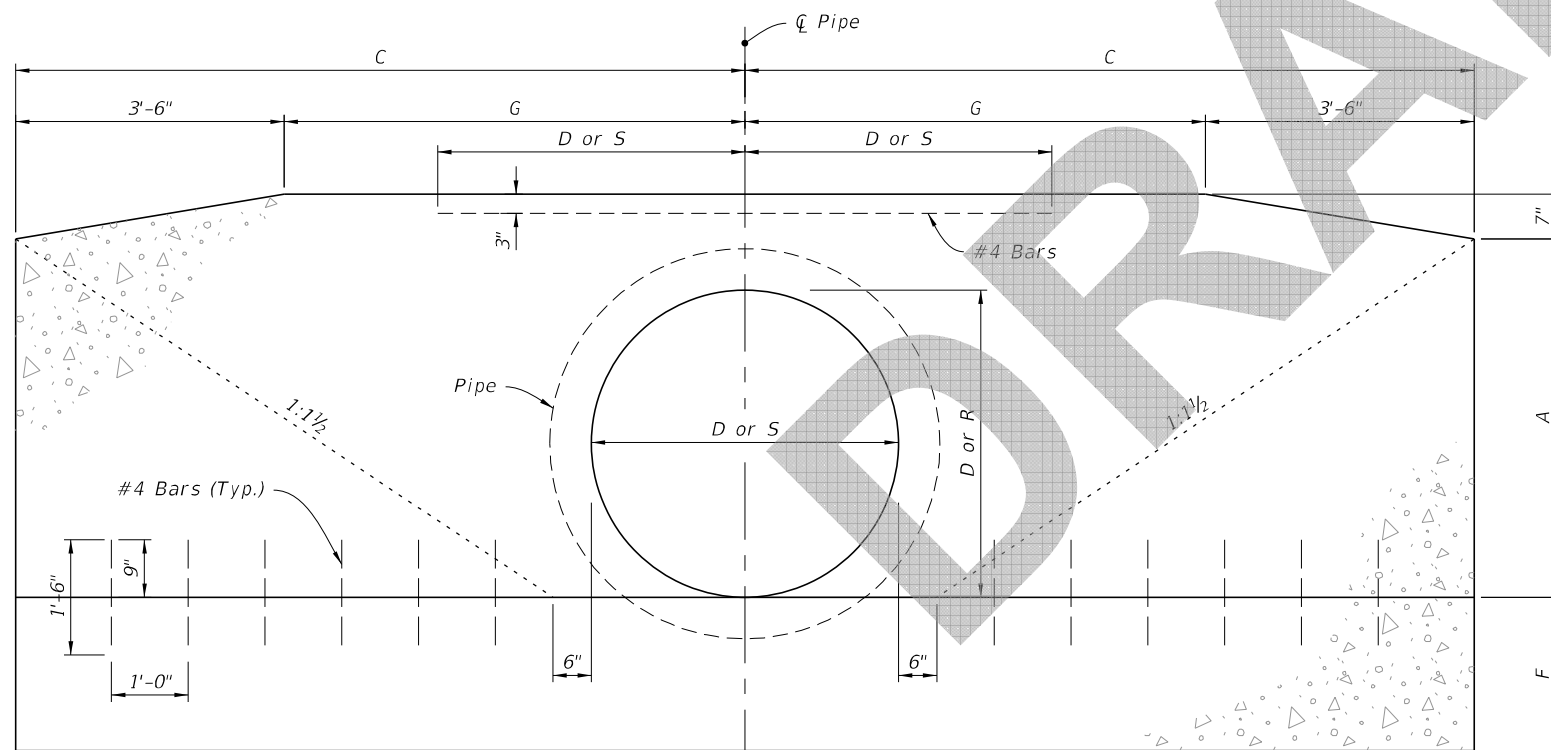
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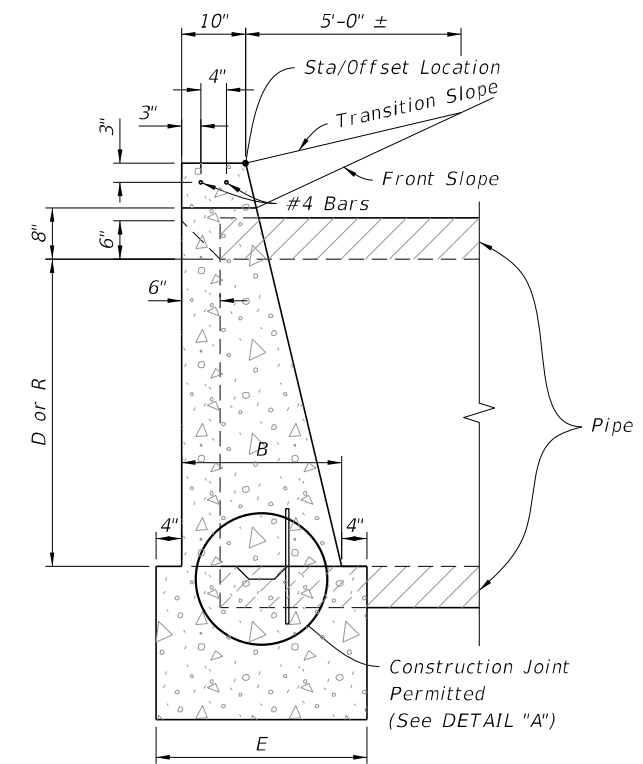
PLAN



DETAIL "A"




FRONT ELEVATION



SIDE ELEVATION

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LAST REVISION	11/01/19	DESCRIPTION:	 FY 2020-21 STANDARD PLANS	STRAIGHT CONCRETE ENDWALLS SINGLE AND MULTIPLE PIPE	INDEX	SHEET
					430-030	2 of 4

**CONCRETE ENDWALL DETAILS**

**ROUND CONCRETE AND CORRUGATED METAL PIPE**

Pipe	Dia. D	Opening Area (SF)				Dimensions										Class I Concrete (CY)																D	
		Number Of Pipes				A	B	C	E	F	G	Y	X				Number Of Pipe And Skew Angle Of Pipe (α)																
		1	2	3	4								0°	15°	30°	45°	Double				Triple				Quadruple								
																	0°	0°	15°	30°	45°	0°	15°	30°	45°	0°	15°	30°	45°				
Concrete	15"	1.23	2.46	3.69	4.92	1'-11"	1'-2"	4'-0"	1'-10"	1'-2"	0'-6"	2'-7"	2'-7"	2'-8"	3'-0"	3'-8"	1.23	1.59	1.60	1.65	1.74	1.94	1.96	2.05	2.23	2.30	2.34	2.47	2.74	15"			
	18"	1.77	3.54	5.31	7.08	2'-2"	1'-3"	4'-6"	1'-11"	1'-3"	1'-0"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"	1.56	1.99	2.01	2.06	2.17	2.43	2.46	2.56	2.79	2.86	2.91	3.06	3.40	18"			
	21"	2.41	4.82	7.23	9.64	2'-5"	1'-4"	5'-0"	2'-0"	1'-4"	1'-6"	3'-2"	3'-2"	3'-3"	3'-8"	4'-6"	1.97													21"			
	24"	3.14	6.28	9.42	12.56	2'-8"	1'-4"	5'-6"	2'-0"	1'-4"	2'-0"	3'-5"	3'-5"	3'-6"	3'-11"	4'-10"	2.24	2.82	2.84	2.91	3.06	3.39	3.43	3.57	3.87	3.97	4.03	4.24	4.69	24"			
	27"	3.98	7.96	11.94	15.92	2'-11"	1'-5"	6'-0"	2'-1"	1'-5"	2'-6"	3'-10"	3'-10"	4'-0"	4'-5"	5'-5"	2.73													27"			
	30"	4.91	9.82	14.73	19.64	3'-2"	1'-6"	6'-6"	2'-2"	1'-6"	3'-0"	4'-3"	4'-3"	4'-5"	4'-11"	6'-0"	3.26	4.13	4.16	4.26	4.49	4.98	5.04	5.25	5.69	5.84	5.93	6.24	6.91	30"			
	36"	7.07	14.14	21.21	28.28	3'-8"	1'-8"	7'-6"	2'-4"	1'-8"	4'-0"	5'-1"	5'-1"	5'-3"	5'-10"	7'-2"	4.53	5.73	5.77	5.92	6.23	6.92	7.00	7.29	7.91	8.13	8.26	8.69	9.62	36"			
	42"	9.62	19.24	28.86	38.48	4'-2"	1'-10"	8'-6"	2'-6"	2'-0"	5'-0"	6'-0"	6'-0"	6'-3"	6'-11"	8'-6"	6.33	8.11	8.17	8.39	8.85	9.90	10.02	10.45	11.38	11.68	11.87	12.51	13.89	42"			
	48"	12.57	25.14	37.71	50.28	4'-8"	2'-1"	9'-6"	2'-9"	2'-0"	6'-0"	6'-9"	6'-9"	7'-0"	7'-10"	9'-7"	8.15	10.40	10.48	10.75	11.33	12.64	12.80	13.34	14.50	14.89	15.13	15.93	17.68	48"			
	54"	15.90	31.80	47.70	63.60	5'-2"	2'-6"	10'-6"	3'-2"	2'-3"	7'-0"	7'-8"	7'-8"	7'-11"	8'-10"	10'-10"	11.71	15.23	15.35	15.78	16.69	18.77	19.02	19.86	21.69	22.29	22.66	23.93	26.67	54"			
Corrugated Metal	15"	1.23	2.46	3.69	4.92	1'-11"	1'-2"	4'-0"	1'-10"	1'-2"	0'-6"	2'-7"	2'-7"	2'-8"	3'-0"	3'-8"	1.24	1.62	1.63	1.68	1.78	1.99	2.02	2.11	2.30	2.37	2.41	2.75	2.84	15"			
	18"	1.77	3.54	5.31	7.08	2'-2"	1'-3"	4'-6"	1'-11"	1'-3"	1'-0"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"	1.59	2.04	2.06	2.11	2.23	2.51	2.54	2.65	2.89	2.96	3.01	3.17	3.53	18"			
	21"	2.41	4.82	7.23	9.64	2'-5"	1'-4"	5'-0"	2'-0"	1'-4"	1'-6"	3'-2"	3'-2"	3'-3"	3'-8"	4'-6"													21"				
	24"	3.14	6.28	9.42	12.56	2'-8"	1'-4"	5'-6"	2'-0"	1'-4"	2'-0"	3'-5"	3'-5"	3'-6"	3'-11"	4'-10"	2.29	2.91	2.93	3.01	3.17	3.52	3.56	3.71	4.03	4.14	4.20	4.43	4.91	24"			
	27"	3.98	7.96	11.94	15.92	2'-11"	1'-5"	6'-0"	2'-1"	1'-5"	2'-6"	3'-10"	3'-10"	4'-0"	4'-5"	5'-5"													27"				
	30"	4.91	9.82	14.73	19.64	3'-2"	1'-6"	6'-6"	2'-2"	1'-6"	3'-0"	4'-3"	4'-3"	4'-5"	4'-11"	6'-0"	3.34	4.28	4.31	4.43	4.67	5.20	5.27	5.49	5.97	6.13	6.23	6.56	7.29	30"			
	36"	7.07	14.14	21.21	28.28	3'-8"	1'-8"	7'-6"	2'-4"	1'-8"	4'-0"	5'-1"	5'-1"	5'-3"	5'-10"	7'-2"	4.64	5.95	6.00	6.15	6.49	7.25	7.34	7.65	8.33	8.57	8.71	9.18	10.20	36"			
	42"	9.62	19.24	28.86	38.48	4'-2"	1'-10"	8'-6"	2'-6"	2'-0"	5'-0"	6'-0"	6'-0"	6'-3"	6'-11"	8'-6"	6.49	8.43	8.50	8.73	9.23	10.38	10.52	10.98	11.99	12.32	12.52	13.22	14.73	42"			
	48"	12.57	25.14	37.71	50.28	4'-8"	2'-1"	9'-6"	2'-9"	2'-0"	6'-0"	6'-9"	6'-9"	7'-0"	7'-10"	9'-7"	8.38	10.85	10.94	11.23	11.87	13.34	13.51	14.11	15.39	15.82	16.08	16.97	18.90	48"			
	54"	15.90	31.80	47.70	63.60	5'-2"	2'-6"	10'-6"	3'-2"	2'-3"	7'-0"	7'-8"	7'-8"	7'-11"	8'-10"	10'-10"	11.77	15.35	15.48	15.90	16.83	18.93	19.18	20.04	21.89	22.51	22.89	24.17	26.96	54"			

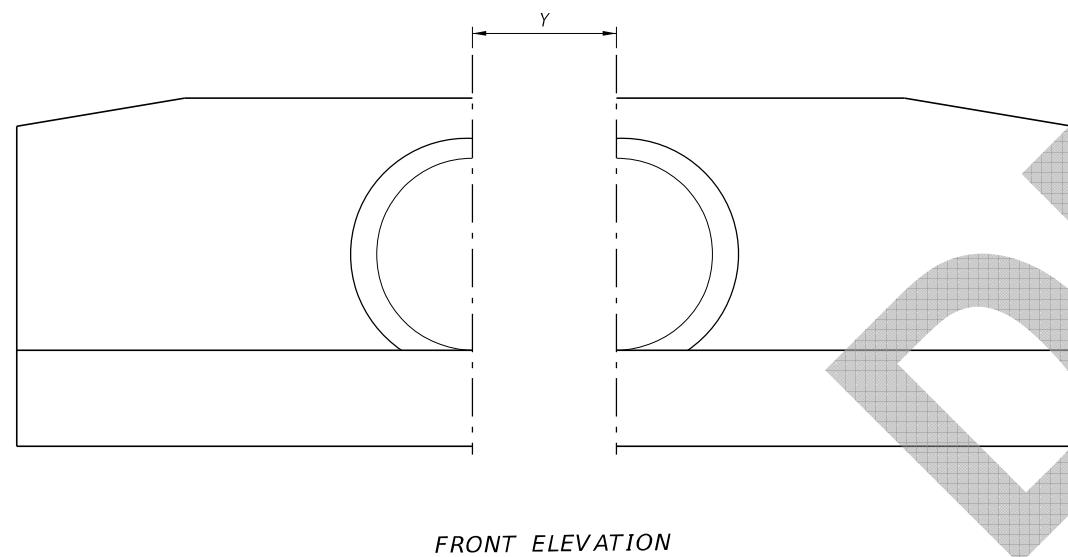
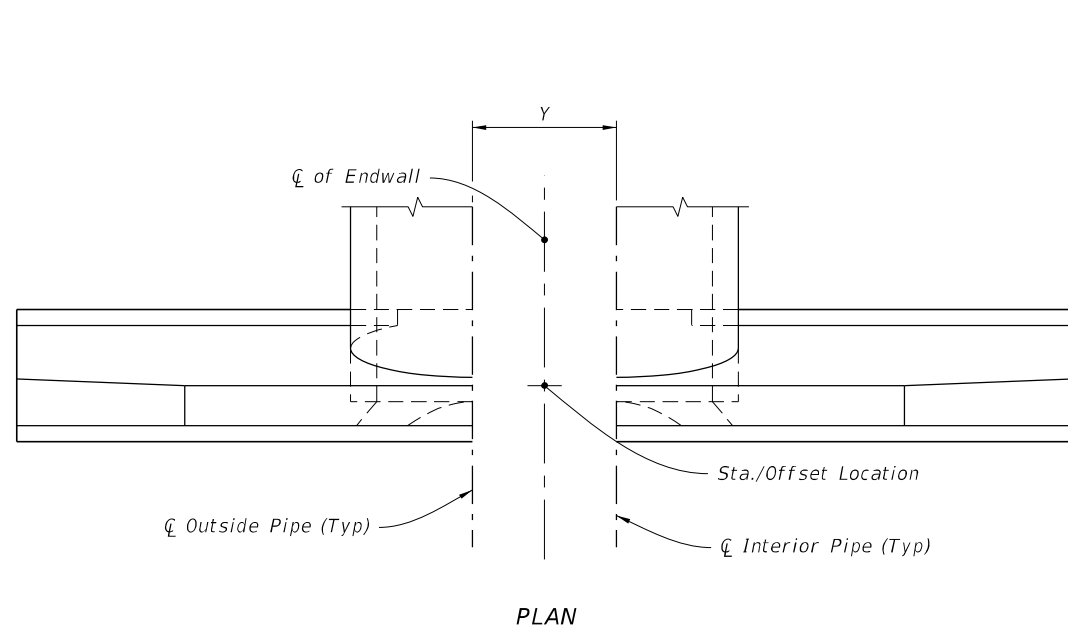
**ELLIPTICAL CONCRETE AND CORRUGATED METAL PIPE**

Pipe	Span S	Rise R	Opening Area (SF)				Dimensions										Class I Concrete (CY)																Span	Rise	Approx. Equiv. Round	
			Number Of Pipes				A	B	C	E	F	G	Y	X				Number Of Pipe And Skew Angle Of Pipe (α)																		
			1	2	3	4								0°	15°	30°	45°	Double				Triple				Quadruple										
																		0°	0°	15°	30°	45°	0°	15°	30°	45°	0°	15°	30°	45°						
Concrete	17"	13"	1.1	2.2	3.3	4.4	1'-9"	1'-2"	3'-10"	1'-10"	1'-2"	0'-4"	2'-6"	2'-6"	2'-7"	2'-11"	3'-6"	1.16	1.47	1.48	1.52	1.60	1.78	1.80	1.88	2.04	2.09	2.12	2.23	2.48	17"	13"	15"			
	21"	15"	1.6	3.2	4.8	6.4	1'-11"	1'-2"	4'-3"	1'-10"	1'-2"	0'-9"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"	1.33	1.69	1.70	1.75	1.84	2.04	2.06	2.15	2.33	2.40	2.44	2.57	2.84	21"	15"	18"			
	28"	20"	2.8	5.6	8.4	11.2	2'-4"	1'-3"	5'-2"	1'-11"	1'-3"	1'-8"	3'-5"	3'-5"	3'-6"	3'-11"	4'-10"	1.78	2.31	2.33	2.39	2.53	2.83	2.87	2.99	3.26	3.36	3.42	3.60	4.01	28"	20"	24"			
	35"	24"	4.3	8.6	12.9	17.2	2'-8"	1'-4"	5'-11 1/2"	2'-0"	1'-4"	2'-5 1/2"	4'-0"	4'-0"	4'-2"	4'-7"	5'-8"	2.34	3.03	3.05	3.14	3.32	3.72	3.77	3.93	4.29	4.40	4.47	4.72	5.25	35"	24"	30"			
	42"	29"	5.9	11.8	17.7	23.6	3'-1"	1'-5"	6'-10 1/2"	2'-1"	1'-5"	3'-4 1/2"	4'-9"	4'-9"	4'-11"	5'-6"	6'-9"	3.13	4.06	4.09	4.20	4.45	4.99	5.06	5.28	5.76	5.93	6.03	6.36	7.09	42"	29"	36"			
	49"	33"	8.4	16.8	25.2	33.6	3'-5"	1'-6"	7'-8"	2'-2"	1'-6"	4'-2"	5'-6"	5'-6"	5'-8"	6'-4"	7'-9"	3.83	5.00	5.04	5.18	5.48	6.16	6.24	6.52	7.12	7.32	7.44	7.86	8.76	49"	33"	42"			
	57"	38"	10.6	21.2	31.8	42.4	3'-10"	1'-7"	8'-7 1/2"	2'-3"	1'-7"	5'-1 1/2"	6'-4"	6'-4"	6'-7"	7'-4"	8'-11"	4.87	6.31	6.36	6.53	6.91	7.74	7.84	8.18	8.93	9.18	9.33	9.85	10.96	57"	38"	48"			
Corrugated Metal	64"	43"	13.2	26.4	39.6	52.8	4'-3"	1'-8"	9'-6 1/2"	2'-4"	1'-8"	6'-0 1/2"	7'-1"	7'-1"	7'-4"	8'-2"	10'-0"	5.88	7.64	7.70	7.91	8.37	9.40	9.52	9.94	10.86	11.15	11.33	11.97	13.33	64"	43"	54"			
	71"	47"	16.9	33.8	50.7	67.6	4'-7"	1'-10"	10'-4"	2'-6"	2'-0"	6'-10"	7'-10"	7'-10"	8'-1"	9'-1"	11'-1"	7.80	10.15	10.23	10.51	11.12	12.49	12.65	13.22	14.43	14.85	15.10	15.94	17.77	71"	47"	60"			
	18"	12"	1.3	2.6	3.9	5.2	1'-8"	1'-2"	3'-9"	1'-10"	1'-2"	0'-3"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"	1.09	1.45	1.46	1.51	1.60	1.80	1.82	1.91	2.09	2.16	2.20	2.33	2.60	12"	18"	15"			
	23"	14"	1.8	3.6	5.4	7.2	1'-10"	1'-3"	4'-2 1/2"	1'-11"	1'-3"	8 1/2"	3'-5"	3'-5"	3'-6"	3'-11"	4'-10"	1.36	1.82	1.84	1.89	2.01	2.29	2.32	2.43	2.68	2.75	2.80	2.97	3.33	14"	23"	18"			
	30"	19"	3.3	6.6	9.9	13.2	2'-3"	1'-4"	5'-1 1/2"	2'-0"	1'-4"	1'-7 1/2"	4'-2"	4'-2"	4'-4"	4'-10"	5'-11"	1.89	2.55	2.57	2.65	2.82	3.22	3.27	3.43	3.77	3.88	3.95	4.19	4.70	19"	30"	24"			
	38"	24"	5.1	10.2	15.3	20.4	2'-8"	1'-5"	6'-3"	2'-1"	1'-5"	2'-9"	5'-2"	5'-2"	5'-4"	6'-0"	7'-4"	2.64	3.55	3.58	3.69	3.93	4.48	4.54	4.77	5.24	5.39	5.49	5.82	6.53	24"	38"	30"			
	45"	29"	7.4	14.8	22.2	29.6	3'-1"	1'-6"	7'-0"	2'-2"	1'-6"	3'-6"	6'-0"	6'-0"	6'-3"	6'-11"	8'-6"	3.32	4.48	4.52	4.66	4.96	5.64	5.72	6.00	6.60	6.80	6.92	7.34	8.24	29"	45"	36"			
	53"	34"	10.2	20.4	30.6	40.8	3'-6"	1'-7"	7'-11 1/2"	2'-3"	1'-7"	4'-5 1/2"	7'-1"	7'-1"	7'-4"	8'-2"	10'-0"	4.24	5.76	5.81	6.00	6.39	7.29	7.40	7.76	8.55	8.81	8.97	9.52	10.70	34"	53"	42"			
	60"	38"	12.9	25.8	38.7	51.6	3'-10"	1'-8"	8'-9"	2'-4"	1'-8"	5'-3"	7'-11"	7'-11"	8'-2"	9'-2"	11'-2"	5.22	7.16	7.23	7.46	7.96	9.10	9.24	9.70	10.71	11.05	11.25	11.95	13.46	38"	60"	48"			
	68"	43"	16.6	33.2	49.8	66.4	4'-3"	1'-10"	9'-8 1/2"	2'-6"	1'-10"	6'-2 1/2"	8'-10"	8'-10"	9'-2"	10'-2"	12'-6"	6.63	9.01	9.09	9.38	10.00	11.39	11.56	12.13	13.36	13.77	14.02	14.88	16.73	43"	68"	54"			
	76"	48"	20.5	41.0	61.5	82.0	4'-8"	2'-1"	10'-8"	2'-9"	2'-0"	7'-2"	9'-9"	9'-9"	10'-1"	11'-3"	13'-9"	8.66	11.74	11.85	12.22	13.02	14.82	15.04	15.77	17.37	17.91	18.23	19.34	21.74	48"	76"	60"			
	83"	53"	24.8	49.6	74.4	99.2	5'-1"	2'-6"	11'-7"	3'-2"	2'-6"	8'-1"	10'-7"	10'-7"	12'-3"	15'-0"		12.50	16.98	17.67	18.83	21.47	21.78	22.86	25.18	25.97	26.44	28.06	31.55	53"	83"	66"				
91"	58"	29.5	59.0	88.5	118.0	5'-6"	2'-10"	12'-6 1/2"	3'-6"	2'-10"	9'-0 1/2"	11'-4"	11'-4"	11'-9"	13'-1"	16'-0"	16.46	22.26	22.46	23.16	24.66	28.05	28.46	29.85	32.85	33.85	34.46	36.55	41.05	58"	91"	72"				

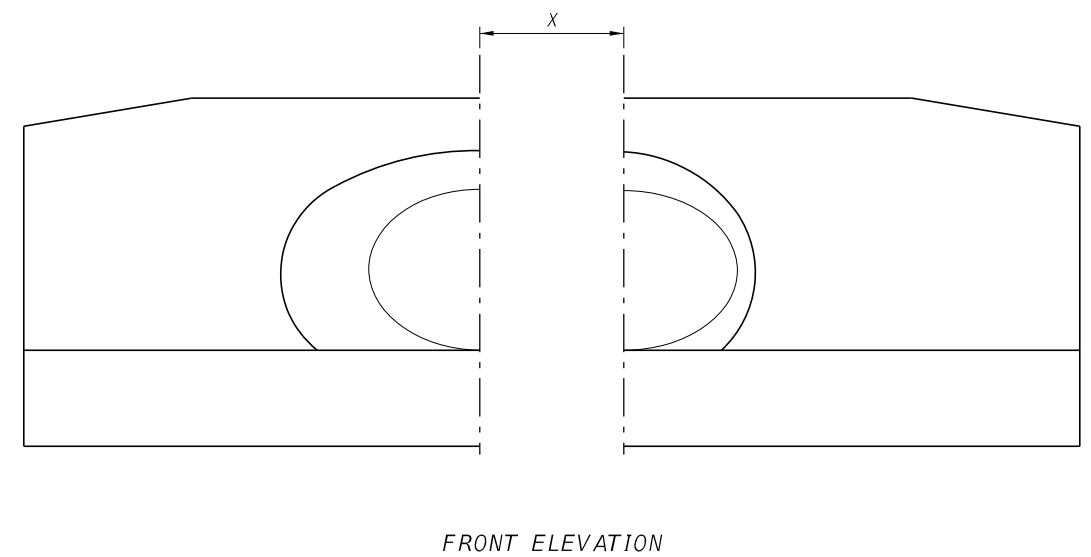
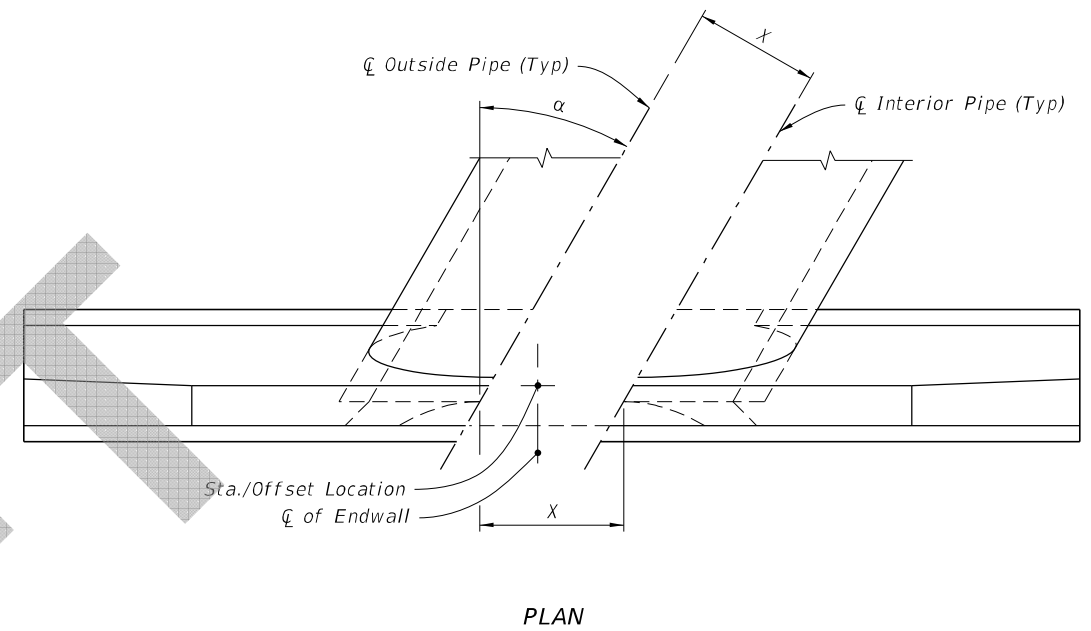
**NOTES:**

- Dimension X is calculated as:  $X = S \cdot \sec \alpha$ .
- Select tabular quantities using skew values as follows:
 

End Skew to Pipe	Use Tabulated Value
0° to 5°	0°



NORMAL PIPE




SKewed PIPE  
(Multiple Pipe Shown, Single Pipe Similar)

LEGEND:

- $\alpha$  Pipe Skew Angle
- S Center to Center between pipes
- X Center to Center along front of Headwall

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SPACING FOR MULTIPLE PIPES

LAST REVISION 11/01/19	REVISION	DESCRIPTION:	 FY 2020-21 STANDARD PLANS	STRAIGHT CONCRETE ENDWALLS SINGLE AND MULTIPLE PIPE	INDEX 430-030	SHEET 4 of 4
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