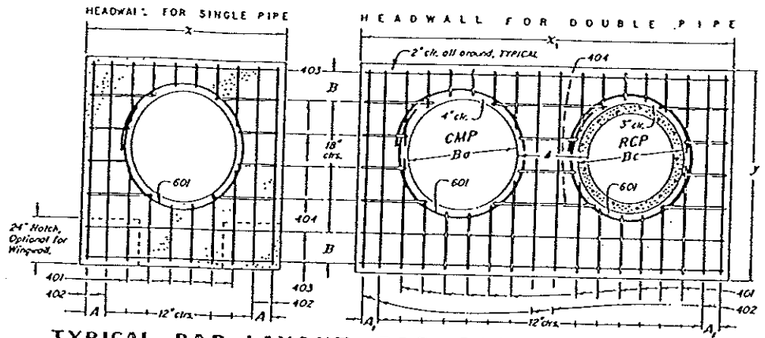
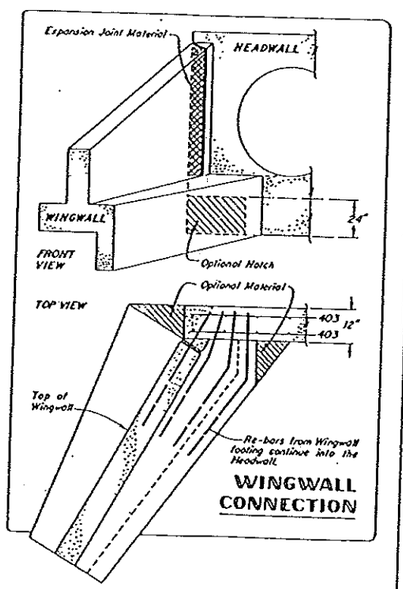
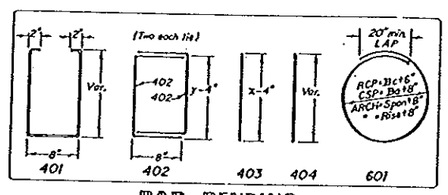


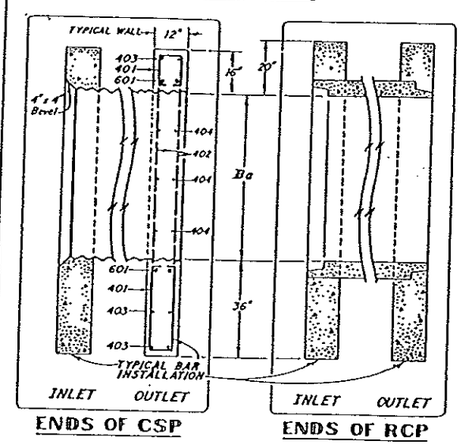
TYPICAL BAR LAYOUT FOR CONCRETE HEADWALLS



WINGWALL CONNECTION

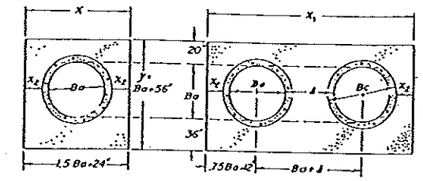


BAR BENDING



ENDS OF CSP

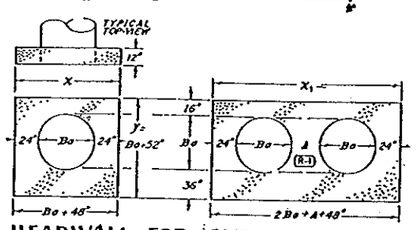
ENDS OF RCP



HEADWALL FOR RCP ⌀ ROUND

DIMENSIONS								QUANTITIES			
								CONCRETE		STEEL	
Ba in.	Bc in.	X ft-in.	A in.	X_1 ft-in.	A_1 in.	y ft-in.	B in.	X_2 in.	SGL cu.yd.	DBL cu.yd.	SGL lbs.	DBL lbs.
60	72	9-6	7	17-0	10	9-8	11	21	2.35	3.59	236	414
66	79	10-3	11½	18-6	7	10-2	14	22	2.60	4.44	249	453
72	86	11-0	10	20-0	10	10-8	17	23	2.85	4.31	270	476
78	93	11-9	8½	21-3	11	11-2	11	24	3.11	5.29	306	527
84	100	12-6	7	22-6	7	11-8	14	25	3.38	5.68	333	572
90	107	13-3	11½	23-9	8½	12-2	17	26	3.64	6.08	335	593
96	114	14-0	10	25-0	10	12-8	11	27	3.94	6.48	379	649
102	121	14-9	8½	26-3	11½	13-2	14	28	4.24	6.89	400	664
108	128	15-6	7	27-6	7	13-8	17	29	4.54	7.30	424	707

* * *



HEADWALL FOR CMP ~ ROUND

DIMENSIONS								QUANTITIES			
								CONCRETE		STEEL	
Ba in.	X ft-in.	A in.	X_1 ft-in.	A_1 in.	y ft-in.	B in.		SGL cu.yd.	DBL cu.yd.	SGL lbs.	DBL lbs.
60	9-0	10	16-6	7	9-4	18		2.38	4.25	217	396
66	9-6	7	17-9	8½	9-10	12		2.58	4.70	232	434
72	10-0	10	19-0	10	10-4	15		2.78	5.17	255	472
78	10-6	7	20-0	10	10-10	18		2.98	5.56	276	499
84	11-0	10	21-0	10	11-4	12		3.18	5.95	297	553
90	11-6	7	22-0	10	11-10	15		3.40	6.36	317	571
96	12-0	10	23-0	10	12-4	18		3.62	6.79	321	597
102	12-6	7	24-0	10	12-10	12		3.84	7.21	364	663
108	13-0	10	25-0	10	13-4	15		4.06	7.63	362	678

* * *

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

Concrete shall be Class A or B.

Headwall shall be perpendicular to the culvert ℄ unless otherwise shown on the plans.

For Wingwall details, see Standard M-601-WW.

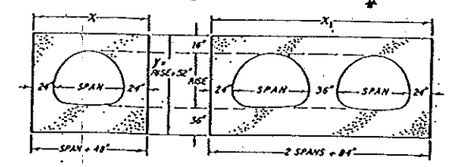
Volume occupied by pipe has been deducted from Steel and Concrete quantities.

4 —— When 2 or more conduits are laid side by side they shall be placed so that the adjacent pipes will be ½ Inside Diameter or ½ Inside Span or 3 feet apart (including wall thickness) whichever is less.

HEADWALL FOR CMP ~ ARCH

DIMENSIONS								QUANTITIES			
								CONCRETE		STEEL	
EQUIV Ba in.	SPAN in.	RISE in.	X ft-in.	A in.	X_1 ft-in.	A_1 in.	y ft-in.	B in.	SGL cu.yd.	DBL cu.yd.	SGL lbs.	DBL lbs.
72	81	59	10-9	8½	20-6	7	9-3	11½	2.72	5.10	250	467
78	87	63	11-3	11½	21-6	7	9-7	8½	2.85	5.34	275	531
84	93	67	11-9	8½	22-10	9	9-11	10½	3.06	5.79	290	547
90	103	71	12-7	7½	24-2	11	10-3	15	3.30	6.21	321	591
96	112	75	13-4	12	25-8	8	10-7	16½	3.53	6.65	314	606
102	117	79	13-9	8½	26-6	7	10-11	9½	3.63	6.86	356	672
108	128	83	14-8	8	28-4	12	11-3	11½	3.96	7.51	378	699

* * *



HEADWALL FOR STRUCTURAL PLATE~ARCH

DIMENSIONS								QUANTITIES			
								CONCRETE		STEEL	
EQUIV Ba in.	SPAN ft-in.	RISE ft-in.	X ft-in.	A in.	X_1 ft-in.	A_1 in.	y ft-in.	B in.	SGL cu.yd.	DBL cu.yd.	SGL lbs.	DBL lbs.
66	6-1	4-7	10-1	10½	19-8	11	8-11	13½	2.52	4.70	232	426
73	7-0	5-1	11-0	10	21-0	10	9-5	9½	2.80	5.25	282	509
84	7-11	5-7	11-11	9½	22-10	9	9-11	12½	3.08	5.79	291	540
93	8-10	6-1	12-10	9	24-8	8	10-5	15½	3.36	6.33	309	622
102	9-9	6-7	13-9	8½	26-6	7	10-11	9½	3.63	6.86	379	673
111	10-11	7-1	14-11	9½	28-10	9	11-5	12½	4.05	7.67	377	711
120	11-10	7-7	15-10	9	30-8	8	11-11	15½	4.36	8.28	393	751
132	12-10	8-5	16-10	9	32-8	8	12-8	11	4.75	9.03	441	839
141	14-1	8-9	18-1	10½	35-2	11	13-1	13½	5.17	9.86	448	931
150	15-4	9-3	19-4	12	37-8	8	13-7	16½	5.69	10.80	490	953
159	15-10	9-10	19-10	9	38-8	8	14-2	11	5.89	11.25	534	1019

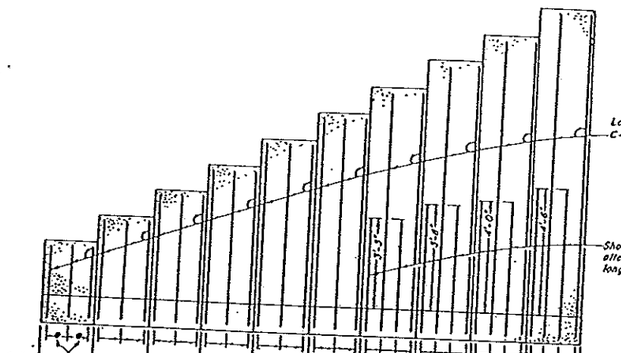
* * *

*SKEW FACTOR TABLE

SKEW ANGLE K°	FACTOR (over K°)
90	1.000
85	1.004
80	1.015
75	1.035
70	1.064
65	1.103
60	1.155
55	1.221
50	1.305
45	1.414
40	1.556
35	1.743
30	2.000

*Multiply X (or X_1) dimension and all quantities by factor if Culvert Skew is less than 90° and Headwall remains parallel to the roadway ℄.

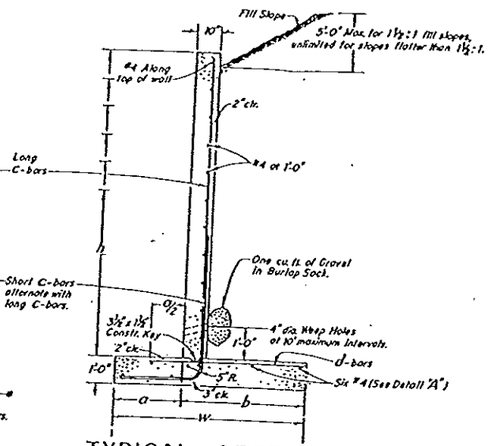
	REFERENCE: Colorado Department of Highways, Standard M-601-CH	STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA	HEADWALLS FOR PIPE CULVERTS — STANDARD DETAIL SD-7



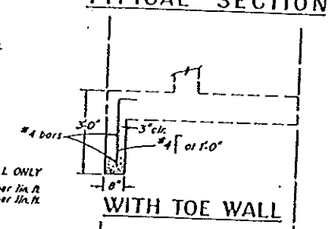
e =	1'-6"	1'-6"	1'-6"	1'-6"	1'-0"	0'-8½"	1'-0"	0'-9½"	0'-7"	0'-5½" ctrs.
h =	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'
a =	1'-0"	1'-2"	1'-4"	1'-6"	1'-8"	1'-10"	2'-0"	2'-2"	2'-4"	2'-6"
b =	1'-8"	2'-0"	2'-4"	2'-8"	3'-0"	3'-4"	3'-8"	4'-0"	4'-4"	4'-8"
w =	2'-8"	3'-2"	3'-8"	4'-2"	4'-8"	5'-2"	5'-8"	6'-2"	6'-8"	7'-2"
c & d bars	#4 at 1'-6"	#4 at 1'-6"	#4 at 1'-6"	#4 at 1'-6"	#4 at 1'-0"	#4 at 8½"	#6 at 1'-0"	#6 at 9½"	#6 at 7"	#6 at 5½" ctrs.
*Conc. cu.yd./Lf	0.161	0.210	0.259	0.308	0.358	0.407	0.457	0.506	0.556	0.604
*Reinf. lb/Lf	8.0	9.3	10.7	12.1	16.2	21.7	29.0	37.0	51.0	67.3

* Does not include Toe Wall quantities.

DESIGN TABLE

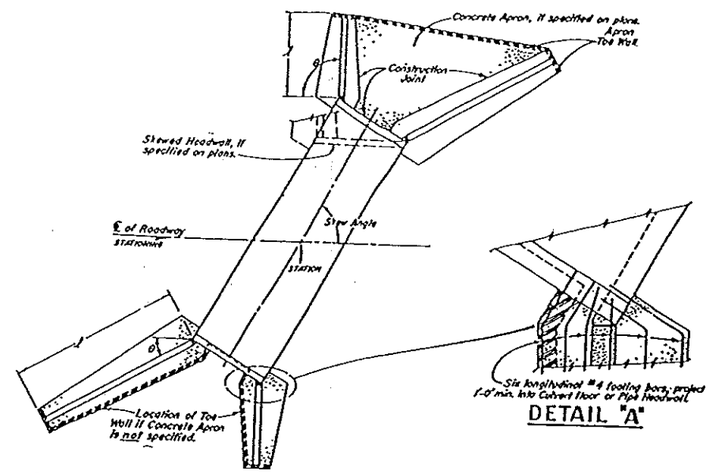


TYPICAL SECTION



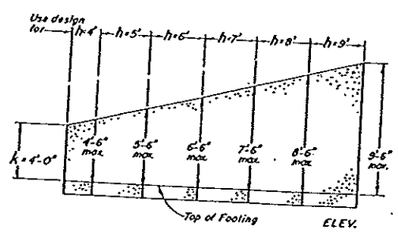
QUANTITIES FOR TOE WALL ONLY
Concrete 0.049 cu.yd. per lin. ft.
Reinforcement 3.4 lb. per lin. ft.

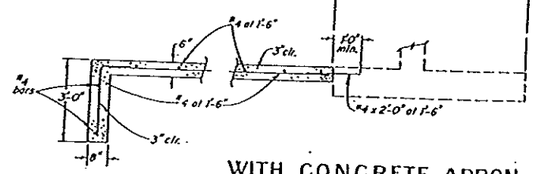
WITH TOE WALL



DETAIL "A"

TYPICAL CULVERT LAYOUT

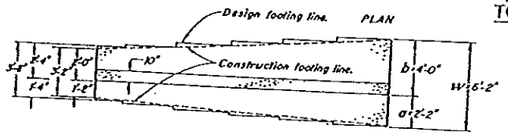




APRON TOE WALL

WITH CONCRETE APRON

Re-bar: .89 lb/sq. ft.



DESIGN EXAMPLE

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

All exposed corners on concrete shall be chamfered ¾".

Wingwall footings and floor of Box Culvert shall be placed monolithically.

Expansion Joint Material shall conform to AASHTO M-213 and payment therefor shall be included in the price for Concrete, (Box Culvert) or (Wall).

Dimensions "H," "Bw," "Rise," "k," "f," "m" and angles for wingwalls shall be as shown on the plans.

The minimum splice length for common bar sizes shall be:

BAR SIZE	#4	#6
SPLICE LENGTH	1'-0"	1'-8"

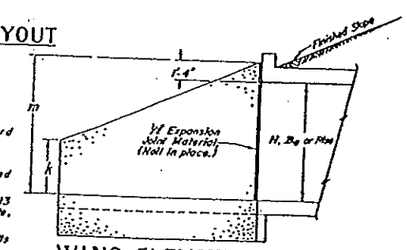
DESIGN DATA:

Unit Stresses: f_s = 20,000 psi
f_c = 1,200 psi
n = 10

Equivalent Fluid Pressure = 30 lbs./cu.ft.
Maximum Toe Pressure = 1 Ton/sq. ft.

All construction joints shall be thoroughly cleaned before fresh concrete is poured.

Wingwall Concrete shall be:
Concrete, Class A (Box Culvert) for CBC's.
Concrete, Class A, B or D (Wall) for Pipes.



WING ELEVATION

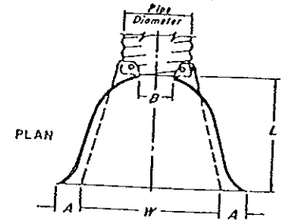
m = H, Bw or Rise + (1'-4") unless otherwise shown on Plans.

REFERENCE: Colorado Department of Highways, Standard M-601-WW

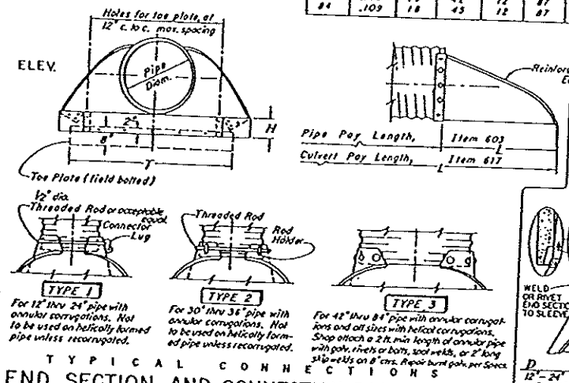
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

WINGWALLS

STANDARD DETAIL SD-8

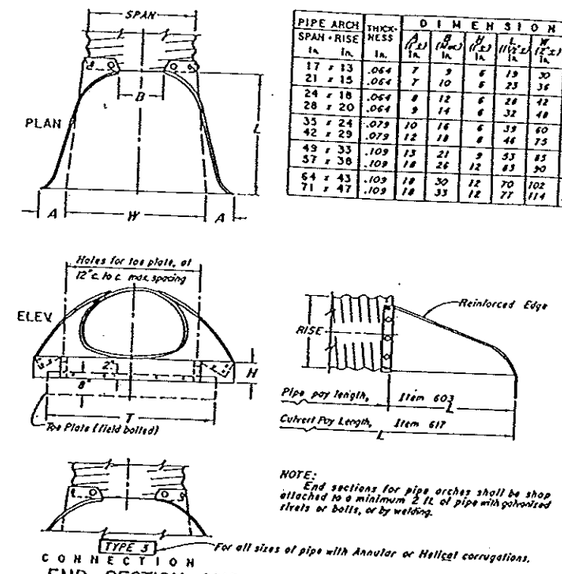


PIPE DIAM. In.	THICKNESS In.	DIMENSIONS A (±2) In.	B (Min.) In.	H (±2) In.	L (1½ D) In.	M (±2) In.	T In.
12	.064	6	6	6	21	24	34
15	.064	7	8	6	26	30	40
18	.064	8	10	6	31	36	46
21	.064	9	12	6	36	42	52
24	.064	10	13	6	41	48	58
30	.079	12	16	8	51	60	70
36	.079	14	19	9	60	72	84
42	.109	16	22	11	69	84	106
48	.109	18	27	12	78	90	112
54	.109	18	30	12	84	102	124
60	.109	18	33	12	87	114	136
66	.109	18	36	12	87	120	142
72	.109	18	39	12	87	126	148
78	.109	18	42	12	87	132	154
84	.109	18	45	12	87	138	160



END SECTION AND CONNECTION DETAILS FOR ROUND CORRUGATED METAL PIPE CULVERTS

STEEL END SECTION FOR CONCRETE PIPE
(Alternate for Concrete End Section)



PIPE ARCH SPAN × RISE In.	In.	THICKNESS In.	DIMENSIONS A (±2) In.	B (Min.) In.	H (±2) In.	L (1½ D) In.	M (±2) In.	T In.
17	13	.064	7	9	6	19	30	40
21	15	.064	7	10	6	23	36	46
24	18	.064	8	12	6	28	42	52
28	20	.064	9	14	6	32	48	58
35	24	.079	10	16	6	39	60	70
42	29	.079	12	18	8	46	75	85
49	33	.109	13	21	9	53	85	103
57	38	.109	18	26	12	63	90	108
64	43	.109	18	30	12	70	102	120
71	47	.109	18	33	12	77	114	132

NOTE:
End sections for pipe arches shall be shop attached to a minimum 2 ft. of pipe with galvanized rivets or bolts, or by welding.

END SECTION AND CONNECTION DETAIL FOR CORRUGATED METAL PIPE ARCH CULVERT

GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

Concrete End Sections are to be furnished with tongue or groove as req'd.

Alternate equivalent designs for Concrete End Sections may be submitted to the Division for approval. Design length of culvert is based on length of End Section shown in table. Additional pipe required to provide the design length of the culvert shall be furnished by and at the expense of the Contractor.

Other sizes of concrete pipe and end sections may be available upon request; however, the designer should contact supplier prior to calling for sizes other than those shown on this standard.

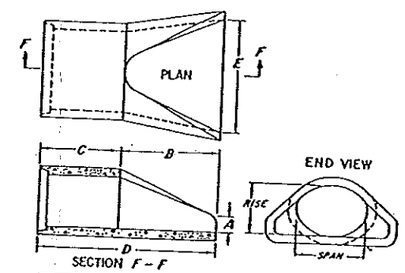
Inside configuration and joint of concrete end section and pipe shall match.

End sections for CMP Arch Culvert shall match the dimensions of the culvert shown on plans.

Galvanized Toe Plate as shown will be required on End Sections for corrugated steel pipe and shall be same thickness as End Sections. Toe Plate shall be field bolted to End Section with ⅜" galvanized bolts, nuts and washers.

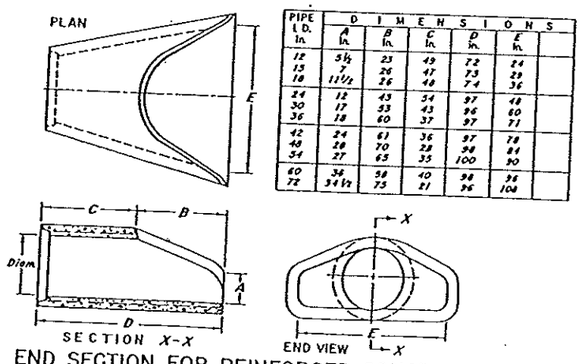
Designs for Aluminum End Sections for use on aluminum culverts shall be submitted to the Division for approval prior to use.

Concrete Pipe Joint Fasteners, where shown on plans, shall be installed so that a minimum of 15 linear feet of the outlet end of the pipe are mechanically locked together. End Section lengths, when used, will be included in the 15 L.F. requirement.



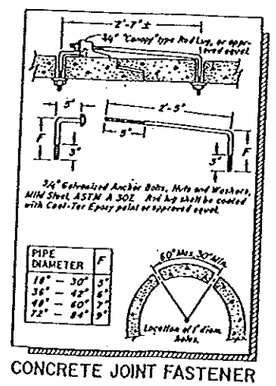
EQUIVALENT CIRCULAR DIAM. (Inches)	NOMINAL (In.) SPAN	RISE	DIMENSIONS (Inches) A	B	C	D	E
24	30	19	6½	39	33	72	48
30	38	24	9½	54	48	78	60
36	43	29	11½	60	54	84	72
42	53	34	13¾	60	60	96	78
48	60	38	21	60	36	96	84
54	68	43	23½	60	36	96	90
60	76	48	30	60	36	96	96

END SECTION FOR REINFORCED CONCRETE ELLIPTICAL PIPE

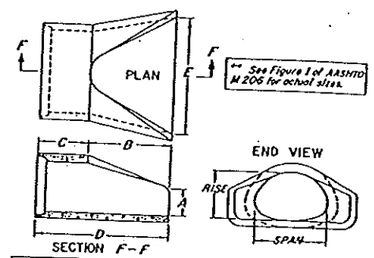


PIPE (I.D. In.	DIMENSIONS A In.	B In.	C In.	D In.	E In.
12	5½	23	49	72	24
15	7	26	47	73	29
18	11½	26	48	74	36
24	12	43	54	97	48
30	17	53	43	96	60
36	18	60	37	97	71
42	24	61	36	97	78
48	28	70	28	98	84
54	27	65	35	100	90
60	34	56	40	98	96
72	34½	75	21	96	104

END SECTION FOR REINFORCED CONCRETE CIRCULAR PIPE



CONCRETE JOINT FASTENER



EQUIVALENT CIRCULAR DIAM. (Inches)	NOMINAL (In.) SPAN	RISE	DIMENSIONS (Inches) A	B	C	D	E
24	29	18	6½	39	33	72	48
30	36	22	9½	50	48	96	60
36	43	27	11½	60	36	96	72
42	50	31	13¾	60	36	96	78
48	54	36	21	60	36	96	84
54	65	40	23½	60	36	96	90
60	72	44	31	60	36	96	96
72	88	54	31	60	39	99	120

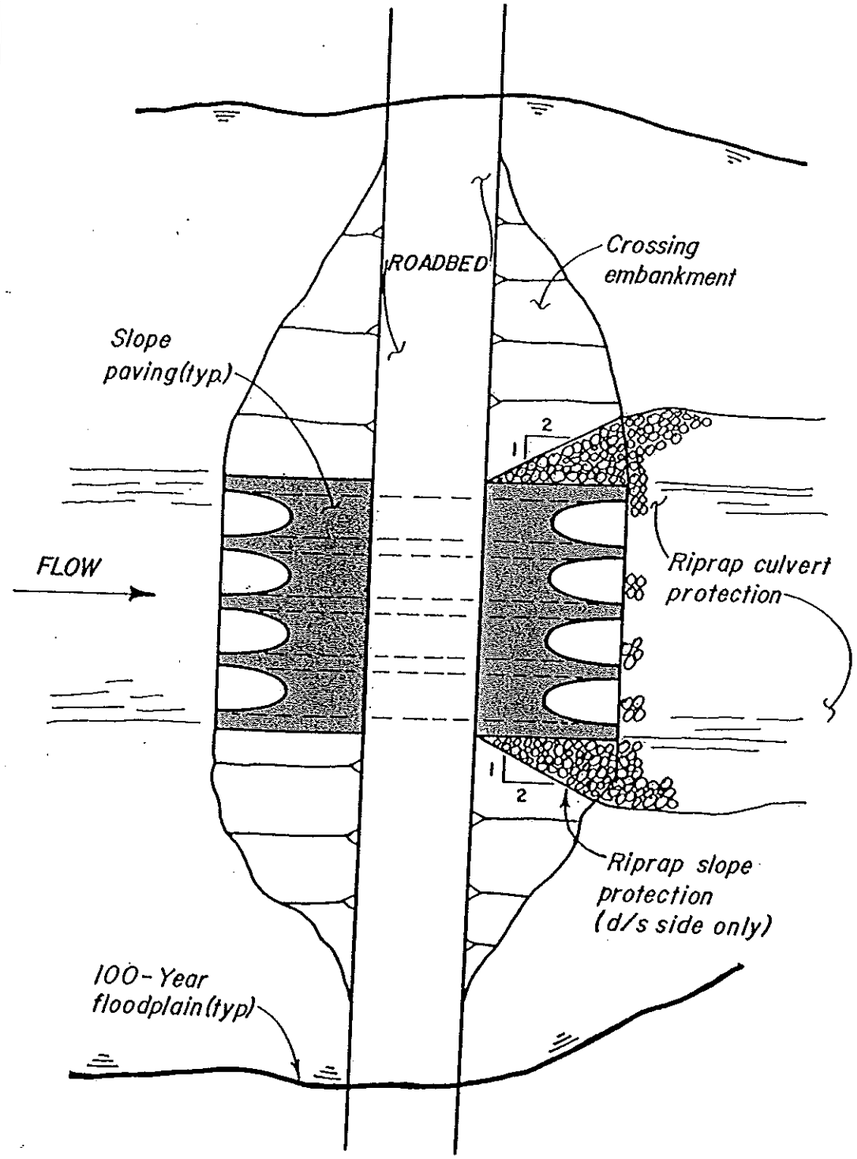
END SECTION FOR REINFORCED CONCRETE ARCH PIPE

REFERENCE: Colorado Department of Highways, Standard M-603-CA

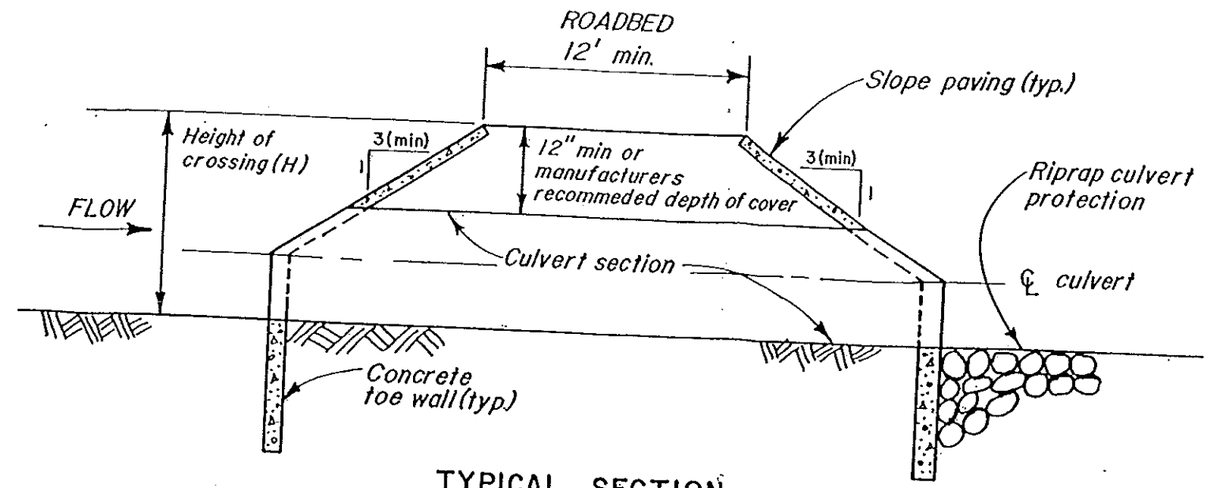
STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA

CONCRETE OR METAL END SECTIONS

STANDARD DETAIL SD-9

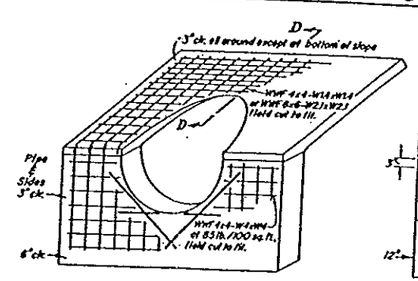


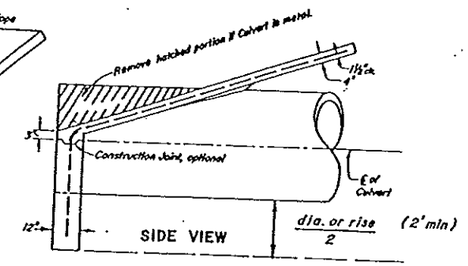
TYPICAL PLAN VIEW

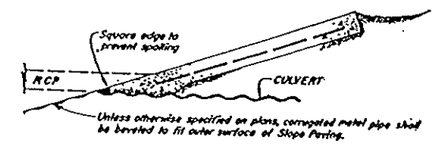


TYPICAL SECTION

HEADWALL WITH SLOPE PAVING

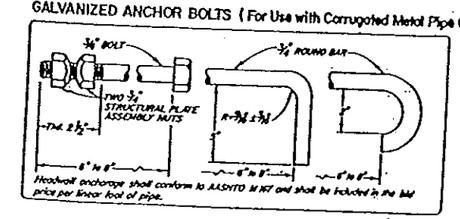


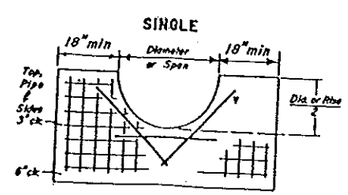


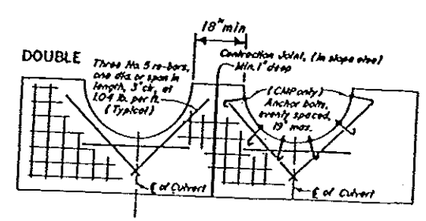


SECTION D-D

TYPICAL
GALVANIZED ANCHOR BOLTS (For Use with Corrugated Metal Pipe Only)







GENERAL NOTES

All work shall be done in accordance with the Standard Specifications applicable to the project.

Concrete shall be Class A or B.

Headwall shall be parallel to roadway centerline--(unless otherwise specified).

Exposed corners on concrete shall be chamfered ¾".

TYPE "S" HEADWALL AND SLOPE PAVING FOR ROUND PIPE OR ARCH PIPE

	REFERENCE: Colorado Department of Highways Standard M-601-KA (with modifications)	STORM DRAINAGE DESIGN AND TECHNICAL CRITERIA	LOW WATER CROSSING STANDARD DETAIL SD-10