

Drainage Design Documentation

**Project No. IM-AL06(900)
I-10 INTERCHANGE MODIFICATIONS
FROM TEXAS ST (EXIT 25A) TO WEST TUNNEL ENTRANCE**

Mobile County

July 2018

**Prepared for
Alabama Department of Transportation**

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I. Introduction

This project includes modifications to the horizontal and vertical alignments of I-10, removal of some current structures, addition of structures, addition of an interchange to connect Canal Street and Water Street, and a new local roadway that goes under I-10 and connects Claiborne Street and Jackson Street to Royal Street.

The project is located in Mobile County, Alabama and has a distance of approximately 1.1 miles. The project includes grade, drain, base, pave, bridges, lighting, sign bridges, utilities, ITS and signals.

II. Engineering Methods

Hydraulic analyses for the cross drain pipes were accomplished using FHWA HY-8 computer software. Ditch design was accomplished using FHWA Hydraulic Toolbox computer software.

Curb inlet spread was calculated using FHWA Hydraulic Toolbox computer software. Pipe systems were analyzed using Bentley StormCAD V8i.

The rainfall runoff estimates were determined based on Hydrological Methodology found in Chapter 4 of the Alabama D.O.T. Hydraulics Manual.

III. Drainage Design

III.1 Cross Drain Hydraulic Data Summary

HY-8 Culvert Analysis Report

Crossing Notes: 24-24B

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 3.68 cfs

Maximum Flow: 5 cfs

Table 1 - Summary of Culvert Flows at Crossing: 24-24B

Headwater Elevation (ft)	Total Discharge (cfs)	18 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
8.64	0.00	0.00	0.00	1
8.99	0.50	0.50	0.00	1
9.14	1.00	1.00	0.00	1
9.26	1.50	1.50	0.00	1
9.36	2.00	2.00	0.00	1
9.47	2.50	2.50	0.00	1
9.57	3.00	3.00	0.00	1
9.67	3.50	3.50	0.00	1
9.70	3.68	3.68	0.00	1
9.84	4.50	4.50	0.00	1
9.92	5.00	5.00	0.00	1
12.29	14.49	14.49	0.00	Overtopping

Table 2 - Culvert Summary Table: 18

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	8.64	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
0.50	0.50	8.99	0.351	0.0*	1-S2n	0.166	0.258	0.166	0.090	4.564	3.689
1.00	1.00	9.14	0.501	0.0*	1-S2n	0.232	0.369	0.242	0.140	5.347	4.753
1.50	1.50	9.26	0.620	0.0*	1-S2n	0.283	0.454	0.283	0.182	6.261	5.489
2.00	2.00	9.36	0.723	0.0*	1-S2n	0.326	0.530	0.341	0.220	6.422	6.060
2.50	2.50	9.47	0.829	0.0*	1-S2n	0.365	0.596	0.381	0.255	6.842	6.530
3.00	3.00	9.57	0.931	0.0*	1-S2n	0.401	0.658	0.401	0.288	7.636	6.935
3.50	3.50	9.67	1.026	0.0*	1-S2n	0.434	0.714	0.454	0.320	7.505	7.289
3.68	3.68	9.70	1.058	0.0*	1-S2n	0.445	0.733	0.466	0.331	7.620	7.406
4.50	4.50	9.84	1.199	0.0*	1-S2n	0.495	0.812	0.519	0.381	8.018	7.882
5.00	5.00	9.92	1.282	0.0*	1-S2n	0.523	0.856	0.547	0.410	8.293	8.138

* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

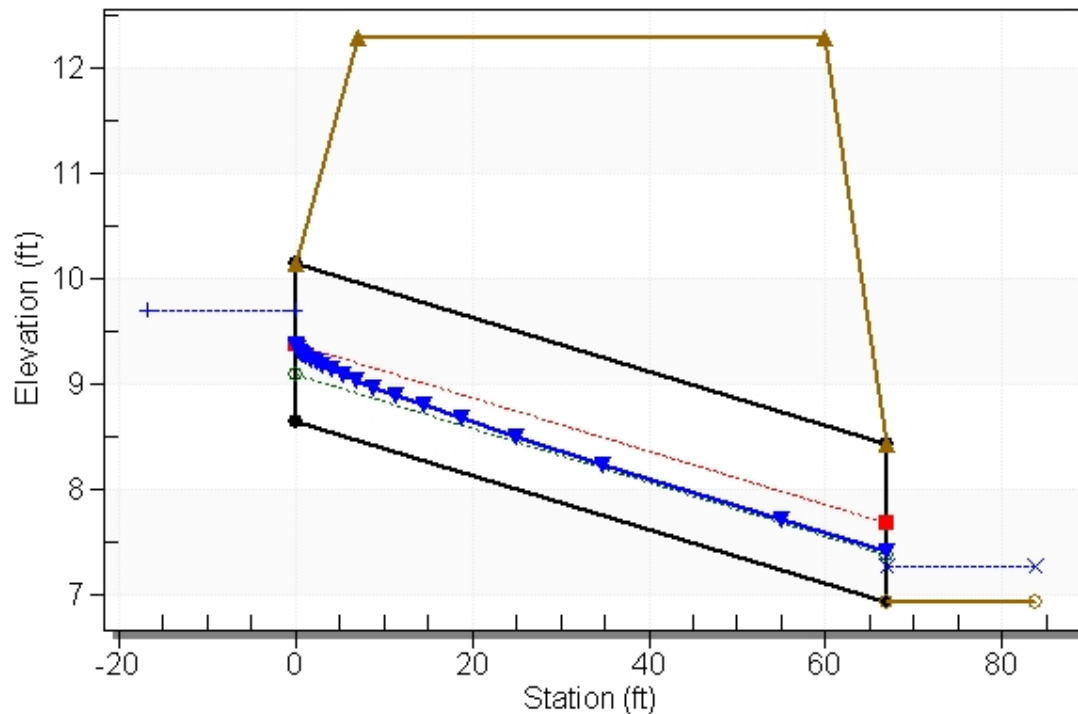
Inlet Elevation (invert): 8.64 ft, Outlet Elevation (invert): 6.93 ft

Culvert Length: 67.02 ft, Culvert Slope: 0.0255

Water Surface Profile Plot for Culvert: 18

Crossing - 24-24B, Design Discharge - 3.7 cfs

Culvert - 18, Culvert Discharge - 3.7 cfs



Site Data - 18

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 8.64 ft

Outlet Station: 67.00 ft

Outlet Elevation: 6.93 ft

Number of Barrels: 1

Culvert Data Summary - 18

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 24-24B)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	6.93	0.00	0.00	0.00	0.00
0.50	7.02	0.09	3.69	0.14	2.16
1.00	7.07	0.14	4.75	0.22	2.24
1.50	7.11	0.18	5.49	0.29	2.27
2.00	7.15	0.22	6.06	0.35	2.28
2.50	7.19	0.26	6.53	0.40	2.28
3.00	7.22	0.29	6.94	0.46	2.28
3.50	7.25	0.32	7.29	0.51	2.27
3.68	7.26	0.33	7.41	0.53	2.27
4.50	7.31	0.38	7.88	0.60	2.25
5.00	7.34	0.41	8.14	0.65	2.24

Tailwater Channel Data - 24-24B

Tailwater Channel Option: Rectangular Channel

Bottom Width: 1.50 ft

Channel Slope: 0.0254

Channel Manning's n: 0.0120

Channel Invert Elevation: 6.93 ft

Roadway Data for Crossing: 24-24B

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 12.29 ft

Roadway Surface: Paved

Roadway Top Width: 53.00 ft

Crossing Notes: 24B-25

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 5.17 cfs

Maximum Flow: 10 cfs

Table 1 - Summary of Culvert Flows at Crossing: 24B-25

Headwater Elevation (ft)	Total Discharge (cfs)	18 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6.93	0.00	0.00	0.00	1
7.43	1.00	1.00	0.00	1
7.66	2.00	2.00	0.00	1
7.87	3.00	3.00	0.00	1
8.05	4.00	4.00	0.00	1
8.22	5.00	5.00	0.00	1
8.25	5.17	5.17	0.00	1
8.56	7.00	7.00	0.00	1
8.74	8.00	8.00	0.00	1
8.95	9.00	9.00	0.00	1
9.19	10.00	10.00	0.00	1
9.61	11.56	11.56	0.00	Overtopping

Table 2 - Culvert Summary Table: 18

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	6.93	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
1.00	1.00	7.43	0.504	0.0*	1-S2n	0.261	0.369	0.261	0.127	4.718	1.696
2.00	2.00	7.66	0.728	0.0*	1-S2n	0.369	0.530	0.369	0.189	5.730	2.139
3.00	3.00	7.87	0.939	0.0*	1-S2n	0.454	0.658	0.454	0.237	6.425	2.436
4.00	4.00	8.05	1.122	0.0*	1-S2n	0.528	0.765	0.528	0.278	6.953	2.665
5.00	5.00	8.22	1.289	0.0*	1-S2n	0.596	0.856	0.619	0.314	7.030	2.853
5.17	5.17	8.25	1.317	0.0*	1-S2n	0.607	0.870	0.607	0.320	7.450	2.883
7.00	7.00	8.56	1.627	0.261	5-S2n	0.721	1.021	0.748	0.377	7.692	3.156
8.00	8.00	8.74	1.815	0.551	5-S2n	0.781	1.092	0.813	0.405	7.926	3.283
9.00	9.00	8.95	2.024	1.037	5-S2n	0.841	1.156	0.874	0.431	8.158	3.397
10.00	10.00	9.19	2.259	1.347	5-S2n	0.900	1.218	0.937	0.455	8.359	3.502

* Full Flow Headwater elevation is below inlet invert.

Straight Culvert

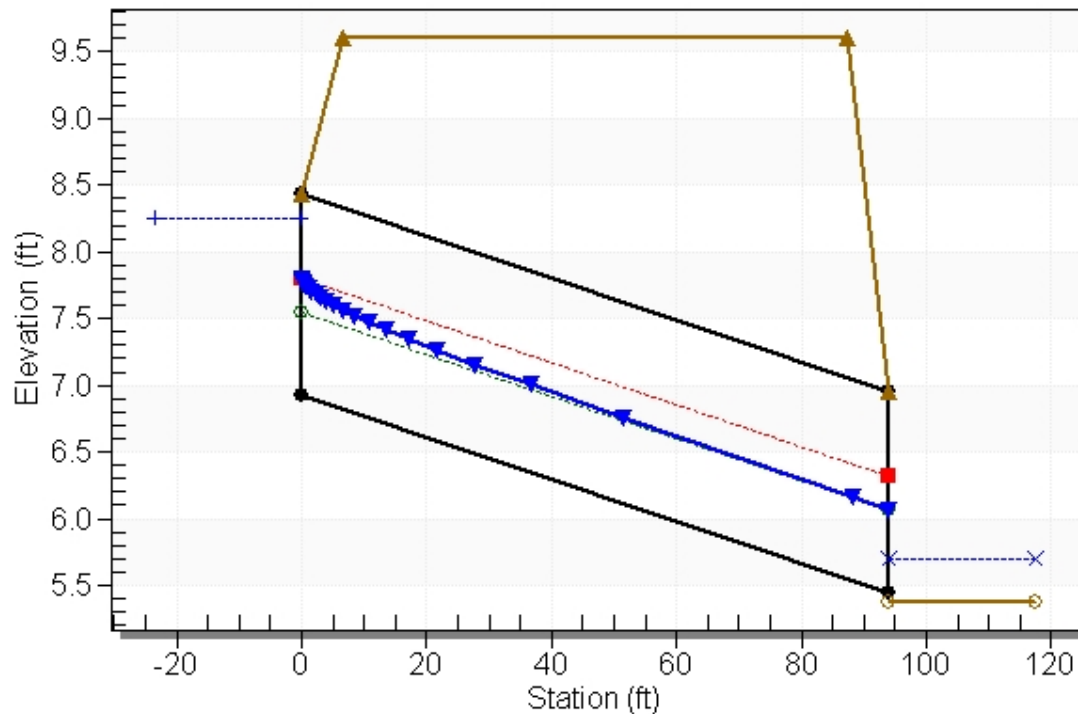
Inlet Elevation (invert): 6.93 ft, Outlet Elevation (invert): 5.45 ft

Culvert Length: 94.01 ft, Culvert Slope: 0.0157

Water Surface Profile Plot for Culvert: 18

Crossing - 24B-25, Design Discharge - 5.2 cfs

Culvert - 18, Culvert Discharge - 5.2 cfs



Site Data - 18

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6.93 ft

Outlet Station: 94.00 ft

Outlet Elevation: 5.45 ft

Number of Barrels: 1

Culvert Data Summary - 18

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: 24B-25)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5.38	0.00	0.00	0.00	0.00
1.00	5.51	0.13	1.70	0.03	0.89
2.00	5.57	0.19	2.14	0.04	0.95
3.00	5.62	0.24	2.44	0.05	0.98
4.00	5.66	0.28	2.67	0.06	1.00
5.00	5.69	0.31	2.85	0.07	1.02
5.17	5.70	0.32	2.88	0.07	1.02
7.00	5.76	0.38	3.16	0.08	1.04
8.00	5.78	0.40	3.28	0.09	1.05
9.00	5.81	0.43	3.40	0.09	1.06
10.00	5.83	0.45	3.50	0.10	1.07

Tailwater Channel Data - 24B-25

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 4.00 ft

Side Slope (H:V): 5.00 (_:1)

Channel Slope: 0.0035

Channel Manning's n: 0.0120

Channel Invert Elevation: 5.38 ft

Roadway Data for Crossing: 24B-25

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 9.61 ft

Roadway Surface: Paved

Roadway Top Width: 81.00 ft

III.2 Closed System Design Data Summary

GUTTER SPREAD & INLET EFFICIENCY

Node	Bypass To	STA	Side	L (ft.)	A.asph (acre)	A.gr	Area acre	Q area (cfs)	Q ttl (cfs)	Depth (ft.)	Spread (ft.)	Q.i (cfs)	Bypass (cfs)	Bypass Percent	Type
Node #	Bypass to Node #	Station	Side	Inlet Opening Length	Area	Area		runoff for area values given	Area runoff + Bypass	Depth at Face of Curb	Ponding				
28	n/a	807+97.00	RT	13	0.09	0.05	0.14	0.79	0.79	0.28	7.97	0.79	0.00	0%	S-1w
28A	28	808+72.00	RT	13	0.09	0.04	0.13	0.76	0.76	0.28	7.82	0.76	0.00	0%	S-1w
29	n/a	807+97.00	LT	13	0.18	0.15	0.33	1.72	1.72	0.35	10.80	1.72	0.00	0%	S-1w
30	28	809+50.00	RT	13	0.12	0.03	0.15	0.94	0.94	0.31	6.86	0.94	0.00	0%	S-1w
31	29	809+50.00	LT	13	0.15	0.17	0.32	1.56	1.56	0.34	10.37	1.56	0.00	0%	S-1w
32	37	811+00.00	RT	13	0.06		0.06	0.42	0.42	0.20	6.21	0.42	0.00	0%	S-1w
33	34	811+00.00	LT	13	0.05	0.07	0.12	0.56	0.56	0.22	4.95	0.56	0.00	0%	S-1w
34	35	812+00.00	LT	13	0.12	0.20	0.32	1.44	1.44	0.26	6.58	1.44	0.00	0%	S-1w
35	36	813+57.00	LT	13	0.20	0.31	0.51	2.33	2.33	0.32	9.09	2.33	0.00	0%	S-1w
36		814+12.00	LT	21	0.25	0.25	0.50	2.51	2.51	0.42	13.79	2.51	SAG		S-2w
75	36	815+15.82	LT	13	0.30	0.20	0.50	2.72	2.72	0.42	13.61	2.72	0.00	0%	S-1w
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
37	38	812+00.00	RT	13	0.10	0.07	0.17	0.91	0.91	0.22	7.96	0.91	0.00	0%	S-1w
38	39	813+59.00	RT	13	0.23	0.05	0.28	1.78	1.78	0.29	7.91	1.78	0.00	0%	S-1w
39		814+12.00	RT	21	0.19	0.04	0.23	1.46	1.46	0.36	11.00	1.46	SAG		S-2w
40	39	814+60.00	RT	21	0.18		0.18	1.27	1.27	0.33	9.86	1.27	0.00	0%	S-2w
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
78	75	816+81.00	RT	6	0.29	0.10	0.39	2.35	2.35	0.41	13.16	2.35	0.00	0%	
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
54	75	817+06.16	LT	13	0.09	0.14	0.23	1.05	1.05	0.33	9.51	1.05	0.00	0%	S-1w
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
55	75	817+02.67	RT	13	0.05		0.05	0.35	0.35	0.24	5.78	0.35	0.00	0%	S-1w
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
56	N/A	817+08.37	RT	13	0.02		0.02	0.14	0.14	0.18	2.79	0.14	0.00	0%	S-1w

GUTTER SPREAD & INLET EFFICIENCY

Node	Bypass	STA	Side	L	A.asph	A.gr	Area	Q area	Q ttl	Depth	Spread	Q.i	Bypass	Bypass	Type
	To			(ft.)	(acre)		acre	(cfs)	(cfs)	(ft.)	(ft.)	(cfs)	(cfs)	Percent	
Node #	Bypass to Node #	Station	Side	Inlet Opening Length	Area	Area		runoff for area values given	Area runoff + Bypass	Depth at Face of Curb	Ponding				
85	84	1704+00.00	LT	13	0.15	0.56	0.71	2.60	2.60	0.31	8.93	2.60	0.00	0%	S-1w
84	83	1702+49.00	LT	13	0.15	0.43	0.58	2.25	2.25	0.33	9.69	2.25	0.00	0%	S-1w
83		1701+99.00	LT	21	0.09	0.23	0.32	1.27	1.27	0.33	9.60	1.27	SAG		S-2w
82	83	1701+48.00	LT	13	0.17	0.27	0.44	1.95	1.95	0.35	10.49	1.95	0.00	0%	S-1w
81	82	1803+89.00	LT	13	0.25		0.25	1.77	1.77	0.27	6.78	1.77	0.00	0%	S-1w
79		1502+35.00	RT	13	0.21		0.21	1.49	1.49	0.28	7.50	1.49	SAG		S-1w
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
76	77	1706+50.00	LT	13	0.12	0.39	0.51	1.92	1.92	0.28	7.44	1.92	0.00	0%	S-1w
77	78	1708+38.00	LT	13	0.20	0.85	1.05	3.76	3.76	0.31	8.85	3.76	0.00	0%	S-1w
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
86A	86	1700+36.03	RT	13	0.29	0.09	0.38	2.30	2.30	0.30	8.33	2.30	0.00	0%	S-1w
86	87	1701+48.00	RT	13	0.13	0.20	0.33	1.47	1.47	0.32	9.17	1.47	0.00	0%	S-1w
87		1701+99.00	RT	21	0.13	0.16	0.29	1.36	1.36	0.35	10.66	1.36	SAG		S-2w
88	87	1702+49.00	RT	13	0.17	0.31	0.48	2.06	2.06	0.32	9.42	2.06	0.00	0%	S-1w
89	88	1704+00.00	RT	13	0.17	0.12	0.29	1.53	1.53	0.27	6.91	1.53	0.00	0%	S-1w
							0.00	0.00	0.00	0.00	0.00	0.00	SAG		
73	74	1706+50.00	RT	13	0.14		0.14	0.99	0.99	0.23	5.09	0.99	0.00	0%	S-1w
74	75	1708+38.00	RT	13	0.22	0.41	0.63	2.69	2.69	0.28	7.54	2.69	0.00	0%	S-1w

PROJECT NO. IM-AL06 (900)

I-10 TEXAS STREET

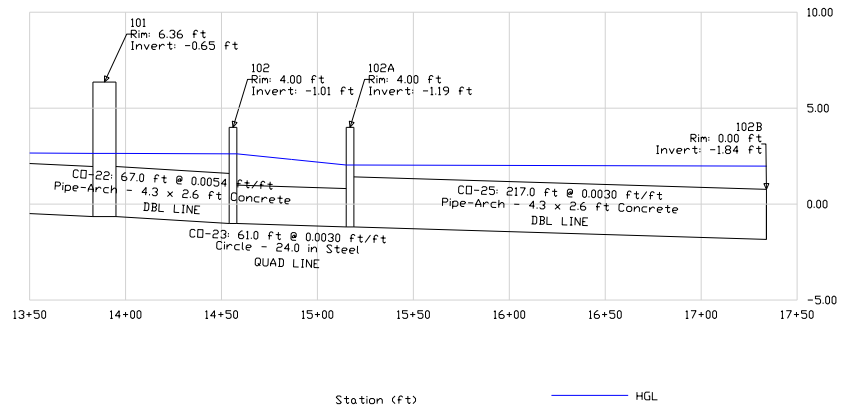
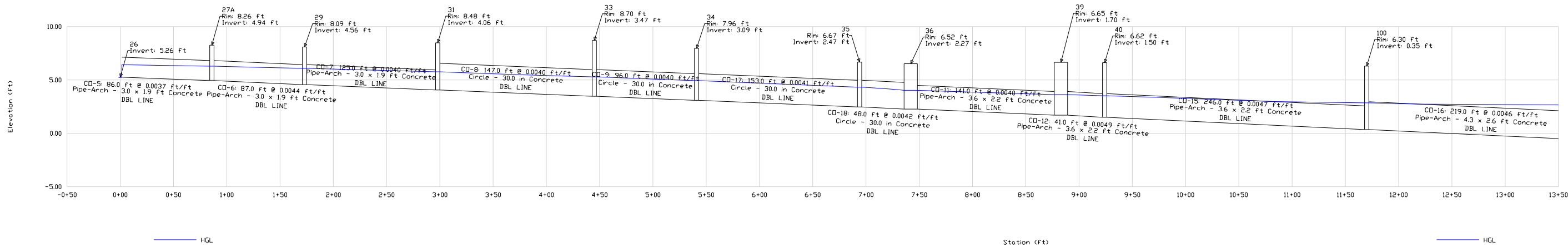
Conduit FlexTable: Combined Pipe/Node Report

Label	Start Node	Stop Node	Flow (cfs)	Rise (Unified) (ft)	Capacity (Full Flow) (cfs)	Velocity (ft/s)	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Slope (ft/ft)
CO-5	26	27A	29.81	1.88	(N/A)	5.15	5.26	4.94	0.0037
CO-6	27A	29	38.31	1.88	(N/A)	5.78	4.94	4.56	0.0044
CO-7	29	31	40.05	1.88	(N/A)	5.61	4.56	4.06	0.0040
CO-8	31	33	41.64	2.50	51.97	5.88	4.06	3.47	0.0040
CO-9	33	34	45.24	2.50	51.61	5.93	3.47	3.09	0.0040
CO-11	36	39	65.58	2.22	(N/A)	6.34	2.27	1.70	0.0040
CO-12	39	40	68.23	2.22	(N/A)	6.91	1.70	1.50	0.0049
CO-15	40	100	69.50	2.22	(N/A)	6.80	1.50	0.35	0.0047
CO-16	100	101	88.43	2.61	(N/A)	7.26	0.35	-0.65	0.0046
CO-17	34	35	46.73	2.50	52.22	6.01	3.09	2.47	0.0041
CO-18	35	36	49.14	2.50	52.95	6.12	2.47	2.27	0.0042
CO-20	56	100	18.93	3.00	37.88	5.36	2.61	2.51	0.0032
CO-21	27	27A	8.50	2.00	16.61	5.32	5.05	4.94	0.0054
CO-22	101	102	88.43	2.61	(N/A)	7.73	-0.65	-1.01	0.0054
CO-23	102	102A	88.43	2.00	49.15	7.04	-1.01	-1.19	0.0030
CO-25	102A	102B	88.43	2.61	(N/A)	6.09	-1.19	-1.84	0.0030

Notes

PROJECT NO. IM-AL06 (900)
I-10 TEXAS STREET

ENGINEERING PROFILE VIEW
NODE 26-102B



IM-AL06(900) I-10 TEXAS STREET

*** NODE 28

Pipe Design

Nodes	Link	Length (ft)	Diam (in)	Invert Up/Dn (ft)	Slope (ft/ft)	Depth Up/Dn (ft)	Min. Cover (ft)	Velocity Act/Full (ft/sec)	--Flow-- Act/Full (cfs)	Estimated Cost (\$)
28A-30	1	74	18	7.25 6.70	.00746	2.8 3.9	1.1	3.7 5.6	1.07 9.86	0.
30-30A	2	39	18	6.70 6.54	.00408	3.9 4.0	2.3	3.5 4.1	1.99 7.29	0.
30A-31A	3	36	18	6.54 6.39	.00412	4.0 4.1	2.3	3.8 4.1	2.74 7.32	0.
31A-32	4	65	18	6.39 6.13	.00402	4.1 4.4	2.5	4.0 4.1	3.21 7.23	0.
32-33	5	78	18	6.13 3.90	.02877	4.4 5.2	2.8	8.4 11.0	3.60 19.36	0.

				LENGTH =	292.	TOTAL LENGTH =	292.			
				COST =	0.	TOTAL COST =	0.			

IM-AL06(900) I-10 TEXAS STREET

*** NODE 37

Pipe Design

Nodes	Link	Length (ft)	Diam (in)	Invert	Slope (ft/ft)	Depth	Min. Cover (ft)	Velocity	--Flow--	Estimated Cost (\$)
				Up/Dn (ft)		Up/Dn (ft)		Act/Full (ft/sec)	Act/Full (cfs)	
37-38	15	156	18	5.30	.01192	4.0	2.2	4.1	.92	0.
				3.44		3.9		7.1	12.46	
38-39	16	50	18	3.44	.00505	3.9	2.2	4.1	2.65	0.
				3.19		3.8		4.6	8.11	

Hydraulic Analysis Report

Project Data

Project Title: IM-AL06(900) – I-10 TEXAS STREET

Designer:

Project Date: Thursday, August 29, 2013

Project Units: U.S. Customary Units

Notes:

Curb and Gutter Analysis: 820+00 10yr

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0020 ft/ft

Cross-Slope of Pavement: 0.0340 ft/ft

Uniform Gutter Geometry

Manning's n: 0.0150

Gutter Width: 2.0000 ft

Width of Spread: 9.9928 ft

Gutter Result Parameters

Design Flow: 2.7600 cfs

Gutter Depression: 0.0000 in

Area of Flow: 1.6976 ft²

E_o (Gutter Flow to Total Flow): 0.4491

Gutter Depth at Curb: 4.0771 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 10.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 2.7600 cfs

Bypass Flow: 0.0000 cfs

Efficiency: 1.0000

Curb and Gutter Analysis: 822+00 10yr

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0020 ft/ft

Cross-Slope of Pavement: 0.0220 ft/ft

Uniform Gutter Geometry

Manning's n: 0.0150

Gutter Width: 2.0000 ft

Width of Spread: 12.0480 ft

Gutter Result Parameters

Design Flow: 2.2000 cfs

Gutter Depression: 0.0000 in

Area of Flow: 1.5967 ft²

E_o (Gutter Flow to Total Flow): 0.3841

Gutter Depth at Curb: 3.1807 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 10.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 2.2000 cfs

Bypass Flow: 0.0000 cfs

Efficiency: 1.0000

Curb and Gutter Analysis: 823+73 10yr

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0020 ft/ft

Cross-Slope of Pavement: 0.0220 ft/ft

Uniform Gutter Geometry

Manning's n: 0.0150

Gutter Width: 2.0000 ft

Width of Spread: 12.6016 ft

Gutter Result Parameters

Design Flow: 2.4800 cfs

Gutter Depression: 0.0000 in

Area of Flow: 1.7468 ft²

E_o (Gutter Flow to Total Flow): 0.3696

Gutter Depth at Curb: 3.3268 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 15.0000 ft

Curb opening height: 4.0000 in

Local Depression: 2.0000 in

Inlet Result Parameters

Perimeter: 15.0000 ft

Effective Perimeter: 15.0000 ft

Area: 7.5000 ft²

Effective Area: 7.5000 ft²

Depth at curb face (upstream of local depression): 0.1448 ft

Computed Width of Spread at Sag: 6.5827 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: 820+00 50yr

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0020 ft/ft

Cross-Slope of Pavement: 0.0340 ft/ft

Uniform Gutter Geometry

Manning's n: 0.0150

Gutter Width: 2.0000 ft

Width of Spread: 11.5703 ft

Gutter Result Parameters

Design Flow: 4.0800 cfs

Gutter Depression: 0.0000 in

Area of Flow: 2.2758 ft²

E_o (Gutter Flow to Total Flow): 0.3975

Gutter Depth at Curb: 4.7207 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 10.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 4.0601 cfs

Bypass Flow: 0.0199 cfs

Efficiency: 0.9951

Curb and Gutter Analysis: 822+00 50yr

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0020 ft/ft

Cross-Slope of Pavement: 0.0220 ft/ft

Uniform Gutter Geometry

Manning's n: 0.0150

Gutter Width: 2.0000 ft

Width of Spread: 14.2468 ft

Gutter Result Parameters

Design Flow: 3.4400 cfs

Gutter Depression: 0.0000 in

Area of Flow: 2.2327 ft²

E_o (Gutter Flow to Total Flow): 0.3323

Gutter Depth at Curb: 3.7611 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 10.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 3.3274 cfs

Bypass Flow: 0.1126 cfs

Efficiency: 0.9673

Curb and Gutter Analysis: 823+73 50yr

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0020 ft/ft

Cross-Slope of Pavement: 0.0220 ft/ft

Uniform Gutter Geometry

Manning's n: 0.0150

Gutter Width: 2.0000 ft

Width of Spread: 14.7446 ft

Gutter Result Parameters

Design Flow: 3.7700 cfs

Gutter Depression: 0.0000 in

Area of Flow: 2.3915 ft²

E_o (Gutter Flow to Total Flow): 0.3224

Gutter Depth at Curb: 3.8926 in

Inlet Input Parameters

Inlet Location: Inlet in Sag

Percent Clogging: 0.0000 %

Inlet Type: Curb Opening

Length of Inlet: 15.0000 ft

Curb opening height: 4.0000 in

Local Depression: 2.0000 in

Inlet Result Parameters

Perimeter: 15.0000 ft

Effective Perimeter: 15.0000 ft

Area: 7.5000 ft²

Effective Area: 7.5000 ft²

Depth at curb face (upstream of local depression): 0.1915 ft

Computed Width of Spread at Sag: 8.7029 ft

Flow type: Weir Flow

Efficiency: 1.0000

Curb and Gutter Analysis: 824+23 10yr

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0010 ft/ft

Cross-Slope of Pavement: 0.0220 ft/ft

Uniform Gutter Geometry

Manning's n: 0.0150

Gutter Width: 2.0000 ft

Width of Spread: 7.8716 ft

Gutter Result Parameters

Design Flow: 0.5000 cfs

Gutter Depression: 0.0000 in

Area of Flow: 0.6816 ft²

E_o (Gutter Flow to Total Flow): 0.5428

Gutter Depth at Curb: 2.0781 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 10.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 0.5000 cfs

Bypass Flow: 0.0000 cfs

Efficiency: 1.0000

Curb and Gutter Analysis: 824+23 50yr

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0010 ft/ft

Cross-Slope of Pavement: 0.0220 ft/ft

Uniform Gutter Geometry

Manning's n: 0.0150

Gutter Width: 2.0000 ft

Width of Spread: 9.0718 ft

Gutter Result Parameters

Design Flow: 0.7300 cfs

Gutter Depression: 0.0000 in

Area of Flow: 0.9053 ft²

E_o (Gutter Flow to Total Flow): 0.4857

Gutter Depth at Curb: 2.3950 in

Inlet Input Parameters

Inlet Location: Inlet on Grade

Inlet Type: Curb Opening

Length of Inlet: 10.0000 ft

Local Depression: 2.0000 in

Inlet Result Parameters

Intercepted Flow: 0.7300 cfs

Bypass Flow: 0.0000 cfs

Efficiency: 1.0000

***** HYDRA ***** (Version 5.0) *****

Date 05-15-**
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IM-AL06(900) I-10 TEXAS STREET

*** CLAIBORNE STREET EX

Pipe Design

Nodes	Link	Length (ft)	Diam (in)	Invert Up/Dn (ft)	Slope (ft/ft)	Depth Up/Dn (ft)	Min. Cover (ft)	Velocity Act/Full (ft/sec)	--Flow-- Act/Full (cfs)	Estimated Cost (\$)
79-79A	1	59	18	7.78 7.22	.00956	4.3 5.1	2.6	4.4 6.3	1.49 11.15	0.
79A-79B	2	24	18	7.22 6.99	.00947	5.1 5.5	3.5	4.4 6.3	1.48 11.10	0.
79B-80	3	33	18	6.99 6.67	.00970	5.5 5.2	3.6	4.4 6.4	1.47 11.24	0.
80-81	4	71	18	6.67 6.39	.00394	5.0 4.4	2.8	3.2 4.1	1.47 7.17	0.
81-82	5	163	24	6.39 5.51	.00540	4.5 3.9	1.7	4.3 5.7	3.17 18.06	0.
82-83	6	47	24	5.51 5.36	.00319	3.9 3.9	1.7	4.1 4.4	5.06 13.88	0.
83-84	7	46	24	5.36 5.22	.00303	3.9 4.2	1.8	4.2 4.3	6.32 13.53	0.
84-85	8	147	24	5.22 4.77	.00305	4.2 5.7	2.0	4.6 4.3	8.56 13.58	0.
85-76	9	246	24	4.77 4.03	.00301	5.7 6.8	3.5	4.8 4.3	11.00 13.47	0.
76-77	10	186	24	4.03 3.47	.00301	6.8 4.4	2.2	4.9 4.3	12.55 13.49	0.
77-78	11	119	30	3.47 3.11	.00303	4.4 3.9	1.2	5.3 5.0	15.69 24.52	0.
78-54	12	21	30	3.11 3.04	.00326	3.9 4.1	1.2	5.6 5.2	17.57 25.45	0.
54-55	13	89	30	3.04 2.77	.00303	4.0 6.0	1.3	5.5 5.0	18.47 24.53	0.

LENGTH	=	1252.	TOTAL LENGTH	=	1252.
COST	=	0.	TOTAL COST	=	0.

***** HYDRA ***** (Version 5.0) *****

Date 05-15-11

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IM-AL06(900) I-10 TEXAS STREET

*** CLAIBORNE STREET EX

Pipe Design

Nodes	Link	Length (ft)	Diam (in)	Invert Up/Dn (ft)	Slope (ft/ft)	Depth Up/Dn (ft)	Min. Cover (ft)	Velocity Act/Full (ft/sec)	--Flow-- Act/Full (cfs)	Estimated Cost (\$)
55-56	14	53	30	2.77 2.61	.00300	6.0 7.0	3.3	5.5 5.0	18.68 24.42	0.
56-100	15	33	30	2.61 2.51	.00302	7.0 6.1	3.4	5.5 5.0	18.93 24.47	0.

				LENGTH =	1338.	TOTAL LENGTH =		1338.		
				COST =	0.	TOTAL COST =		0.		

***** HYDRA ***** (Version 5.0) *****

Date 05-14-**
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IM-AL06(900) I-10 TEXAS STREET

*** CLAIBORNE STREET EX

Pipe Design

Nodes	Link	Length (ft)	Diam (in)	Invert Up/Dn (ft)	Slope (ft/ft)	Depth Up/Dn (ft)	Min. Cover (ft)	Velocity Act/Full (ft/sec)	--Flow-- Act/Full (cfs)	Estimated Cost (\$)
86A-86	1	112	18	6.77 5.51	.01126	6.5 3.7	2.1	5.3 6.9	2.33 12.11	0.
86-87	2	47	18	5.51 5.36	.00320	3.7 3.8	2.1	3.8 3.7	3.82 6.46	0.
87-88	3	46	18	5.36 5.22	.00303	3.8 4.0	2.2	4.0 3.6	5.19 6.28	0.
88-89	4	147	24	5.22 4.78	.00299	4.0 5.6	1.8	4.4 4.3	7.26 13.44	0.
89-73	5	246	24	4.78 4.04	.00301	5.6 6.8	3.4	4.5 4.3	8.64 13.48	0.
73-74	6	182	24	4.04 3.49	.00302	6.8 4.4	2.3	4.6 4.3	9.30 13.50	0.
74-75	7	105	24	3.49 3.17	.00306	4.4 3.7	1.5	4.9 4.3	11.67 13.59	0.
75-36	8	100	24	3.17 2.40	.00767	3.7 4.5	1.5	7.3 6.8	14.00 21.52	0.

				LENGTH =	985.	TOTAL LENGTH =	985.			
				COST =	0.	TOTAL COST =	0.			

III.3 Ditch Design Data Summary

Hydraulic Analysis Report

Project Data

Project Title: IM-AL06(900) – I-10 TEXAS STREET

Designer:

Project Date: Thursday, August 14, 2014

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Channel Analysis Ramp A L 40520-40600

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 6.0000 ft/ft

Side Slope 2 (Z2): 5.0000 ft/ft

Longitudinal Slope: 0.0029 ft/ft

Manning's n: 0.1043

Flow: 1.1900 cfs

Result Parameters

Depth: 0.7428 ft

Area of Flow: 3.0347 ft²

Wetted Perimeter: 8.3060 ft

Hydraulic Radius: 0.3654 ft

Average Velocity: 0.3921 ft/s

Top Width: 8.1709 ft

Froude Number: 0.1134

Critical Depth: 0.3115 ft

Critical Velocity: 2.2301 ft/s

Critical Slope: 0.2989 ft/ft

Critical Top Width: 3.45 ft

Calculated Max Shear Stress: 0.1344 lb/ft²

Calculated Avg Shear Stress: 0.0661 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis A L 40520-40600

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.066117 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.134419 lb/ft²
Manning's n: 0.104298
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.000790835 lb/ft²
Permissible Shear Stress on Vegetation: 5.54705 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp A L 40520-40600

Channel Analysis: Channel Analysis Ramp A L 40600-40700

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 6.0000 ft/ft
Longitudinal Slope: 0.0090 ft/ft
Manning's n: 0.0684
Flow: 2.8200 cfs

Result Parameters

Depth: 0.6855 ft
Area of Flow: 2.8192 ft²
Wetted Perimeter: 8.3391 ft
Hydraulic Radius: 0.3381 ft
Average Velocity: 1.0003 ft/s
Top Width: 8.2257 ft
Froude Number: 0.3011
Critical Depth: 0.4241 ft
Critical Velocity: 2.6131 ft/s
Critical Slope: 0.1165 ft/ft
Critical Top Width: 5.09 ft
Calculated Max Shear Stress: 0.3850 lb/ft²
Calculated Avg Shear Stress: 0.1899 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Ramp A L 40600-40700

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.189862 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.384961 lb/ft²
Manning's n: 0.0683956
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.00526673 lb/ft²
Permissible Shear Stress on Vegetation: 2.38541 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp A L 40600-40700

Channel Analysis: Channel Analysis Ramp A L 40700-40737

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0090 ft/ft
Manning's n: 0.0642
Flow: 3.5300 cfs

Result Parameters

Depth: 0.8138 ft
Area of Flow: 2.9803 ft²
Wetted Perimeter: 7.5237 ft
Hydraulic Radius: 0.3961 ft
Average Velocity: 1.1845 ft/s
Top Width: 7.3243 ft
Froude Number: 0.3272
Critical Depth: 0.5330 ft
Critical Velocity: 2.7617 ft/s
Critical Slope: 0.0860 ft/ft
Critical Top Width: 5.40 ft
Calculated Max Shear Stress: 0.4570 lb/ft²
Calculated Avg Shear Stress: 0.2225 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Ramp A L 40700-40737

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.22246 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.457033 lb/ft²
Manning's n: 0.0641951
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.00709779 lb/ft²
Permissible Shear Stress on Vegetation: 2.10141 lb/ft²

This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp A L 40700-40737

Channel Analysis: Channel Analysis I-10 R 13630-13712

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 0.0001 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0021 ft/ft
Manning's n: 0.0150
Flow: 6.6400 cfs

Result Parameters

Depth: 0.5318 ft
Area of Flow: 2.6926 ft²
Wetted Perimeter: 6.7243 ft
Hydraulic Radius: 0.4004 ft
Average Velocity: 2.4660 ft/s
Top Width: 6.1271 ft
Froude Number: 0.6556
Critical Depth: 0.4099 ft
Critical Velocity: 3.3610 ft/s
Critical Slope: 0.0052 ft/ft
Critical Top Width: 5.64 ft
Calculated Max Shear Stress: 0.0697 lb/ft²
Calculated Avg Shear Stress: 0.0525 lb/ft²

Channel Analysis: Channel Analysis I-10 R 13712-13855

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 3.0000 ft/ft
Side Slope 2 (Z2): 0.0001 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0442 ft/ft
Manning's n: 0.0150
Flow: 10.7000 cfs

Result Parameters

Depth: 0.2929 ft
Area of Flow: 1.3001 ft²
Wetted Perimeter: 5.2189 ft
Hydraulic Radius: 0.2491 ft
Average Velocity: 8.2304 ft/s
Top Width: 4.8786 ft
Froude Number: 2.8097
Critical Depth: 0.5627 ft
Critical Velocity: 3.9256 ft/s
Critical Slope: 0.0048 ft/ft
Critical Top Width: 5.69 ft
Calculated Max Shear Stress: 0.8077 lb/ft²
Calculated Avg Shear Stress: 0.6871 lb/ft²

Channel Analysis: Channel Analysis I-10 R 15325-15570

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0418 ft/ft
Manning's n: 0.0435
Flow: 4.0600 cfs

Result Parameters

Depth: 0.2880 ft
Area of Flow: 1.5665 ft²
Wetted Perimeter: 6.9390 ft
Hydraulic Radius: 0.2258 ft
Average Velocity: 2.5917 ft/s
Top Width: 6.8798 ft
Froude Number: 0.9571
Critical Depth: 0.2806 ft
Critical Velocity: 2.6777 ft/s
Critical Slope: 0.0460 ft/ft
Critical Top Width: 6.81 ft
Calculated Max Shear Stress: 0.7511 lb/ft²
Calculated Avg Shear Stress: 0.5889 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis I-10 R 15325-15570

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.588851 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.751131 lb/ft²
Manning's n: 0.0434911
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.0254153 lb/ft²
Permissible Shear Stress on Vegetation: 0.964512 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis I-10 R 15325-15570

Channel Analysis: Channel Analysis Ramp C R 120167-120500

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0358 ft/ft
Manning's n: 0.0446
Flow: 4.4900 cfs

Result Parameters

Depth: 0.3215 ft
Area of Flow: 1.8025 ft²
Wetted Perimeter: 7.2808 ft
Hydraulic Radius: 0.2476 ft
Average Velocity: 2.4909 ft/s
Top Width: 7.2146 ft
Froude Number: 0.8782
Critical Depth: 0.2978 ft
Critical Velocity: 2.7471 ft/s
Critical Slope: 0.0476 ft/ft
Critical Top Width: 6.98 ft
Calculated Max Shear Stress: 0.7181 lb/ft²
Calculated Avg Shear Stress: 0.5531 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Ramp C R 120167-120500

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.554064 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.719679 lb/ft²
Manning's n: 0.0445634
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.0231932 lb/ft²
Permissible Shear Stress on Vegetation: 1.01266 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp C R 120167-120500

Channel Analysis: Channel Analysis Ramp C L 120400-120500

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 2.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0489 ft/ft
Manning's n: 0.0150
Flow: 1.0700 cfs

Result Parameters

Depth: 0.0703 ft
Area of Flow: 0.3009 ft²
Wetted Perimeter: 4.5846 ft
Hydraulic Radius: 0.0656 ft
Average Velocity: 3.5564 ft/s
Top Width: 4.5622 ft
Froude Number: 2.4405
Critical Depth: 0.1250 ft
Critical Velocity: 1.9018 ft/s
Critical Slope: 0.0069 ft/ft
Critical Top Width: 5.00 ft
Calculated Max Shear Stress: 0.2144 lb/ft²
Calculated Avg Shear Stress: 0.2002 lb/ft²

Channel Analysis: Channel Analysis Ramp C L 120300-120400

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0367 ft/ft
Manning's n: 0.0495
Flow: 2.1300 cfs

Result Parameters

Depth: 0.2264 ft
Area of Flow: 1.1363 ft²
Wetted Perimeter: 6.0931 ft
Hydraulic Radius: 0.1865 ft
Average Velocity: 1.8745 ft/s
Top Width: 6.0377 ft
Froude Number: 0.7615
Critical Depth: 0.1914 ft
Critical Velocity: 2.2888 ft/s
Critical Slope: 0.0661 ft/ft
Critical Top Width: 5.72 ft
Calculated Max Shear Stress: 0.5185 lb/ft²
Calculated Avg Shear Stress: 0.4271 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Ramp C L 120300-120400

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.427072 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.518489 lb/ft²
Manning's n: 0.0494541
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.013568 lb/ft²
Permissible Shear Stress on Vegetation: 1.24713 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp C L 120300-120400

Channel Analysis: Channel Analysis Ramp C L 120136-120300

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0297 ft/ft
Manning's n: 0.0486
Flow: 3.5300 cfs

Result Parameters

Depth: 0.3110 ft
Area of Flow: 1.7276 ft²
Wetted Perimeter: 7.1740 ft
Hydraulic Radius: 0.2408 ft
Average Velocity: 2.0433 ft/s
Top Width: 7.1100 ft
Froude Number: 0.7305
Critical Depth: 0.2580 ft
Critical Velocity: 2.5863 ft/s
Critical Slope: 0.0589 ft/ft
Critical Top Width: 6.58 ft
Calculated Max Shear Stress: 0.5764 lb/ft²
Calculated Avg Shear Stress: 0.4463 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Ramp C L 120136-120300

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.446293 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.576365 lb/ft²
Manning's n: 0.0485909
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.0156231 lb/ft²
Permissible Shear Stress on Vegetation: 1.20397 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp C L 120136-120300

Channel Analysis: Channel Analysis Ramp D 130100-130200

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0286 ft/ft
Manning's n: 0.0605
Flow: 0.9500 cfs

Result Parameters

Depth: 0.1708 ft
Area of Flow: 0.8289 ft²
Wetted Perimeter: 5.7429 ft
Hydraulic Radius: 0.1443 ft
Average Velocity: 1.1461 ft/s
Top Width: 5.7077 ft
Froude Number: 0.5300
Critical Depth: 0.1147 ft
Critical Velocity: 1.8117 ft/s
Critical Slope: 0.1152 ft/ft
Critical Top Width: 5.15 ft
Calculated Max Shear Stress: 0.3048 lb/ft²
Calculated Avg Shear Stress: 0.2576 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Ramp D

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.257586 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.304764 lb/ft²
Manning's n: 0.0605388
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.00532201 lb/ft²
Permissible Shear Stress on Vegetation: 1.86885 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp D 130100-130200

Channel Analysis: Channel Analysis Water ST L 80277-80580

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0116 ft/ft
Manning's n: 0.0485
Flow: 20.8200 cfs

Result Parameters

Depth: 0.9757 ft
Area of Flow: 8.6633 ft²
Wetted Perimeter: 13.9583 ft
Hydraulic Radius: 0.6207 ft
Average Velocity: 2.4032 ft/s
Top Width: 13.7574 ft
Froude Number: 0.5337
Critical Depth: 0.7044 ft
Critical Velocity: 3.9296 ft/s
Critical Slope: 0.0445 ft/ft
Critical Top Width: 11.04 ft
Calculated Max Shear Stress: 0.7063 lb/ft²
Calculated Avg Shear Stress: 0.4493 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Water St L

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.449256 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.706279 lb/ft²
Manning's n: 0.0484624
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.0192462 lb/ft²
Permissible Shear Stress on Vegetation: 1.19761 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Water ST L 80277-80580

Channel Analysis: Channel Analysis Water St R 80370-80550

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0089 ft/ft
Manning's n: 0.0150
Flow: 9.3300 cfs

Result Parameters

Depth: 0.3907 ft
Area of Flow: 2.2494 ft²
Wetted Perimeter: 7.6117 ft
Hydraulic Radius: 0.2955 ft
Average Velocity: 4.1478 ft/s
Top Width: 7.5159 ft
Froude Number: 1.3361
Critical Depth: 0.4615 ft
Critical Velocity: 3.3266 ft/s
Critical Slope: 0.0048 ft/ft
Critical Top Width: 8.15 ft
Calculated Max Shear Stress: 0.2170 lb/ft²
Calculated Avg Shear Stress: 0.1641 lb/ft²

Channel Analysis: Channel Analysis Ramp A R 40218-40486

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0102 ft/ft
Manning's n: 0.0572
Flow: 8.1800 cfs

Result Parameters

Depth: 0.6931 ft
Area of Flow: 5.1746 ft²
Wetted Perimeter: 11.0739 ft
Hydraulic Radius: 0.4673 ft
Average Velocity: 1.5808 ft/s
Top Width: 10.9312 ft
Froude Number: 0.4049
Critical Depth: 0.4217 ft
Critical Velocity: 3.1757 ft/s
Critical Slope: 0.0711 ft/ft
Critical Top Width: 8.22 ft
Calculated Max Shear Stress: 0.4412 lb/ft²
Calculated Avg Shear Stress: 0.2974 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Ramp A R 40218-40486

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.297413 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.44116 lb/ft²
Manning's n: 0.0571556
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.00864287 lb/ft²
Permissible Shear Stress on Vegetation: 1.66581 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp A R 40218-40486

Channel Analysis: Channel Analysis I-10 R 12850-13097

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0093 ft/ft
Manning's n: 0.0532
Flow: 16.3600 cfs

Result Parameters

Depth: 0.9592 ft
Area of Flow: 8.4373 ft²
Wetted Perimeter: 13.7896 ft
Hydraulic Radius: 0.6119 ft
Average Velocity: 1.9390 ft/s
Top Width: 13.5921 ft
Froude Number: 0.4337
Critical Depth: 0.6191 ft
Critical Velocity: 3.7240 ft/s
Critical Slope: 0.0556 ft/ft
Critical Top Width: 10.19 ft
Calculated Max Shear Stress: 0.5566 lb/ft²
Calculated Avg Shear Stress: 0.3551 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis I-10 R 128520-13097

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.355074 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.55665 lb/ft²
Manning's n: 0.0532446
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.0125664 lb/ft²
Permissible Shear Stress on Vegetation: 1.44563 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis I-10 R 12850-13097

Channel Analysis: Channel Analysis Ramp A R 40486-40747

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0127 ft/ft
Manning's n: 0.0566
Flow: 5.7400 cfs

Result Parameters

Depth: 0.5462 ft
Area of Flow: 3.6762 ft²
Wetted Perimeter: 9.5741 ft
Hydraulic Radius: 0.3840 ft
Average Velocity: 1.5614 ft/s
Top Width: 9.4617 ft
Froude Number: 0.4414
Critical Depth: 0.3440 ft
Critical Velocity: 2.9175 ft/s
Critical Slope: 0.0738 ft/ft
Critical Top Width: 7.44 ft
Calculated Max Shear Stress: 0.4328 lb/ft²
Calculated Avg Shear Stress: 0.3043 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Ramp A R 40486-40747

Notes:

Lining Input Parameters

Channel Lining Type: Vegetation
Specific Weight of Water: 62.4 lb/ft³
Height of Vegetation: 0.333 ft
Vegetation Condition is good
Growth Form of Vegetation is mixed
Cf: 0.75

See HEC-15, Table 4.5 (default: 0.75 for Good cover factor and Mixed growth form)
soil is noncohesive
D75: 0.1
Safety Factor: 1

Lining Results

Cn: 0.165205
Permissible Soil Shear Stress: 0.04 lb/ft²
Mean Boundary Shear Stress: 0.304288 lb/ft²
Maximum Shear Stress on the Channel Bottom: 0.432828 lb/ft²
Manning's n: 0.0566355
Soil Grain Roughness: 0.0177136
Effective Shear Stress: 0.0086361 lb/ft²
Permissible Shear Stress on Vegetation: 1.63563 lb/ft²
This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp A R 40486-40747

Channel Analysis: Channel Analysis Ramp A R 40747-40900

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 4.0000 ft/ft
Channel Width: 4.0000 ft
Longitudinal Slope: 0.0242 ft/ft
Manning's n: 0.0250
Flow: 13.1200 cfs

Result Parameters

Depth: 0.4781 ft
Area of Flow: 2.8271 ft²
Wetted Perimeter: 7.9429 ft
Hydraulic Radius: 0.3559 ft
Average Velocity: 4.6408 ft/s
Top Width: 7.8252 ft
Froude Number: 1.3606
Critical Depth: 0.5698 ft
Critical Velocity: 3.6670 ft/s
Critical Slope: 0.0124 ft/ft
Critical Top Width: 8.56 ft
Calculated Max Shear Stress: 0.7220 lb/ft²
Calculated Avg Shear Stress: 0.5375 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis Ramp A R 40747-40900

Notes:

Lining Input Parameters

Channel Lining Type: Rolled Erosion Control Product

Shear Stress on RECP that results in 0.5 in of erosion: 8 lb/ft²

See <http://www.ectc.org/specifications.asp> or document FP-03, Table 713-3 or 713-4 to get this value

Manning's n value input as user-supplied n

RECP is an open weave textile

Manning's n: 0.025

Manning's n range: 0.022-0.028

Specific Weight of Water: 62.4 lb/ft³

soil is noncohesive

D75: 0.1

Safety Factor: 1

Lining Results

Permissible Soil Shear Stress: 0.04 lb/ft²

Mean Boundary Shear Stress: 0.537479 lb/ft²

Maximum Shear Stress on the Channel Bottom: 0.722044 lb/ft²

Effective Shear Stress: 0 lb/ft²

Permissible Shear Stress on RECP: 4.14618 lb/ft²

This value is compared with the maximum shear stress times the safety factor to determine lining stability

Channel Bottom Shear Results

channel bottom is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: Channel Analysis Ramp A R 40747-40900