WINZLER & KELLY
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM

TO: Suzy Lahitte

COMPANY: State of California, Department of Parks and Recreation

FROM: **Elmer Alex, PE** Elmer B. Alex
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EXP 9/2010
CIVIL
STATE OF CALIFORNIA

DATE: January 11, 2008

RE: Cuyamaca Rancho State Park – Equestrian Facilities Hydrology and Hydraulic Study

JOB #: 0714306016

Winzler & Kelly is tasked to provide hydrologic and hydraulic analysis study for the equestrian facilities located at the proposed Descanso Campground Site and Paso Picacho Parking Lot located within the Cuyamaca Rancho State Park. The analysis includes calculating the existing hydrology and hydraulics at both locations, recommending storm drain improvements based on the proposed development and suggest Best Management Practices (BMPs) to aid in the water quality leaving the site.

This technical memorandum summarizes the hydrology and hydraulic analysis and BMP sizing. The following references are cited.

- San Diego Hydrology Manual (June 2003)
- County of San Diego Standard Urban Storm Water Mitigation Plan For Land Development and Public Improvement Projects (2-10-03)
- California Stormwater Quality Association, Stormwater Best Management Practice Handbook (January 2003, Errata 9-04)

HYDROLOGY

The hydrology analysis is based on the Rational Method as shown in Chapter 3 of the San Diego Hydrology Manual. The formula is expressed as follows.

$$Q = C\,I\,A \qquad \text{<Equation 1>}$$

Where: Q = peak discharge, in cubic feet per second (cfs)

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C = runoff coefficient
I = average rainfall intensity, in inches per hour
A = drainage area, in acres

Based on the contour maps that shows the topography at vicinity of the sites, the offsite drainage area is divided into 11 watersheds for the Descanso Campground site and 1 watershed for the Paso Picacho site. The location of each watershed are shown in Figures 1 and 2.

The runoff coefficient (C) is estimated based on the following equation.

$$C = 0.90 \times (\% \text{ Impervious}) + C_p \times (1 - \% \text{ Impervious}) \qquad \textit{<Equation 2>}$$

Where: C_p = Pervious Coefficient Runoff Value for the soil type

Based on the Soil Type Map in Appendix A of the San Diego Hydrology Manual, the soil type for the site is Group D. In Table 3-1 of the San Diego Hydrology Manual, the C_p factor for Group D soil on Undisturbed Natural Terrain (0% Impervious) is 0.35. Both of the project sites are currently undeveloped and have no impervious areas on site, therefore it can be assumed that the runoff coefficient for both sites is 0.35 throughout.

The storm intensity (I) is based on the following equation.

$$I = 7.44\, P_6\, D^{-0.645} \qquad \textit{<Equation 3>}$$

Where: P_6 = adjusted 6-hour storm rainfall amount, in inches
D = duration, in minutes

This analysis utilizes Equation 3 to determine the intensity of the 2-, 5-, 10-, 25-, 50- and100-year 6-hour storm event (Q100). .

According to the San Diego Hydrology Manual, the P_6 should be between 45% and 65% of the adjusted 24-hour storm rainfall amount (P_{24}). The P_{24} was found using the 24 Hours Rainfall Isopluvial Map in Appendix B of the San Diego Hydrology Manual.

The duration (D) is based on the time of concentration of each watershed (T_c). The time of concentration is based on the following equation.

$$T_c = T_i + T_t \qquad \textit{<Equation 4>}$$

Where: T_i = initial time of concentration, in minutes
T_t = travel time, in minutes

The initial time of concentration represents the sheet flow at the upstream end of a drainage basin. It can be estimated based on the FAA drainage equation as shown in Figure 3-3 of the San Diego Hydrology Manual. The equation is as follows.

$$T_i = 1.8\ (1.1 - C)\ D^{1/2}\ S^{-1/3} \qquad \text{<Equation 5>}$$

Where: C = runoff coefficient
D = watercourse distance, in feet
S = watercourse slope, in feet/feet

As suggested by the San Diego Hydrology Manual, the watercourse distance (D) for the natural or rural watersheds should be limited to 50 to 100 feet. Therefore, the D used in this analysis is the most upstream 100 feet of each watershed. The watercourse slope (S) is the slope of the flow path corresponding to D. The runoff coefficient is approximated for the flow path D based on Table 3-1 in the San Diego Hydrology Manual.

The calculated T_i is subject to the T_i limit as listed in Table 3-2 of the San Diego Hydrology Manual. The calculation parameters for each watershed is listed in Table 2.

TABLE 1 - INITIAL TIME OF CONCENTRATION

Watershed	Land Use	C	S	Ti max
		-	ft/ft	min
WS-1	Undisturbed Natural Terrain (Natural)	0.35	0.11	6.9
WS-2	Undisturbed Natural Terrain (Natural)	0.35	0.19	5.4
WS-3	Undisturbed Natural Terrain (Natural)	0.35	0.12	6.9
WS-4	Undisturbed Natural Terrain (Natural)	0.35	0.02	10.9
WS-5	Undisturbed Natural Terrain (Natural)	0.35	0.08	6.9
WS-6	Undisturbed Natural Terrain (Natural)	0.35	0.08	6.9
WS-7	Undisturbed Natural Terrain (Natural)	0.35	0.30	4.3
WS-8	Undisturbed Natural Terrain (Natural)	0.35	0.16	5.4
WS-9	Undisturbed Natural Terrain (Natural)	0.35	0.08	10.9
WS-10	Undisturbed Natural Terrain (Natural)	0.35	0.13	10.9
WS-11	Undisturbed Natural Terrain (Natural)	0.35	0.12	6.9
PP-1	Undisturbed Natural Terrain (Natural)	0.35	0.32	6.9

The travel time is the time required for the runoff to flow to the point of interest. Since the flow paths for the watersheds are mostly over natural ground, the Kirpich equation as shown in Figure 3-5 of the San Diego Hydrology Manual is being used. The equation is as follows.

$$T_t = (11.9L^3/\Delta E)^{0.385} \qquad \text{<Equation 6>}$$

Where: L = watercourse distance, in miles
ΔE = change in elevation, in feet

Table 3 summarizes the T_t and T_c for each watershed.

TABLE 2 - TIME OF CONCENTRATION			
Watershed	Ti	Tt	Tc
	min	min	min
WS-1	6.9	3.73	10.63
WS-2	5.4	3.65	9.05
WS-3	6.9	4.72	11.62
WS-4	10.9	13.96	24.86
WS-5	6.9	4.82	11.72
WS-6	6.9	3.45	10.35
WS-7	4.3	2.94	7.24
WS-8	5.4	3.46	8.86
WS-9	10.9	4.77	15.67
WS-10	10.9	3.09	13.99
WS-11	6.9	7.02	13.92
PP-1	4.23	4.46	8.69

The design flow for each watershed, calculated base on the information from the watershed map, as well as Equation 1 to Equation 6, are summarized in Table 3. Note that within the Descanso Campground site, there are two different drainage systems, one that flows towards the western culverts that go under Viejas Boulevard and another that flows towards the eastern culvert that is under Viejas Boulevard. Watersheds WS-1 through WS-10 all flow towards the western culverts and WS-11 flows towards the eastern culvert. The flows for the western culvert drainage system must be combined through the Modified Rational Method for junction analysis as presented in Section 3.4 of the San Diego County Hydrology Manual. It is necessary to use the Modified Rational Method if the watershed contains junctions from independent drainage systems. The peak flow, time of concentration and rainfall intensity must be calculated for each independent watershed, and should be arranged in such a manner that for the flows that are going to be combined, be placed and numbered in order from smallest to largest time of concentration such that Q_1, T_1 and I_1 correspond to the contributing watershed with the shortest time of concentration. The flows from the contributing watersheds are combined in the following manner:

$$T_1 < T_2 < T_3 < T_4 \qquad \text{<}\textit{Equation 7}\text{>}$$

$$Q_{T1} = Q_1 + T_1/T_2\, Q_2 + T_1/T_3\, Q_3 + T_1/T_4\, Q_4$$

$$Q_{T2} = Q_2 + I_2/I_1\ Q_1 + T_2/T_3\ Q_3 + T_2/T_4\ Q_4$$

$$Q_{T3} = Q_3 + I_3/I_1\ Q_1 + I_3/I_2\ Q_2 + T_3/T_4\ Q_4$$

$$Q_{T4} = Q_4 + I_4/I_1\ Q_1 + I_4/I_2\ Q_2 + I_4/I_3\ Q_3$$

Where: Q_{Tn} = total combined flow for the nth ranked time of concentration, in cfs
Q_n = flow corresponding to the nth ranked time of concentration, in cfs
I_n = rainfall intensity fort the nth ranked time of concentration, in in/hr
T_n = the nth ranked time of concentration, in minutes

Select the largest Q_T and use the time of concentration associated with that Q for the flow and time of concentration at the junction. Equation 7 can be modified to deal with more or less than four contributing watersheds as shown in Section 3.4.2 of the Hydrology Manual. The calculated 10- and 100-year flows for the watersheds, junction points and drainage systems are summarized below. The 10-year flows are shown because the hydraulic improvements that we are going to suggest will be based on the 10-year design flows. It will be explained in further detail in a later section.

TABLE 3 – 10-YEAR DESIGN FLOW

Basin	Watershed		Flow Line				Q10
		Area	Length	Slope	Intensity	C	Flow
	ID	ac	ft	ft/ft	in/hr	-	cfs
West Culvert	WS-1	19.89	1020	0.11	4.4	0.35	30
	WS-2	11.52	1270	0.18	4.9	0.35	20
	WS-3	20.43	1396	0.12	4.1	0.35	30
	Junction 1	**51.84**	-	-	-	-	**75**
	WS-4	36.83	2443	0.02	2.5	0.35	33
	Junction 2	**91.8**	-	-	-	-	**79**
	WS-5	11.34	1213	0.08	4.1	0.35	16
	WS-6	12.82	777	0.08	4.4	0.35	20
	WS-7	6.67	1222	0.30	5.6	0.35	13
	WS-8	9.26	1085	0.15	4.9	0.35	16
	Junction 3	**40.09**	-	-	-	-	**59**
	WS-9	33.79	1165	0.08	3.4	0.35	40
	Junction 4	**73.88**	-	-	-	-	**90**
	WS-10	25.47	1167	0.13	3.7	0.35	**33**
	Junction 5	**99.35**	-	-	-	-	**108**
West Culvert	**Junction 6**	**188.02**	**Q10 Design Flow for Western Culvert**				**168**
East Culvert	WS-11	17.7	2378	0.12	3.7	0.35	23
East Culvert	**-**	**17.7**	**Q10 Design Flow for Eastern Culvert**				**23**
Paso Picacho East	PP-1	30.17	2068	0.39	5.3	0.35	56
Paso Picacho East	-	**30.17**	**Q10 Design Flow for Paso Picacho East**				**56**

TABLE 4 – 100-YEAR DESIGN FLOW							
Basin	Watershed		Flow Line				Q100
		Area	Length	Slope	Intensity	C	Flow
	ID	ac	ft	ft/ft	in/hr	-	cfs
West Culvert	WS-1	19.89	1020	0.11	7.6	0.35	53
	WS-2	11.52	1270	0.18	8.4	0.35	34
	WS-3	20.43	1396	0.12	7.2	0.35	51
	Junction 1	**51.84**	-	-	-	-	**131**
	WS-4	36.83	2443	0.02	4.4	0.35	57
	Junction 2	**91.8**	-	-	-	-	**138**
	WS-5	11.34	1213	0.08	7.14	0.35	28
	WS-6	12.82	777	0.08	7.74	0.35	34
	WS-7	6.67	1222	0.30	9.74	0.35	22
	WS-8	9.26	1085	0.15	8.56	0.35	27
	Junction 3	**40.09**	-	-	-	-	**103**
	WS-9	33.79	1165	0.08	5.93	0.35	70
	Junction 4	**73.88**	-	-	-	-	**157**
	WS-10	25.47	1167	0.13	6.4	0.35	**57**
	Junction 5	**99.35**	-	-	-	-	**187**
West Culvert	**Junction 6**	**188.02**	**Q100 Design Flow for Western Culvert**				**292**
East Culvert	WS-11	17.7	2378	0.12	6.4	0.35	40
East Culvert	**-**	**17.7**	**Q100 Design Flow for Eastern Culvert**				**40**
Paso Picacho East	PP-1	30.17	2068	0.39	9.16	0.35	97
Paso Picacho East	-	**30.17**	**Q100 Design Flow for Paso Picacho East**				**97**

EXISTING HYDRAULICS ANALYSIS

The Descanso Campground site currently has existing drainage systems including storm water culverts and drainage channels that were analyzed as part of Hydrologic Analysis for both sites. Paso Picacho East is currently undeveloped and does not have significant drainage systems. The existing culverts were analyzed using Hydrocalc Hydraulics program created by Dodson which uses the methods and equations described in the Federal Highway Administration report "Hydraulic Design of Higway Culverts" (FHWA, 1985). The culverts were surveyed in the field and the geometry and type of culvert was entered into the Hydrocalc Hydraulics program to calculate the capacity. The culvert geometries are summarized below:

TABLE 5 - CULVERT GEOMETRY					
Culvert ID	Type	Diameter	Length	Δ Elevation	Slope
		in	ft	ft	ft/ft
C-1	CMP	30	38	2.34	0.062
C-2	CMP	36	39.8	1.24	0.031
C-3	CMP	30	52.4	0.61	0.012
C-4	CMP	12	34.6	0.64	0.018
C-5	CMP	12	26.96	2.13	0.079
C-6	CMP	18	19.95	0.91	0.046

Culverts C-1 through C-3 are where the Descanso Campground site drains into the Sweetwater River. According to FEMA FIRM Maps of the Sweetwater River system, the 100-year floodplain for the Sweetwater River encroaches into the Descanso Campground site, at elevation 3,404 feet, through the tributaries that feed into culverts C-1 through C-3. Therefore, during a 100-year event for the Sweetwater River, the existing culverts do not have any capacity for the runoff from the Descanso Campground site. Since it is unlikely that a 100-year event for the Sweetwater River and Descanso Campground site occur at exactly the same time, it is assumed that the tailwater condition for analyzing culverts C-1 through C-3 is at the top of bank, elevation 3,400 feet, of the Sweetwater River. This would provide a tailwater condition for culverts C-1 through C-3. Culverts C-4 through C-6 are elevated or are in steep enough terrain that it can be assumed that they will be inlet controlled as well. The capacity of the culvert is reached when the headwater elevation breaches the elevation of the road. The analysis can be found in Appendix B and is summarized below:

TABLE 6 - EXISTING CULVERT FLOW ANALYSIS					
Culvert ID	Diameter	Maximum Allowable Headwater	Tailwater Depth	Flow Capacity	Design Event Capacity
	in	ft	ft	cfs	
C-1	30	4.13	3.47	40	< 2-year
C-2	36	5.23	3.47	63	
C-3	30	5.58	3.19	45	100-year
C-4	12	1.0	0	2.5	< 2-year
C-5	12	1.0	0	2.5	< 2-year
C-6	18	1.5	0	6.5	< 2-year

Based on the existing drainage patterns of the watersheds and calculated hydrology of the site, culverts C-1 and C-2 are the draining features for the "West Culvert" Basin in Table 4. C-1 and C-2 have a combined flow capacity of 103 cfs, which is less than the combined 2-year event WS-1 through WS-10 of 112 cfs. Culvert C-3 is at the end of the "East Culvert" Basin has a capacity of 45 cfs, which exceeds the 100-year flow of 39.6 cfs for WS-12. Culverts C-5 and C-6 are close to the bottom of WS-11 and their capacity are well below the 2-year event of 15 cfs for the basin. Culvert C-4 is within the WS-11, but not in the main tributary, rather it has a much smaller contributing area within the basin. The capacity for C-4 is a little less than the 2-year event of 2.75 cfs for the sub-watershed within WS-11.

Within the Descanso Campground site, there are two existing significant drainage channels, as previously stated in this report, the drainage channel that conveys water to the western culvert that goes under Viejas Road (Western Channel) and the drainage channel that flows to the eastern culvert (Eastern Channel). These two channels were analyzed with a steady state model in HEC-RAS to evaluate the existing capacity of the drainage systems. The hydrologic design flows for the respective drainage channels, calculated previously, were used to model the different water surface profiles within the drainage systems. As stated previously in the culvert analysis, the 100-year water surface elevation for the Sweetwater River encroaches into the Descanso Campground site through these two drainage systems up to an elevation of 3,404 feet, but it is unlikely that the 100-year for the Sweetwater River and the two drainage channels to occur at the same time, therefore we are assuming a tailwater boundary condition of 3,400 feet in Sweetwater River, which is the top of its banks.

Based on the above assumptions, the HEC-RAS model shows that the Western Channel can convey up to the 100-year design flow within its banks up until the culverts, where none of the design flows stay within the banks. This supports the analysis that the culverts only have less than a 2-year design flow capacity. The Eastern Channel has the capacity to maintain the 100-year design flow within its banks throughout the reach. The HEC-RAS output can be viewed in Appendix C.

PROPOSED HYDROLOGY

Based on the draft design for Descanso Campground dated December 10, 2007, a portion of the overland runoff will be re-routed with new drainage channels causing differentiating flows between the existing and proposed condition. As shown in Figure 4 the proposed channels are labeled with Drainage Channel 1 flowing towards the western culverts (C-1 and C-2) going under Viejas Boulevard and Drainage Channels 2 through 4 flowing towards the eastern culvert (C-3). As discussed with State Parks, the new channels will be sized to convey the 10-year design flow and anything above the 10-year will be out of the channel banks and sheet flow based on the site grading.

It is anticipated that the site grading will be close to the existing conditions, therefore design flows larger than the 10-year will be similar to the existing conditions design flows minus the 10-year flow being conveyed by the new channels. Equations 1 through 7 defined previously in this report and based on the San Diego Hydrology Manual were used to calculate the proposed hydrology for the Descanso Campground. Watersheds WS-3 and WS-4 had to be divided into sub-basins due to the proposed drainage channels on the site. As a result, the analysis includes watershed WS-3 and WS-3B as well as WS-4 and WS-4B as shown in Figure 1. For flows above the 10-year design flow, the sub-basins are merged back together for the analysis. The proposed 10-year and 100-year design flows are summarized on Table 7 and 8 below.

It is recommended for the proposed development that any structure that is not intended to get inundated have a pad elevation higher than 3,404 feet which is the 100-year floodplain according to FEMA or be elevated such that the sheet flow from runoff will not impact the area.

For the Paso Picacho Parking Lot Site, it is recommended that for the 10-year design storm and smaller, the runoff be segregated between the clean storm water coming from the mountain side and the parking lot and animal maintenance areas. This is for water quality purposes which will be discussed a later section. It is anticipated that a concrete v-ditch will be used to route the mountain side flows away from the parking lot and animal maintenance facilities, maintaining the volume of water within the same watershed. For the 10-year design storm and smaller, the Paso Picacho Parking Lot will have sub-basins within PP-1, labeled PP-1B for the parking lot and PP-1C for the animal maintenance area. For storms larger than the 10-year, the basin is merged back together as only PP-1.

TABLE 7 – 10-YEAR DESIGN FLOW

Basin	Watershed		Flow Line				Q10
		Area	Length	Slope	Intensity	C	Flow
	ID	ac	ft	ft/ft	in/hr	-	cfs
West Culvert	WS-1	19.89	1020	0.11	4.37	0.35	30
	WS-2	11.52	1270	0.18	4.85	0.35	20
	WS-3	11.06	866	0.19	4.66	0.35	18
	Junction 1	**42.47**	-	-	-	-	**66**
	WS-4	33.81	2443	0.02	2.53	0.35	30
	Drainage Channel 1	**76.28**	-	-	-	-	**70**
West Culvert	**Junction 6**	**76.28**	**Q10 Design Flow for Western Culvert**				**70**
East Culvert	WS-3B	9.37	1573	0.13	4.06	0.35	13
	WS-4B	3.02	527	0.04	3.7	0.35	4
	Drainage Channel 2	**12.39**	**-**	**-**	**-**	**-**	**15**
	WS-5	11.34	1213	0.08	4.10	0.35	16
	WS-6	12.82	777	0.08	4.44	0.35	20
	WS-7	6.67	1222	0.3	5.60	0.35	13
	WS-8	9.26	1085	0.15	4.92	0.35	16
	Junction 3	**40.09**	**-**	**-**	**-**	**-**	**59**
	WS-9	33.79	1165	0.08	3.40	0.35	40
	Junction 4	**73.88**	**-**	**-**	**-**	**-**	**90**
	WS-10	25.47	1167	0.13	3.66	0.35	33
	Drainage Channel 3	**99.35**	**-**	**-**	**-**	**-**	**108**
	Drainage Channel 4	**111.74**	**-**	**-**	**-**	**-**	**121**
	WS-11	17.7	2378	0.12	3.68	0.35	23
East Culvert	**-**	**129.44**	**Q10 Design Flow for Eastern Culvert**				**140**
Paso Picacho East	PP-1	28.75	2068	0.39	5.26	0.35	53
	V-Ditch	**28.75**	**-**	**-**	**-**	**-**	**53**
	PP-1A	0.75	100	.01	5.46	0.77	3
	PP-1B	0.67	100	.01	3.48	0.35	1
	BMP Bypass	**1.42**	**-**	**-**	**-**	**-**	**5**
Paso Picacho East	-	**30.17**	**Q10 Design Flow for Paso Picacho East**				**54**

TABLE 8 – 100-YEAR DESIGN FLOW

Basin	Watershed		Flow Line				Q100
		Area	Length	Slope	Intensity	C	Flow
	ID	ac	ft	ft/ft	in/hr	-	cfs
West Culvert	WS-1	19.89	1020	0.11	7.6	0.35	53
	WS-2	11.52	1270	0.18	8.4	0.35	34
	WS-3	20.43	1396	0.12	7.2	0.35	38
	Junction 1	**51.84**	-	-	-	-	**118**
	WS-4	36.83	2443	0.02	4.4	0.35	42
	Junction 2	**91.8**	-	-	-	-	**123**
	WS-5	11.34	1213	0.08	7.14	0.35	28
	WS-6	12.82	777	0.08	7.74	0.35	34
	WS-7	6.67	1222	0.30	9.74	0.35	22
	WS-8	9.26	1085	0.15	8.56	0.35	27
	Junction 3	**40.09**	-	-	-	-	**103**
	WS-9	33.79	1165	0.08	5.93	0.35	70
	Junction 4	**73.88**	-	-	-	-	**157**
	WS-10	25.47	1167	0.13	6.4	0.35	**57**
	Junction 5	**99.35**	-	-	-	-	**66**
West Culvert	**Junction 6**	**188.02**	**Q100 Design Flow for Western Culvert**				**177**
East Culvert	WS-11	17.7	2378	0.12	6.4	0.35	40
	Drainage Channel 4	-	-	-	-	-	121
East Culvert	**-**	**17.7**	**Q100 Design Flow for Eastern Culvert**				**161**
Paso Picacho East	PP-1	30.17	2068	0.39	9.16	0.35	97
Paso Picacho East	-	**30.17**	**Q100 Design Flow for Paso Picacho East**				**97**

*For watersheds flowing to the West Culvert(WS-1 thru WS-10), the Q10 flowing in the proposed channels that intercepts the sheet flow (for WS-3 and WS-5 thru WS-10) is subtracted from the West Culvert Q100 flow and is added to the East Culvert Q100 flow when compared to the Existing Conditions Hydrology.

The comparison for the existing and proposed flows that flow towards the culverts that are under Viejas Boulevard are summarized below.

TABLE 9 – EXISTING AND PROPOSED FLOW COMPARISON						
Western Culverts Flow Comparison						
	2 year	5 year	10 year	25 year	50 year	100 year
Existing	112	140	168	217	267	292
Proposed	47	58	70	103	152	177

Eastern Culvert Flow Comparison						
	2 year	5 year	10 year	25 year	50 year	100 year
Existing	15	19	23	30	36	40
Proposed	96	120	144	150	157	161

Paso Picacho Parking Lot Flow Comparison						
	2 year	5 year	10 year	25 year	50 year	100 year
Existing	37	46	56	72	89	97
Proposed	36	45	54	70	86	94

PROPOSED HYDRAULIC ANALYSIS

As discussed with State Parks, the new channels will be sized to convey the 10-year design flow and anything above the 10-year will be out of the channel banks and sheet flow based on the site grading. State Parks also stated that they prefer the channel depth to be a maximum depth of 2 feet. Based on the proposed hydrology discussed in detail above, assuming a 2:1 sideslope for the channels, Manning's Equation and the State Parks recommendations, the flow capacity and channel dimensions are summarized below for the Descanso Campground Site.

TABLE 10 – SUMMARY OF PROPOSED DRAINAGE CHANNELS				
Drainage Channel	10-Yr Design Flow (cfs)	Depth (ft)	Bottom Width (ft)	Total Width (ft)
1	69.88	2	2.47	10.47
2	14.97	2	1	9
3	107.54	2	5.1	13.1
4	120.95	2	6.02	14.02

For the Paso Picacho Parking Lot, the concrete v-ditch should have the following dimensions.

TABLE 11 – SUMMARY OF PROPOSED DRAINAGE CHANNELS				
Drainage Channel	10-Yr Design Flow (cfs)	Depth (ft)	Bottom Width (ft)	Total Width (ft)
v-ditch	54	1.7	0	6.8

Based on the flows calculated for the proposed site conditions of the Descanso Campground, and the calculated capacity of culverts C-1 through C-3, the western culverts (C-1 and C-2: capacity of 103 cfs) will have the capacity to pass the 25-year design flow, improved from not being capable of passing the 2-year flow. The eastern culvert (C-3: capacity of 45 cfs) will not be able to pass the proposed 2-year design flow. It is recommended that culvert C-1 through C-3 be replaced with culverts or a bridge that will allow the 100-year design flow to pass without over topping Viejas Boulevard. Culverts C-4 through C-6 remain unaffected by the proposed conditions and have less than a 2-year flow capacity. It is recognized that culverts C-4 through C-6 are not under major roads and may not need to be replaced.

Assuming that the new culverts under Viejas Boulevard will have approximately the same alignment and started and ending invert, the following are possible recommendations for the western and eastern culverts to allow the 100-year design flow to pass without overtopping Viejas Boulevard. A bridge spanning the two channels is also an option.

TABLE 12 – POSSIBLE CULVERT OPTIONS

	Proposed 100 Year Flow (cfs)	Culvert Options	Option Flow Capacity (cfs)
Western Culverts	177.27	3 x 36"	189
		3 x 42"	249
		2 x 48"	204
Eastern Culverts	160.58	3 x 36"	168
		2 x 42"	176
		2 x 48"	214

The suggested dimensions and flows for the new drainage channels are summarized in Table 7 above.

WATER QUALITY ANALYSIS

In general conformance with the County of San Diego Standard Urban Storm Water Mitigation Plan for Land Development and Public Improvement Project (SUSMP), the proposed development at the Descanso Campground and Paso Picacho Parking Lot was roughly examined in regards to potential water quality impacts to existing water bodies. It is outlined in the SUSMP that a Storm Water Management Plan (SWMP) should be submitted during the project application process, which includes details of post-construction BMPs early in the design process, construction BMPs, and the implementation of a long-term post-construction maintenance program, therefore this section will be general in regards to water quality and treatment options.

Based on the definition of a Priority Project within the SUSMP, it is anticipated that the proposed development will be a Priority Project based on the following criteria:

> *Parking lots 5,000 square feet or more or with 15 or more parking spaces and potentially exposed to urban runoff. Parking lot is defined as a land area or facility for the temporary parking or storage of motor vehicles used personally, for business, or for commerce.*
>
> *Street, roads, highways and freeways. This category includes construction of any paved surface which is 5,000 square feet or greater used for the transportation of automobiles, trucks, motorcycles, and other vehicles.*

Because the project will be considered a Priority Project, it will be necessary to implement Site Design BMPs, Source Control BMPs, and Treatment Control BMPs to the maximum extent practicable based on the pollutants of concern, receiving water bodies and proposed development.

The pollutants of concern as suggested by the SUSMP are summarized below based on the anticipated development.

TABLE 13 – POLLUTANTS OF CONCERN

Development Type	Anticipated	Potential
Parking Lot	Heavy Metals	Sediments
	Trash & Debris	Nutrients
	Oil & Grease	Oxygen Demanding Substances
Streets and Roads	Sediments	Nutrients
	Heavy Metals	Oxygen Demanding Substances
	Organic Compounds	
	Trash & Debris	
	Oil & Grease	
Animal Facility*	Oxygen Demanding Substances	
	Bacteria & Viruses	

*Not included in the SUSMP but anticipated source of pollutants

The Descanso Campground Site is located in the Sweetwater Hydrologic Unit in the Upper Sweetwater Hydrologic Area and in the Descanso Hydrologic Subarea (Hydrologic Basin Number 909.34) and the site currently discharges and is proposed to discharge into Sweetwater

River. Sweetwater River is not listed as a Clean Water Act Section 303(d) impaired water body nor is it a county Environmentally Sensitive Area.

The Paso Picacho Parking Site is located in the Sweetwater Hydrologic Unit in the Upper Sweetwater Hydrologic Area and in the Garnet Hydrologic Subarea (Hydrologic Basin Number 909.35) and the site currently discharges and is proposed to discharge into Harper Creek which drains into Sweetwater River. Harper Creek and Sweetwater River are not listed as a Clean Water Act Section 303(d) impaired water body nor is it a county Environmentally Sensitive Area.

STORM WATER BMPS

Based on the pollutants of concern, the project should be designed to minimize the introduction of the pollutants generated by storm water runoff to the receiving waters mentioned in the previous section. The project sites are being designed to use class 2 aggregate or decomposed granite for the roads, parking lots and campground sites rather than concrete to reduce the quantity of impervious areas. The reduction of impervious area is in conformance with Site Design BMPs in the SUSMP and will aid in reducing the amount of pollutants in the storm water by promoting rainfall infiltration and minimizing the directly connected impervious areas. To remove the potential pollutants to the maximum extent practicable, we are suggesting the implementation of permanent Treatment Control BMPs. The Treatment Control BMPs will follow the sizing parameters and site location criteria outlined in the SUSMP.

The grade of the site is such that the areas where the majority of the exposure to animals and animal maintenance is sloping towards the western channel (Drainage Channel 1). For this reason and the associated pollutants of concern summarized in Table 11, we are proposing the placement of a detention basin near the site property line and Drainage Channel 1. Detention Basins have high removal efficiency for sediments and trash and debris and medium removal efficiency for nutrients, heavy metals, oxygen demanding substances and oil and grease according to the SUSMP. The detention pond will provide treatment for the storm water runoff coming from parking lots, streets and roads, and animal facilities. A portion of the storm water will be treated by roadside vegetated swales and vegetated buffer strips before entering the detention basin or Drainage Channel 1.

The detention pond sizing is based on the SUSMP and California Stormwater Quality Association, Stormwater Best Management Practice Handbook (BMP Handbook). In both guidelines, several methods are suggested to estimate the volume-based detention pond design criteria. One method which both guidelines recommend the Urban Runoff Quality Management approach (WEF Manual of Practice No.23/ ASCE Manual of Practice No. 87 (1998)). This analysis is based on the Urban Runoff Quality Management approach.

There are two regression equations in the Urban Runoff Quality Management approach:

$$C = 0.858i^3 - 0.78i^2 + 0.774i + 0.04 \qquad \text{<}\textit{Equation 8}\text{>}$$

$$P_o = (a \cdot C) \cdot P_6 \qquad \text{<Equation 9>}$$

Where: C = runoff coefficient
i = watershed imperviousness ratio
P_o = maximized detention volume, in watershed inches
a = regression constant
P_6 = mean annual runoff-producing rainfall depths, in watershed inches

The watershed imperviousness ratio (i) was assumed to be zero for watersheds WS-1 through WS-3 and 0.10 for WS-4, which is a conservative value given that the proposed development will be decomposed granite and/or class 2 aggregate. The P_6 value is based on the San Diego WSO Airport value as shown in Table 1 of Appendix D in the BMP Handbook. The P_6 value for this analysis is 0.57 inches.

The regression constant (a) is related to the detention pond draw down time. In order to allow sufficient time for the runoff sedimentation settles in the detention pond, while minimizing potential vector bleeding due to prolonged stormwater detention, the detention pond is designed based on 24 hours draw down. At 24 hours draw down, the regression constant is 1.582.

It is assumed that only watersheds WS-1, WS-2, WS-3 and WS-4 (not WS-3B and WS-4B) will provide surface runoff to the detention pond.

TABLE 14 – DESCANCO CAMPGROUNG DETENTION POND DESIGN VOLUME

Basin	Watershed		Basin Volume - 85% Capture	
	ID	Area	Maximized Detention Volume	Volume
		ac	in	cf
1	WS-1	19.89	0.036	2600
	WS-2	11.52	0.036	1505
	WS-3	11.06	0.036	1445
	WS-4	33.81	0.099	12150
1	**-**	**74.28**	**Total Basin Volume**	**17700**

The analysis shows that the estimated detention pond volume is around 17,700 cubic feet (0.41 acre-ft). To maintain elevation with Drainage Channel 1, the detention pond will have a depth of 2 feet, therefore the approximate area needed for the basin will be 8,850 square feet (0.2 acre).

The remaining area of the site that drains towards the eastern culverts under Viejas Boulevard by way of Drainage Channels 2, 3 and 4, are predominately exposed to runoff from roads and parking lots and not exposed to animal waste. Vegetated swales have a medium efficiency rating for the major pollutants of concern (Table 11) according to the SUSMP, and will be utilized as treatment control BMPs for this area. According to the SUSMP, there are no minimum

dimensions for the vegetated swales, as a result they will be sized for routing the 10-year design storm. The table below summarizes the recommended size of the vegetated swales to route the 10-year design storm. Figure 4 shows the proposed BMPs for the Descanso Campground Site.

TABLE 15 – DESCANSO CAMPGROUND VEGETATED SWALE SIZE

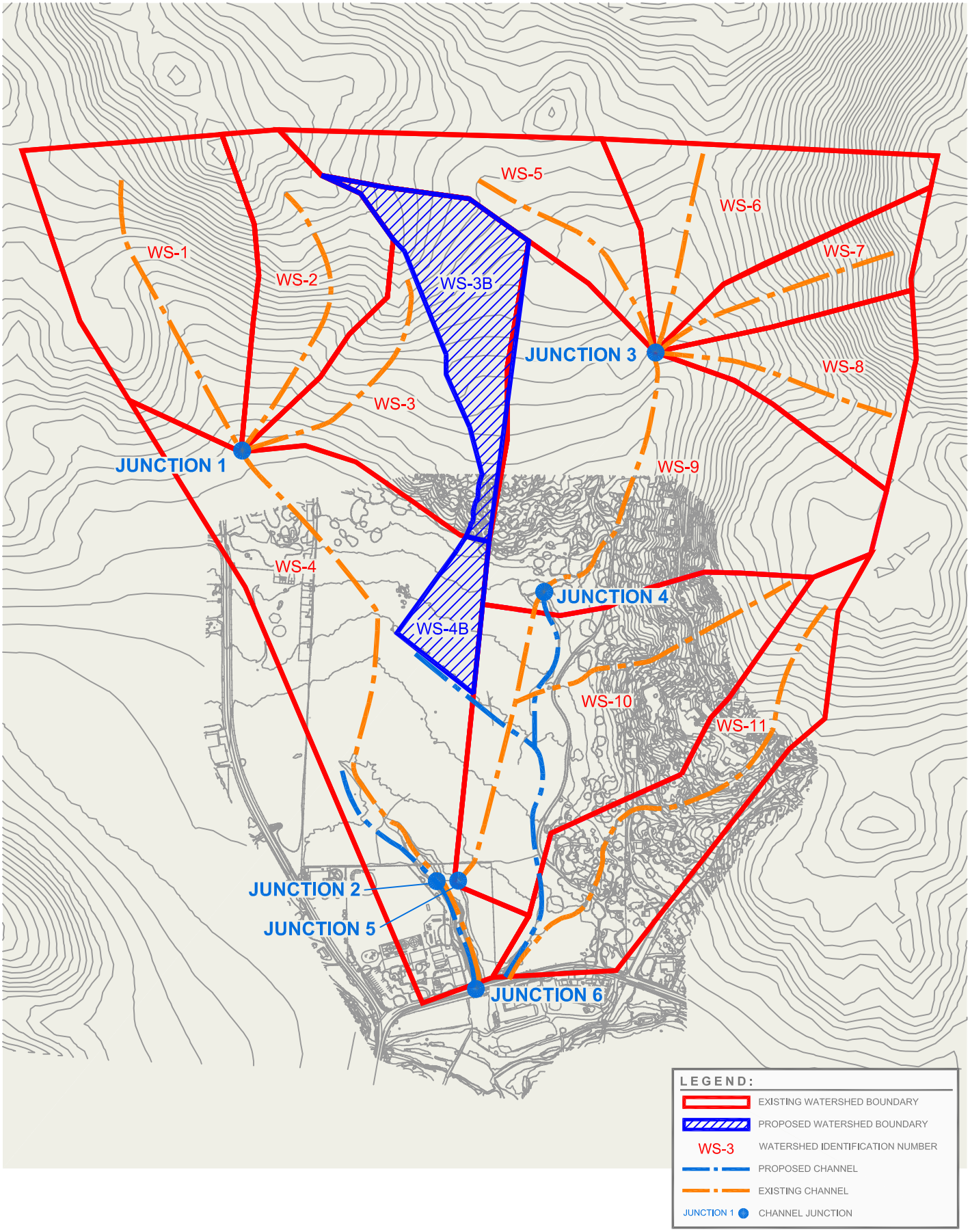
Vegetated Swale	Contributing Area (acre)	10-Yr Design Flow (cfs)	Depth (ft)	Bottom Width (ft)	Total Width (ft)
5	4.16	5.3	1	1	5
6	0.617	0.75	1	1	5
7	13.54	17.4	1.5	1	7

The Paso Picacho Parking Lot Site is anticipated to be exposed to concentrated amounts of animal waste, therefore it is recommended that a detention basin be used as the treatment control BMP. A vegetated swale or concrete v-ditch should be placed just upslope of the proposed development so that the non-impacted rainfall runoff from watershed PP-1 can be routed away from the parking lot, reducing the needed BMP treatment area. Based on equations 8 and 9, an impervious ratio of 0.85 for the decomposed granite parking lot in PP-1B and 0 for PP-1C, a P_6 value of 0.57 from the San Diego WSO Airport and a 24-hour draw down regression constant of 1.582 the detention pond volume is summarized below.

TABLE 16 – PASO PICACHO PARKING LOT DETENTION POND DESIGN VOLUME

Basin	Watershed		Basin Volume - 85% Capture	
	ID	Area	Maximized Detention Volume	Volume
		ac	in	cf
1	PP-1A	0.75	0.596	1623
	PP-1B	0.67	0.036	88
1	**-**	**1.42**	**Total Basin Volume**	**1711**

The analysis shows that the estimated detention pond volume is around 1,711 cubic feet (0.04 acre-ft). The parking lot should be graded in a manner that allows all the runoff from the parking lot and animal maintenance areas flow towards the proposed BMP shown in Figure 5.

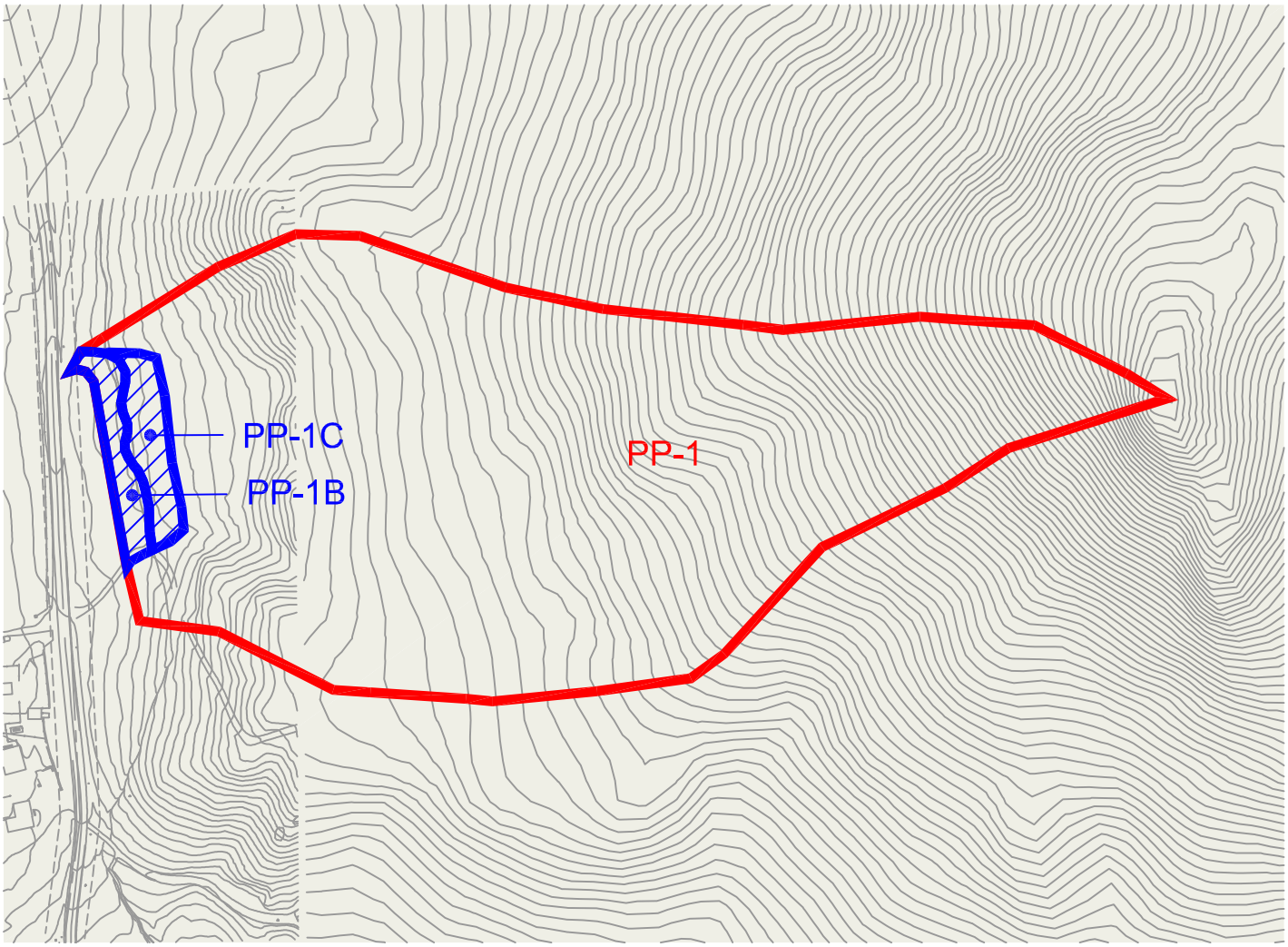


CUYAMACA RANCHO STATE PARK
EQUESTRIAN FACILITIES
HYDROLOGY AND HYDRAULIC ANALYSIS

NORTH

FIGURE 1
EXISTING AND PROPOSED WATERSHED DELINEATION
FOR THE DESCANSO CAMPGROUND SITE
SCALE: NONE

WINZLER & KELLY
CONSULTING ENGINEERS



LEGEND:

- EXISTING WATERSHED BOUNDARY
- PROPOSED WATERSHED BOUNDARY
- PP-1 WATERSHED IIDENTIFICATION NUMBER
- PROPOSED CULVERT

CUYAMACA RANCHO STATE PARK
EQUESTRIAN FACILITIES
HYDROLOGY AND HYDRAULIC ANALYSIS

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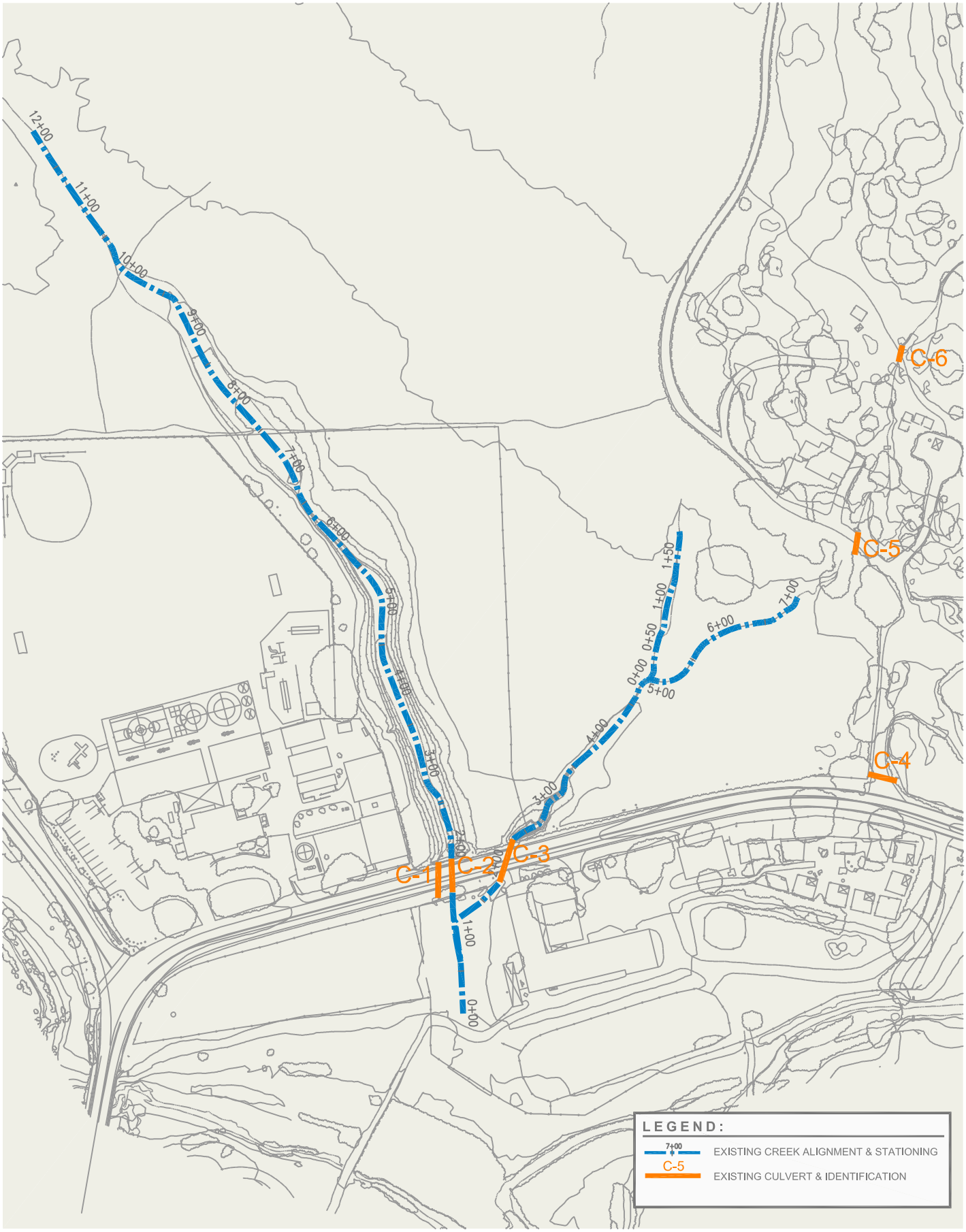
NORTH

FIGURE 2
EXISTING AND PROPOSED WATERSHED DELINEATION
FOR THE PASO PICACHO PARKING LOT
SCALE: NONE

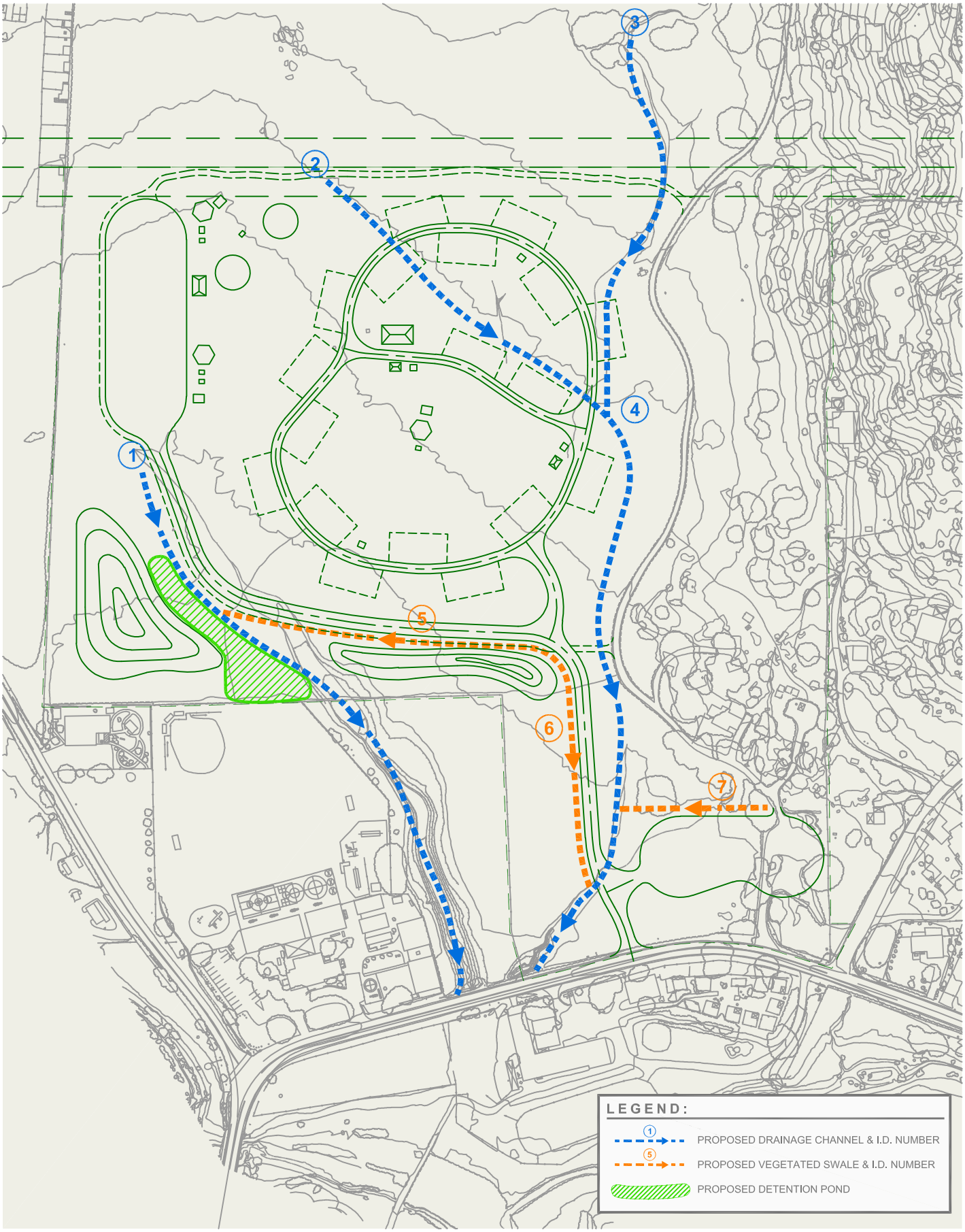


CUYAMACA RANCHO STATE PARK
EQUESTRIAN FACILITIES
HYDROLOGY AND HYDRAULIC ANALYSIS

NORTH

FIGURE 3
EXISTING HYDROLOGY AND HYDRAULIC MAP
FOR THE DESCANSO CAMPGROUND SITE
SCALE: NONE

WINZLER & KELLY
CONSULTING ENGINEERS



CUYAMACA RANCHO STATE PARK
EQUESTRIAN FACILITIES
HYDROLOGY AND HYDRAULIC ANALYSIS

NORTH

FIGURE 4
PROPOSED IMPROVEMENTS
FOR THE DESCANSO CAMPGROUND SITE
SCALE: NONE

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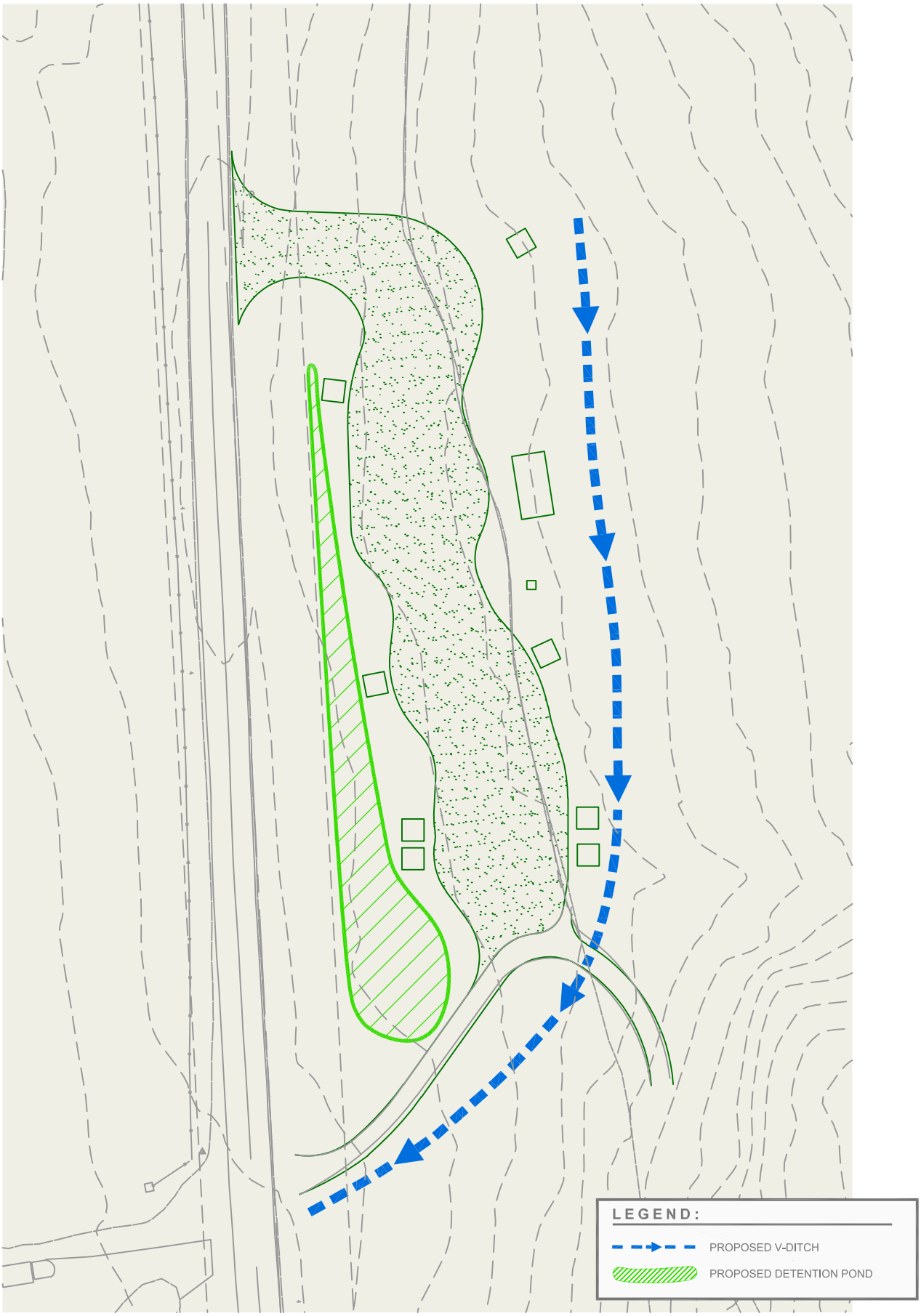

CUYAMACA RANCHO STATE PARK
EQUESTRIAN FACILITIES
HYDROLOGY AND HYDRAULIC ANALYSIS

NORTH

FIGURE 5
PROPOSED IMPROVEMENTS
FOR THE PASO PICCHO PARKING SITE
SCALE: NONE

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APPENDIX A

CALCULATIONS

EXISTING HYDROLOGY CALCULATIONS

DESCANSO CAMPGROUND SITE

							2-year		5-year		10-year		25-year		50-year		100-year	
	Acres	Length (ft)	ΔE (ft)	Slope (ft/ft)	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
WS-1	19.89	1020	116	0.11372549	0.35	6.9615	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-2	11.52	1270	237.65	0.18712598	0.35	4.032	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3	20.43	1396	162	0.11604585	0.35	7.1505	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4	36.83	2443	52	0.0212853	0.35	12.8905	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-5	11.34	1213	101	0.08326463	0.35	3.969	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-6	12.82	777	63	0.08108108	0.35	4.487	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-7	6.67	1222	371	0.30360065	0.35	2.3345	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-8	9.26	1085	171	0.15760369	0.35	3.241	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-9	33.79	1165	92	0.07896996	0.35	11.8265	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-10	25.47	1167	285	0.13411765	0.35	8.9145	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-11	17.7	2378	286	0.12026913	0.35	6.195	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

Time of Concentration Calculations				
	Ti (minutes)	Tt (hr)	Tt (minutes)	Tc (minutes)
WS-1	6.9	0.06231036	3.7386217	10.6386217
WS-2	5.4	0.06089766	3.65385987	9.05385987
WS-3	6.9	0.07872683	4.72360994	11.6236099
WS-4	10.9	0.23272	13.9632003	24.8632003
WS-5	6.9	0.08028583	4.81714974	11.7171497
WS-6	6.9	0.05756169	3.45370163	10.3537016
WS-7	4.3	0.04906838	2.94410258	7.24410258
WS-8	5.4	0.05763168	3.45790052	8.85790052
WS-9	10.9	0.07943127	4.76587646	15.6658765
WS-10	10.9	0.05149855	3.08991276	13.9899128
WS-11	6.9	0.11702191	7.0213143	13.9213143

Rainfall Intensity Calculations						
	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
WS-1	2.914099521	3.6426244	4.37114928	5.66630462	6.96146	7.609038
WS-2	3.233610155	4.04201269	4.85041523	6.2875753	7.724735	8.443315
WS-3	2.752329835	3.44041229	4.12849475	5.35175246	6.57501	7.186639
WS-4	1.685431698	2.10678962	2.52814755	3.2772283	4.026309	4.400849
WS-5	2.738137566	3.42267196	4.10720635	5.32415638	6.541106	7.149581
WS-6	2.96557389	3.70696736	4.44836084	5.76639368	7.084427	7.743443
WS-7	3.733837208	4.66729651	5.60075581	7.26023902	8.919722	9.749464
WS-8	3.279571288	4.09946411	4.91935693	6.37694417	7.834531	8.563325
WS-9	2.270385795	2.83798224	3.40557869	4.41463905	5.423699	5.92823
WS-10	2.442276112	3.05284514	3.66341417	4.74887022	5.834326	6.377054
WS-11	2.450031605	3.06253951	3.67504741	4.76395034	5.852853	6.397305

Design Flow Calculations for Watersheds Independently						
	Q2	Q5	Q10	Q25	Q50	Q100
WS-1	20.28650382	25.3581298	30.4297557	39.4459796	48.4622	52.97032
WS-2	13.03791614	16.2973952	19.5568742	25.3515036	31.14613	34.04345
WS-3	19.68053449	24.6006681	29.5208017	38.2677059	47.01461	51.38806
WS-4	21.7260573	27.1575716	32.589086	42.2451114	51.90114	56.72915
WS-5	10.867668	13.584585	16.301502	21.1315767	25.96165	28.37669
WS-6	13.30653005	16.6331626	19.9597951	25.8738084	31.78782	34.74483
WS-7	8.716642962	10.8958037	13.0749644	16.949028	20.82309	22.76012
WS-8	10.62909054	13.2863632	15.9436358	20.6676761	25.39172	27.75374
WS-9	26.8507176	33.563397	40.2760764	52.2097287	64.14338	70.11021
WS-10	21.7716704	27.214588	32.6575056	42.3338036	52.0101	56.84825
WS-11	15.17794579	18.9724322	22.7669187	29.5126724	36.25843	39.6313

Junction 1 (WS-1thru WS-3) Calculations - Using Modified Rational Method													
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	9.053859869	45.6320378	16.2973952	19.5568742	25.3515	31.14613	34.04345	3.23361	4.042013	4.850415	6.287575	7.724735	8.443315
T2	10.6386217	20.2865038	25.3581298	30.4297557	39.44598	48.4622	52.97032	2.9141	3.642624	4.371149	5.666305	6.96146	7.609038
T3	11.62360994	19.6805345	24.6006681	29.5208017	38.26771	47.01461	51.38806	2.75233	3.440412	4.128495	5.351752	6.57501	7.186639

Junction 1 Calculations - Using Modified Rational Method Continuted						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	78.22615946	57.0400473	68.4480567	88.7289624	109.0099	119.1503
Qt2	79.42247365	62.5611914	75.0734297	97.3174088	119.5614	130.6834
Qt3	77.68118809	62.4228407	74.9074088	97.1021966	119.297	130.3944
Junction 1	50.0489531	62.5611914	75.0734297	97.3174088	119.5614	130.6834

Junction 2 (WS-1 thru WS-3 + WS4) Calculations - Add Tc for Junction 1 to Tt for WS-3 to get new Q using Rational Method															
	Junction 1 Tc	WS-3 Tt	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 2	10.6	13.96	24.56	1.69882306	2.123529	2.548235	3.303267	4.0583	4.435816	52.72212	65.90266	79.08319	102.5152	125.9473	137.6633

Junction 3 (WS-5 thru WS-8) Calculations - Using Modified Rational Method													
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	7.244102578	8.71664296	10.8958037	13.0749644	16.94903	20.82309	22.76012	3.733837	4.667297	5.600756	7.260239	8.919722	9.749464
T2	8.857900521	10.6290905	13.2863632	15.9436358	20.66768	25.39172	27.75374	3.279571	4.099464	4.919357	6.376944	7.834531	8.563325
T3	10.35370163	13.30653	16.6331626	19.9597951	25.87381	31.78782	34.74483	2.965574	3.706967	4.448361	5.766394	7.084427	7.743443
T4	11.71714974	10.867668	13.584585	16.301502	21.13158	25.96165	28.37669	2.738138	3.422672	4.107206	5.324156	6.541106	7.149581

Junction 3 Calculations - Using Modified Rational Method						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	33.43824692	41.7978086	50.1573704	65.0188135	79.88026	87.31098
Qt2	37.88509453	47.3563682	56.8276418	73.6654616	90.50328	98.92219
Qt3	39.4441558	49.3051947	59.1662337	76.6969696	94.22771	102.9931
Qt4	38.42017726	48.0252216	57.6302659	74.7059002	91.78153	100.3194
Junction 3	39.4441558	49.3051947	59.1662337	76.6969696	94.22771	102.9931

Junction 4 Calculations - Add Tc for Junction 3 to Tt for WS-9 to get new Q using Rational Method															
	Previous Tc	Tt to Junctio	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 4	10.35	4.76	15.11	2.32391298	2.904891	3.485869	4.51872	5.55157	6.067995	60.09174	75.11468	90.13761	116.8451	143.5525	156.9062

Junction 5 Calculations - Add Tc for Junction 4 to Tt for WS-10 to get new Q using Rational Method														
	Previous Tc	Tt to Junctio	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 5 Cal	15.11	3.08	18.19	2.06183235	2.57729	3.092749	4.009118	4.925488	5.383673	71.69507	89.61883	107.5426	139.4071	171.2715	187.2038

Junction 6 Calculations - Using Modified Rational Method													
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	18.19	71.6950655	89.6188318	107.542598	139.4071	171.2715	187.2038	2.061832	2.57729	3.092749	4.009118	4.925488	5.383673
T2	24.56320027	52.7176936	65.8971169	79.0765403	102.5066	125.9367	137.6518	1.69868	2.12335	2.54802	3.302989	4.057958	4.435443

Junction 6 Calculations - Using Modified Rational Method						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	110.7345569	138.418196	166.101835	215.317194	264.5326	289.1402
Qt2	111.785054	139.731318	167.677581	217.359827	267.0421	291.8832
Junction 5	111.785054	139.731318	167.677581	217.359827	267.0421	291.8832

Total Volume	V2 (acre-in)	V5	V10	V25	V50	V100
	118.4526	148.06575	177.6789	230.3245	282.9701	309.2929
	5.150113043	6.4376413	7.72516957	10.0141087	12.30305	13.44752

EXISTING HYDROLOGY CALCULATIONS

PASO PICACHO PARKING LOT SITE

							2 Year		5 Year		10 Year		25 Year		50 Year		100 Year	
	Acres	Length (ft)	ΔE	Slope	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
PP-1	30.17	2068	810	0.391682785	0.35	10.5595	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

	Ti (minutes)	Tt (hr)		Tc (minutes)
PP-1	3.975169092	0.066702	4.002108	7.977276915

	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
PP-1	3.508723776	4.385905	5.263086	6.822518454	8.381951	9.161668

	Q2	Q5	Q10	Q25	Q50	Q100
PP-1	37.05036872	46.31296	55.57555	72.04238362	88.50921	96.74263

PROPOSED HYDROLOGY CALCULATIONS

DESCANSO CAMPGROUND SITE

PROPOSED HYDROLOGY CALCULATIONS

DESCANSO CAMPGROUND SITE
Q10 AND BELOW

Drainage Channel 1

							2-year		5-year		10-year		25-year		50-year		100-year	
	Acres	Length (ft)	ΔE (ft)	Slope (ft/ft)	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
WS-1	19.89	1020	116	0.113725	0.35	6.9615	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-2	11.52	1270	237.65	0.187126	0.35	4.032	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3	11.06	866	165	0.190531	0.35	3.871	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3B	9.37	1573	200	0.127146	0.35	3.2795	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4	33.81	2443	52	0.021285	0.35	11.8335	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4B	3.02	527	20	0.037951	0.35	1.057	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-5	11.34	1213	101	0.083265	0.35	3.969	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-6	12.82	777	63	0.081081	0.35	4.487	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-7	6.67	1222	371	0.303601	0.35	2.3345	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-8	9.26	1085	171	0.157604	0.35	3.241	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-9	33.79	1165	92	0.07897	0.35	11.8265	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-10	25.47	1167	285	0.134118	0.35	8.9145	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-11	17.7	2378	286	0.120269	0.35	6.195	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

Time of Concentration Calculations				
	Ti (minutes	Tt (hr)	Tt (minutes	Tc (minutes)
WS-1	6.9	0.06231	3.738622	10.63862
WS-2	5.4	0.060898	3.65386	9.05386
WS-3	6.9	0.045034	2.702069	9.602069
WS-3B	6.9	0.083324	4.999422	11.89942
WS-4	10.9	0.23272	13.9632	24.8632
WS-4B	10.3	0.057179	3.430752	13.73075
WS-5	6.9	0.080286	4.81715	11.71715
WS-6	6.9	0.057562	3.453702	10.3537
WS-7	4.3	0.049068	2.944103	7.244103
WS-8	5.4	0.057632	3.457901	8.857901
WS-9	10.9	0.079431	4.765876	15.66588
WS-10	10.9	0.051499	3.089913	13.98991
WS-11	6.9	0.117022	7.021314	13.92131

Rainfall Intensity Calculations						
	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
WS-1	2.9141	3.642624	4.371149	5.666305	6.96146	7.609038
WS-2	3.23361	4.042013	4.850415	6.287575	7.724735	8.443315
WS-3	3.113294	3.891617	4.669941	6.053627	7.437313	8.129156
WS-3B	2.711011	3.388764	4.066516	5.27141	6.476304	7.078751
WS-4	1.685432	2.10679	2.528148	3.277228	4.026309	4.400849
WS-4B	2.47191	3.089887	3.707865	4.806491	5.905118	6.454431
WS-5	2.738138	3.422672	4.107206	5.324156	6.541106	7.149581
WS-6	2.965574	3.706967	4.448361	5.766394	7.084427	7.743443
WS-7	3.733837	4.667297	5.600756	7.260239	8.919722	9.749464
WS-8	3.279571	4.099464	4.919357	6.376944	7.834531	8.563325
WS-9	2.270386	2.837982	3.405579	4.414639	5.423699	5.92823
WS-10	2.442276	3.052845	3.663414	4.74887	5.834326	6.377054
WS-11	2.450032	3.06254	3.675047	4.76395	5.852853	6.397305

Design Flow Calculations for Watersheds Independently						
	Q2	Q5	Q10	Q25	Q50	Q100
WS-1	20.2865	25.35813	30.42976	39.44598	48.4622	52.97032
WS-2	13.03792	16.2974	19.55687	25.3515	31.14613	34.04345
WS-3	12.05156	15.06445	18.07734	23.43359	28.78984	31.46796
WS-3B	8.89076	11.11345	13.33614	17.28759	21.23904	23.21476
WS-4	19.94456	24.93069	29.91683	38.78108	47.64533	52.07745
WS-4B	2.612809	3.266011	3.919213	5.080461	6.241709	6.822333
WS-5	10.86767	13.58458	16.3015	21.13158	25.96165	28.37669
WS-6	13.30653	16.63316	19.9598	25.87381	31.78782	34.74483
WS-7	8.716643	10.8958	13.07496	16.94903	20.82309	22.76012
WS-8	10.62909	13.28636	15.94364	20.66768	25.39172	27.75374
WS-9	26.85072	33.5634	40.27608	52.20973	64.14338	70.11021
WS-10	21.77167	27.21459	32.65751	42.3338	52.0101	56.84825
WS-11	15.17795	18.97243	22.76692	29.51267	36.25843	39.6313

Junction 1 (WS-1thru WS-3) Calculations - Using Modified Rational Method													
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	9.05386	13.03792	16.2974	19.55687	25.3515	31.14613	34.04345	3.23361	4.042013	4.850415	6.287575	7.724735	8.443315
T2	9.602069	12.05156	15.06445	18.07734	23.43359	28.78984	31.46796	3.113294	3.891617	4.669941	6.053627	7.437313	8.129156
T3	10.63862	20.2865	25.35813	30.42976	39.44598	48.4622	52.97032	2.9141	3.642624	4.371149	5.666305	6.96146	7.609038

Junction 1 Calculations - Using Modified Rational Method Continuted						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	41.66598	52.08248	62.49897	81.01719	99.5354	108.7945
Qt2	44.29062	55.36327	66.43593	86.12065	105.8054	115.6477
Qt3	43.31663	54.14579	64.97495	84.22679	103.4786	113.1045
Junction 1	44.29062	55.36327	66.43593	86.12065	105.8054	115.6477

Junction 2 (WS-1 thru WS-3 + WS4) Calculations - Add Tc for Junction 1 to Tt for WS-3 to get new Q using Rational Method															
	Junction 1	WS-4 Tt	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 2	9.6	13.96	23.56	1.744988	2.181235	2.617482	3.393032	4.168582	4.556357	46.58768	58.2346	69.88152	90.58716	111.2928	121.6456

Only Q2 thru Q10 are flows through the channel. Above Q10 is out of bank.

Drainage Channel 2

							2-year		5-year		10-year		25-year		50-year		100-year	
	Acres	Length (ft)	ΔE (ft)	Slope (ft/ft)	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
WS-1	19.89	1020	116	0.113725	0.35	6.9615	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-2	11.52	1270	237.65	0.187126	0.35	4.032	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3	11.06	866	165	0.190531	0.35	3.871	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3B	9.37	1573	200	0.127146	0.35	3.2795	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4	33.81	2443	52	0.021285	0.35	11.8335	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4B	3.02	527	20	0.037951	0.35	1.057	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-5	11.34	1213	101	0.083265	0.35	3.969	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-6	12.82	777	63	0.081081	0.35	4.487	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-7	6.67	1222	371	0.303601	0.35	2.3345	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-8	9.26	1085	171	0.157604	0.35	3.241	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-9	33.79	1165	92	0.07897	0.35	11.8265	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-10	25.47	1167	285	0.134118	0.35	8.9145	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-11	17.7	2378	286	0.120269	0.35	6.195	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

Time of Concentration Calculations				
	Ti (minutes)	Tt (hr)	Tt (minutes	Tc (minutes)
WS-1	6.9	0.06231	3.738622	10.63862
WS-2	5.4	0.060898	3.65386	9.05386
WS-3	6.9	0.045034	2.702069	9.602069
WS-3B	6.9	0.083324	4.999422	11.89942
WS-4	10.9	0.23272	13.9632	24.8632
WS-4B	10.3	0.057179	3.430752	13.73075
WS-5	6.9	0.080286	4.81715	11.71715
WS-6	6.9	0.057562	3.453702	10.3537
WS-7	4.3	0.049068	2.944103	7.244103
WS-8	5.4	0.057632	3.457901	8.857901
WS-9	10.9	0.079431	4.765876	15.66588
WS-10	10.9	0.051499	3.089913	13.98991
WS-11	6.9	0.117022	7.021314	13.92131

Rainfall Intensity Calculations						
	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
WS-1	2.914099521	3.642624	4.371149	5.666305	6.96146	7.609038
WS-2	3.233610155	4.042013	4.850415	6.287575	7.724735	8.443315
WS-3	3.113293887	3.891617	4.669941	6.053627	7.437313	8.129156
WS-3B	2.711010891	3.388764	4.066516	5.27141	6.476304	7.078751
WS-4	1.685431698	2.10679	2.528148	3.277228	4.026309	4.400849
WS-4B	2.471909669	3.089887	3.707865	4.806491	5.905118	6.454431
WS-5	2.738137566	3.422672	4.107206	5.324156	6.541106	7.149581
WS-6	2.96557389	3.706967	4.448361	5.766394	7.084427	7.743443
WS-7	3.733837208	4.667297	5.600756	7.260239	8.919722	9.749464
WS-8	3.279571288	4.099464	4.919357	6.376944	7.834531	8.563325
WS-9	2.270385795	2.837982	3.405579	4.414639	5.423699	5.92823
WS-10	2.442276112	3.052845	3.663414	4.74887	5.834326	6.377054
WS-11	2.450031605	3.06254	3.675047	4.76395	5.852853	6.397305

Design Flow Calculations for Watersheds Independently						
	Q2	Q5	Q10	Q25	Q50	Q100
WS-1	20.28650382	25.35813	30.42976	39.44598	48.4622	52.97032
WS-2	13.03791614	16.2974	19.55687	25.3515	31.14613	34.04345
WS-3	12.05156064	15.06445	18.07734	23.43359	28.78984	31.46796
WS-3B	8.890760218	11.11345	13.33614	17.28759	21.23904	23.21476
WS-4	19.944556	24.93069	29.91683	38.78108	47.64533	52.07745
WS-4B	2.61280852	3.266011	3.919213	5.080461	6.241709	6.822333
WS-5	10.867668	13.58458	16.3015	21.13158	25.96165	28.37669
WS-6	13.30653005	16.63316	19.9598	25.87381	31.78782	34.74483
WS-7	8.716642962	10.8958	13.07496	16.94903	20.82309	22.76012
WS-8	10.62909054	13.28636	15.94364	20.66768	25.39172	27.75374
WS-9	26.8507176	33.5634	40.27608	52.20973	64.14338	70.11021
WS-10	21.7716704	27.21459	32.65751	42.3338	52.0101	56.84825
WS-11	15.17794579	18.97243	22.76692	29.51267	36.25843	39.6313

Reach 2 Calculations - Flow Calculation from WS-3B and WS-4B															
	Previous Tc	Tt to Junct	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 4	11.89942176	3.430752	15.33017	2.30233	2.877912	3.453495	4.476753	5.500011	6.011639	9.984054	12.48007	14.97608	19.41344	23.8508	26.06947

Only Q2 thru Q10 are flows through the channel. Above Q10 is out of bank.

Drainage Channel 3

							2-year		5-year		10-year		25-year		50-year		100-year	
	Acres	Length (ft)	ΔE (ft)	Slope (ft/ft)	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
WS-1	19.89	1020	116	0.11372549	0.35	6.9615	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-2	11.52	1270	237.65	0.187125984	0.35	4.032	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3	11.06	866	165	0.190531178	0.35	3.871	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3B	9.37	1573	200	0.127145582	0.35	3.2795	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4	33.81	2443	52	0.021285305	0.35	11.8335	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4B	3.02	527	20	0.037950664	0.35	1.057	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-5	11.34	1213	101	0.083264633	0.35	3.969	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-6	12.82	777	63	0.081081081	0.35	4.487	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-7	6.67	1222	371	0.303600655	0.35	2.3345	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-8	9.26	1085	171	0.157603687	0.35	3.241	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-9	33.79	1165	92	0.078969957	0.35	11.8265	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-10	25.47	1167	285	0.134117647	0.35	8.9145	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-11	17.7	2378	286	0.120269134	0.35	6.195	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

Time of Concentration Calculations				
	Ti (minutes)	Tt (hr)	Tt (minutes)	Tc (minutes)
WS-1	6.9	0.06231	3.738621701	10.6386217
WS-2	5.4	0.060898	3.653859869	9.053859869
WS-3	6.9	0.045034	2.702069384	9.602069384
WS-3B	6.9	0.083324	4.999421762	11.89942176
WS-4	10.9	0.23272	13.96320027	24.86320027
WS-4B	10.3	0.057179	3.430752293	13.73075229
WS-5	6.9	0.080286	4.817149736	11.71714974
WS-6	6.9	0.057562	3.453701627	10.35370163
WS-7	4.3	0.049068	2.944102578	7.244102578
WS-8	5.4	0.057632	3.457900521	8.857900521
WS-9	10.9	0.079431	4.765876458	15.66587646
WS-10	10.9	0.051499	3.089912759	13.98991276
WS-11	6.9	0.117022	7.021314304	13.9213143

Rainfall Intensity Calculations						
	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
WS-1	2.914099521	3.642624	4.371149282	5.666304624	6.96146	7.609038
WS-2	3.233610155	4.042013	4.850415232	6.287575301	7.724735	8.443315
WS-3	3.113293887	3.891617	4.669940831	6.053627003	7.437313	8.129156
WS-3B	2.711010891	3.388764	4.066516337	5.271410066	6.476304	7.078751
WS-4	1.685431698	2.10679	2.528147547	3.277228302	4.026309	4.400849
WS-4B	2.471909669	3.089887	3.707864503	4.806491023	5.905118	6.454431
WS-5	2.738137566	3.422672	4.107206349	5.324156378	6.541106	7.149581
WS-6	2.96557389	3.706967	4.448360836	5.766393676	7.084427	7.743443
WS-7	3.733837208	4.667297	5.600755812	7.260239016	8.919722	9.749464
WS-8	3.279571288	4.099464	4.919356931	6.37694417	7.834531	8.563325
WS-9	2.270385795	2.837982	3.405578692	4.414639046	5.423699	5.92823
WS-10	2.442276112	3.052845	3.663414168	4.748870218	5.834326	6.377054
WS-11	2.450031605	3.06254	3.675047407	4.763950343	5.852853	6.397305

Design Flow Calculations for Watersheds Independently						
	Q2	Q5	Q10	Q25	Q50	Q100
WS-1	20.28650382	25.35813	30.42975572	39.44597964	48.4622	52.97032
WS-2	13.03791614	16.2974	19.55687422	25.35150361	31.14613	34.04345
WS-3	12.05156064	15.06445	18.07734096	23.43359013	28.78984	31.46796
WS-3B	8.890760218	11.11345	13.33614033	17.28758931	21.23904	23.21476
WS-4	19.944556	24.93069	29.916834	38.78108111	47.64533	52.07745
WS-4B	2.61280852	3.266011	3.91921278	5.080461011	6.241709	6.822333
WS-5	10.867668	13.58458	16.301502	21.13157667	25.96165	28.37669
WS-6	13.30653005	16.63316	19.95979507	25.87380842	31.78782	34.74483
WS-7	8.716642962	10.8958	13.07496444	16.94902798	20.82309	22.76012
WS-8	10.62909054	13.28636	15.94363581	20.66767606	25.39172	27.75374
WS-9	26.8507176	33.5634	40.2760764	52.20972867	64.14338	70.11021
WS-10	21.7716704	27.21459	32.6575056	42.33380356	52.0101	56.84825
WS-11	15.17794579	18.97243	22.76691869	29.51267237	36.25843	39.6313

Junction 3 (WS-5 thru WS-8) Calculations - Using Modified Rational Method													
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	7.244102578	8.716643	10.8958037	13.07496444	16.94903	20.82309	22.76012	3.733837	4.667297	5.600756	7.260239	8.919722	9.749464
T2	8.857900521	10.62909	13.28636318	15.94363581	20.66768	25.39172	27.75374	3.279571	4.099464	4.919357	6.376944	7.834531	8.563325
T3	10.35370163	13.30653	16.63316256	19.95979507	25.87381	31.78782	34.74483	2.965574	3.706967	4.448361	5.766394	7.084427	7.743443
T4	11.71714974	10.86767	13.584585	16.301502	21.13158	25.96165	28.37669	2.738138	3.422672	4.107206	5.324156	6.541106	7.149581

Junction 3 Calculations - Using Modified Rational Method						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	33.43824692	41.79781	50.15737038	65.01881345	79.88026	87.31098
Qt2	37.88509453	47.35637	56.82764179	73.66546158	90.50328	98.92219
Qt3	39.4441558	49.30519	59.1662337	76.69696961	94.22771	102.9931
Qt4	38.42017726	48.02522	57.63026589	74.70590022	91.78153	100.3194
Junction 3	39.4441558	49.30519	59.1662337	76.69696961	94.22771	102.9931

Junction 4 Calculations - Add Tc for Junction 3 to Tt for WS-9 to get new Q using Rational Method															
	Previous Tc	Tt to Junct	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 4	10.35	4.76	15.11	2.323912977	2.904891	3.485869	4.51872	5.55157	6.067995	60.09174	75.11468	90.13761	116.8451	143.5525	156.9062

Junction 5 Calculations - Add Tc for Junction 4 to Tt for WS-10 to get new Q using Rational Method															
	Previous Tc	Tt to Junct	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 5	15.11	3.08	18.19	2.061832352	2.57729	3.092749	4.009118	4.925488	5.383673	71.69507	89.61883	107.5426	139.4071	171.2715	187.2038

Only Q2 thru Q10 are flows through the channel. Above Q10 is out of bank.

Drainage Channel 4

							2-year		5-year		10-year		25-year		50-year		100-year	
	Acres	Length (ft)	ΔE (ft)	Slope (ft/ft)	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
WS-1	19.89	1020	116	0.11372549	0.35	6.9615	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-2	11.52	1270	237.65	0.187125984	0.35	4.032	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3	11.06	866	165	0.190531178	0.35	3.871	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3B	9.37	1573	200	0.127145582	0.35	3.2795	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4	33.81	2443	52	0.021285305	0.35	11.8335	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4B	3.02	527	20	0.037950664	0.35	1.057	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-5	11.34	1213	101	0.083264633	0.35	3.969	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-6	12.82	777	63	0.081081081	0.35	4.487	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-7	6.67	1222	371	0.303600655	0.35	2.3345	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-8	9.26	1085	171	0.157603687	0.35	3.241	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-9	33.79	1165	92	0.078969957	0.35	11.8265	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-10	25.47	1167	285	0.134117647	0.35	8.9145	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-11	17.7	2378	286	0.120269134	0.35	6.195	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

Time of Concentration Calculations				
	Ti (minutes	Tt (hr)	Tt (minutes	Tc (minutes)
WS-1	6.9	0.06231	3.738622	10.6386217
WS-2	5.4	0.060898	3.65386	9.053859869
WS-3	6.9	0.045034	2.702069	9.602069384
WS-3B	6.9	0.083324	4.999422	11.89942176
WS-4	10.9	0.23272	13.9632	24.86320027
WS-4B	10.3	0.057179	3.430752	13.73075229
WS-5	6.9	0.080286	4.81715	11.71714974
WS-6	6.9	0.057562	3.453702	10.35370163
WS-7	4.3	0.049068	2.944103	7.244102578
WS-8	5.4	0.057632	3.457901	8.857900521
WS-9	10.9	0.079431	4.765876	15.66587646
WS-10	10.9	0.051499	3.089913	13.98991276
WS-11	6.9	0.117022	7.021314	13.9213143

Rainfall Intensity Calculations						
	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
WS-1	2.9141	3.642624	4.371149	5.666304624	6.96146	7.609038
WS-2	3.23361	4.042013	4.850415	6.287575301	7.724735	8.443315
WS-3	3.113294	3.891617	4.669941	6.053627003	7.437313	8.129156
WS-3B	2.711011	3.388764	4.066516	5.271410066	6.476304	7.078751
WS-4	1.685432	2.10679	2.528148	3.277228302	4.026309	4.400849
WS-4B	2.47191	3.089887	3.707865	4.806491023	5.905118	6.454431
WS-5	2.738138	3.422672	4.107206	5.324156378	6.541106	7.149581
WS-6	2.965574	3.706967	4.448361	5.766393676	7.084427	7.743443
WS-7	3.733837	4.667297	5.600756	7.260239016	8.919722	9.749464
WS-8	3.279571	4.099464	4.919357	6.37694417	7.834531	8.563325
WS-9	2.270386	2.837982	3.405579	4.414639046	5.423699	5.92823
WS-10	2.442276	3.052845	3.663414	4.748870218	5.834326	6.377054
WS-11	2.450032	3.06254	3.675047	4.763950343	5.852853	6.397305

Design Flow Calculations for Watersheds Independently						
	Q2	Q5	Q10	Q25	Q50	Q100
WS-1	20.2865	25.35813	30.42976	39.44597964	48.4622	52.97032
WS-2	13.03792	16.2974	19.55687	25.35150361	31.14613	34.04345
WS-3	12.05156	15.06445	18.07734	23.43359013	28.78984	31.46796
WS-3B	8.89076	11.11345	13.33614	17.28758931	21.23904	23.21476
WS-4	19.94456	24.93069	29.91683	38.78108111	47.64533	52.07745
WS-4B	2.612809	3.266011	3.919213	5.080461011	6.241709	6.822333
WS-5	10.86767	13.58458	16.3015	21.13157667	25.96165	28.37669
WS-6	13.30653	16.63316	19.9598	25.87380842	31.78782	34.74483
WS-7	8.716643	10.8958	13.07496	16.94902798	20.82309	22.76012
WS-8	10.62909	13.28636	15.94364	20.66767606	25.39172	27.75374
WS-9	26.85072	33.5634	40.27608	52.20972867	64.14338	70.11021
WS-10	21.77167	27.21459	32.65751	42.33380356	52.0101	56.84825
WS-11	15.17795	18.97243	22.76692	29.51267237	36.25843	39.6313

Reach 2 Flow															
	Previous T	Tt to Junct	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 4	11.89942	3.430752	15.33017	2.302329989	2.877912	3.453495	4.476753	5.500011	6.011639	9.984054	12.48007	14.97608	19.41344	23.8508	26.06947

Reach 3 Flow															
	Previous T	Tt to Junct	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 5	15.11	3.08	18.19	2.061832352	2.57729	3.092749	4.009118	4.925488	5.383673	71.69507	89.61883	107.5426	139.4071	171.2715	187.2038

Junction 3 (WS-5 thru WS-8) Calculations - Using Modified Rational Method													
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	15.33017	9.984054	12.48007	14.97608099	19.41344	23.8508	26.06947	2.30233	2.877912	3.453495	4.476753	5.500011	6.011639
T2	18.19	71.69507	89.61883	107.5425982	139.4071	171.2715	187.2038	2.061832	2.57729	3.092749	4.009118	4.925488	5.383673

Junction 3 Calculations - Using Modified Rational Method						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	70.40724	88.00906	105.6109	136.9029751	168.1951	183.8411
Qt2	80.6362	100.7953	120.9543	156.7926139	192.6309	210.5501
Reach 4	80.6362	100.7953	120.9543	156.7926139	192.6309	210.5501

Drainage Channel 4 + WS-11													
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	13.92	15.17795	18.97243	22.76691869	29.51267	36.25843	39.6313	2.450032	3.06254	3.675047	4.76395	5.852853	6.397305
T2	18.19	80.6362	100.7953	120.9543022	156.7926	192.6309	210.5501	2.061832	2.57729	3.092749	4.009118	4.925488	5.383673

Eastern Culvert Calcs - Using Modified Rational Method						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	83.13655	103.9207	124.7048	161.654402	198.604	217.0788
Qt2	93.40925	116.7616	140.1139	181.6291028	223.1443	243.9019
Reach 4	93.40925	116.7616	140.1139	181.6291028	223.1443	243.9019

Only Q2 thru Q10 are flows through the channel. Above Q10 is out of bank.

PROPOSED HYDROLOGY CALCULATIONS

DESCANSO CAMPGROUND SITE
Q25 AND ABOVE

Flow to the Western Culvert (WS-1 thru WS-10)

							2-year		5-year		10-year		25-year		50-year		100-year	
	Acres	Length (ft)	ΔE (ft)	Slope (ft/ft)	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
WS-1	19.89	1020	116	0.11372549	0.35	6.9615	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-2	11.52	1270	237.65	0.18712598	0.35	4.032	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-3	20.43	1396	162	0.11604585	0.35	7.1505	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-4	36.83	2443	52	0.0212853	0.35	12.8905	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-5	11.34	1213	101	0.08326463	0.35	3.969	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-6	12.82	777	63	0.08108108	0.35	4.487	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-7	6.67	1222	371	0.30360065	0.35	2.3345	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-8	9.26	1085	171	0.15760369	0.35	3.241	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-9	33.79	1165	92	0.07896996	0.35	11.8265	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-10	25.47	1167	285	0.13411765	0.35	8.9145	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
WS-11	17.7	2378	286	0.12026913	0.35	6.195	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

Time of Concentration Calculations				
	Ti (minutes)	Tt (hr)	Tt (minutes	Tc (minutes)
WS-1	6.9	0.06231	3.738622	10.6386217
WS-2	5.4	0.060898	3.65386	9.05385987
WS-3	6.9	0.078727	4.72361	11.6236099
WS-4	10.9	0.23272	13.9632	24.8632003
WS-5	6.9	0.080286	4.81715	11.7171497
WS-6	6.9	0.057562	3.453702	10.3537016
WS-7	4.3	0.049068	2.944103	7.24410258
WS-8	5.4	0.057632	3.457901	8.85790052
WS-9	10.9	0.079431	4.765876	15.6658765
WS-10	10.9	0.051499	3.089913	13.9899128
WS-11	6.9	0.117022	7.021314	13.9213143

Rainfall Intensity Calculations						
	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
WS-1	2.91409952	3.642624	4.371149	5.66630462	6.96146	7.609038
WS-2	3.23361015	4.042013	4.850415	6.2875753	7.724735	8.443315
WS-3	2.75232984	3.440412	4.128495	5.35175246	6.57501	7.186639
WS-4	1.6854317	2.10679	2.528148	3.2772283	4.026309	4.400849
WS-5	2.73813757	3.422672	4.107206	5.32415638	6.541106	7.149581
WS-6	2.96557389	3.706967	4.448361	5.76639368	7.084427	7.743443
WS-7	3.73383721	4.667297	5.600756	7.26023902	8.919722	9.749464
WS-8	3.27957129	4.099464	4.919357	6.37694417	7.834531	8.563325
WS-9	2.27038579	2.837982	3.405579	4.41463905	5.423699	5.92823
WS-10	2.44227611	3.052845	3.663414	4.74887022	5.834326	6.377054
WS-11	2.4500316	3.06254	3.675047	4.76395034	5.852853	6.397305

Design Flow Calculations for Watersheds Independently						
	Q2	Q5	Q10	Q25	Q50	Q100
WS-1	20.2865038	25.35813	30.42976	39.4459796	48.4622	52.97032
WS-2	13.0379161	16.2974	19.55687	25.3515036	31.14613	34.04345
WS-3	19.6805345	24.60067	29.5208	38.2677059	47.01461	51.38806
WS-4	21.7260573	27.15757	32.58909	42.2451114	51.90114	56.72915
WS-5	10.867668	13.58458	16.3015	21.1315767	25.96165	28.37669
WS-6	13.30653	16.63316	19.9598	25.8738084	31.78782	34.74483
WS-7	8.71664296	10.8958	13.07496	16.949028	20.82309	22.76012
WS-8	10.6290905	13.28636	15.94364	20.6676761	25.39172	27.75374
WS-9	26.8507176	33.5634	40.27608	52.2097287	64.14338	70.11021
WS-10	21.7716704	27.21459	32.65751	42.3338036	52.0101	56.84825
WS-11	15.1779458	18.97243	22.76692	29.5126724	36.25843	39.6313

Junction 1 (WS-1thru WS-3) Calculations - Using Modified Rational Method														
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	9.05385987	45.63204	16.2974	19.5568742	25.3515	31.14613	34.04345	3.23361	4.042013	4.850415	6.287575	7.724735	8.443315
T2	10.6386217	20.2865	25.35813	30.4297557	39.44598	48.4622	52.97032	2.9141	3.642624	4.371149	5.666305	6.96146	7.609038
T3	11.6236099	19.68053	24.60067	29.5208017	24.93	33.68	38.05	2.75233	3.440412	4.128495	5.351752	6.57501	7.186639

Junction 1 Calculations - Using Modified Rational Method Continuted						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	78.2261595	57.04005	68.44806	78.3399592	98.62328	108.761
Qt2	79.4224736	62.56119	75.07343	85.1099441	107.3568	118.4756
Qt3	77.6811881	62.42284	74.90741	83.7644906	105.9624	117.0563
Junction 1	79.4224736	62.56119	75.07343	85.1099441	107.3568	118.4756

Junction 2 (WS-1 thru WS-3 + WS4) Calculations - Add Tc for Junction 1 to Tt for WS-3 to get new Q using Rational Method															
	Junction 1 Tc	WS-3 Tt	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 2	10.6	13.96	24.56	1.69882306	2.123529	2.548235	3.303267	4.0583	4.435816	52.72212	65.90266	79.08319	87.53924	110.9713	122.6873

Junction 3 (WS-5 thru WS-8) Calculations - Using Modified Rational Method														
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	7.24410258	8.716643	10.8958	13.0749644	16.94903	20.82309	22.76012	3.733837	4.667297	5.600756	7.260239	8.919722	9.749464
T2	8.85790052	10.62909	13.28636	15.9436358	20.66768	25.39172	27.75374	3.279571	4.099464	4.919357	6.376944	7.834531	8.563325
T3	10.3537016	13.30653	16.63316	19.9597951	25.87381	31.78782	34.74483	2.965574	3.706967	4.448361	5.766394	7.084427	7.743443
T4	11.7171497	10.86767	13.58458	16.301502	21.13158	25.96165	28.37669	2.738138	3.422672	4.107206	5.324156	6.541106	7.149581

Junction 3 Calculations - Using Modified Rational Method						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	33.4382469	41.79781	50.15737	65.0188135	79.88026	87.31098
Qt2	37.8850945	47.35637	56.82764	73.6654616	90.50328	98.92219
Qt3	39.4441558	49.30519	59.16623	76.6969696	94.22771	102.9931
Qt4	38.4201773	48.02522	57.63027	74.7059002	91.78153	100.3194
Junction 3	39.4441558	49.30519	59.16623	76.6969696	94.22771	102.9931

Junction 4 Calculations - Add Tc for Junction 3 to Tt for WS-9 to get new Q using Rational Method															
	Previous Tc	Tt to Juncti	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 4	10.35	4.76	15.11	2.32391298	2.904891	3.485869	4.51872	5.55157	6.067995	60.09174	75.11468	90.13761	116.8451	143.5525	156.9062

Junction 5 Calculations - Add Tc for Junction 4 to Tt for WS-10 to get new Q using Rational Method															
	Previous Tc	Tt to Juncti	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 5 Calculations - Add Tc for Junction 4	15.11	3.08	18.19	2.06183235	2.57729	3.092749	4.009118	4.925488	5.383673	71.69507	89.61883	107.5426	18.45707	50.32155	66.25378

Junction 6 Calculations - Using Modified Rational Method													
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	18.19	71.69507	89.61883	107.542598	18.45707	50.32155	66.25378	2.061832	2.57729	3.092749	4.009118	4.925488	5.383673
T2	24.5632003	52.71769	65.89712	79.0765403	87.53924	110.9713	122.6873	1.69868	2.12335	2.54802	3.302989	4.057958	4.435443

Junction 6 Calculations (Western Culvert) - Using Modified Rational Method						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	110.734557	138.4182	166.1018	83.2832664	132.5001	157.1085
Qt2	111.785054	139.7313	167.6776	102.745455	152.4297	177.2718
Junction 5	111.785054	139.7313	167.6776	102.745455	152.4297	177.2718

Only Q25 thru Q100 are significant

Flow to the Eastern Culvert (WS-11)

							2-year		5-year		10-year		25-year		50-year		100-year	
	Acres	Length (ft)	ΔE	Slope	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
WS-11	17.7	2378	286	0.120269134	0.35	6.195	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

	Ti (minutes)	Tt (hr)		Tc (minutes)
WS-11	6.9	0.117022	7.021314	13.9213143

	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
WS-11	2.450031605	3.06254	3.675047	4.763950343	5.852853	6.397305

	Q2	Q5	Q10	Q25	Q50	Q100
WS-11	15.17794579	18.97243	22.76692	29.51267237	36.25843	39.6313

Q at confluence for E. Culvert						
	2yr	5yr	10yr	25yr	50yr	100yr
Q	15.17794579	18.97243	22.76692	150.4626724	157.2084	160.5813
	95.80794579	119.7624	143.7169			

The yellow highlighted area is the flow from reach 4 plus the flow from WS-11
It is the flow that will be directed to the eastern culvert
The green is the same

PROPOSED HYDROLOGY CALCULATIONS

PASO PICACHO PARKING LOT SITE

							2 Year		5 Year		10 Year		25 Year		50 Year		100 Year	
	Acres	Length (ft)	ΔE	Slope	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
PP-1	28.75	2068	810	0.391682785	0.35	10.0625	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
PP-1B	0.75	100	1	0.01	0.77	0.5775	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
PP-1C	0.67	100	1	0.01	0.35	0.2345	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

	Time of Concentration Calculations			
	Ti (minutes)	Tt (hr)	Tt (min)	Tc (minutes)
PP-1	3.975169092	0.066701797	4.002107823	7.977276915
PP-1B	5.94	0.026573172	1.594390324	7.534390324
PP-1C	13.5	0.026573172	1.594390324	15.09439032

	Rainfall Intensity Calculations					
	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
PP-1	3.508723776	4.385904721	5.263085665	6.822518454	8.381951	9.161668
PP-1B	3.640402519	4.550503149	5.460603779	7.078560454	8.696517	9.505495
PP-1C	2.325462786	2.906828483	3.48819418	4.521733196	5.555272	6.072042

	Peak Flow Calculations					
	Q2	Q5	Q10	Q25	Q50	Q100
PP-1	35.306533	44.13316625	52.9597995	68.65159195	84.34338	92.18928
PP-1B	2.102332455	2.627915569	0.67	4.087868662	5.022239	5.489424
PP-1C	0.545321023	0.681651279	0.817981535	1.060346434	1.302711	1.423894

BMP Bypass (PP-1B thru PP-1C) Calculations															
	PP-1C Tc	PP-1BTt	New Tc	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr	Q2	Q5	Q10	Q25	Q50	Q100
Junction 2	15.09	1.59	16.68	2.18036394	2.725455	3.270546	4.239597	5.208647	5.693173	1.770456	2.213069	2.655683	3.442552	4.229422	4.622856

Junction 1 (WS-1thru WS-3) Calculations - Using Modified Rational Method														
	T	Q2	Q5	Q10	Q25	Q50	Q100	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
T1	7.977276915	35.306533	44.13316625	52.9597995	68.65159	84.34338	92.18928	3.508724	4.385905	5.263086	6.822518	8.381951	9.161668
T2	16.68	1.770455519	2.213069399	2.655683279	3.442552	4.229422	4.622856	2.180364	2.725455	3.270546	4.239597	5.208647	5.693173

Junction 1 Calculations - Using Modified Rational Method Continuted						
	2yr	5yr	10yr	25yr	50yr	100yr
Qt1	36.15326046	45.19157557	54.22989068	70.29800644	86.36612	94.40018
Qt2	23.71036766	29.63795958	35.56555149	46.10349268	56.64143	61.9104
Junction 1	36.15326046	45.19157557	54.22989068	70.29800644	86.36612	94.40018

PROPOSED HYDROLOGY CALCULATIONS

VEGETATED SWALE (BMP) HYDROLOGY

							2-year		5-year		10-year		25-year		50-year		100-year	
	Acres	Length (ft)	ΔE	Slope	C	CA	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24	P6	P24
swale5	4.16	480	12	0.025	0.35	1.456	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
swale6	0.617	417	6	0.014388489	0.35	0.21595	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5
swale7	13.54	2378	286	0.120269134	0.35	4.739	1.8	3.5	2.25	5	2.7	6	3.5	7.5	4.3	9	4.7	9.5

	Ti (minutes)	Tt (hr)	Tt (min)	Tc (minutes)
swale5	10.3	0.062487	3.749242	14.04924222
swale6	10.9	0.069361	4.161631	15.06163092
swale7	6.9	0.117022	7.021314	13.9213143

	I 2yr	I 5yr	I 10yr	I 25yr	I 50yr	I 100yr
swale5	2.43561881	3.044524	3.653428	4.73592547	5.818423	6.359671
swale6	2.3287239	2.910905	3.493086	4.528074244	5.563063	6.080557
swale7	2.4500316	3.06254	3.675047	4.763950343	5.852853	6.397305

	Q2	Q5	Q10	Q25	Q50	Q100
swale5	3.54626099	4.432826	5.319391	6.895507484	8.471623	9.259681
swale6	0.50288793	0.62861	0.754332	0.977837633	1.201343	1.313096
swale7	11.6106998	14.51337	17.41605	22.57636067	27.73667	30.31683

APPENDIX B

HLW OUTPUT
EXISTING CULVERTS

C-1

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

September 20, 2007

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft).....	2.5
FHWA Chart Number.....	2
FHWA Scale Number (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.024
Entrance Loss Coefficient of Culvert Opening.....	0.5
Culvert Length (ft).....	38.0
Invert Elevation at Downstream end of Culvert (ft).....	3,396.53
Invert Elevation at Upstream end of Culvert (ft).....	3,398.87
Culvert Slope (ft/ft).....	0.0616
Starting Flow Rate (cfs).....	39.0
Incremental Flow Rate (cfs).....	1.0
Ending Flow Rate (cfs).....	49.0
Starting Tailwater Depth (ft).....	3.47
Incremental Tailwater Depth (ft).....	0.0
Ending Tailwater Depth (ft).....	3.47

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
39.0	3.47	4.04	3.77	1.55	2.11	1.55	12.18
40.0	3.47	4.16	3.91	1.58	2.13	1.58	12.25
41.0	3.47	4.29	4.05	1.61	2.15	1.61	12.31
42.0	3.47	4.42	4.19	1.63	2.17	1.63	12.36
43.0	3.47	4.56	4.34	1.66	2.19	1.66	12.42
44.0	3.47	4.69	4.49	1.69	2.21	1.69	12.47
45.0	3.47	4.83	4.65	1.72	2.23	1.72	12.52
46.0	3.47	4.98	4.81	1.75	2.24	1.75	12.57
47.0	3.47	5.12	4.97	1.77	2.26	1.77	12.62
48.0	3.47	5.27	5.13	1.8	2.27	1.8	12.66
49.0	3.47	5.42	5.3	1.83	2.29	1.83	12.69

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C-2

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

September 20, 2007

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft).....	3.0
FHWA Chart Number.....	2
FHWA Scale Number (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.024
Entrance Loss Coefficient of Culvert Opening.....	0.5
Culvert Length (ft).....	38.0
Invert Elevation at Downstream end of Culvert (ft).....	3,396.53
Invert Elevation at Upstream end of Culvert (ft).....	3,397.77
Culvert Slope (ft/ft).....	0.0326
Starting Flow Rate (cfs).....	60.0
Incremental Flow Rate (cfs).....	1.0
Ending Flow Rate (cfs).....	70.0
Starting Tailwater Depth (ft).....	3.47
Incremental Tailwater Depth (ft).....	0.0
Ending Tailwater Depth (ft).....	3.47

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
60.0	3.47	4.75	4.96	2.27	2.5	3.0	8.49
61.0	3.47	4.84	5.05	2.3	2.52	3.0	8.63
62.0	3.47	4.94	5.14	2.33	2.54	3.0	8.77
63.0	3.47	5.03	5.24	2.37	2.55	3.0	8.91
64.0	3.47	5.13	5.33	2.41	2.57	3.0	9.05
65.0	3.47	5.23	5.43	2.45	2.59	3.0	9.2
66.0	3.47	5.33	5.53	2.49	2.6	3.0	9.34
67.0	3.47	5.43	5.63	2.54	2.62	3.0	9.48
68.0	3.47	5.53	5.73	2.59	2.63	3.0	9.62
69.0	3.47	5.63	5.84	2.65	2.64	3.0	9.76
70.0	3.47	5.74	5.94	2.75	2.66	3.0	9.9

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C-3

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

September 20, 2007

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft).....	2.5
FHWA Chart Number.....	2
FHWA Scale Number (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.024
Entrance Loss Coefficient of Culvert Opening.....	0.5
Culvert Length (ft).....	52.4
Invert Elevation at Downstream end of Culvert (ft).....	3,396.81
Invert Elevation at Upstream end of Culvert (ft).....	3,397.42
Culvert Slope (ft/ft).....	0.0116
Starting Flow Rate (cfs).....	40.0
Incremental Flow Rate (cfs).....	1.0
Ending Flow Rate (cfs).....	50.0
Starting Tailwater Depth (ft).....	0.0
Incremental Tailwater Depth (ft).....	0.0
Ending Tailwater Depth (ft).....	0.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
40.0	0.0	4.23	3.92	2.5	2.13	2.5	8.15
41.0	0.0	4.35	4.06	2.5	2.15	2.5	8.35
42.0	0.0	4.49	4.19	2.5	2.17	2.5	8.56
43.0	0.0	4.62	4.31	2.5	2.19	2.5	8.76
44.0	0.0	4.76	4.44	2.5	2.21	2.5	8.96
45.0	0.0	4.9	4.58	2.5	2.23	2.5	9.17
46.0	0.0	5.04	4.71	2.5	2.24	2.5	9.37
47.0	0.0	5.18	4.85	2.5	2.26	2.5	9.57
48.0	0.0	5.33	4.99	2.5	2.27	2.5	9.78
49.0	0.0	5.49	5.13	2.5	2.29	2.5	9.98
50.0	0.0	5.64	5.27	2.5	2.3	2.5	10.19

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

September 20, 2007

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft).....	1.0
FHWA Chart Number.....	2
FHWA Scale Number (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.024
Entrance Loss Coefficient of Culvert Opening.....	0.5
Culvert Length (ft).....	34.6
Invert Elevation at Downstream end of Culvert (ft).....	3,408.25
Invert Elevation at Upstream end of Culvert (ft).....	3,408.89
Culvert Slope (ft/ft).....	0.0185
Starting Flow Rate (cfs).....	1.0
Incremental Flow Rate (cfs).....	1.0
Ending Flow Rate (cfs).....	11.0
Starting Tailwater Depth (ft).....	0.0
Incremental Tailwater Depth (ft).....	0.0
Ending Tailwater Depth (ft).....	0.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.0	0.0	0.58	0.65	0.43	0.42	0.42	3.19
2.0	0.0	0.9	0.97	0.65	0.6	0.6	4.04
3.0	0.0	1.25	1.32	1.0	0.74	0.74	4.8
4.0	0.0	1.66	1.97	1.0	0.85	0.85	5.64
5.0	0.0	2.22	2.97	1.0	0.92	0.92	6.63
6.0	0.0	2.89	4.15	1.0	0.96	0.96	7.76
7.0	0.0	3.69	5.52	1.0	0.98	0.98	8.97
8.0	0.0	4.61	7.11	1.0	0.99	0.99	10.22
9.0	0.0	5.66	8.91	1.0	0.99	0.99	11.48
10.0	0.0	6.82	10.91	1.0	0.99	0.99	12.74
11.0	0.0	8.12	13.13	1.0	1.0	1.0	14.01

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

September 20, 2007

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft).....	1.0
FHWA Chart Number.....	2
FHWA Scale Number (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.024
Entrance Loss Coefficient of Culvert Opening.....	0.5
Culvert Length (ft).....	26.96
Invert Elevation at Downstream end of Culvert (ft).....	3,410.18
Invert Elevation at Upstream end of Culvert (ft).....	3,412.18
Culvert Slope (ft/ft).....	0.0742
Starting Flow Rate (cfs).....	1.0
Incremental Flow Rate (cfs).....	1.0
Ending Flow Rate (cfs).....	11.0
Starting Tailwater Depth (ft).....	0.0
Incremental Tailwater Depth (ft).....	0.0
Ending Tailwater Depth (ft).....	0.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.0	0.0	0.55	0.0	0.3	0.42	0.3	5.14
2.0	0.0	0.87	0.0	0.43	0.6	0.43	6.24
3.0	0.0	1.22	0.0	0.54	0.74	0.54	6.91
4.0	0.0	1.64	0.0	0.65	0.85	0.65	7.36
5.0	0.0	2.19	0.0	0.78	0.92	0.78	7.61
6.0	0.0	2.86	2.04	1.0	0.96	1.0	7.64
7.0	0.0	3.66	3.16	1.0	0.98	1.0	8.91
8.0	0.0	4.59	4.44	1.0	0.99	1.0	10.19
9.0	0.0	5.63	5.88	1.0	0.99	0.99	11.48
10.0	0.0	6.8	7.5	1.0	0.99	0.99	12.74
11.0	0.0	8.09	9.28	1.0	1.0	1.0	14.01

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C-6

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

January 10, 2008

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft).....	1.5
FHWA Chart Number.....	2
FHWA Scale Number (Type of Culvert Entrance).....	1
Manning's Roughness Coefficient (n-value).....	0.024
Entrance Loss Coefficient of Culvert Opening.....	0.5
Culvert Length (ft).....	19.95
Invert Elevation at Downstream end of Culvert (ft).....	0.0
Invert Elevation at Upstream end of Culvert (ft).....	0.91
Culvert Slope (ft/ft).....	0.0456
Starting Flow Rate (cfs).....	1.0
Incremental Flow Rate (cfs).....	0.5
Ending Flow Rate (cfs).....	7.0
Starting Tailwater Depth (ft).....	0.0
Incremental Tailwater Depth (ft).....	0.0
Ending Tailwater Depth (ft).....	0.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.0	0.0	0.47	0.0	0.29	0.37	0.29	4.16
1.5	0.0	0.6	0.0	0.36	0.46	0.36	4.66
2.0	0.0	0.71	0.0	0.41	0.53	0.41	5.08
2.5	0.0	0.8	0.0	0.46	0.6	0.46	5.42
3.0	0.0	0.9	0.0	0.51	0.66	0.51	5.7
3.5	0.0	0.99	0.0	0.55	0.71	0.55	5.94
4.0	0.0	1.07	0.0	0.59	0.77	0.59	6.16
4.5	0.0	1.16	0.0	0.63	0.81	0.63	6.37
5.0	0.0	1.24	0.0	0.67	0.86	0.67	6.55
5.5	0.0	1.32	0.0	0.71	0.9	0.71	6.7
6.0	0.0	1.41	0.0	0.74	0.95	0.74	6.86
6.5	0.0	1.49	0.0	0.78	0.99	0.78	6.99
7.0	0.0	1.57	0.0	0.82	1.02	0.82	7.12

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APPENDIX C

HEC-RAS OUTPUT
EXISTING CONDITIONS

WESTERN CHANNEL

HEC-RAS Plan: Plan 01 River: Cuyamaca Reach: western culvert

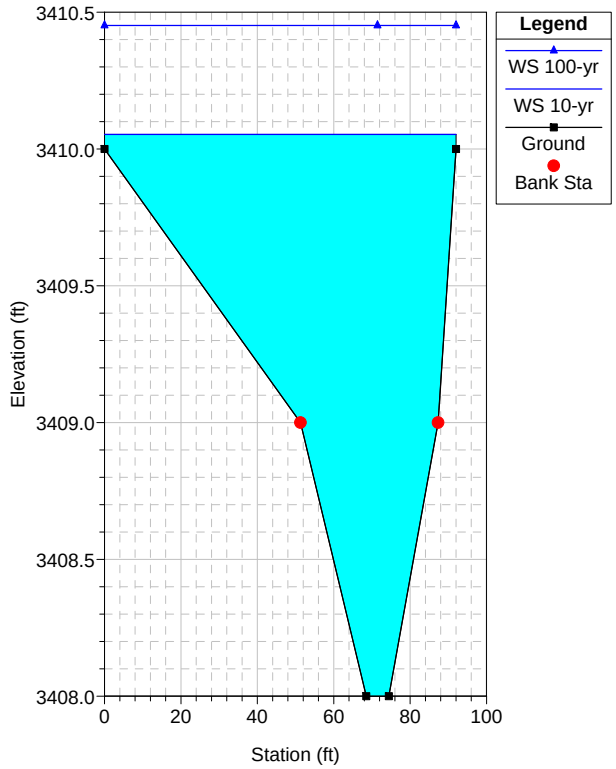
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
western culvert	1200	2-yr	111.78	3408.00	3409.79		3409.84	0.002337	1.97	66.66	80.10	0.30
western culvert	1200	5-yr	139.73	3408.00	3409.93		3409.99	0.002401	2.13	78.82	88.19	0.31
western culvert	1200	10-yr	167.67	3408.00	3410.05		3410.12	0.002456	2.27	89.87	92.01	0.31
western culvert	1200	25-yr	217.36	3408.00	3410.23		3410.31	0.002550	2.48	106.45	92.01	0.32
western culvert	1200	50-yr	267.04	3408.00	3410.39		3410.48	0.002677	2.68	120.40	92.01	0.34
western culvert	1200	100-yr	291.88	3408.00	3410.45		3410.55	0.002760	2.78	126.47	92.01	0.34
western culvert	1100	2-yr	111.78	3408.00	3409.32		3409.45	0.007490	3.00	40.78	64.14	0.51
western culvert	1100	5-yr	139.73	3408.00	3409.44		3409.59	0.007631	3.25	49.32	76.08	0.52
western culvert	1100	10-yr	167.67	3408.00	3409.54		3409.71	0.007888	3.48	57.26	85.70	0.54
western culvert	1100	25-yr	217.36	3408.00	3409.68		3409.88	0.008342	3.84	70.53	99.72	0.56
western culvert	1100	50-yr	267.04	3408.00	3409.80		3410.02	0.008632	4.12	83.46	111.70	0.58
western culvert	1100	100-yr	291.88	3408.00	3409.86		3410.09	0.008721	4.24	89.88	117.21	0.59
western culvert	1000	2-yr	111.78	3407.00	3407.73	3407.73	3408.02	0.035753	4.38	25.53	43.39	1.01
western culvert	1000	5-yr	139.73	3407.00	3407.83	3407.83	3408.16	0.034718	4.65	30.06	45.70	1.01
western culvert	1000	10-yr	167.67	3407.00	3407.94	3407.93	3408.29	0.031538	4.75	35.26	48.21	0.98
western culvert	1000	25-yr	217.36	3407.00	3408.11	3408.08	3408.49	0.026891	4.97	44.15	58.32	0.93
western culvert	1000	50-yr	267.04	3407.00	3408.26	3408.22	3408.67	0.023612	5.17	53.69	70.15	0.90
western culvert	1000	100-yr	291.88	3407.00	3408.32	3408.30	3408.75	0.022591	5.26	58.45	75.36	0.89
western culvert	900	2-yr	111.78	3405.00	3405.97	3405.70	3406.12	0.011076	3.06	36.59	44.23	0.59
western culvert	900	5-yr	139.73	3405.00	3406.11	3405.81	3406.27	0.011335	3.27	42.77	47.59	0.61
western culvert	900	10-yr	167.67	3405.00	3406.22	3405.90	3406.41	0.011987	3.49	48.08	50.58	0.63
western culvert	900	25-yr	217.36	3405.00	3406.37	3406.06	3406.60	0.013482	3.88	55.98	54.74	0.68
western culvert	900	50-yr	267.04	3405.00	3406.49	3406.22	3406.77	0.014970	4.25	62.87	58.12	0.72
western culvert	900	100-yr	291.88	3405.00	3406.54	3406.29	3406.85	0.015725	4.42	66.00	59.59	0.74
western culvert	800	2-yr	111.78	3404.00	3404.73		3404.86	0.014095	2.91	38.36	59.78	0.64
western culvert	800	5-yr	139.73	3404.00	3404.81		3404.97	0.015015	3.21	43.51	61.45	0.67
western culvert	800	10-yr	167.67	3404.00	3404.92		3405.09	0.014230	3.35	49.98	63.48	0.67
western culvert	800	25-yr	217.36	3404.00	3405.09		3405.29	0.012584	3.55	61.40	69.69	0.65
western culvert	800	50-yr	267.04	3404.00	3405.25		3405.46	0.011110	3.71	73.27	77.85	0.62
western culvert	800	100-yr	291.88	3404.00	3405.33		3405.55	0.010493	3.77	79.45	81.77	0.61
western culvert	700	2-yr	111.78	3403.00	3403.97		3404.04	0.005214	2.11	53.06	63.70	0.41
western culvert	700	5-yr	139.73	3403.00	3404.18		3404.25	0.004015	2.08	67.05	67.23	0.37
western culvert	700	10-yr	167.67	3403.00	3404.33		3404.41	0.003762	2.17	77.38	69.67	0.36
western culvert	700	25-yr	217.36	3403.00	3404.57		3404.65	0.003525	2.31	94.20	73.48	0.36
western culvert	700	50-yr	267.04	3403.00	3404.77		3404.86	0.003457	2.45	109.07	76.69	0.36
western culvert	700	100-yr	291.88	3403.00	3404.86		3404.96	0.003411	2.51	116.45	78.23	0.36
western culvert	600	2-yr	111.78	3401.00	3403.26		3403.44	0.006669	3.41	34.10	34.66	0.50
western culvert	600	5-yr	139.73	3401.00	3403.78		3403.89	0.003117	2.85	58.48	59.48	0.36
western culvert	600	10-yr	167.67	3401.00	3403.92		3404.05	0.003290	3.07	67.45	66.31	0.37
western culvert	600	25-yr	217.36	3401.00	3404.17		3404.31	0.003227	3.27	85.03	73.02	0.37
western culvert	600	50-yr	267.04	3401.00	3404.37		3404.52	0.003237	3.46	100.13	76.42	0.38
western culvert	600	100-yr	291.88	3401.00	3404.47		3404.62	0.003187	3.53	107.98	78.12	0.38
western culvert	500	2-yr	111.78	3401.00	3403.17		3403.20	0.000907	1.44	77.56	46.55	0.19
western culvert	500	5-yr	139.73	3401.00	3403.73		3403.76	0.000552	1.35	106.40	56.15	0.16
western culvert	500	10-yr	167.67	3401.00	3403.86		3403.90	0.000655	1.53	113.90	58.39	0.17
western culvert	500	25-yr	217.36	3401.00	3404.09		3404.14	0.000799	1.79	127.75	61.81	0.19
western culvert	500	50-yr	267.04	3401.00	3404.27		3404.33	0.000950	2.04	139.16	63.88	0.21
western culvert	500	100-yr	291.88	3401.00	3404.36		3404.43	0.001008	2.15	145.20	64.95	0.22
western culvert	400	2-yr	111.78	3400.00	3403.13		3403.15	0.000299	1.12	107.94	55.27	0.12
western culvert	400	5-yr	139.73	3400.00	3403.70		3403.72	0.000226	1.10	142.21	64.11	0.11
western culvert	400	10-yr	167.67	3400.00	3403.83		3403.85	0.000281	1.26	150.37	66.04	0.12
western culvert	400	25-yr	217.36	3400.00	3404.05		3404.08	0.000369	1.50	165.36	69.59	0.14
western culvert	400	50-yr	267.04	3400.00	3404.22		3404.26	0.000463	1.73	177.63	72.77	0.15
western culvert	400	100-yr	291.88	3400.00	3404.31		3404.36	0.000504	1.83	184.24	74.42	0.16
western culvert	300	2-yr	111.78	3400.00	3403.10		3403.12	0.000305	1.09	107.18	52.00	0.12
western culvert	300	5-yr	139.73	3400.00	3403.68		3403.70	0.000230	1.09	140.67	63.27	0.11
western culvert	300	10-yr	167.67	3400.00	3403.80		3403.82	0.000289	1.25	148.38	65.59	0.12
western culvert	300	25-yr	217.36	3400.00	3404.01		3404.04	0.000383	1.49	162.69	69.59	0.14
western culvert	300	50-yr	267.04	3400.00	3404.17		3404.22	0.000483	1.73	174.11	71.07	0.16
western culvert	300	100-yr	291.88	3400.00	3404.26		3404.31	0.000527	1.83	180.20	71.85	0.17
western culvert	200	2-yr	111.78	3397.50	3403.08	3399.21	3403.09	0.000176	0.80	141.63	85.15	0.09
western culvert	200	5-yr	139.73	3397.50	3403.67	3399.43	3403.68	0.000127	0.78	193.03	89.91	0.08
western culvert	200	10-yr	167.67	3397.50	3403.79	3399.63	3403.80	0.000158	0.89	203.64	90.86	0.09
western culvert	200	25-yr	217.36	3397.50	3403.99	3399.94	3404.01	0.000209	1.07	222.74	92.55	0.10
western culvert	200	50-yr	267.04	3397.50	3404.15	3400.25	3404.18	0.000264	1.24	237.62	95.38	0.12
western culvert	200	100-yr	291.88	3397.50	3404.24	3400.39	3404.26	0.000288	1.32	245.65	96.91	0.12

HEC-RAS Plan: Plan 01 River: Cuyamaca Reach: western culvert (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
western culvert	150		Culvert									
western culvert	100	2-yr	111.78	3396.50	3400.00		3400.01	0.000038	0.43	258.39	82.14	0.04
western culvert	100	5-yr	139.73	3396.50	3400.01		3400.01	0.000059	0.54	258.55	82.17	0.05
western culvert	100	10-yr	167.67	3396.50	3400.01		3400.01	0.000085	0.65	258.73	82.20	0.06
western culvert	100	25-yr	217.36	3396.50	3400.01		3400.02	0.000143	0.84	259.15	82.27	0.08
western culvert	100	50-yr	267.04	3396.50	3400.02		3400.04	0.000215	1.03	259.67	82.36	0.10
western culvert	100	100-yr	291.88	3396.50	3400.02		3400.04	0.000256	1.12	259.95	82.40	0.11
western culvert	0	2-yr	111.78	3396.00	3400.00	3396.50	3400.00	0.000033	0.40	276.35	87.30	0.04
western culvert	0	5-yr	139.73	3396.00	3400.00	3396.58	3400.00	0.000051	0.51	276.35	87.30	0.05
western culvert	0	10-yr	167.67	3396.00	3400.00	3396.65	3400.01	0.000074	0.61	276.35	87.30	0.06
western culvert	0	25-yr	217.36	3396.00	3400.00	3396.77	3400.01	0.000124	0.79	276.35	87.30	0.08
western culvert	0	50-yr	267.04	3396.00	3400.00	3396.88	3400.01	0.000188	0.97	276.35	87.30	0.10
western culvert	0	100-yr	291.88	3396.00	3400.00	3396.94	3400.02	0.000224	1.06	276.35	87.30	0.10

western culvert Plan: Plan 01 10/10/2007

RS = 1200



western culvert Plan: Plan 01 10/10/2007

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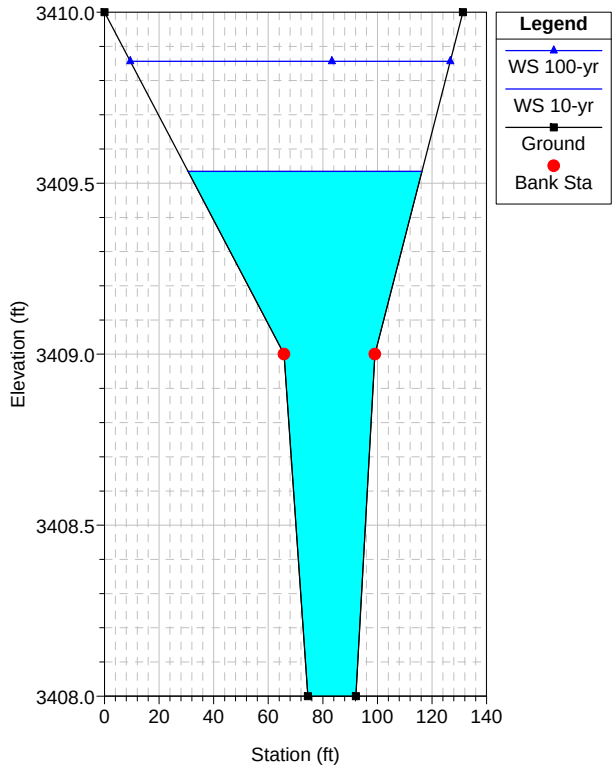

western culvert Plan: Plan 01 10/10/2007

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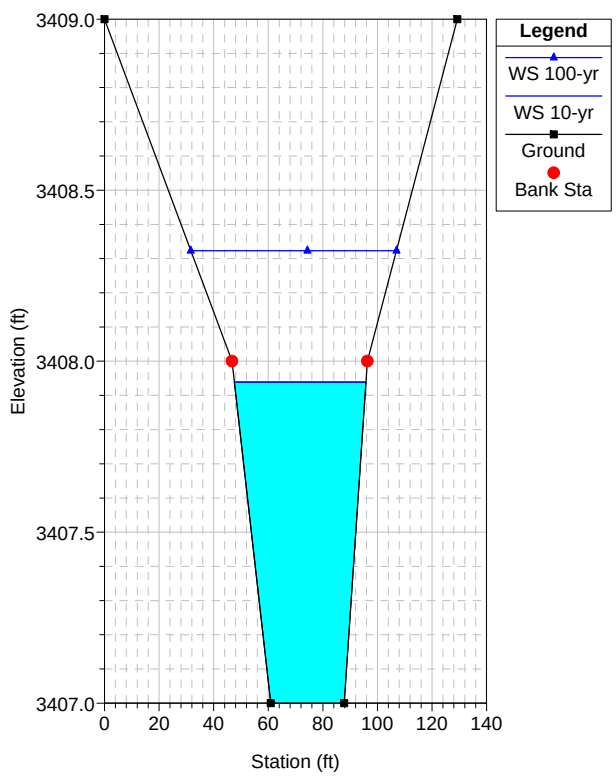

western culvert Plan: Plan 01 10/10/2007

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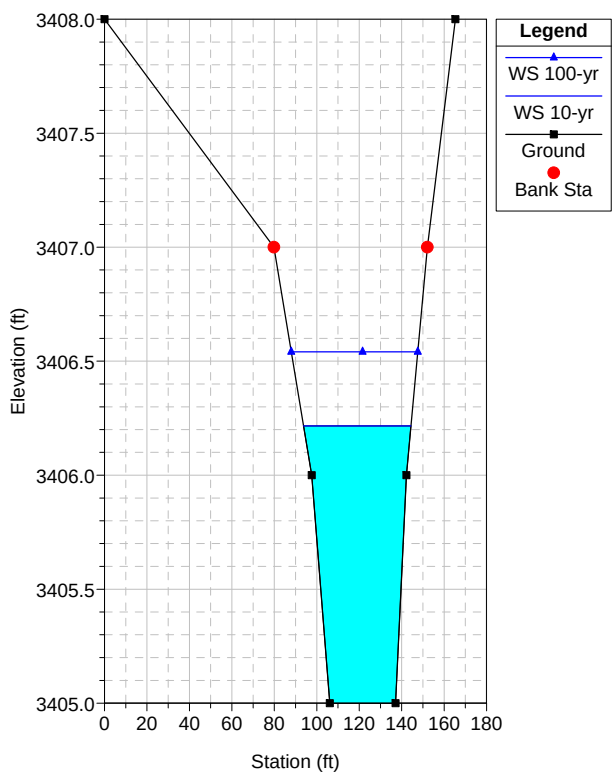

western culvert Plan: Plan 01 10/10/2007
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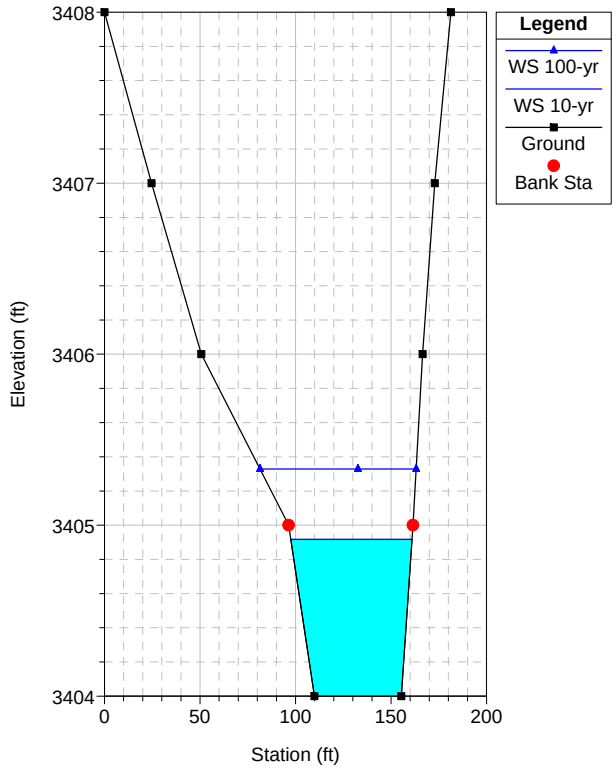

western culvert Plan: Plan 01 10/10/2007
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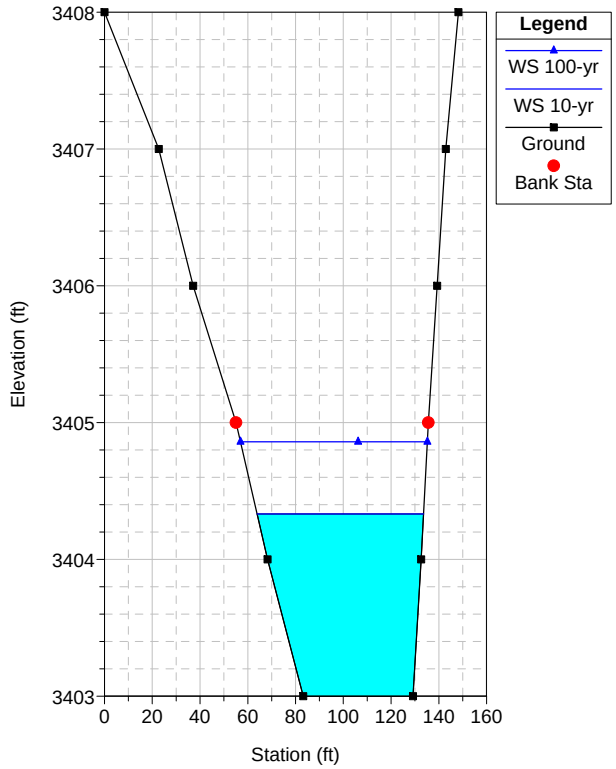

western culvert Plan: Plan 01 10/10/2007
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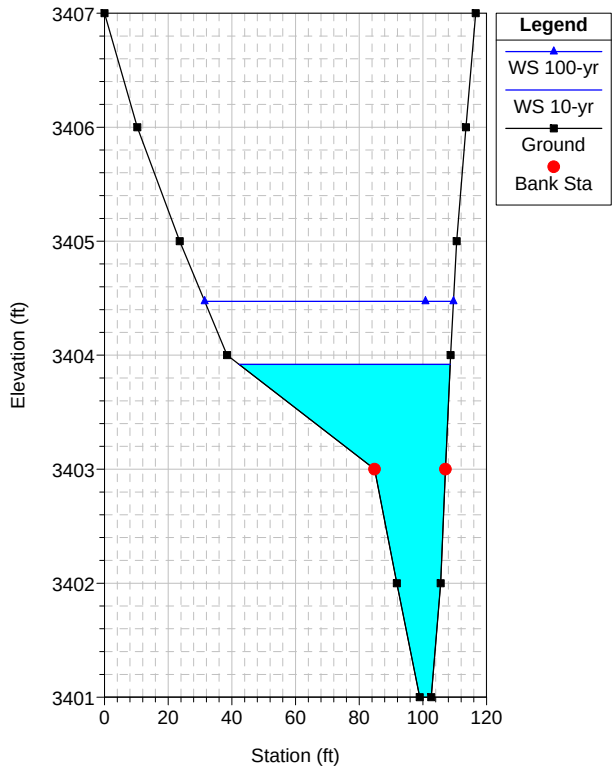

western culvert Plan: Plan 01 10/10/2007
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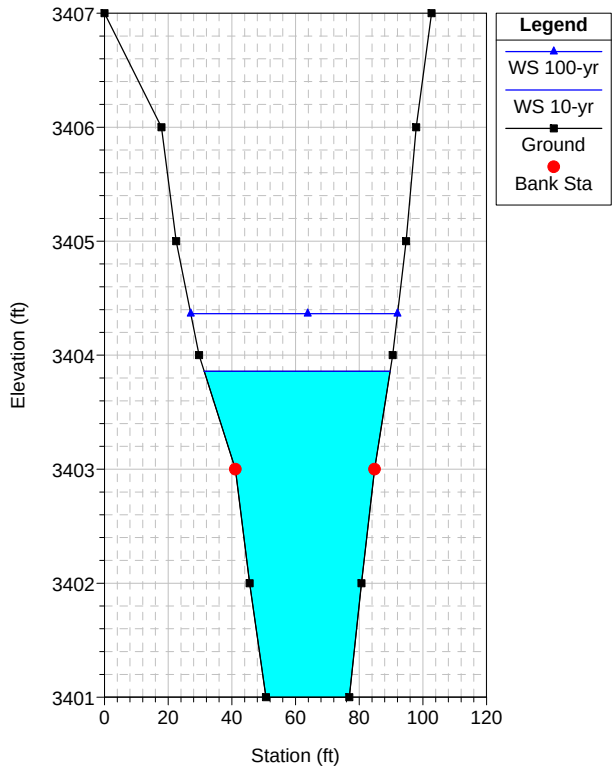

western culvert Plan: Plan 01 10/10/2007
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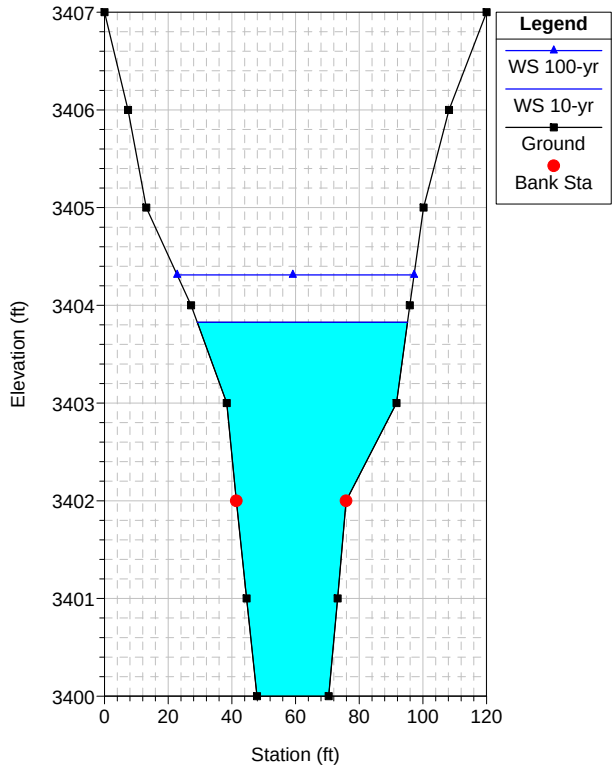

western culvert Plan: Plan 01 10/10/2007
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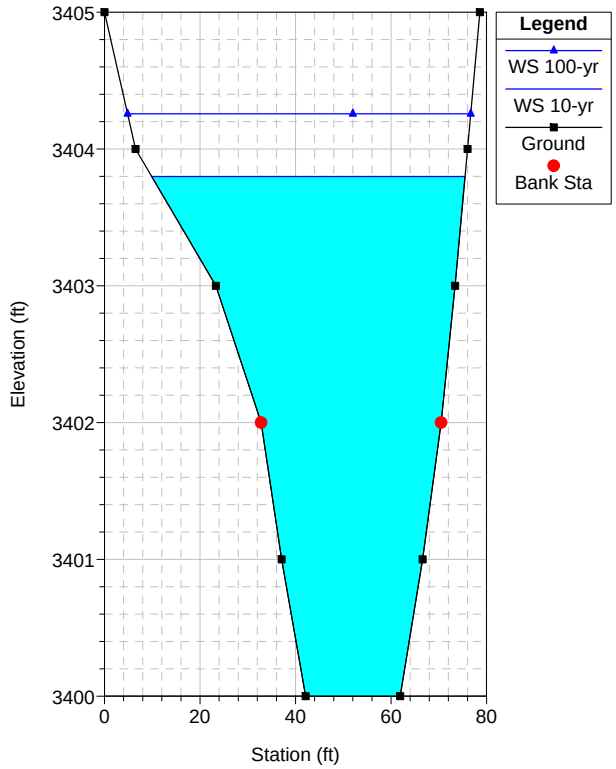

western culvert Plan: Plan 01 10/10/2007
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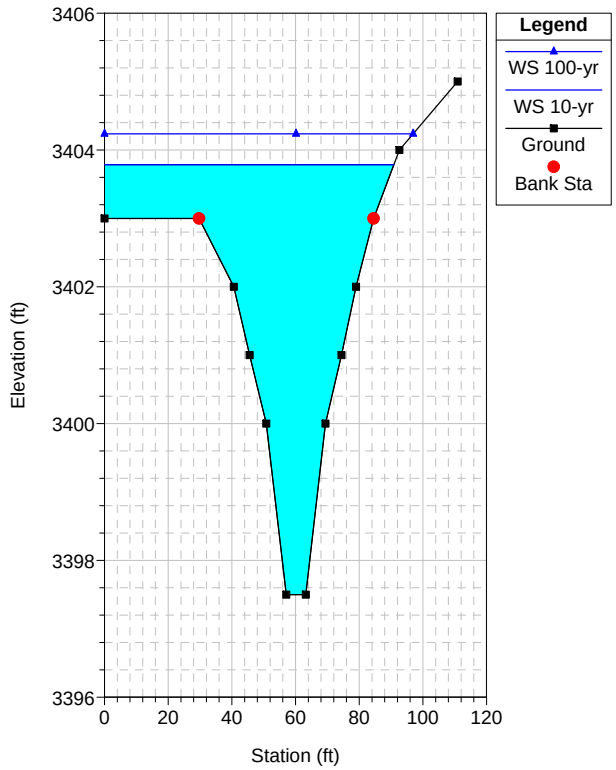

western culvert Plan: Plan 01 10/10/2007
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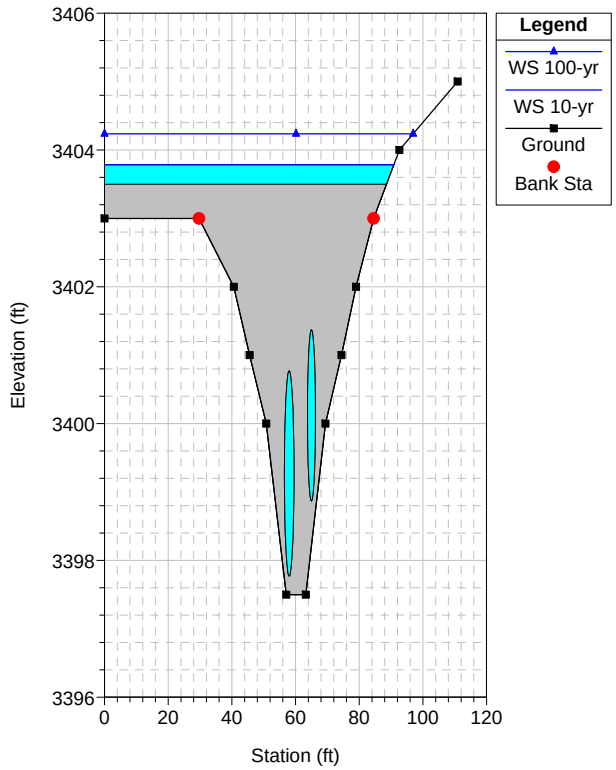

western culvert Plan: Plan 01 10/10/2007

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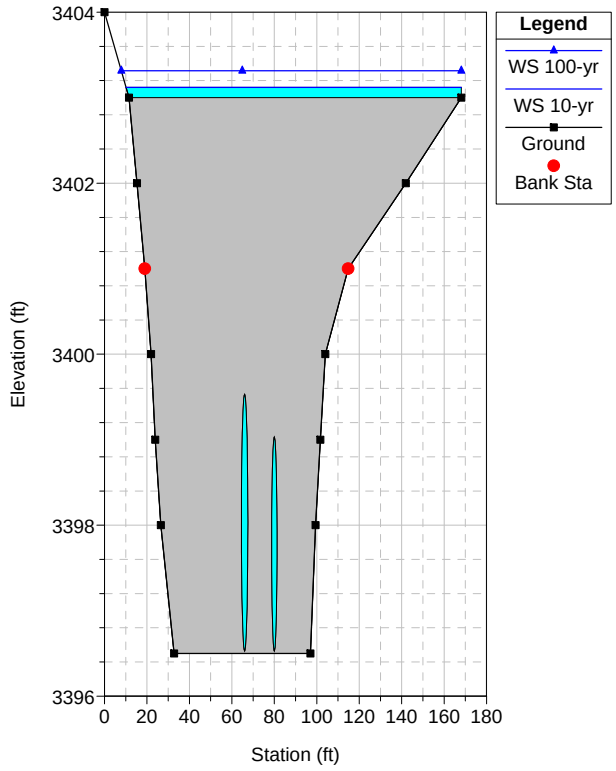

western culvert Plan: Plan 01 10/10/2007

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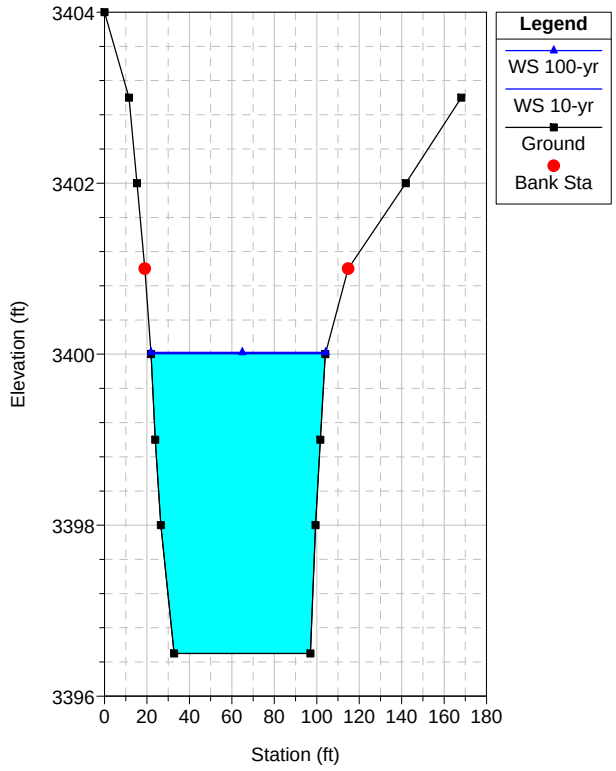

western culvert Plan: Plan 01 10/10/2007

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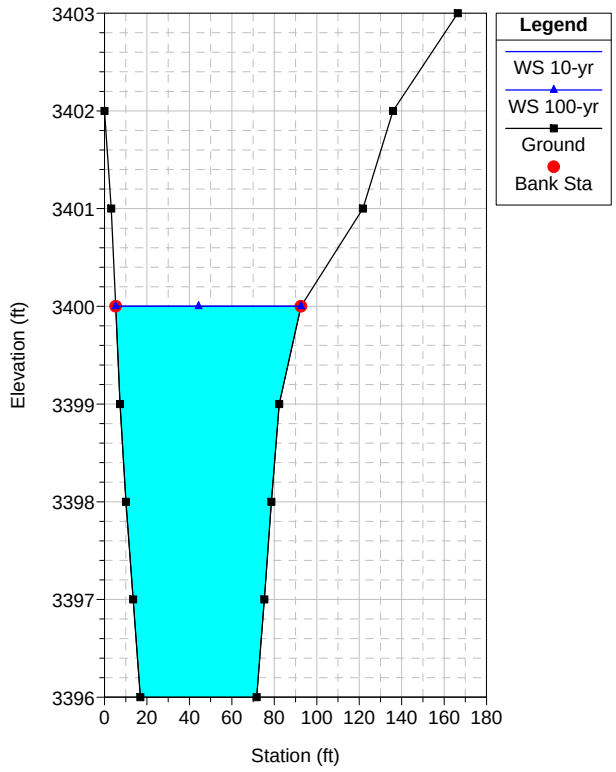


EASTERN CHANNEL

HEC-RAS Plan: Plan 01

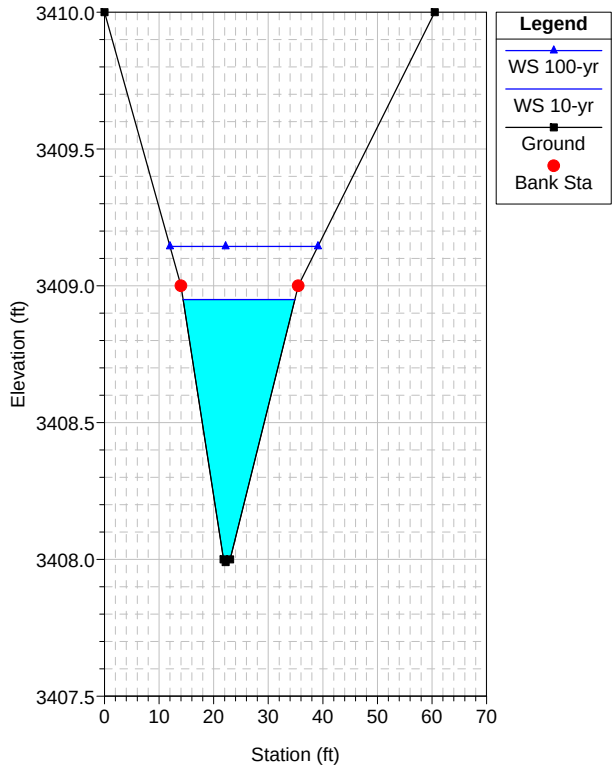
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
main	700	2-yr	12.40	3407.99	3408.82	3408.56	3408.86	0.006841	1.57	7.88	17.92	0.42
main	700	5-yr	15.70	3407.99	3408.89	3408.62	3408.94	0.007345	1.72	9.15	19.31	0.44
main	700	10-yr	18.70	3407.99	3408.95	3408.67	3409.00	0.007596	1.81	10.31	20.48	0.45
main	700	25-yr	24.30	3407.99	3409.04	3408.75	3409.10	0.007834	1.99	12.21	22.99	0.47
main	700	50-yr	29.60	3407.99	3409.10	3408.82	3409.18	0.008074	2.18	13.77	25.51	0.48
main	700	100-yr	33.00	3407.99	3409.14	3408.86	3409.22	0.008069	2.27	14.86	27.12	0.49
main	600	2-yr	12.40	3407.00	3407.24	3407.24	3407.36	0.053935	2.73	4.53	21.27	1.04
main	600	5-yr	15.70	3407.00	3407.29	3407.29	3407.41	0.047151	2.83	5.54	22.25	1.00
main	600	10-yr	18.70	3407.00	3407.32	3407.32	3407.46	0.045420	2.97	6.30	22.97	1.00
main	600	25-yr	24.30	3407.00	3407.38	3407.38	3407.54	0.043575	3.19	7.62	24.16	1.00
main	600	50-yr	29.60	3407.00	3407.43	3407.43	3407.60	0.041925	3.35	8.82	25.20	1.00
main	600	100-yr	33.00	3407.00	3407.45	3407.45	3407.64	0.042680	3.49	9.44	25.72	1.02
main	500	2-yr	12.40	3405.20	3406.13		3406.16	0.003891	1.35	9.50	23.44	0.33
main	500	5-yr	15.70	3405.20	3406.21		3406.25	0.003745	1.46	11.55	27.32	0.33
main	500	10-yr	18.70	3405.20	3406.28		3406.31	0.003617	1.53	13.44	30.49	0.33
main	500	25-yr	24.30	3405.20	3406.38		3406.42	0.003476	1.65	16.88	35.51	0.33
main	500	50-yr	29.60	3405.20	3406.50		3406.54	0.002886	1.65	21.41	41.19	0.31
main	500	100-yr	33.00	3405.20	3406.55		3406.59	0.002820	1.69	23.62	43.71	0.31
trib	150	2-yr	2.70	3407.11	3407.47	3407.47	3407.55	0.047151	2.26	1.20	6.70	0.94
trib	150	5-yr	3.30	3407.11	3407.49	3407.49	3407.58	0.052107	2.47	1.34	7.09	1.00
trib	150	10-yr	4.00	3407.11	3407.52	3407.52	3407.62	0.051563	2.58	1.55	7.63	1.01
trib	150	25-yr	5.20	3407.11	3407.56	3407.56	3407.68	0.050418	2.73	1.91	8.46	1.01
trib	150	50-yr	6.40	3407.11	3407.60	3407.60	3407.73	0.050081	2.87	2.23	9.15	1.02
trib	150	100-yr	7.00	3407.11	3407.62	3407.62	3407.75	0.049095	2.91	2.41	9.50	1.02
trib	100	2-yr	2.70	3405.58	3406.27		3406.28	0.000150	0.27	9.85	17.48	0.06
trib	100	5-yr	3.30	3405.58	3406.34		3406.34	0.000164	0.30	10.93	17.98	0.07
trib	100	10-yr	4.00	3405.58	3406.40		3406.40	0.000183	0.33	12.02	18.48	0.07
trib	100	25-yr	5.20	3405.58	3406.49		3406.49	0.000206	0.38	13.80	19.26	0.08
trib	100	50-yr	6.40	3405.58	3406.59		3406.59	0.000210	0.40	15.82	20.11	0.08
trib	100	100-yr	7.00	3405.58	3406.64		3406.64	0.000210	0.42	16.82	20.52	0.08
trib	50	2-yr	2.70	3405.66	3406.26		3406.26	0.000540	0.44	6.45	17.54	0.12
trib	50	5-yr	3.30	3405.66	3406.32		3406.32	0.000507	0.46	7.53	18.38	0.12
trib	50	10-yr	4.00	3405.66	3406.38		3406.38	0.000496	0.49	8.64	19.20	0.12
trib	50	25-yr	5.20	3405.66	3406.47		3406.48	0.000474	0.53	10.50	20.52	0.12
trib	50	50-yr	6.40	3405.66	3406.58		3406.58	0.000415	0.55	12.69	21.96	0.11
trib	50	100-yr	7.00	3405.66	3406.63		3406.63	0.000390	0.56	13.80	22.66	0.11
trib	20	2-yr	2.70	3405.80	3406.21		3406.22	0.007331	1.27	3.13	21.72	0.41
trib	20	5-yr	3.30	3405.80	3406.28		3406.29	0.002884	0.93	4.87	22.04	0.26
trib	20	10-yr	4.00	3405.80	3406.35		3406.36	0.001876	0.83	6.31	22.30	0.22
trib	20	25-yr	5.20	3405.80	3406.45		3406.46	0.001207	0.76	8.56	22.70	0.18
trib	20	50-yr	6.40	3405.80	3406.56		3406.56	0.000811	0.71	11.05	23.13	0.15
trib	20	100-yr	7.00	3405.80	3406.61		3406.62	0.000700	0.69	12.24	23.34	0.14
confluence	486.965	2-yr	15.10	3404.97	3406.05		3406.10	0.005796	1.70	8.91	17.46	0.40
confluence	486.965	5-yr	19.00	3404.97	3406.13		3406.18	0.006018	1.88	10.30	19.94	0.42
confluence	486.965	10-yr	22.70	3404.97	3406.18		3406.25	0.006343	2.05	11.50	21.87	0.43
confluence	486.965	25-yr	29.50	3404.97	3406.27		3406.35	0.006920	2.32	13.59	24.86	0.46
confluence	486.965	50-yr	36.00	3404.97	3406.40		3406.48	0.005838	2.35	17.00	29.10	0.43
confluence	486.965	100-yr	40.00	3404.97	3406.45	3406.08	3406.54	0.005895	2.45	18.44	30.71	0.44
confluence	400	2-yr	15.10	3404.58	3405.08		3405.16	0.027126	2.21	6.82	26.18	0.76
confluence	400	5-yr	19.00	3404.58	3405.13	3405.07	3405.21	0.026348	2.34	8.11	27.98	0.77
confluence	400	10-yr	22.70	3404.58	3405.17	3405.11	3405.26	0.026038	2.46	9.24	29.48	0.77
confluence	400	25-yr	29.50	3404.58	3405.24	3405.17	3405.34	0.024046	2.57	11.48	32.22	0.76
confluence	400	50-yr	36.00	3404.58	3405.22	3405.22	3405.39	0.043230	3.36	10.73	31.32	1.01
confluence	400	100-yr	40.00	3404.58	3405.24	3405.24	3405.43	0.042808	3.44	11.61	32.37	1.01
confluence	300	2-yr	15.10	3401.00	3401.64	3401.64	3401.91	0.039064	4.21	3.59	6.51	1.00
confluence	300	5-yr	19.00	3401.00	3401.73	3401.73	3402.04	0.038244	4.50	4.22	6.77	1.00
confluence	300	10-yr	22.70	3401.00	3401.82	3401.82	3402.16	0.036984	4.71	4.82	7.00	1.00
confluence	300	25-yr	29.50	3401.00	3401.95	3401.95	3402.36	0.037171	5.12	5.76	7.36	1.02
confluence	300	50-yr	36.00	3401.00	3402.36		3402.58	0.017904	3.78	9.52	11.24	0.72
confluence	300	100-yr	40.00	3401.00	3403.05		3403.11	0.003667	2.03	19.74	18.33	0.34
confluence	250	2-yr	15.10	3397.42	3400.43	3398.09	3400.44	0.000257	0.72	21.08	10.50	0.09
confluence	250	5-yr	19.00	3397.42	3400.69	3398.20	3400.70	0.000302	0.80	23.90	11.62	0.10
confluence	250	10-yr	22.70	3397.42	3400.98	3398.29	3400.99	0.000304	0.82	27.54	12.92	0.10
confluence	250	25-yr	29.50	3397.42	3401.67	3398.45	3401.68	0.000198	0.80	38.16	18.14	0.08
confluence	250	50-yr	36.00	3397.42	3402.49	3398.58	3402.50	0.000112	0.71	55.51	23.74	0.07

HEC-RAS Plan: Plan 01 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
confluence	250	100-yr	40.00	3397.42	3403.08	3398.66	3403.08	0.000075	0.64	70.52	26.90	0.06
confluence	200		Culvert									
confluence	175.782	2-yr	15.10	3396.81	3400.00		3400.01	0.000217	0.67	22.41	11.09	0.08
confluence	175.782	5-yr	19.00	3396.81	3400.00		3400.01	0.000345	0.85	22.40	11.09	0.11
confluence	175.782	10-yr	22.70	3396.81	3400.00		3400.01	0.000492	1.01	22.39	11.09	0.13
confluence	175.782	25-yr	29.50	3396.81	3399.99		3400.02	0.000834	1.32	22.37	11.08	0.16
confluence	175.782	50-yr	36.00	3396.81	3399.99		3400.03	0.001246	1.61	22.33	11.07	0.20
confluence	175.782	100-yr	40.00	3396.81	3399.99		3400.04	0.001543	1.79	22.31	11.06	0.22
confluence	150	2-yr	15.10	3398.00	3400.00		3400.00	0.000079	0.39	39.11	25.09	0.05
confluence	150	5-yr	19.00	3398.00	3400.00		3400.00	0.000125	0.49	39.08	25.09	0.07
confluence	150	10-yr	22.70	3398.00	3400.00		3400.00	0.000178	0.58	39.07	25.08	0.08
confluence	150	25-yr	29.50	3398.00	3400.00		3400.00	0.000302	0.76	39.01	25.07	0.11
confluence	150	50-yr	36.00	3398.00	3399.99		3400.01	0.000452	0.92	38.94	25.05	0.13
confluence	150	100-yr	40.00	3398.00	3399.99		3400.01	0.000560	1.03	38.90	25.04	0.15
confluence	100	2-yr	15.10	3396.50	3400.00		3400.00	0.000001	0.06	258.13	82.10	0.01
confluence	100	5-yr	19.00	3396.50	3400.00		3400.00	0.000001	0.07	258.13	82.10	0.01
confluence	100	10-yr	22.70	3396.50	3400.00		3400.00	0.000002	0.09	258.15	82.10	0.01
confluence	100	25-yr	29.50	3396.50	3400.00		3400.00	0.000003	0.11	258.15	82.10	0.01
confluence	100	50-yr	36.00	3396.50	3400.00		3400.00	0.000004	0.14	258.15	82.10	0.01
confluence	100	100-yr	40.00	3396.50	3400.00		3400.00	0.000005	0.15	258.17	82.11	0.02
confluence	0	2-yr	15.10	3396.00	3400.00	3396.13	3400.00	0.000001	0.05	276.35	87.30	0.01
confluence	0	5-yr	19.00	3396.00	3400.00	3396.15	3400.00	0.000001	0.07	276.35	87.30	0.01
confluence	0	10-yr	22.70	3396.00	3400.00	3396.18	3400.00	0.000001	0.08	276.35	87.30	0.01
confluence	0	25-yr	29.50	3396.00	3400.00	3396.21	3400.00	0.000002	0.11	276.35	87.30	0.01
confluence	0	50-yr	36.00	3396.00	3400.00	3396.24	3400.00	0.000003	0.13	276.35	87.30	0.01
confluence	0	100-yr	40.00	3396.00	3400.00	3396.25	3400.00	0.000004	0.14	276.35	87.30	0.01

eastern culvert Plan: Plan 01 9/27/2007

RS = 700



eastern culvert Plan: Plan 01 9/27/2007

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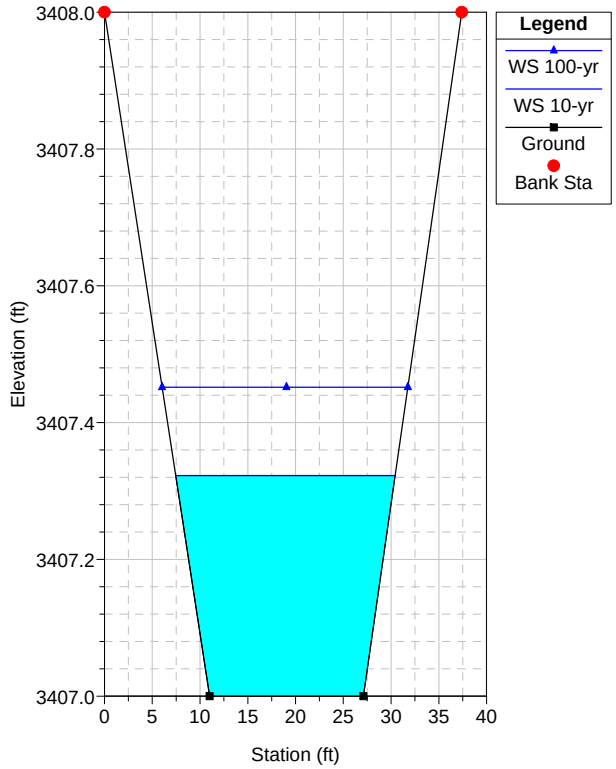
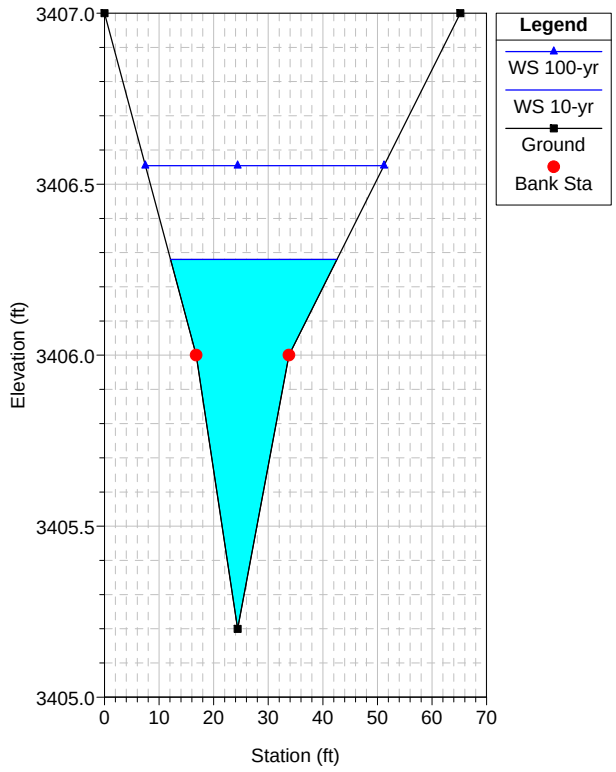


eastern culvert Plan: Plan 01 9/27/2007

RS = 500



eastern culvert Plan: Plan 01 9/27/2007

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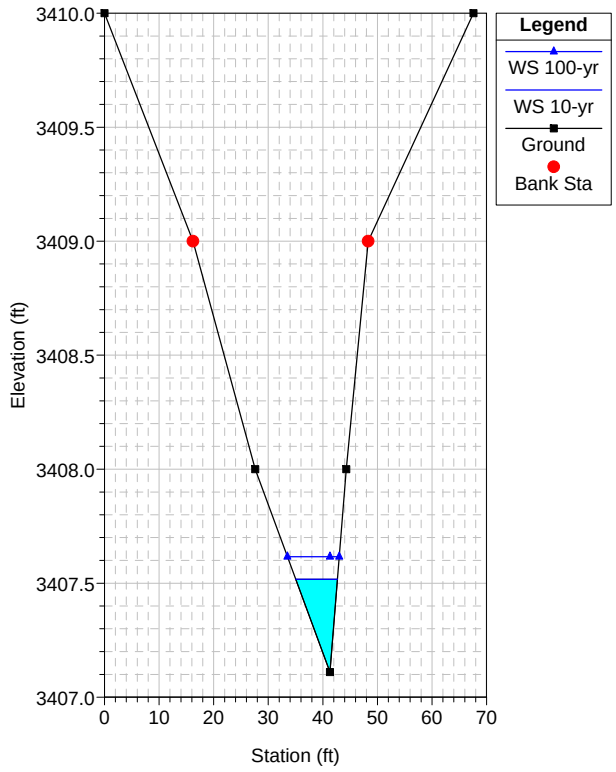

eastern culvert Plan: Plan 01 9/27/2007

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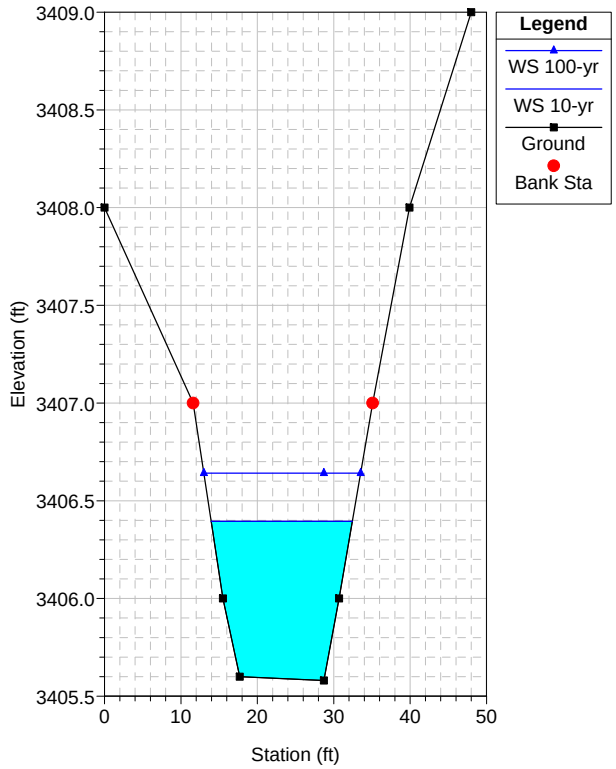

eastern culvert Plan: Plan 01 9/27/2007

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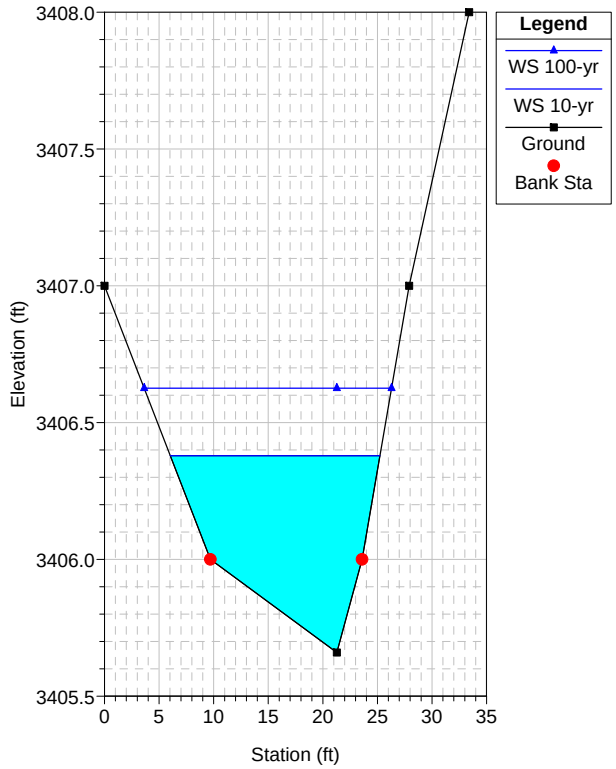
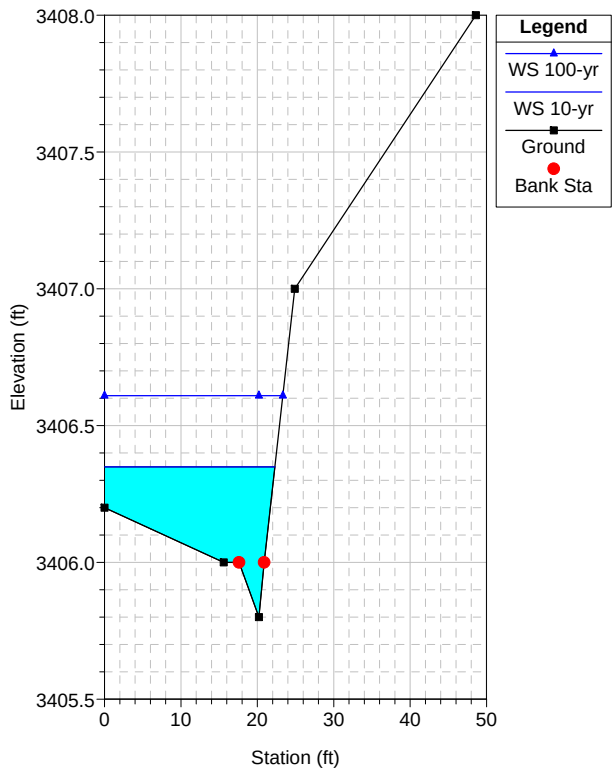


eastern culvert Plan: Plan 01 9/27/2007

RS = 20



eastern culvert Plan: Plan 01 9/27/2007

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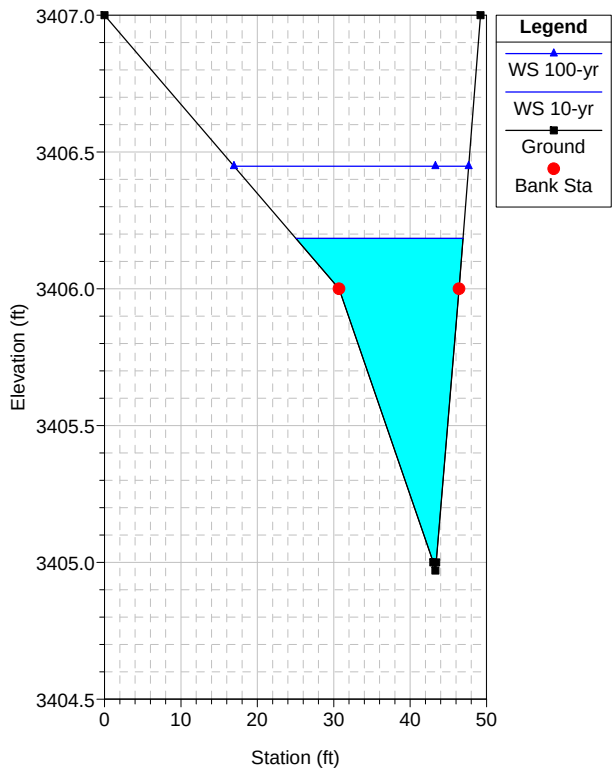

eastern culvert Plan: Plan 01 9/27/2007

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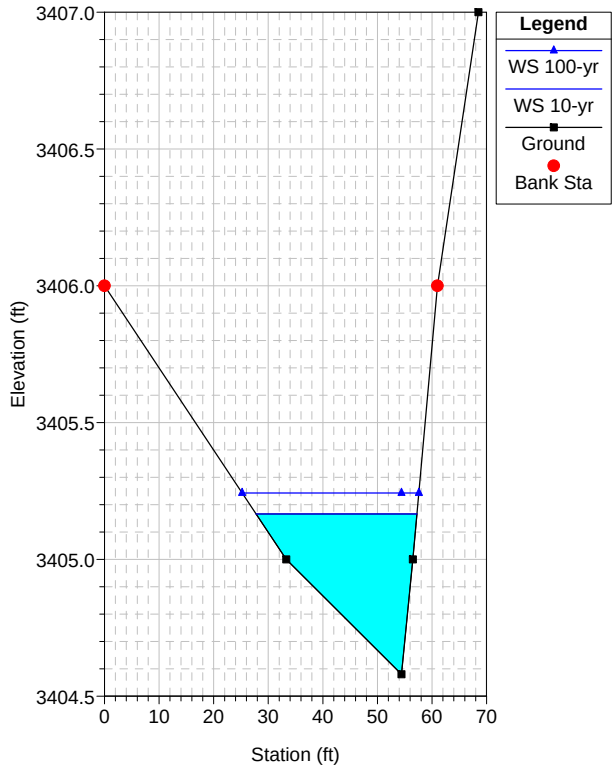

eastern culvert Plan: Plan 01 9/27/2007

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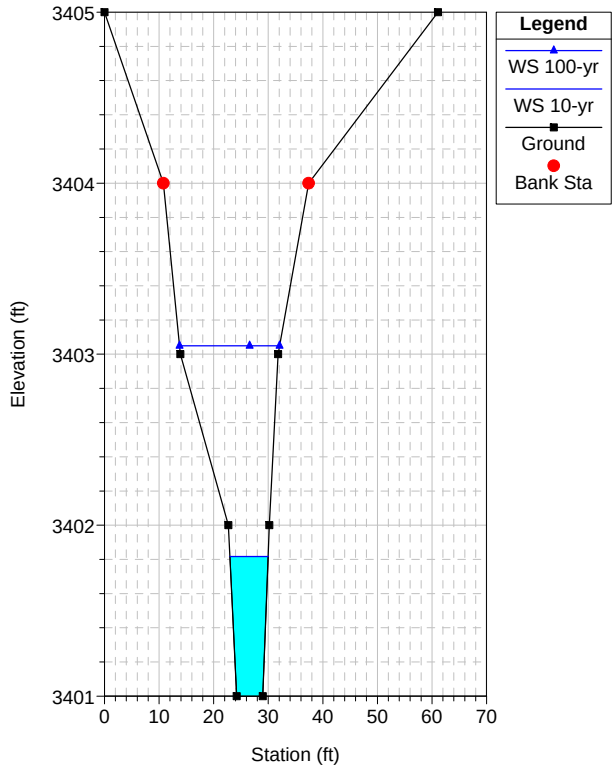

eastern culvert Plan: Plan 01 9/27/2007

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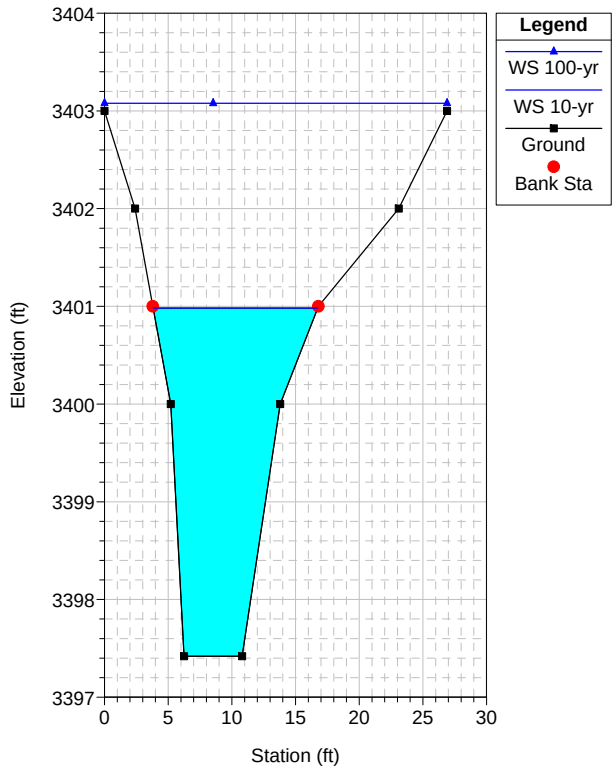

eastern culvert Plan: Plan 01 9/27/2007

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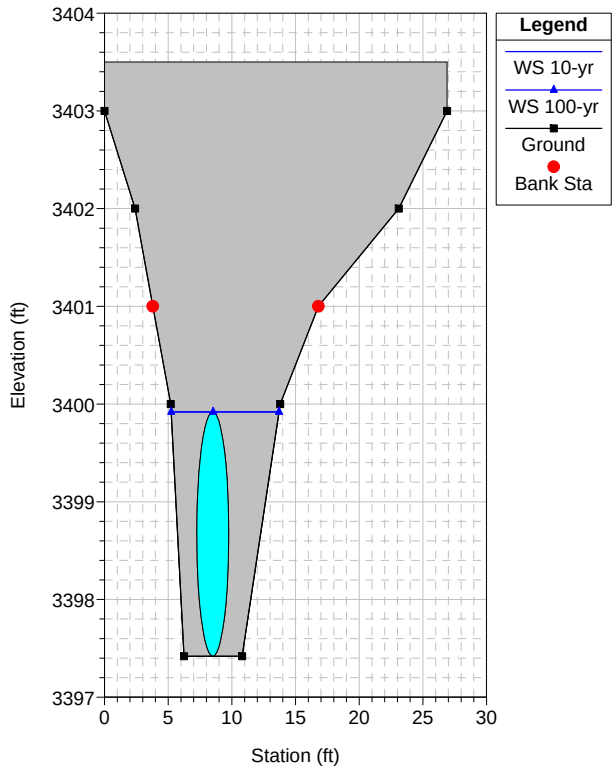

eastern culvert Plan: Plan 01 9/27/2007

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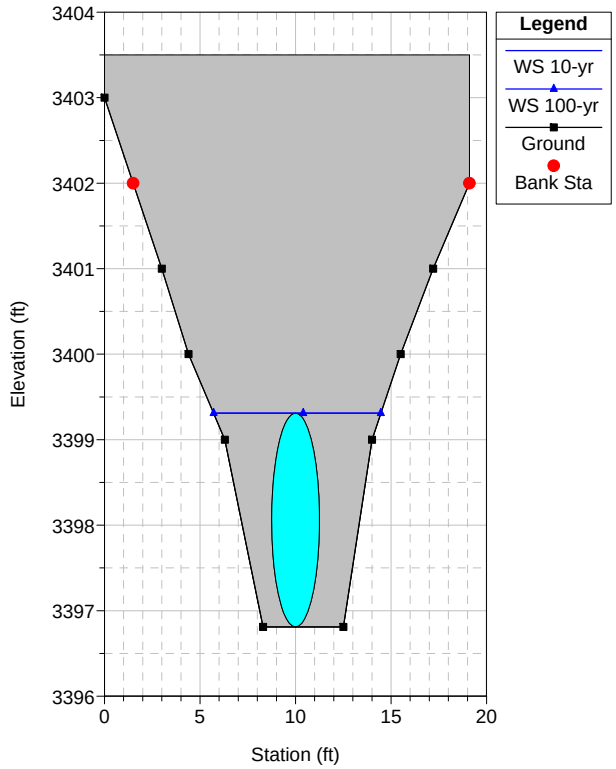
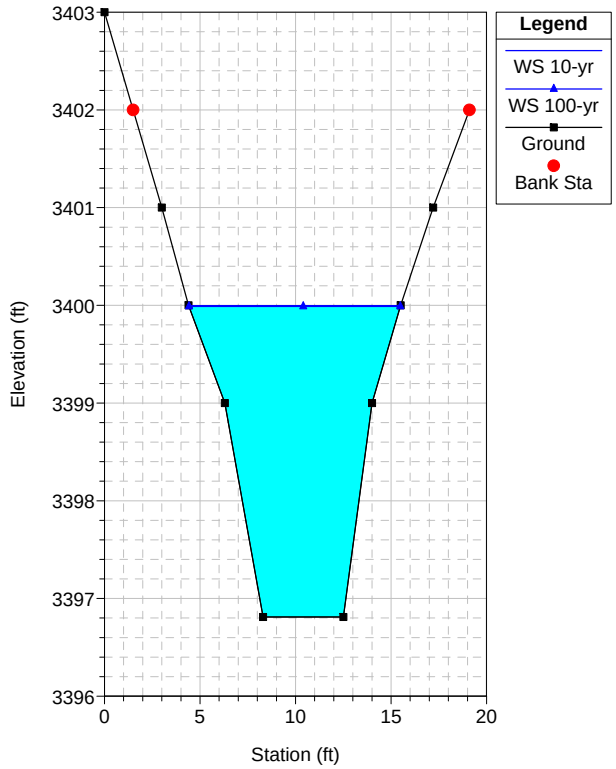


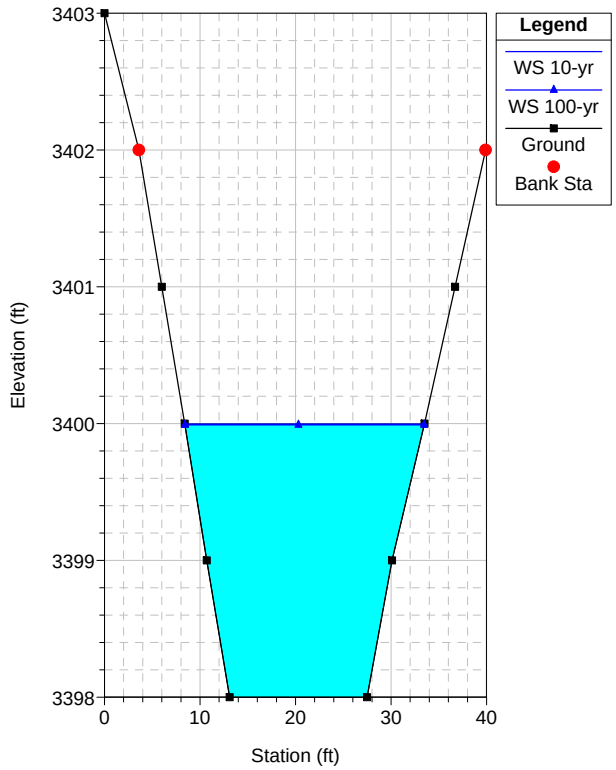
eastern culvert Plan: Plan 01 9/27/2007

RS = 175.782



eastern culvert Plan: Plan 01 9/27/2007

RS = 150



eastern culvert Plan: Plan 01 9/27/2007

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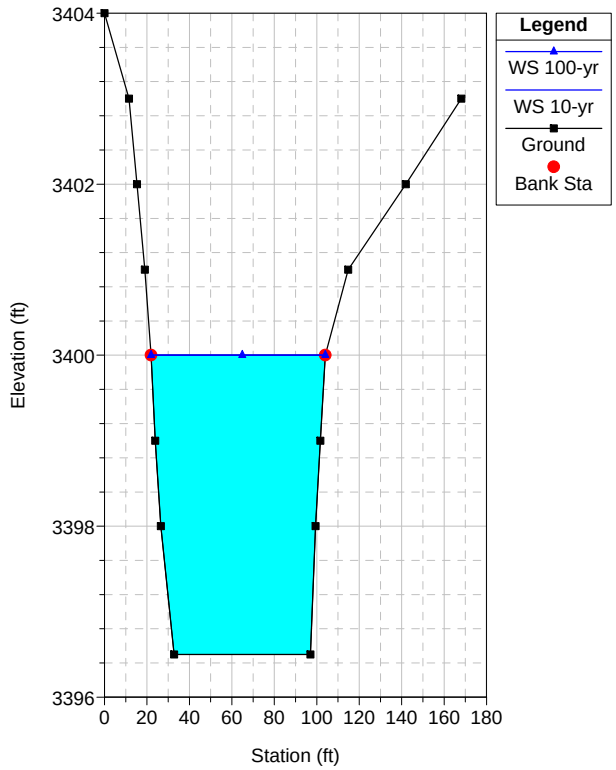
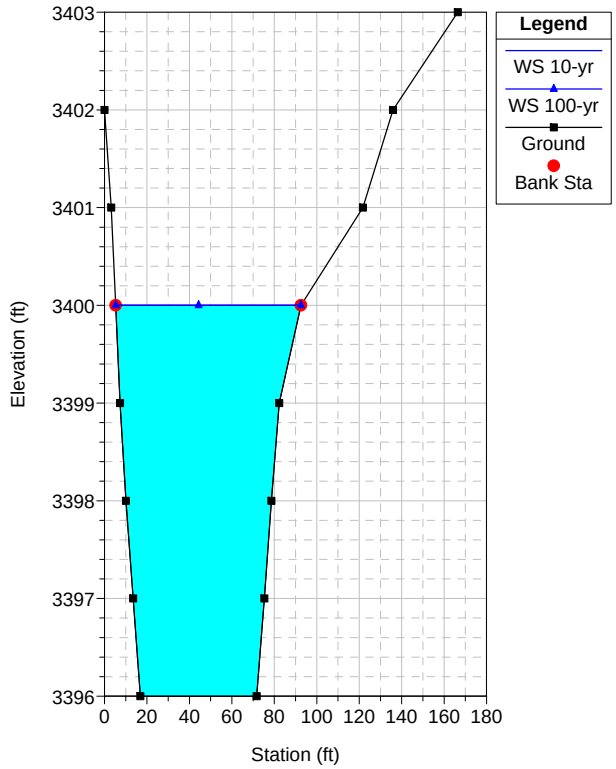


eastern culvert Plan: Plan 01 9/27/2007

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