BEAVER DAM WASH FLOOD HAZARD ASSESSMENT

FLOOD RESPONSE PLAN

2005 Flood Photo

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W E

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0 200 ft-US

LEGEND

Safety Hazard Rating for Adults

- Very High
- High
- Moderate
- Low
- Minimal Flood Hazard

SEAL OF MOHAVE COUNTY ARIZONA

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BEAVER DAM WASH FLOOD HAZARD ASSESSMENT
Agreement Number 06024

FLOOD RESPONSE PLAN

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December 2007
Revised: December 20, 2007
Revised: January 11, 2009

NOTICE:

THE USER SHOULD READ THE ENTIRE FLOOD RESPONSE PLAN CAREFULLY AND SHOULD BE AWARE OF ALL ELEMENTS OF THIS PLAN, INCLUDING STRENGTHS AND LIMITATIONS, AND INDIVIDUAL RESPONSIBILITIES. THE FLOOD RESPONSE PLAN PRESENTED HEREIN IS USEFUL AS ONE STEP IN DEVELOPING A FLOOD WARNING SYSTEM FOR THE RESIDENTS WITHIN THE BEAVER DAM STUDY AREA. HOWEVER, THE POSSIBILITY OF INADVERTENT ERROR IN DESIGN OR FAILURE OF EQUIPMENT FUNCTION EXISTS AND MAY PREVENT THE SYSTEM FROM OPERATING PERFECTLY AT ALL TIMES. THEREFORE, NOTHING CONTAINED HEREIN MAY BE CONSTRUED AS A GUARANTEE OF THE SYSTEM OR ITS OPERATION, OR CREATE ANY LIABILITY ON THE PART OF ANY PARTY OR ITS DIRECTORS, OFFICERS, EMPLOYEES OR AGENTS FOR ANY DAMAGE THAT MAY BE ALLEGED TO RESULT FROM THE OPERATION, OR FAILURE TO OPERATE, OF THE SYSTEM OR ANY OF ITS COMPONENT PARTS. THIS CONSTITUTES NOTICE TO ANY AND ALL PERSONS OR PARTIES THAT THE NATIONAL WEATHER SERVICE, MOHAVE COUNTY FLOOD CONTROL DISTRICT, MOHAVE COUNTY DEPARTMENT OF EMERGENCY MANAGEMENT, MOHAVE COUNTY SHERIFF'S OFFICE, , AND ARID HYDROLOGY & HYDRAULICS, LLC. OR ANY OFFICER, AGENT OR EMPLOYEE THEREOF, SHALL NOT BE LIABLE FOR ANY DEATHS, INJURIES, OR DAMAGES OF WHAT EVER KIND THAT MAY RESULT FROM RELIANCE ON THE TERMS AND CONDITIONS OF THIS SYSTEM.

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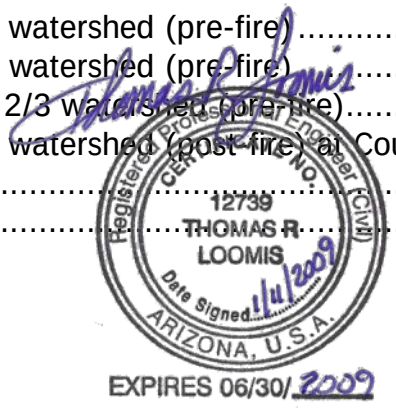


REVISIONS

December 20, 2007. The report was revised to reflect review comments received from Mohave County.

January 5, 2009. The report was revised to include the stream gage rating curves and supporting documentation in Appendix A. Table 2.2 and Table 2.5 through Table 2.8 were revised, including revisions to the Warning Stage 2 flow criteria and the addition of stage control data to column 6. Mohave County staff revision recommendations were made to Table 2.8 and corresponding revisions made to Table 2.6 and Table 2.7.

January 11, 2009. The report was revised to incorporate final review comments from Mohave County staff and re-sealed.

1 INTRODUCTION

The Mohave County Flood Control District contracted with Arid Hydrology & Hydraulics, LLC (AridHH) to prepare a Flood Response Plan (FRP) as one component of the Beaver Dam Wash Flood Hazard Assessment (FHA), per Agreement Number 06024. The project site is located in the extreme northwest corner of Mohave County as shown on Figure 1.1. The project General Study Area, as shown on Figure 1.2, is located in the W1/2 of Section 4 and the E1/2 of Section 5, T40N, R15W, GSRM, Mohave County, Arizona, at the community of Beaver Dam, Arizona. In January 2005, Beaver Dam, Arizona was impacted by a large multi-day flood in Beaver Dam Wash. Many homes were flooded and filled with several feet of flood water. Some were washed away or severely damaged by high velocity flows and erosion that affected the structures foundation. The purpose of the FRP is to reduce the potential for property damage and loss of life resulting from floods on the Beaver Dam Wash at the community of Beaver Dam.

The FRP was developed under the guidance of the Mohave County Flood Control District (MCFCD). In addition, the Mohave County Department of Public Works (MCPW), Mohave County Emergency Management (MCEM), and the Mohave County Sheriff's Office (MCSO) are included as the primary sources of local emergency response resources.

The FRP consists of five components:

1. Flood Detection Criteria
2. Communications
3. Effective Lead Time
4. Agency Action Plan
5. Resident Action Plan

These components are presented in the following sections. This report is intentionally short and concise to make it easily useable during a flood emergency. The technical basis for the FRP is contained in the *Flood Hazard Assessment Report* (AridHH, 2007), which is a part of this project.

Figure 1.1 Location Map

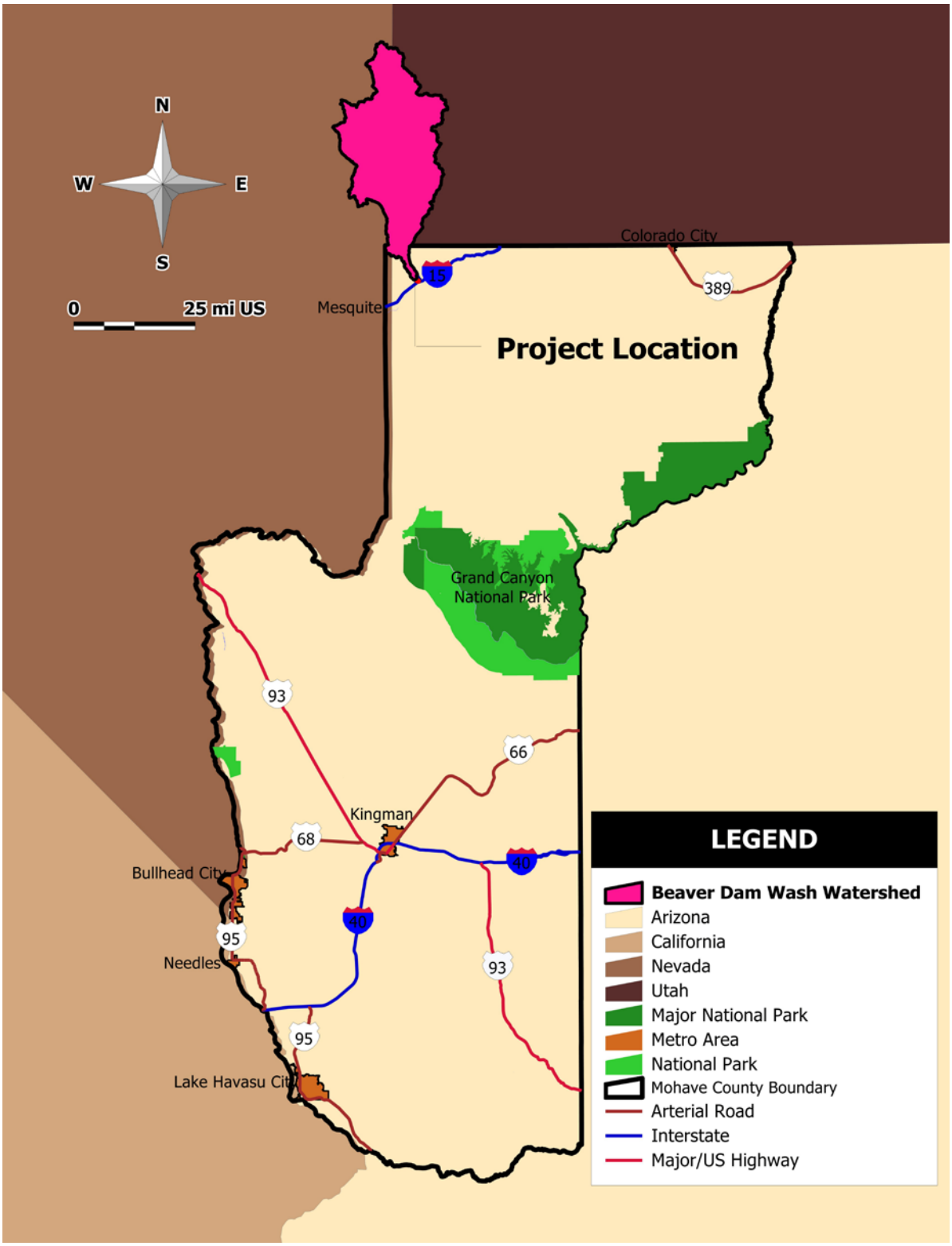
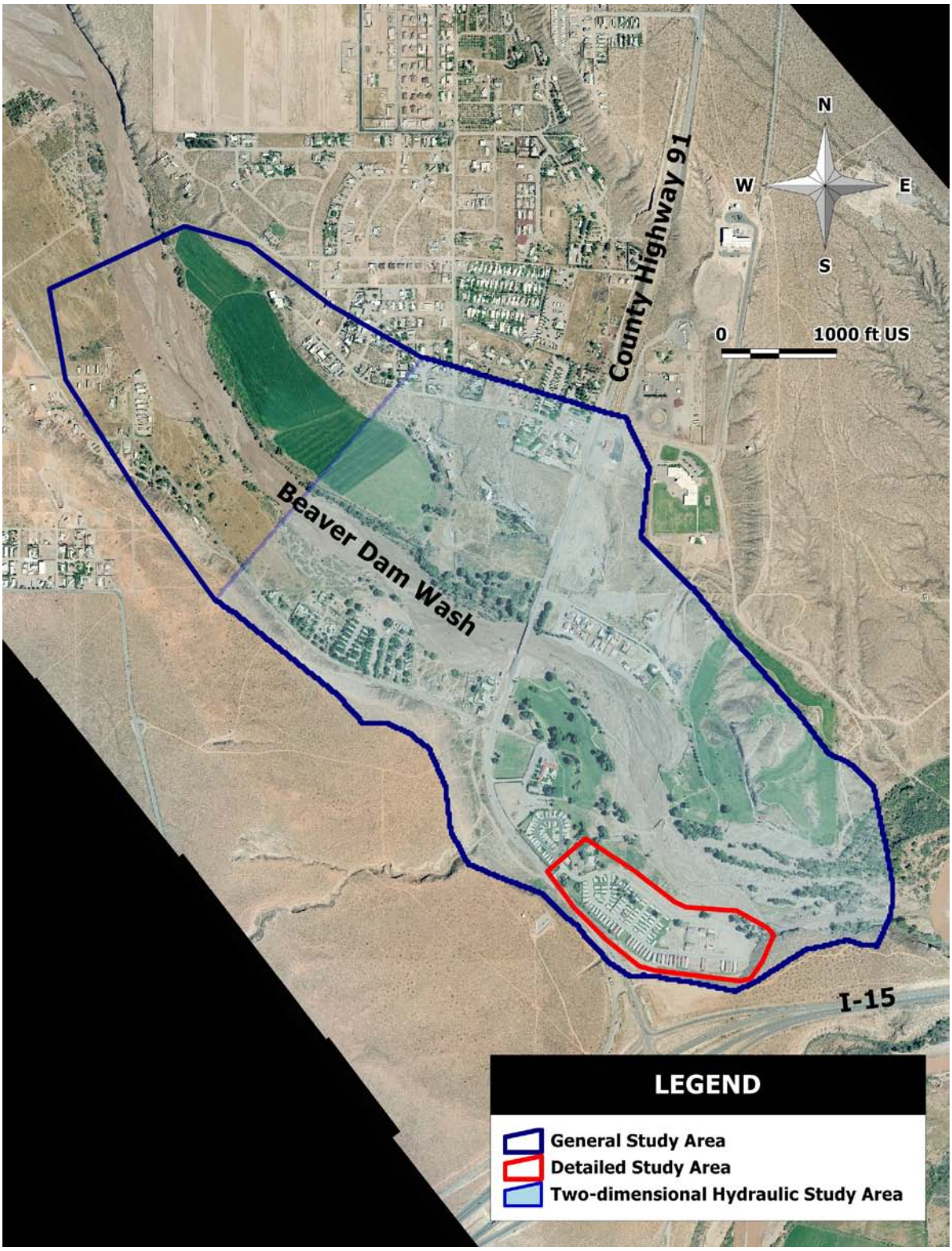


Figure 1.2 Vicinity Map



2 FLOOD DETECTION AND WARNING

Flood detection criteria were developed based upon the results of the hydrologic and hydraulic analyses and the additional gages that have been installed as proposed in AridHH (2007). Hydraulic rating curves for the stream flow gages shown on Figure 2.1 have been developed for use in the Mohave County flood warning ALERT system. Refer to APPENDIX A for the rating curves and supporting hydraulic calculation documentation.

The flood detection criteria are based upon the rainfall intensities required to produce the critical threshold stages or discharges that inundate the emergency access route and/or reach the lowest floor elevations of residences in the area. These criteria are recommended for use by the MCEM and the National Weather Service (NWS) to disseminate flood warning messages to residents in the warning area and to appropriate emergency response agencies, thereby triggering implementation of the FRP action plans. Table 2.1 contains the threshold peak discharge values corresponding to emergency access cut-off or flood water stage reaching the lowest floor in the warning area. Table 2.2 (entire watershed), Table 2.3 (upper watershed) and Table 2.4 (lower 2/3 watershed) below contain summaries of the threshold criteria for each level of flood alert in the warning sequence. Each watershed scenario is capable of producing runoff discharges sufficient to reach the threshold values in Table 2.1, assuming the average listed amounts of precipitation occur over the entire watershed considered. A summary of the flood warning message sequence for triggering a possible evacuation is shown in Table 2.5. Acronyms used in the flood warning sequence descriptions are listed in Table 2.6. A detailed sequence is listed in Table 2.7. It is assumed that residents will be kept informed via the NWS and through the encouraged use of NOAA Weather Radios. Notice of evacuation is recommended to be announced by automated warning system (Codespear, or reverse 911 when it becomes available in Beaver Dam), radio/television, door-to-door, and through use of an on-site siren.

Table 2.1 Threshold discharge values at warning area

Location	Threshold Discharge, cfs
(1)	(2)
Access Road: Clark Gable Drive 190 ft east of Scarlet O'Hara Drive	12,800
Lowest Floor (APN 402-87-016)	13,700

Table 2.2 Pre-Fire Flood Detection Criteria – Rainfall over entire watershed

Flood Warning Stage	Rainfall[1]		Measured Discharge/Rise			
	Total Depth	Duration	Motoqua (1)	Catclaw Canyon (2)	Indian Canyon (3)	Highway 91 (8)
	(in)	(hrs)	(cfs)/(ft)	(cfs)/(ft)	(cfs)/(ft)	(cfs)/(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	1.0	<11.5	330	530	370	10
2	2.8	<12.4	1,000	1,150	830	350
3	3.0	<14.5	9,000	10,100	8,700	3,400

[1] Average of measured values at gages 1, 3, 4 and 8. Include gages 5, 6, and 7 if available.

Table 2.3 Pre-Fire Flood Detection Criteria – Rainfall over upper watershed

Flood Warning Stage	Rainfall[1]		Measured Discharge			
	Total Depth	Duration	Motoqua (1)	Catclaw Canyon (2)	Indian Canyon (3)	Highway 91 (8)
	(in)	(hrs)	(cfs)	(cfs)	(cfs)	(cfs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	1.0	<11.5	330	530	370	10
2	2.8	<12.4	1,000	630	450	20
3	3.0	<14.5	4,000	3,100	900	100

[1] Average of measured values at gages 1 and 4. Include gages 5, 6 and 7 if available.

Table 2.4 Pre-Fire Flood Detection Criteria – Rainfall over lower 2/3 watershed

Flood Warning Stage	Rainfall[1]		Measured Discharge			
	Total Depth	Duration	Motoqua (1)	Catclaw Canyon (2)	Indian Canyon (3)	Highway 91 (8)
	(in)	(hrs)	(cfs)	(cfs)	(cfs)	(cfs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	0.7	<11.5	n/a	380	340	100
2	2.6	<12.4	n/a	1,000	770	375
3	2.7	<14	n/a	7,000	5,700	2,600

[1] Average of measured values at gages 1, 3 and 8. Include gages 5 and 7 if available.

The three watershed scenarios are shown graphically on Figure 2.1, Figure 2.2 and Figure 2.3. Graphs of 24-hour precipitation and resulting runoff response over time for each watershed scenario are shown on Figure 2.4, Figure 2.5 and Figure 2.6. The information on the three graphs is the basis for the data shown in Table 2.2, Table 2.3 and Table 2.4.

Table 2.5 Logic for programming ALERT system

Time, hours	Precipitation		Logic	Stream Flow		
	Gages	Average Precipitation, inches		Gage	Stage, feet	Discharge, cfs
Warning Stage 1						
<=11.5	(1,3,4,5,6,7,8) (1,4,5,6,7) (1,3,5,7,8)	1.0	**OR**	1 Motoqua	3425.8	>=330, AND
				2 Catclaw	2636.5	>=530, AND
				3 Indian	2552.9	>=370, AND
				8 Highway 91	1832.8	>=10
Warning Stage 2						
<=+0.9	(1,3,4,5,6,7,8) (1,4,5,6,7) (1,3,5,7,8)	2.8	**OR**	1 Motoqua	3427.1	>=1,000, AND
				2 Catclaw	2637.1	>=1,150, AND
				3 Indian	2553.5	>=830 AND
				8 Highway 91	1834.6	>=350
Warning Stage 3						
<=+2.5	1,3,4,5,6,7,8	3.0	**OR**	1 Motoqua	3429.6	>=9,000, AND
				2 Catclaw	2639.7	>=10,100, AND
				3 Indian	2555.7	>=8,700, AND
				8 Highway 91	1837.7	>=3,400
OR						
<=+2.5	1,4,5,6,7	3.1	**OR**	1 Motoqua	3428.5	>=4,000, AND
				2 Catclaw	2638.1	>=3,100, AND
				3 Indian	2553.5	>=900, AND
				8 Highway 91	1834.0	>=100
OR						
<=+2.0	1,3,5,7,8	3.0	**OR**	2 Catclaw	2639.1	>=7,000, AND
				3 Indian	2555.1	>=5,700, AND
				8 Highway 91	1837.2	>=2,600

NOTE: Due to the effects of fire, the watershed response time could be significantly shorter than listed in Table 2.5 for a minimum of the next two years. The actual period affected could be much longer and is unknown.

Table 2.6 Summary of flood detection warning sequence

Warning Stage	**Communication**	**Message Content** (includes effective time)	**Flood Condition Status**
(1)	(2)	(3)	(4)
STAGE 1 (triggered by NWS)	National Weather Service: NOAA Weather Radio, Commercial Radio and/or TV	National Weather Service Flash Flood Watch advisory for Northwest Mohave County	Flash flooding possible in extreme northwest Mohave County, including Beaver Dam Wash.
	AFWS communicates by e mail/pager/texting to: AFWSS, PWD, APWD, EGRC, EMC, EMAC, FCDE, BDFD, SCDC, and SOAS	NWS Advisory. May send:"This is a Stage 1 Flood Advisory for the Beaver Dam Area of the Arizona Strip. The potential need to evacuate selected areas due to flooding exists but is not imminent".	Flash flooding is possible in the Beaver Dam area of extreme northwest Mohave County.
STAGE 2 (triggered by AFWSS)	National Weather Service: NOAA Weather Radio, Commercial Radio and/or TV	National Weather Service Thunderstorm or Flash Flood Warning	Flash Flooding is imminent or occurring in extreme northwest Mohave County, including Beaver Dam. Prepare for possible evacuation.
	AFWSS communicates to: AFWSS, PWD, APWD, EGRC, EMC, EMAC, FCDE, BDFD, SCDC, and SOAS	"This is a Stage 2 Flood Advisory for the Beaver Dam Area of the Arizona Strip. The potential need to evacuate selected areas is high. Beaver Dam Area response agencies should activate personnel in preparation for possible evacuation duties. Residents in Beaver Dam Estates should prepare to evacuate upon receipt of a Stage 3 alert".	Heavy rainfall detected in northwest Mohave County Beaver Dam Wash watershed. Mohave County AFWS detects rainfall values that have exceeded the warning thresholds established for the Beaver Dam Wash watershed. Potential for life-threatening flooding exists.
STAGE 3 (triggered by EMC)	AFWSS communicates to: AFWSS, PWD, APWD, EGRC, EMC, EMAC, FCDE, BDFD, SCDC, and SOAS	This is a Stage 3 Flood Avisory for the Beaver Dam Area of the Arizona Strip. Notify all residents of Beaver Dam Estates to evacuate immediately.	Extreme rainfall detected in northwest Mohave County Beaver Dam Wash watershed. Mohave County AFWS detects rainfall and streamflow values that have exceeded the evacuation notice threshold established for the Beaver Dam Wash watershed. Potential for life-threatening flooding exists.
	National Weather Service: NOAA Weather Radio, Commercial Radio and/or TV	This is a Stage 3 Flood Avisory for the Beaver Dam Area of the Arizona Strip. All residents of Beaver Dam Estates are to evacuate immediately.	
All Clear	MCDM Communicates to: AFWSS, PWD, APWD, EGRC, EMC, EMAC, FCDE, BDFD, SCDC, and SOAS	Beaver Dam All Clear	Flood levels on Beaver Dam Wash have dropped below critical depths. Potential for additional extreme flooding is minimal.

Table 2.7 List of acronyms used in flood warning procedures

MC - Mohave County	AFWS –MC ALERT Flood Warning System	AFWSS - AFWS Supervisor
PWD –MC Public Works Director	APWD - MC Assistant Public Works Director	EGRC - MC Engineering Manager (Construction)
EMC – MC Emergency Management Coordinator	EMAC - MC Emergency Management Assistant Coordinator	
FCDE – MC Flood Control District Engineer	BDFD – Beaver Dam/Littlefield Fire Chief or designee	
SODC – MC Sheriff's Office Dispatch Center	SOAS – MC Sheriff's Office personnel on Arizona Strip	

Table 2.8 Detailed notifications/warnings – Beaver Dam / Littlefield flood event

STAGE 1 – National Weather Service Advisory of Flood Watch for Beaver Dam area

1. NWS sends out standard Flood Watch advisory for NW Mohave County (Washington County and Lincoln County advisories will also be monitored)
2. ALERT Flood Warning System (AFWS) receives NWS Flood Watch advisory and automatically forwards via e-mail to the following parties:

   a. AFWS Supervisor
   b. Public Works Director
   c. Assistant Public Works Director
   d. Engineering Manager (Construction)
   e. Flood Control District Engineer
   f. Beaver Dam / Littlefield Fire Chief or designee
   g. Emergency Management Coordinator
   h. Emergency Management Assistant Coordinator
   i. Mohave County Sheriff's Office Dispatch Center
   j. Mohave County Sheriff's Office personnel on the Arizona Strip

   The information forwarded will include the National Weather Service Bulletin in its entirety.

3. Emergency Management and the AFWS Supervisor will evaluate the NWS forecasted severity of the weather event and may send additional information to the addressees above, which may include the following message for probable serious flooding:

STAGE 1 (FLOOD WATCH) ALERT MESSAGE:

"*This is a Stage 1 Advisory for the Beaver Dam Area of the Arizona Strip. The potential need to evacuate selected areas due to flooding exists but is not imminent (effective time)".*

NOTE: Between STAGE 1 and STAGE 2, as weather events develop, it is possible that the NWS will send out a thunderstorm warning or even a flood warning for the region that includes Beaver Dam. By themselves, these NWS warnings will not trigger a Stage 2 Alert for this plan.

Table 2.8 Detailed notifications/warnings – Beaver Dam / Littlefield flood event

STAGE 2 – AFWS detects rainfall values that have exceeded the warning thresholds established for the Beaver Dam Wash watershed. Potential for life-threatening flooding exists.

1. AFWS Supervisor receives automated ALERT warning, validates the information, and forwards it via pager and/or e-mail and texting to the same addresses listed under Stage 1, Step 2, on the preceding page:
2. AFWS Supervisor sends the following message via pager and/or e-mail and texting to the same addressees as in Step 1 above:

STAGE 2 ALERT MESSAGE:

"This is a Stage 2 Flood Advisory for the Beaver Dam Area of the Arizona Strip. The potential need to evacuate selected areas due to flooding is high. Beaver Dam Area first response agencies should activate personnel in preparation for possible evacuation duties. Residents in Beaver Dam Estates should prepare to evacuate upon receipt of a Stage 3 Alert (effective time)".

3. AFWS Supervisor will obtain e-mail or verbal confirmation of receipt of the Stage 2 Alert message by the Sheriff's Office Dispatch Center.
4. Sheriff's Office Dispatch Center verbally notifies Deputies on the Arizona Strip and Beaver Dam / Littlefield Fire District of the Stage 2 Alert.
5. Emergency Management contacts Public Works Director or designee and AFWS Supervisor to discuss current situation and additional preparatory measures.
6. Emergency Management contacts Beaver Dam / Littlefield Fire District and Sheriff's Deputies on Strip to discuss the deployment of personnel to monitor the situation at observation posts along the Beaver Dam Wash and preparations for possible evacuation.
7. Emergency Management discusses event with NWS duty officer in Las Vegas.
8. Emergency Management activates STAGE 2 FLOOD ALERT message (see above) to residents of threatened area via automated call system.
9. Engineering Manager (Construction) or designee initiates preparatory planning with Road Department and/or Traffic Control for road closures and traffic control in Beaver Dam area.
10. Updates on situation will continue with frequent communication among MCSO, MCPW, MCEM, NWS, BDFD, and AFWS Supervisor.
11. MCEM monitors situation and decides when to notify other response agencies (American Red Cross, Salvation Army, and Arizona Division of Emergency Management) to prepare for possible disaster assistance.

Table 2.8 Detailed notifications/warnings – Beaver Dam / Littlefield flood event

Stage 3 – AFWS stream gauges detect flows at the logic software calculated trigger point for evacuation decision

1. AFWS Supervisor notifies via telephone the first available person in the following line of succession that the threshold point for evacuation has been reached.

   a. Public Works Director or designee;
   b. Emergency Management Coordinator or Assistant Coordinator;
   c. Beaver Dam / Littlefield Fire Chief or designee;
   d. Sheriff's Deputy on Arizona Strip.

2. Evacuation decision is validated and authorized by the first available person above.

3. AFWS Supervisor sends via pager and/or e-mail a STAGE 3 EVACUATION ALERT MESSAGE to the individuals listed under Stage 1, Step 2.

STAGE 3 (EVACUATION) ALERT MESSAGE:

"This is a Stage 3 Warning for the Beaver Dam Area of the Arizona Strip. Notify all residents of Beaver Dam Estates to evacuate immediately (effective time)"

4. Sheriff's Office Dispatch Center verbally notifies Sheriff's Office personnel on Arizona Strip and Beaver Dam / Littlefield Fire District of the evacuation decision and the Stage 3 alert.

5. Emergency Management activates STAGE 3 (EVACUATION) FLOOD ALERT message (see above) to residents of threatened area via automated call system and activates siren at Beaver Dam Estates.

6. Sheriff's Deputies or Beaver Dam firefighters on scene at Beaver Dam Estates verify siren activation or manually activate siren if necessary, then commence door to door warnings of all residents in threatened area.

7. Emergency Management notifies NWS Las Vegas and other responders, such as the American Red Cross, Salvation Army, and ADEM duty officer, of the evacuation decision.

8. Emergency Management or Public Works Director notifies the County Manager.

9. Emergency Management and other designated Public Works personnel respond to the scene; Emergency Management prepares to activate the county EOC.

10. Incident Command at Beaver Dam, composed of Beaver Dam / Littlefield Fire Chief or designee and Sheriff's Deputies, verbally verifies to Emergency Management and/or the County EOC that all residents have been warned and have been evacuated or otherwise accounted for.

NOTE: The Mohave County Flood Warning Alert System does not extend to radio stations in the Arizona Strip area and will not be used in this scenario. NWS will be relied upon to activate any NOAA radios in the area and send evacuation warnings to TV and radio stations covering the Beaver Dam area.

Figure 2.1 Entire Beaver Dam Wash watershed

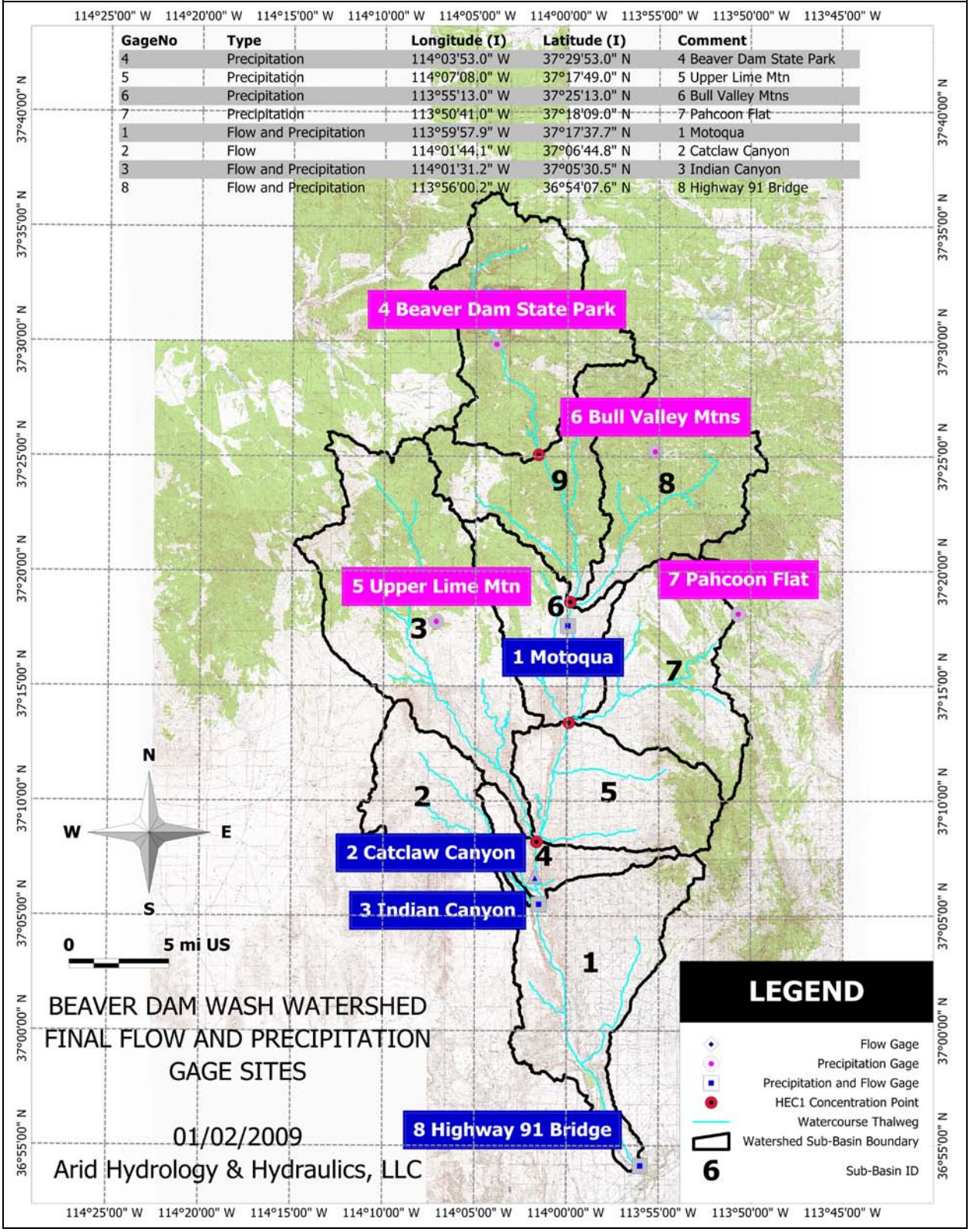


Figure 2.2 Upper Beaver Dam Wash watershed

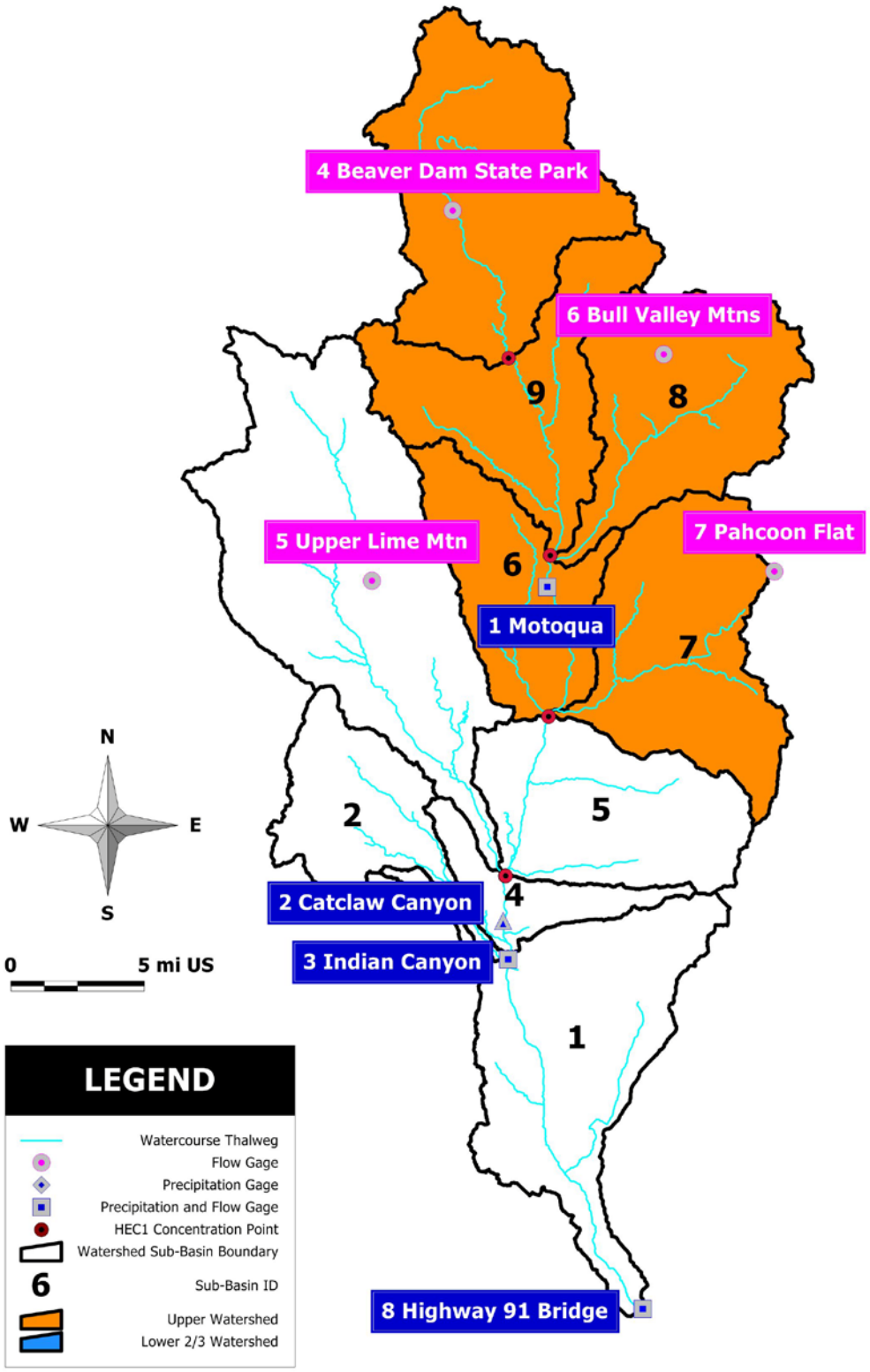


Figure 2.3 Lower Two Thirds Beaver Dam Wash watershed

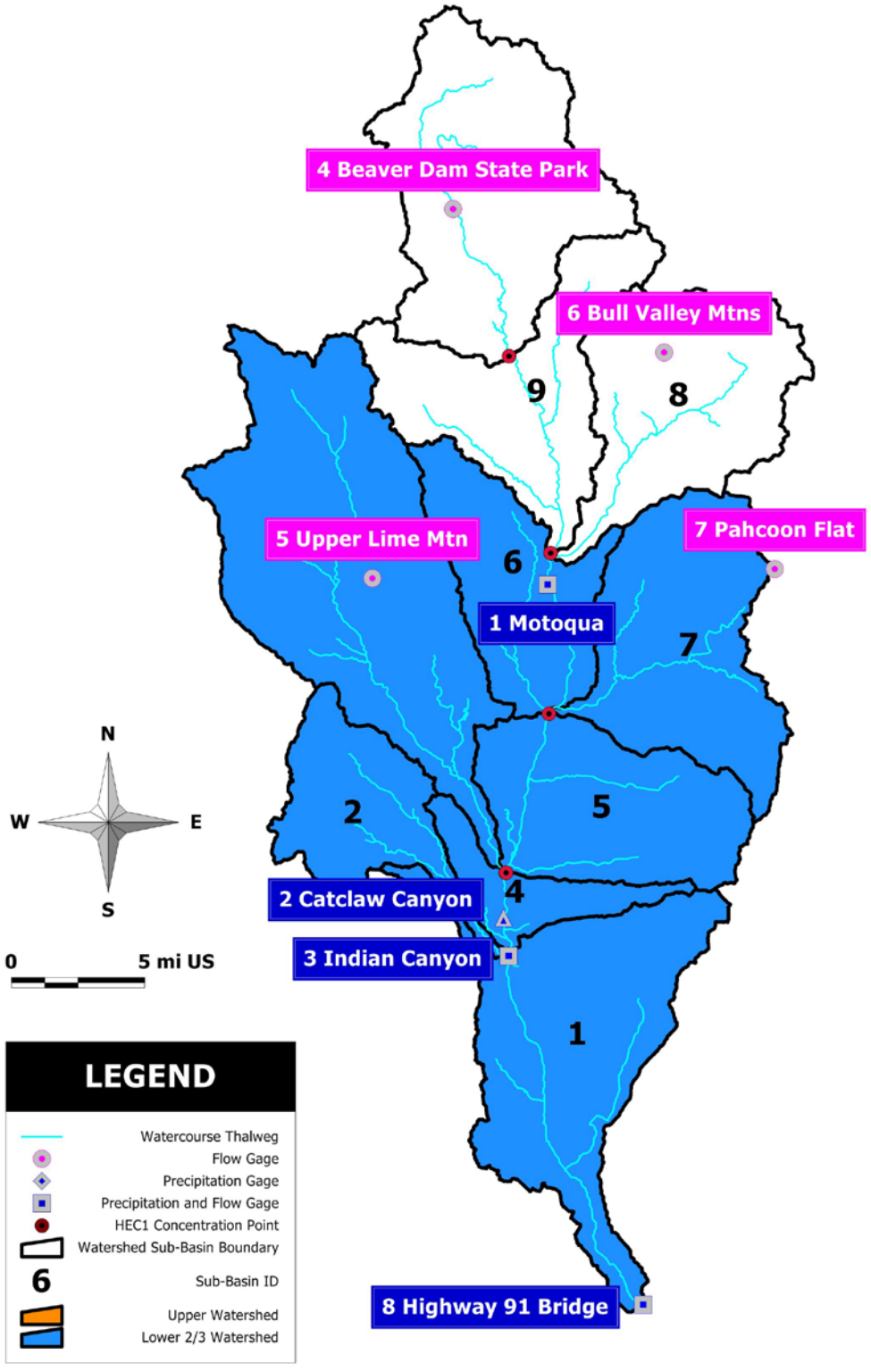


Figure 2.4 Precipitation and runoff response for entire watershed (pre-fire)

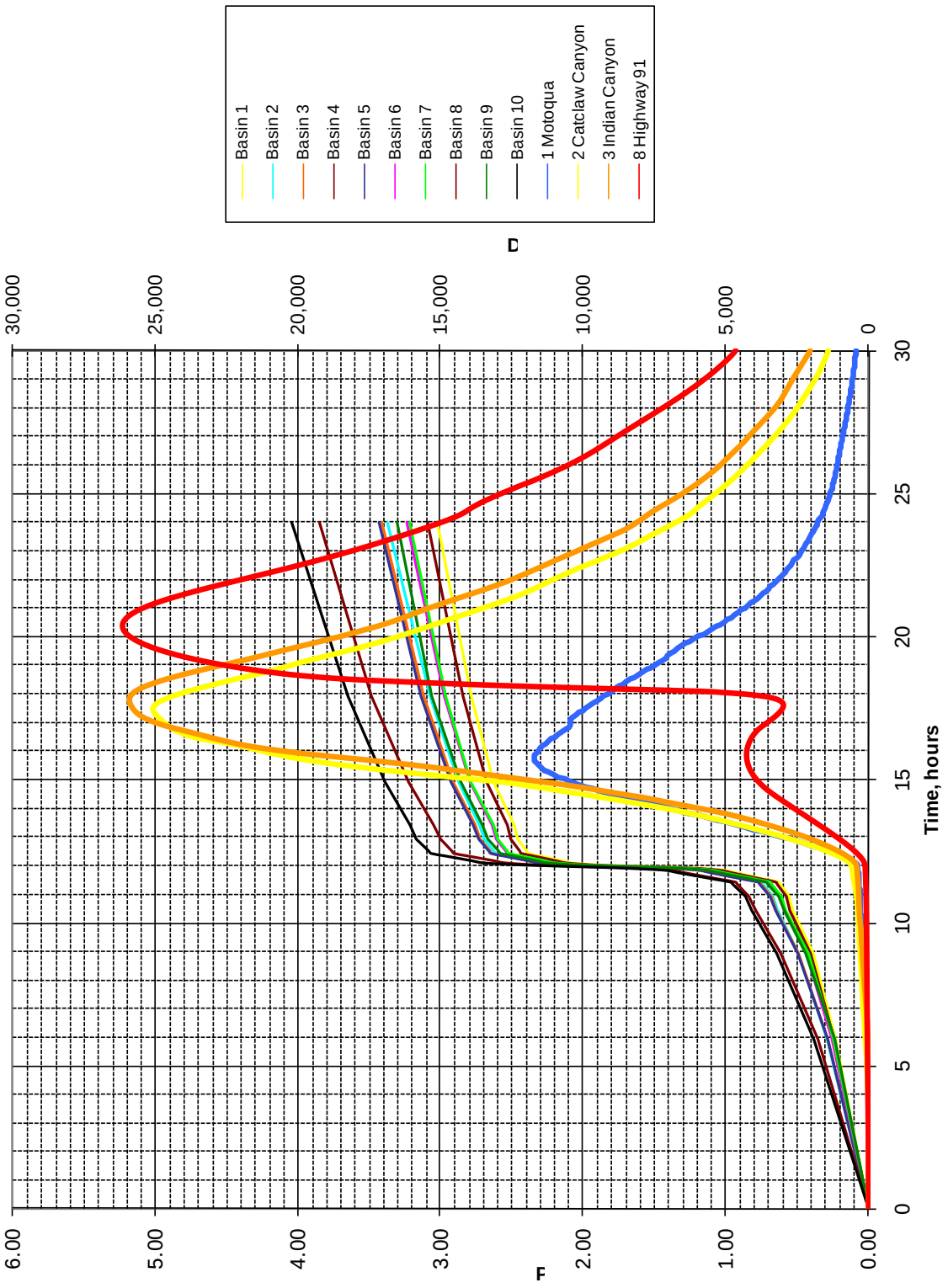


Figure 2.5 Precipitation and runoff response for upper watershed (pre-fire)

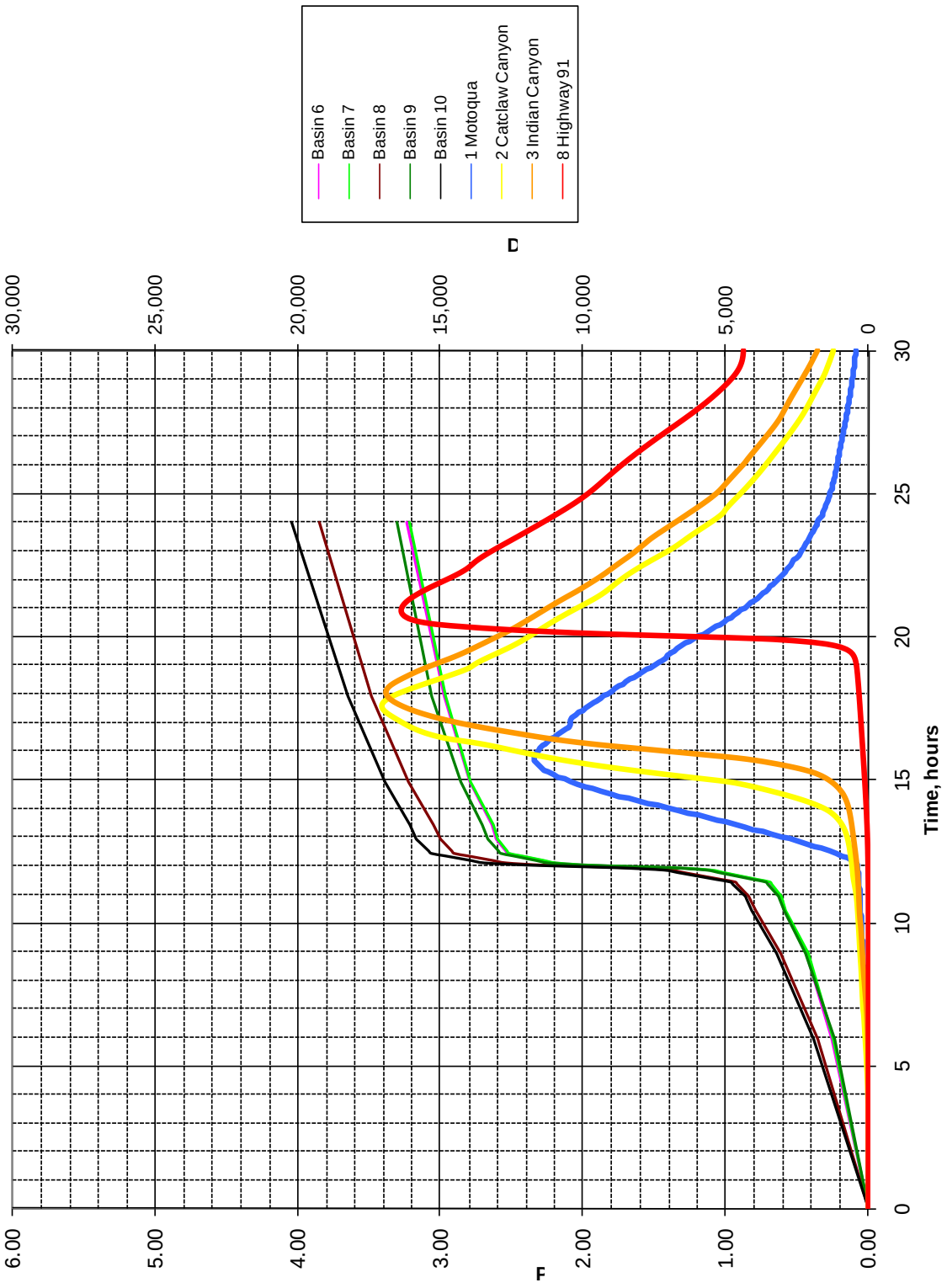


Figure 2.6 Precipitation and runoff response for lower 2/3 watershed (pre-fire)

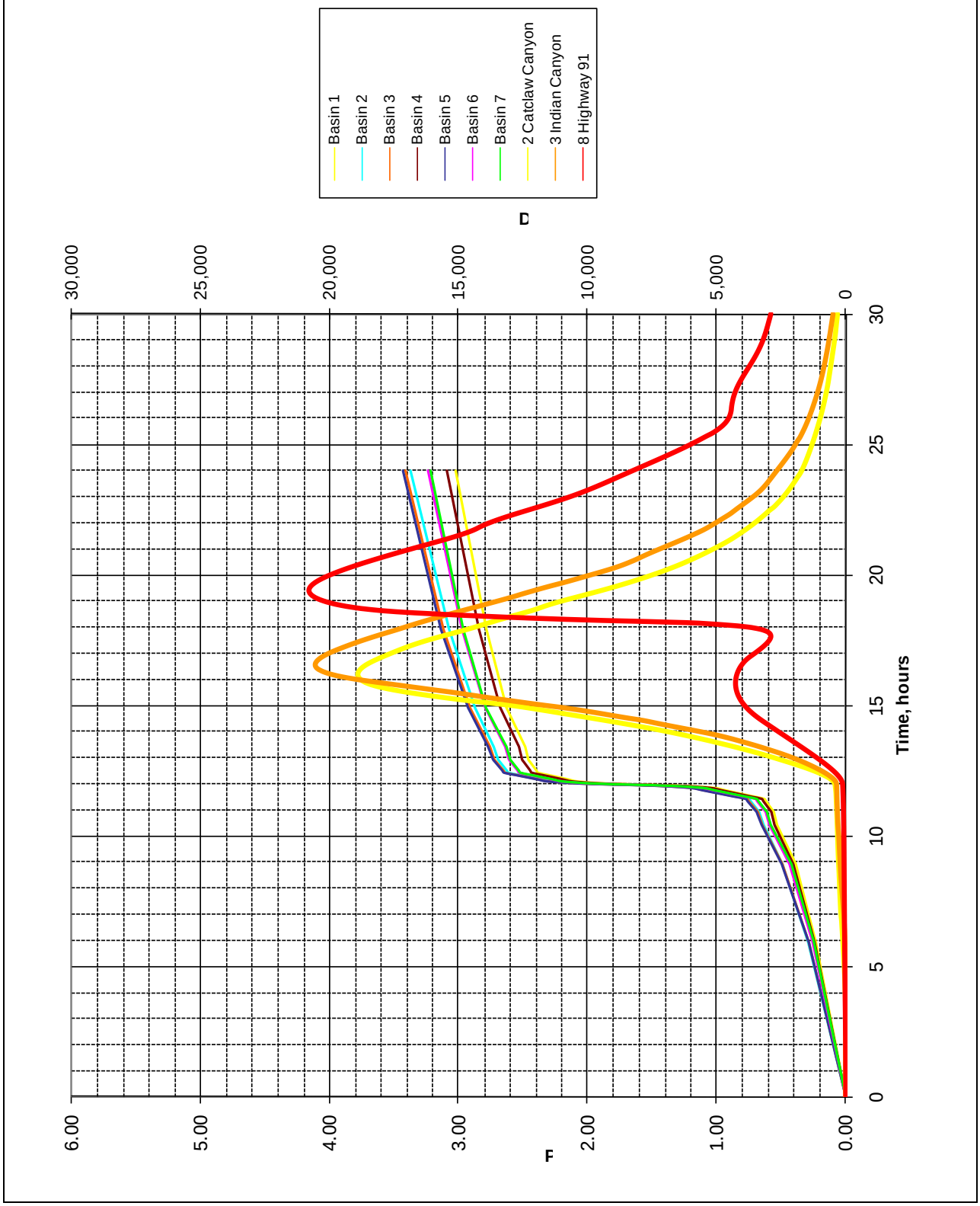
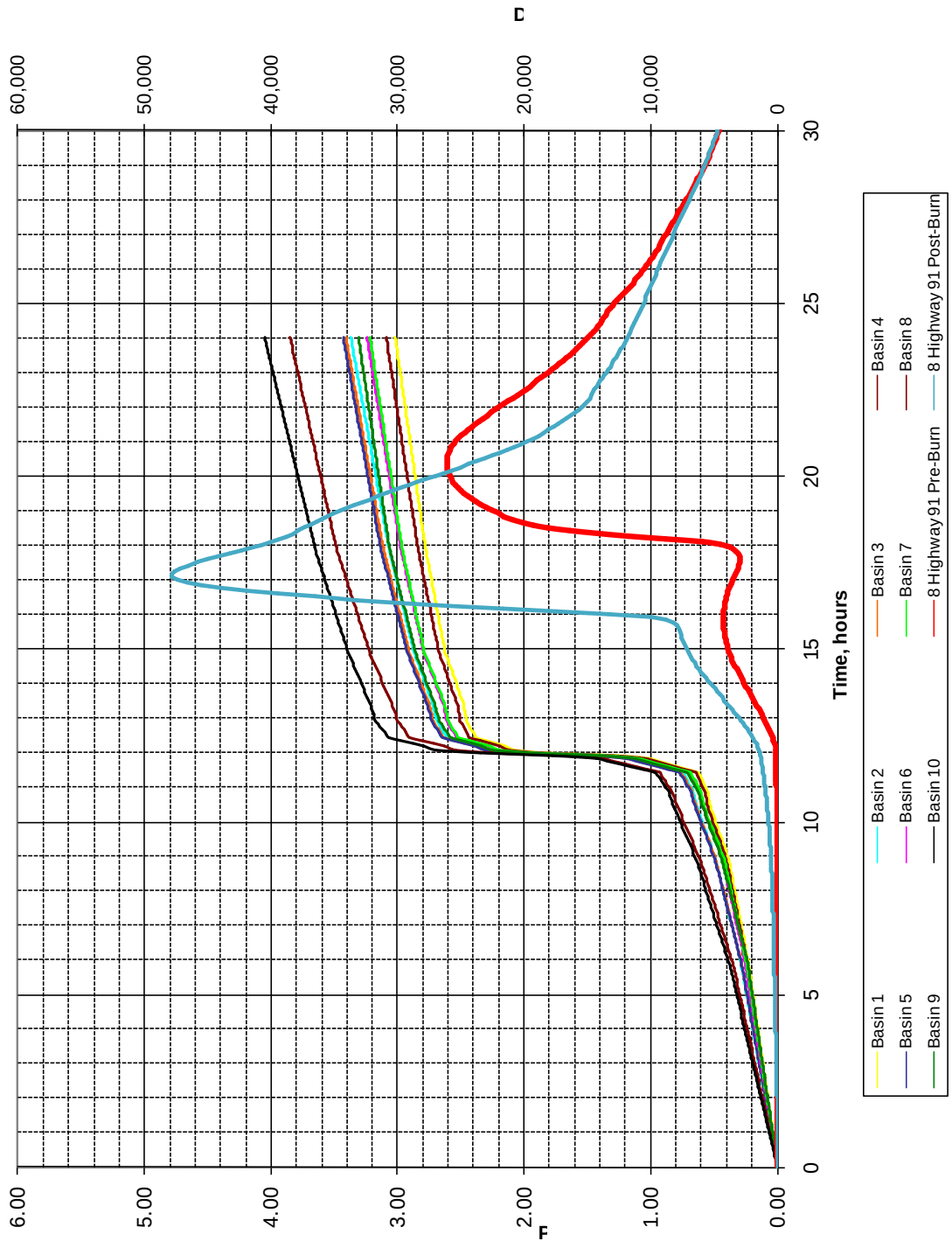


Figure 2.7 Precipitation and runoff response for entire watershed (post-fire) at County Highway 91



3 EFFECTIVE LEAD TIME

The effective lead time available for the implementation of a flood response plan is the time period afforded to the residents of the potential hazard area to evacuate before a flood reaches inescapable proportions. The estimate of that critical evacuation window is the total hydrologic lead time minus the emergency response time. For the purposes of this study, hydrologic lead time is defined as the time to emergency access blockage by flood waters minus the time of most intense precipitation. The effective lead time for all three watershed-precipitation scenarios is shown in Table 3.1. Note that there is very little effective lead time, especially for such a remote area. This is especially true for the possible post-fire conditions. Emergency managers should be aware of the possible reduced available flood warning time due to faster rainfall-runoff responses in the burned areas of the watershed. Also erosion hazards will tend to be greater during the post-fire watershed recovery period.

Decision makers in a flood emergency must exercise caution in the use of, and reliance upon, the lead time estimates provided in Table 3.1. These lead times are estimates based upon the best available information and should not be strictly interpreted. There are a number of variables affecting hydrologic response that are storm specific and thus accurate estimates are not possible. Emergency response time is also highly dependant on circumstances during the storm event. The estimated lead times should only be used as an indicator of the urgency of the necessary response actions and as a decision-making tool for prioritization of the response activities.

An additional unknown is the Beaver Dam Wash watershed response to the wildfires that occurred in 2005 and 2006. Over 40 percent of the watershed, including most of sub-basins 2-9 and small portions of sub-basins 1 and 10 were affected. As can be seen in Table 3.1, the effective lead time could be one-half that of a healthy watershed. It is also possible the watershed could respond even faster than anticipated. During the post-burn recovery period (length unknown), the stream flow gages will be more important than the precipitation gages. The actual response of the burned watershed to rainfall is even more uncertain than for the pre-burn condition, so the flow rate triggers could be caused by much lower precipitation amounts than for a normally vegetated watershed. It is also possible that the watershed will never recover completely, and faster than anticipated watershed response times could be the norm.

Table 3.1 Estimated lead time for flood response scenarios

Watershed Condition	Precipitation Scenario	Hydrologic Lead Time, hours (min)	Emergency Response Time, hours				Effective Lead Time, hours [(3)-(5)+(7)] or [(3)-(4)+(6)]	
			Decision Time		Action Time			
			Min	Max	Min	Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Pre-Fires (2005-2006)	Entire Watershed	6.0	1.0	2.0	2.0	3.0	1.0	3.0
	Upper Watershed	8.0	1.0	3.0	2.0	3.0	2.0	5.0
	Lower 2/3 Watershed	6.0	1.0	2.0	2.0	3.0	1.0	3.0
Post-Fires (2005-2006)	Entire Watershed	3.0	0.5	1.0	1.0	2.0	0.0	1.5

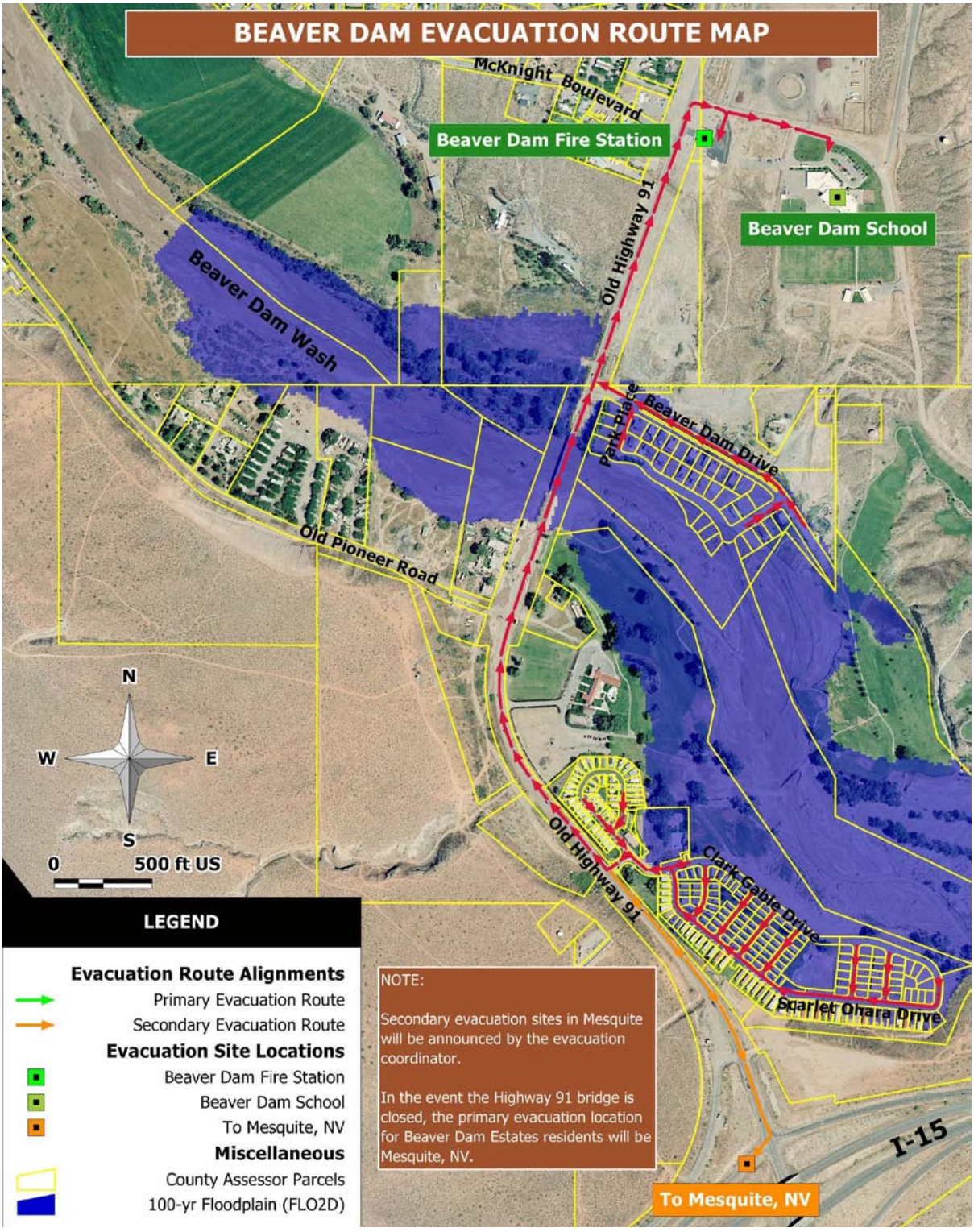
4 RESIDENT ACTION PLAN

The resident action plan is designed to be a plastic laminated handout that residents can keep in their home, on the refrigerator or other visible location. It consists of a descriptive table on the front that lists the various flood messages, a description of what the message means, and a description of actions to take. A map depicting the evacuation routes is on the reverse side.

Table 4.1 Resident action plan

Message	What It Means	What You Need To Do
(NOAA Weather Radio, Radio, TV) National Weather Service Flash Flood Watch	• National Weather Service Flash Flood Watch for Northwestern Mohave County (begin time/end time) • Be Alert!	Monitor the NOAA weather radio continually for updates. Other sources of flood information: • Some commercial radio and TV stations voluntarily broadcast NWS flash flood watch and flash flood warning information • Flood information may be available by monitoring the MCFCD web page at: http://www.co.mohave.az.us/pw • 24-hour hydrologic and weather information for the entire state is available at: http://www.afws.org
(NOAA Weather Radio, Radio, TV) National Weather Service Flash Flood Warning (begin time/end time)	• Flash Flooding is imminent or occurring in extreme northwest Mohave County, including Beaver Dam. • Prepare for possible evacuation.	• You MAY be instructed to EVACUATE and will need to do so at a moment's notice. You may only have minutes! Get Prepared! • Monitor the NOAA weather radio continually for updates. • Locate all residents of your home, including pets and livestock. • Collect absolute necessities and load in your vehicle(s). Include a flashlight. Secure premises.
(NOAA Weather Radio, Radio, TV) National Weather Service Severe Flood Alert and Evacuation Notice for Beaver Dam (begin time/end time or all clear)	• Extreme rainfall detected in the Beaver Dam Wash watershed. • Critical flow rates detected by stream gages. Severe flash flooding is imminent or occurring. • Evacuation order has been issued.	• IMMEDIATELY EVACUATE all residents and pets from your home and get to the evacuation site (see map on reverse). Act quickly! • Turn off lights, heating and air-conditioning units. • Hang a light-colored sheet or towel over your door to indicate to emergency personnel that you have evacuated. • Monitor your NOAA weather radio for updates. • Follow the evacuation route shown on the map. DO NOT cross any barricaded roads! NEVER drive through flooded roadways, especially at night when dangers are harder to recognize. • Report to the evacuation site for registration, even if you do not plan to stay. • Seek medical care at the nearest hospital if needed. Food, clothing, and first aid may be available from emergency aid organizations such as the Red Cross.
(Siren Sounds) Sheriff's Department Conducting Door-to-door Evacuation	• Evacuation order has been issued.	
All Clear Message	• Floods on Beaver Dam Wash have dropped below critical depths. Potential for additional extreme flooding is minimal.	• Leave the evacuation site and return to your home using the same route in reverse. • Use flashlights to examine buildings. Flammables may be inside. • Electrical equipment should be dried and checked before being returned to service. • Boil drinking water before using. • Throw out any fresh food that has come in contact with flood waters.

Figure 4.1 Evacuation route map



APPENDIX A STREAM GAGE HYDRAULIC RATING CURVES

A.1 Rating Curves

Hydraulic rating curves were developed as a part of this study for the four stream flow gages recommended in AridHH (2007). These curves were developed for use with the Mohave County flood warning ALERT system and the data developed was also used to populate the Stream Flow Stage Elevation column in Table 2.5. The rating curves are shown graphically on Figure A.2 through Figure A.4, and in tabular form in Table A.1 and Table A.2.

Figure A.2 Motoqua gage rating curve

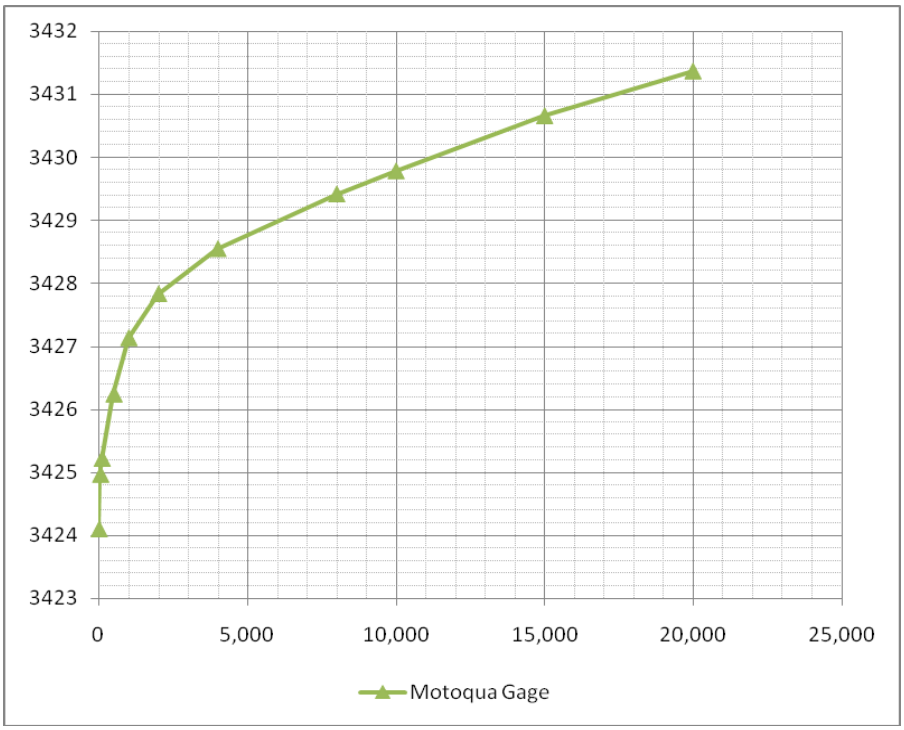


Figure A.3 Catclaw Canyon gage rating curve

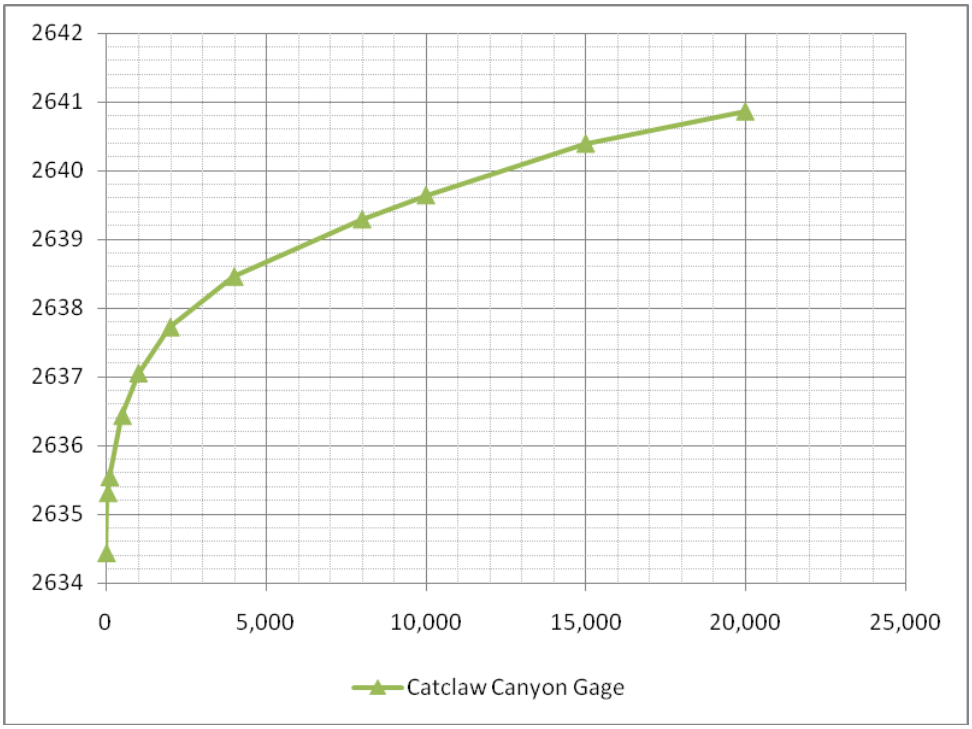


Figure A.4 Indian Canyon gage rating curve

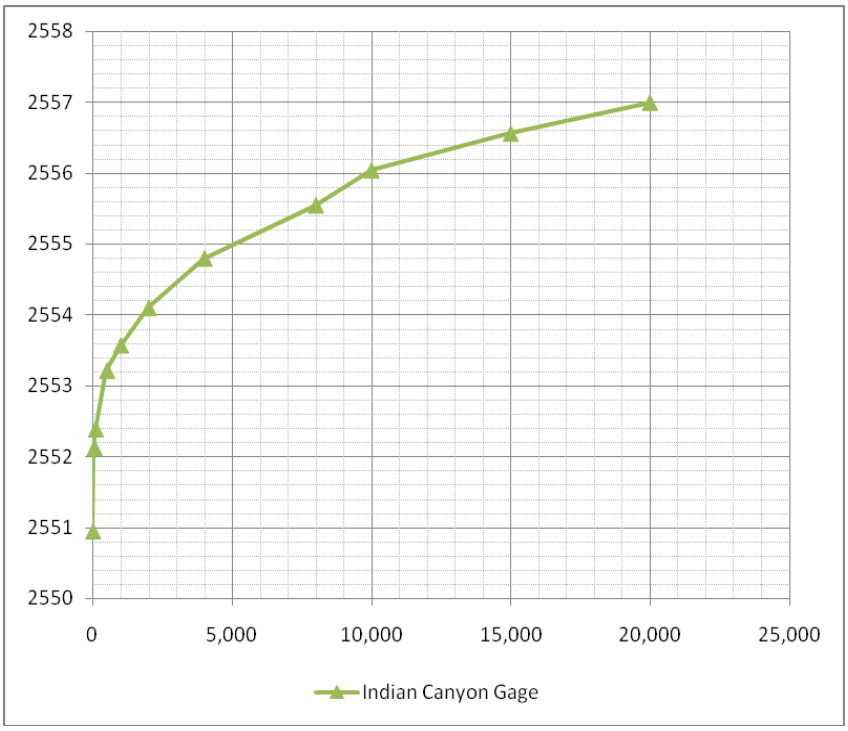


Figure A.5 Highway 91 Bridge rating curve

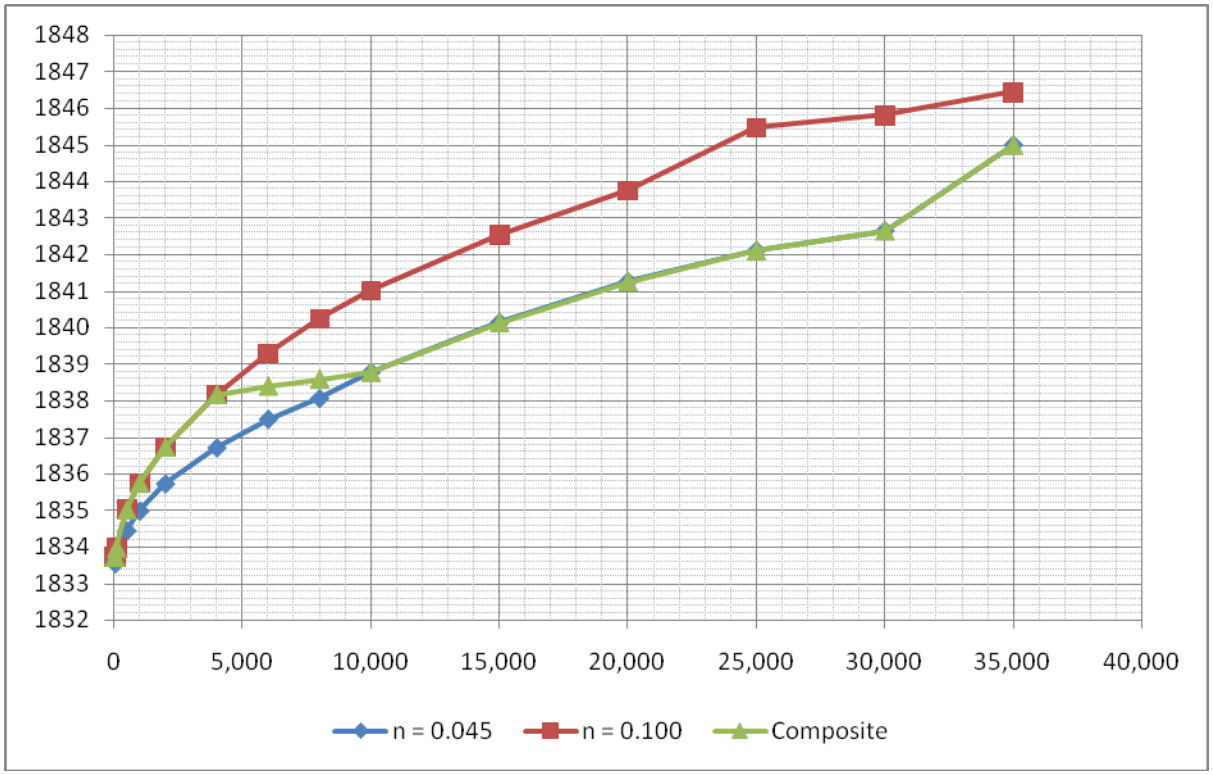


Table A.2 Rating curve data for watershed flow gages

Discharge	Motoqua		Catclaw Canyon		Indian Canyon	
	Height	WSEL	Height	WSEL	Height	WSEL
cfs	ft	ft	ft	ft	ft	ft
0	-0.1	3424.1	-1.8	2634.4	-1.8	2550.9
50	0.7	3425.0	-0.9	2635.3	-0.7	2552.1
100	1.0	3425.2	-0.7	2635.5	-0.4	2552.4
500	2.0	3426.2	0.2	2636.4	0.4	2553.2
1,000	2.9	3427.1	0.8	2637.0	0.8	2553.6
2,000	3.6	3427.8	1.5	2637.7	1.3	2554.1
4,000	4.3	3428.5	2.2	2638.5	2.0	2554.8
8,000	5.2	3429.4	3.1	2639.3	2.8	2555.5
10,000	5.6	3429.8	3.4	2639.6	3.3	2556.0
15,000	6.4	3430.7	4.2	2640.4	3.8	2556.6
20,000	7.1	3431.4	4.6	2640.9	4.2	2557.0
Sensor Elev:	3424.23		2636.23		2552.78	
	Height above PT Sensor					

Table A.3 Rating curve data for Highway 91 Bridge gage

	n=0.100		n=0.045		Composite	
Discharge	Height	WSEL	Height	WSEL	Height	WSEL
cfs	ft	ft	ft	ft	ft	ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0	-1.2	1832.54	-1.2	1832.54	-1.2	1832.54
50	0.0	1833.71	-0.2	1833.54	0.0	1833.71
100	0.3	1833.96	0.0	1833.72	0.3	1833.96
500	1.3	1835.00	0.7	1834.44	1.3	1835.00
1,000	2.0	1835.73	1.3	1834.98	2.0	1835.73
2,000	3.0	1836.72	2.0	1835.72	3.0	1836.72
4,000	4.5	1838.16	3.0	1836.71	4.5	1838.16
6,000	5.6	1839.29	3.8	1837.49	4.7	1838.39
8,000	6.5	1840.24	4.4	1838.06	4.9	1838.58
10,000	7.3	1841.02	5.1	1838.77	5.1	1838.77
15,000	8.8	1842.54	6.4	1840.13	6.4	1840.13
20,000	10.1	1843.76	7.5	1841.25	7.5	1841.25
25,000	11.8	1845.47	8.4	1842.10	8.4	1842.10
30,000	12.1	1845.81	8.9	1842.64	8.9	1842.64
35,000	12.7	1846.45	11.3	1844.99	11.3	1844.99

Sensor Elev:	1833.7
	Height above PT Sensor
	Rating curve WSEL may decrease in the 8,000 to 12,000 cfs range due to removal of vegetation and the resulting decrease in flow resistance. Be aware that this could be a sign of rapidly increasing peak discharge rather than decreasing flood stage.
	NOTE: The composite rating curve is an average of the rating curves for the cross sections immediately upstream and downstream of the bridge. The computed inlet and outlet water surface elevations for the two cross sections were averaged for each discharge based on the channel n-value equal to 0.045 and 0.100, creating two average rating curves. Then a composite of the two rating curves was created and is shown in column 7. The rating curve may not be valid for flow rates above when pressure flow occurs at the bridge inlet. Pressure flow could begin when the flow rate exceeds 25,000 to 30,000 cfs. Visual observations and engineering judgment will be needed when interpreting the gage results for flow rates above 25,000 cfs. It is also possible one or both bridge approaches could fail before flow overtops the road, as occurred during the 2005 flood. This condition would significantly affect the flow through the bridge and the rating curve would become invalid.

A.2 Development of Rating Curves

The US Army Corps of Engineers HEC-RAS computer program version 4.0.0 dated March 2008 was used to prepare the hydraulic computer models. All elevations used in the HEC-RAS models are in NAVD 1988 vertical datum. The rating curves were derived from the HEC-RAS model results. There is no detailed topography available for the Motoqua, Catclaw Canyon, and Indian Canyon locations, so a field survey was necessary to gather the needed data. There is detailed survey data available for the Highway 91 Bridge gage site but physical changes have been made to the bridge, the bridge approaches and the channel and banks upstream and downstream of the bridge. The available topography is from URS, 2005. The field survey was conducted on October 6-9, 2008 and included as-builting of the Highway 91 Bridge. The survey field data report is contained in Section A.3 of this report.

Four cross sections each were taken at the Motoqua, Catclaw Canyon, and Indian Canyon sites. These cross sections were used to prepare the HEC-RAS models. The cross section locations and configurations for all four flow gages are shown on Figure A.5 through Figure A.8. Cross section plots are shown on Figure A.9 through Figure A.28.

The HEC-RAS models were run in mixed mode. The upstream and downstream boundary conditions were set to normal depth. The average ground slope was input as the estimated slope. The models were run and then the average slope of the energy gradeline for all flow rates was input as the normal depth boundary condition slope.

The Manning's n-values for the HEC-RAS models were assigned using the procedures in Drainage Design Manual for Mohave County. The n-value computations for the Motoqua, Catclaw Canyon and Indian Canyon models are shown in Table A.3.

Manning's n-values for the Highway 91 Bridge model were assigned using the n-values from URS (2005) and using engineering judgment. The Highway 91 Bridge model was run using an upper and lower assignment of n-values to simulate the current vegetation conditions in the channel, and the scenario where flow removes the vegetation. Using a stream power approach, it is estimated that the existing vegetation will be bent over or removed by flow rates between 6,000 and 12,000 cfs. The rating curve for the Highway 91 Bridge gage reflects this approach. Ineffective flow areas to simulate flow contraction and expansion at the bridge approaches was computed using a contraction ratio of 1:1 and an expansion ratio of 1.5:1, based the procedure defined in the HEC-RAS Reference Manual.

The HEC-RAS input and output files are available for review on the DVD included with this report.

Table A.4 Manning's n-value computations

Cross Section		Base	Degree of Irregularity	Variation in channel cross section	Effects of obstructions	Amount of vegetation	Degree of meandering	n: Sum(3-7)*8
1	2	3	4	5	6	7	8	9
Motoqua								
1	Channel	0.035	0.005	0.005	0.004	0.000	1.00	0.049
	Left	0.030	0.005	0.008	0.004	0.007	1.10	0.059
	Right	0.030	0.005	0.005	0.004	0.005	1.00	0.049
2	Channel	0.035	0.005	0.005	0.004	0.000	1.00	0.049
	Left	0.035	0.005	0.008	0.004	0.007	1.10	0.065
	Right	0.030	0.005	0.005	0.004	0.010	1.00	0.054
3	Channel	0.030	0.005	0.005	0.004	0.000	1.00	0.044
	Left	0.040	0.005	0.008	0.006	0.010	1.15	0.079
	Right	0.035	0.005	0.005	0.004	0.010	1.00	0.059
4	Channel	0.030	0.005	0.005	0.004	0.000	1.00	0.044
	Left	0.040	0.005	0.008	0.004	0.010	1.10	0.074
	Right	0.035	0.005	0.005	0.004	0.000	1.00	0.049
Catclaw Canyon								
1	Channel	0.028	0.005	0.005	0.003	0.000	1.00	0.041
	Left	0.030	0.005	0.005	0.005	0.010	1.00	0.055
	Right	0.025	0.007	0.005	0.003	0.001	1.00	0.041
2	Channel	0.030	0.005	0.005	0.004	0.001	1.00	0.045
	Left	0.025	0.005	0.008	0.005	0.010	1.10	0.058
	Right	0.030	0.005	0.005	0.004	0.001	1.00	0.045
3	Channel	0.030	0.005	0.005	0.004	0.000	1.00	0.044
	Left	0.035	0.006	0.008	0.007	0.010	1.10	0.073
	Right	0.035	0.005	0.005	0.004	0.010	1.00	0.059
4	Channel	0.030	0.005	0.005	0.004	0.000	1.00	0.044
	Left	0.030	0.005	0.005	0.004	0.005	1.00	0.049
	Right	0.030	0.005	0.005	0.005	0.002	1.00	0.047
Indian Canyon								
1	Channel	0.028	0.005	0.005	0.003	0.005	1.00	0.046
	Left	0.028	0.006	0.005	0.003	0.010	1.00	0.052
	Right	0.028	0.004	0.005	0.003	0.000	1.00	0.040
2	Channel	0.030	0.006	0.005	0.005	0.002	1.00	0.048
	Left	0.025	0.007	0.008	0.005	0.010	1.05	0.058
	Right	0.028	0.004	0.005	0.003	0.000	1.00	0.040
3	Channel	0.030	0.005	0.005	0.004	0.005	1.00	0.049
	Left	0.030	0.006	0.007	0.004	0.010	1.00	0.057
	Right	0.028	0.005	0.003	0.004	0.000	1.00	0.040
4	Channel	0.028	0.005	0.005	0.004	0.001	1.00	0.043
	Left	0.030	0.006	0.007	0.004	0.010	1.00	0.057
	Right	0.025	0.005	0.006	0.010	0.002	1.00	0.048

Figure A.6 Motoqua gage cross section location map

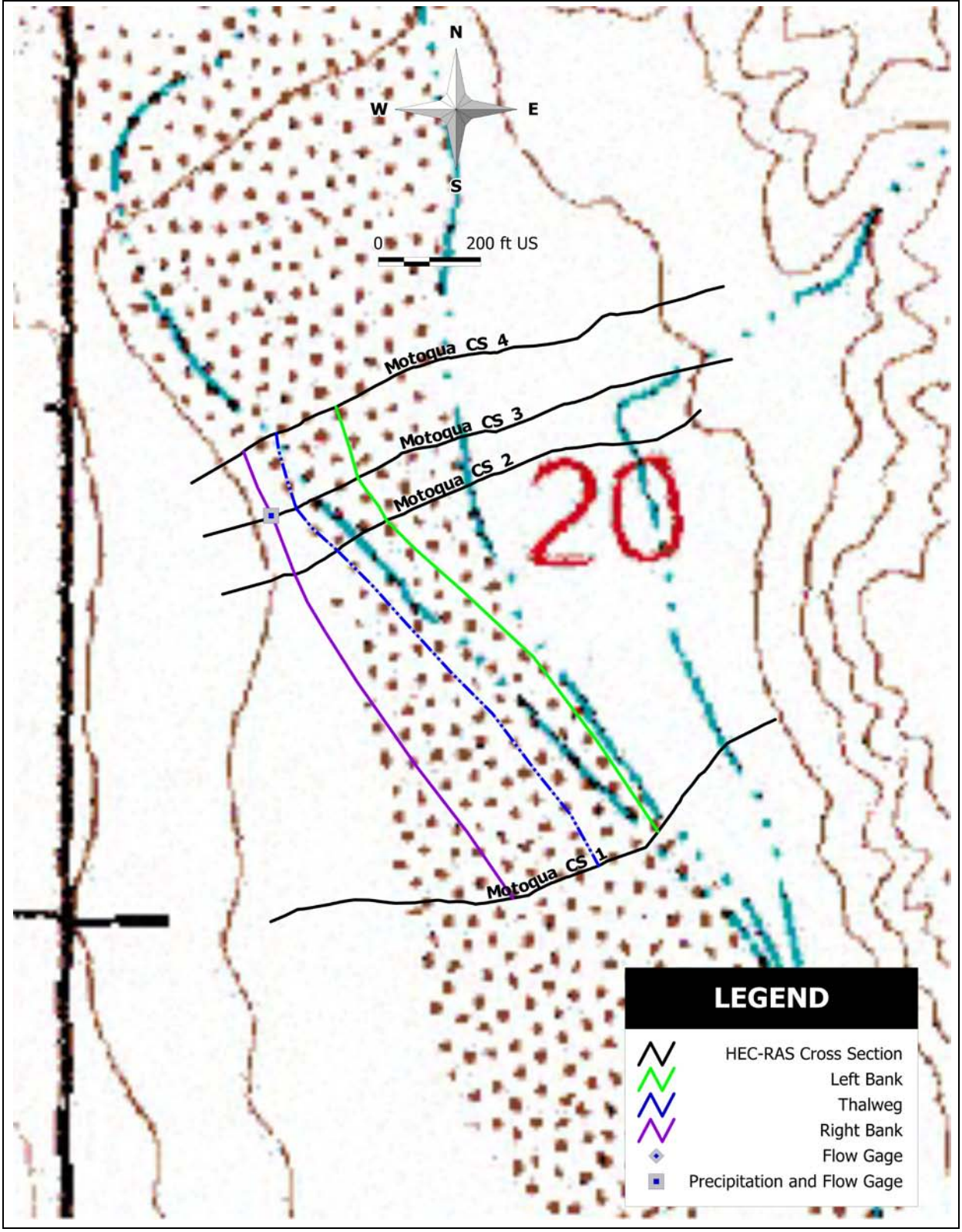


Figure A.7 Catclaw Canyon gage cross section location map

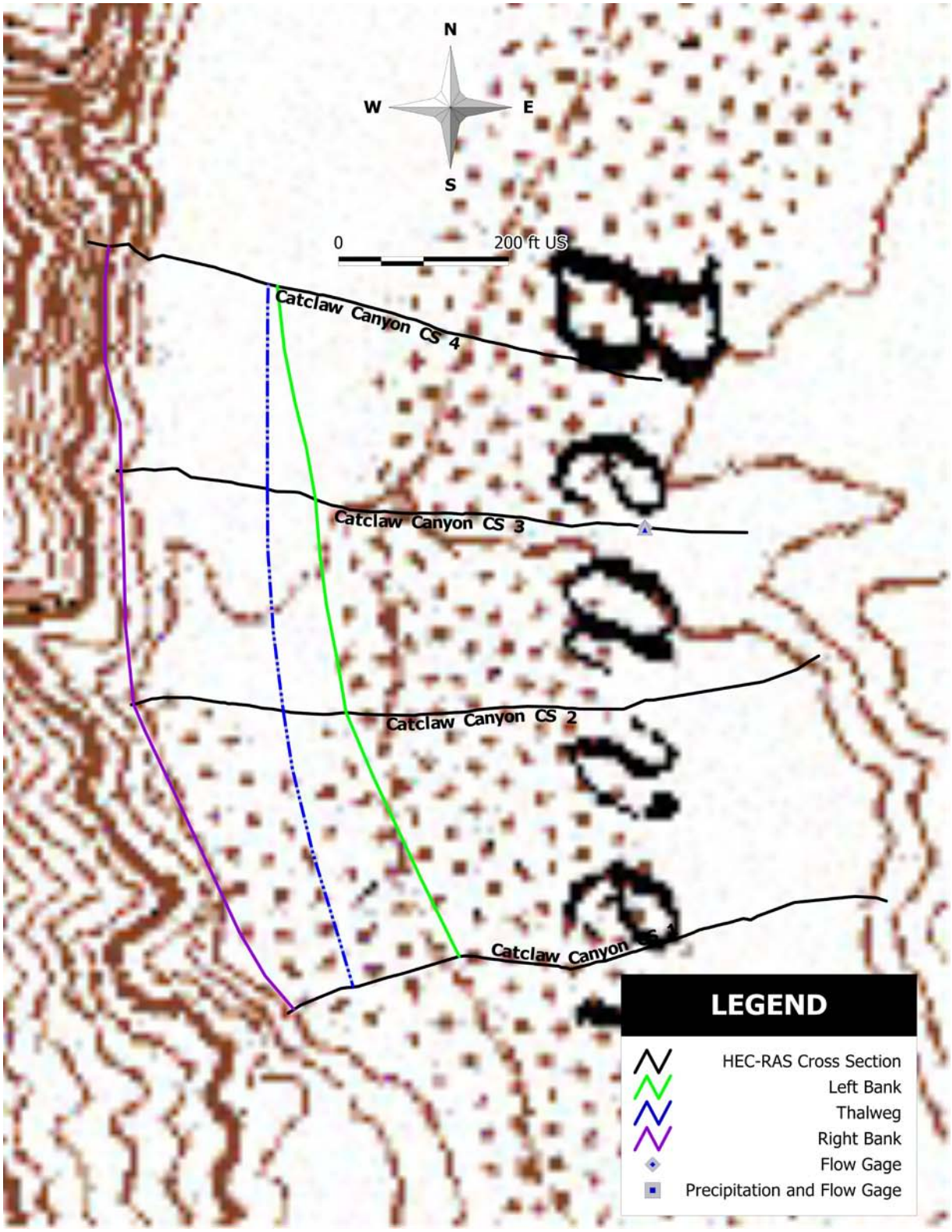


Figure A.8 Indian Canyon gage cross section location map

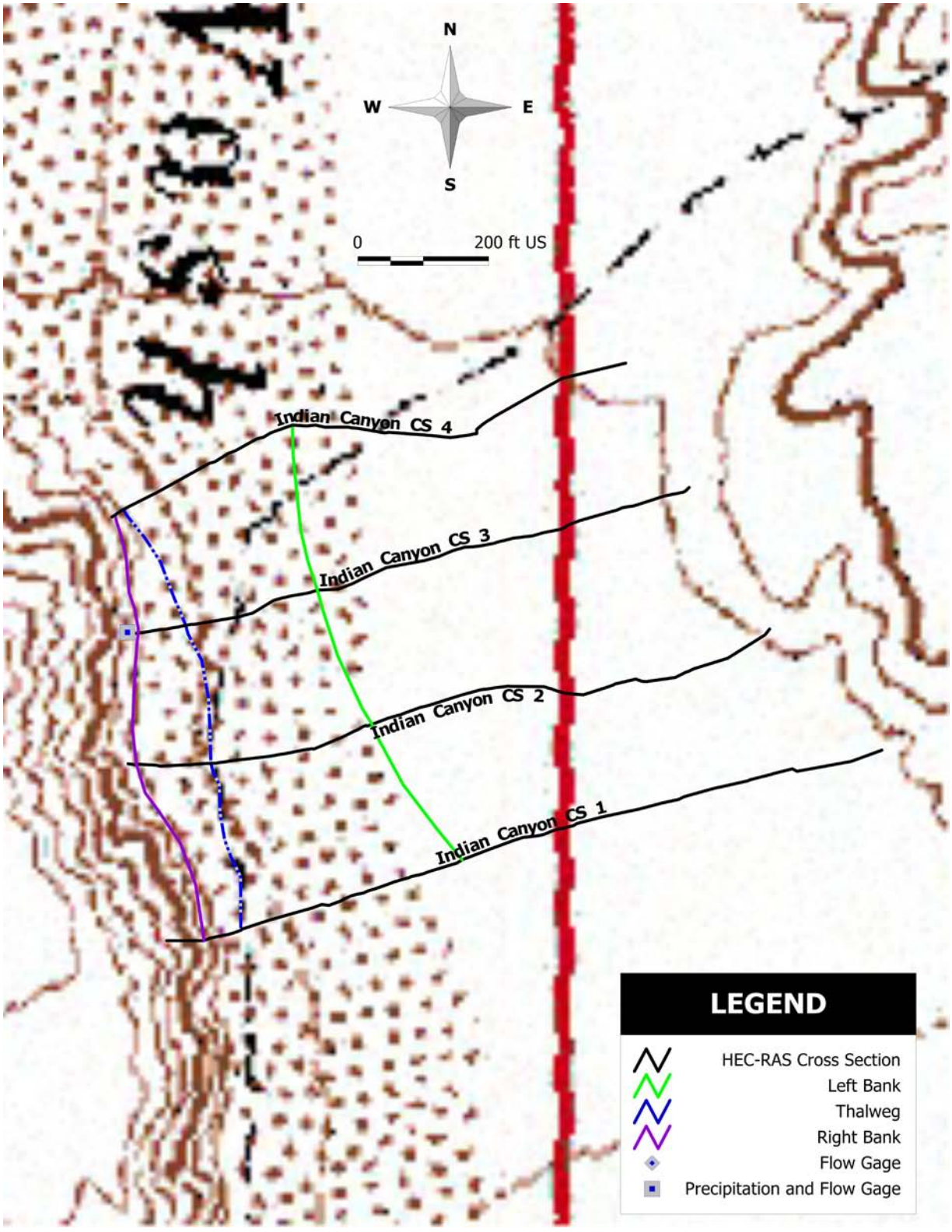


Figure A.9 Highway 91 Bridge gage cross section location map

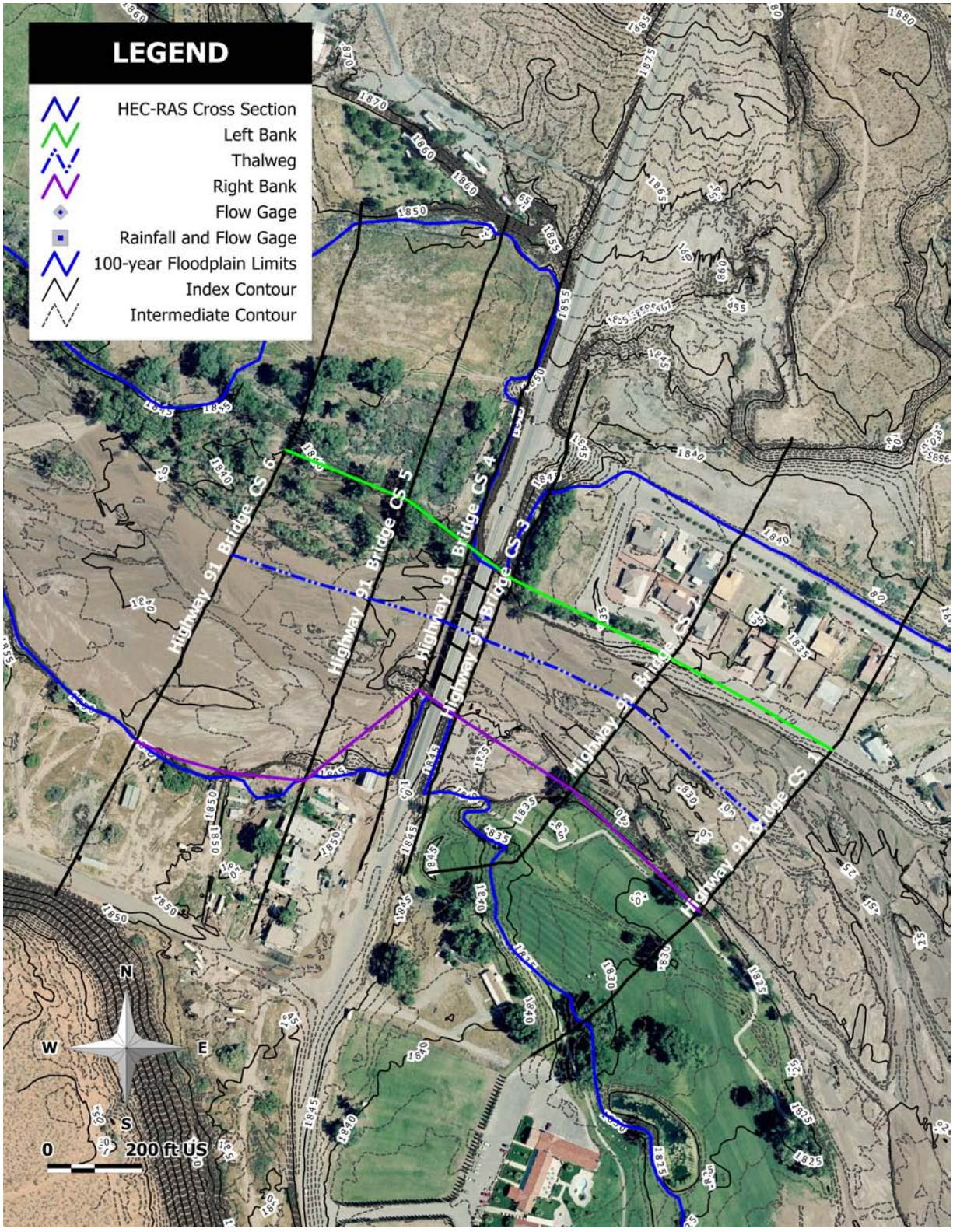
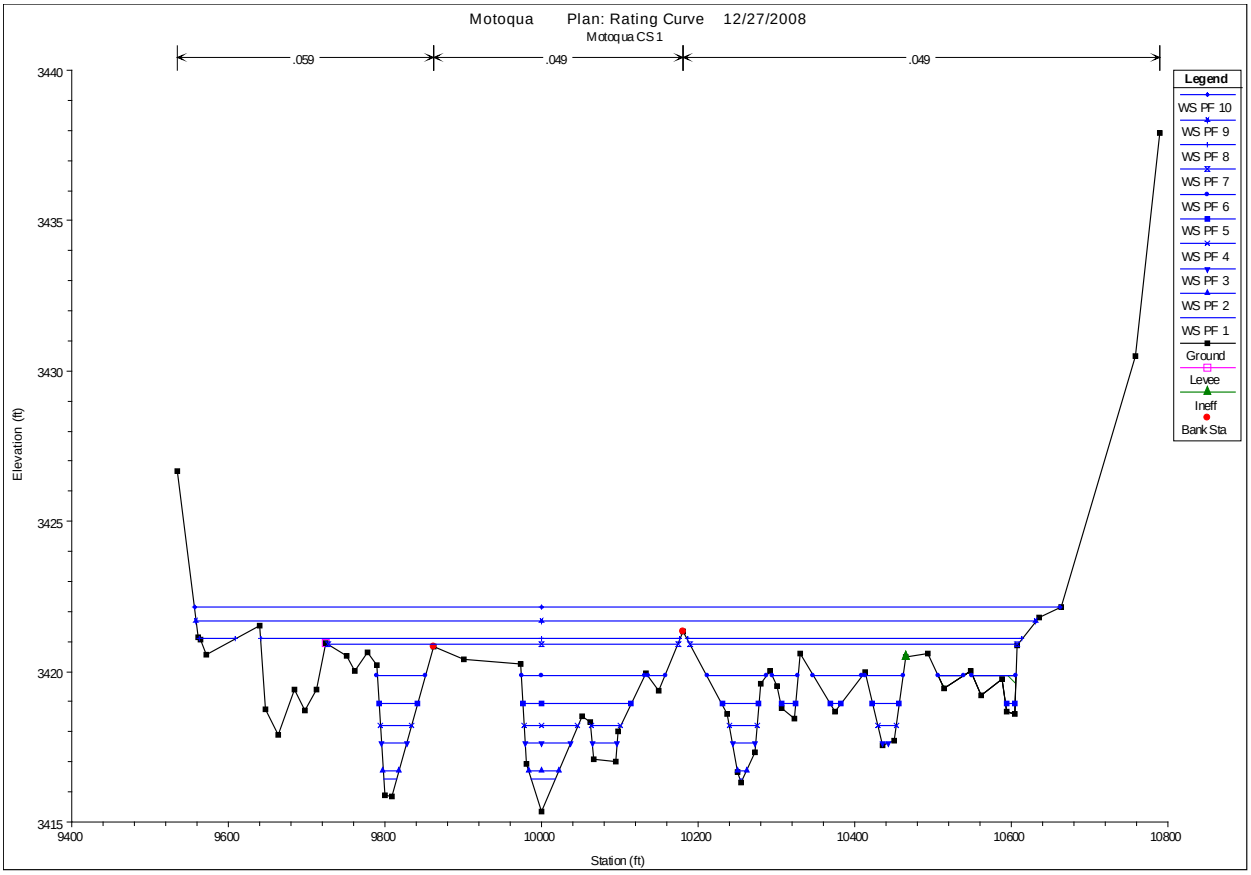


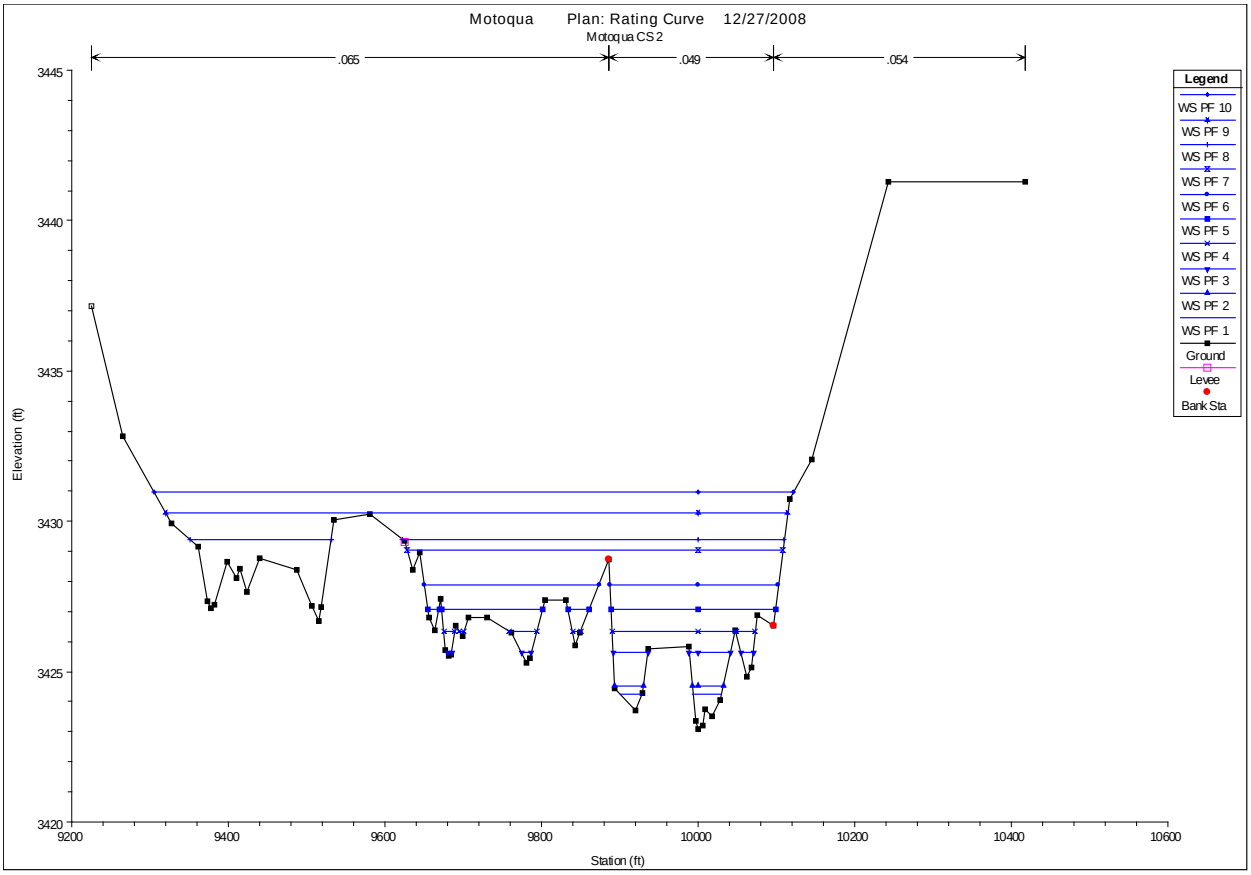
Figure A.10 Motoqua HEC-RAS model cross section 1



No photograph

Left Overbank	Channel	Right Overbank

Figure A.11 Motoqua HEC-RAS model cross section 2



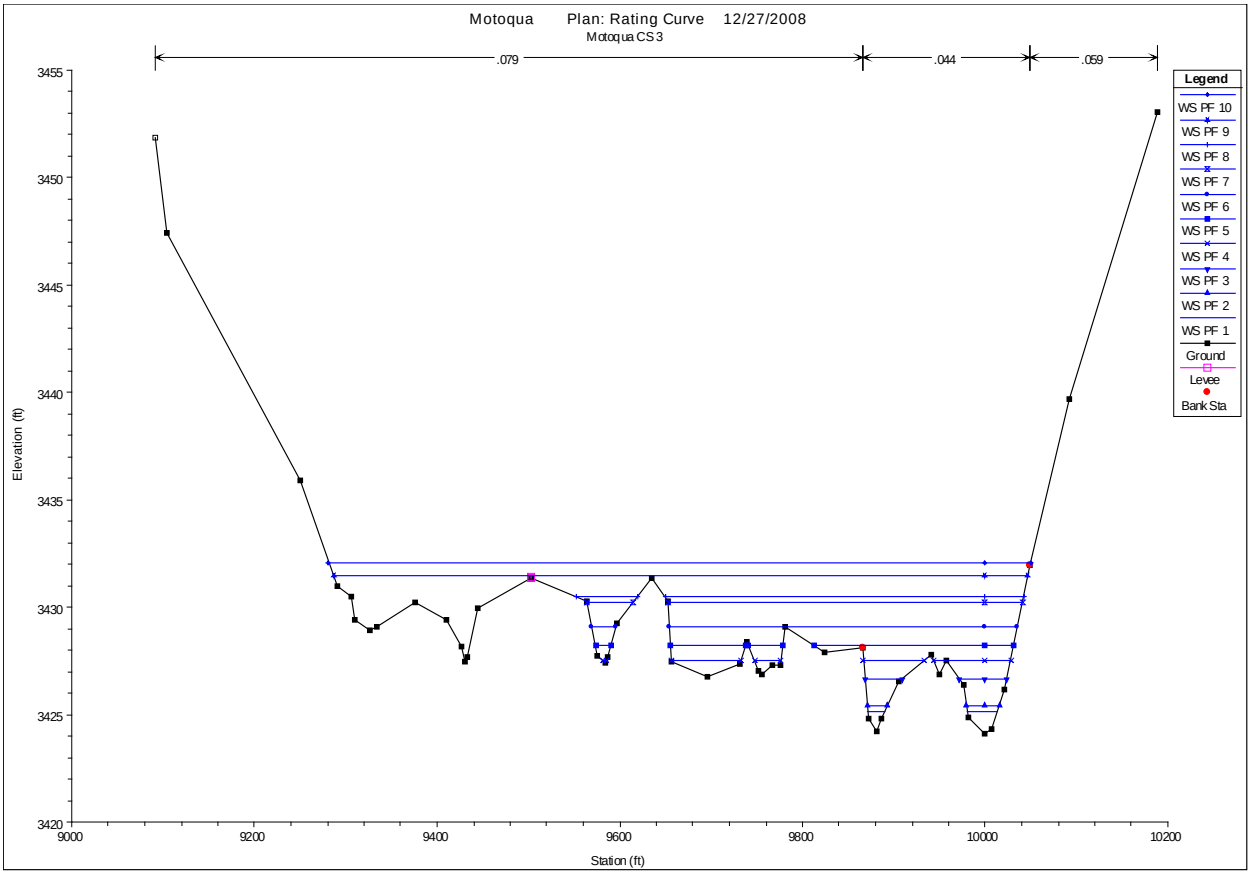
Left Overbank

Channel

No photograph

Right Overbank

Figure A.12 Motoqua HEC-RAS model cross section 3

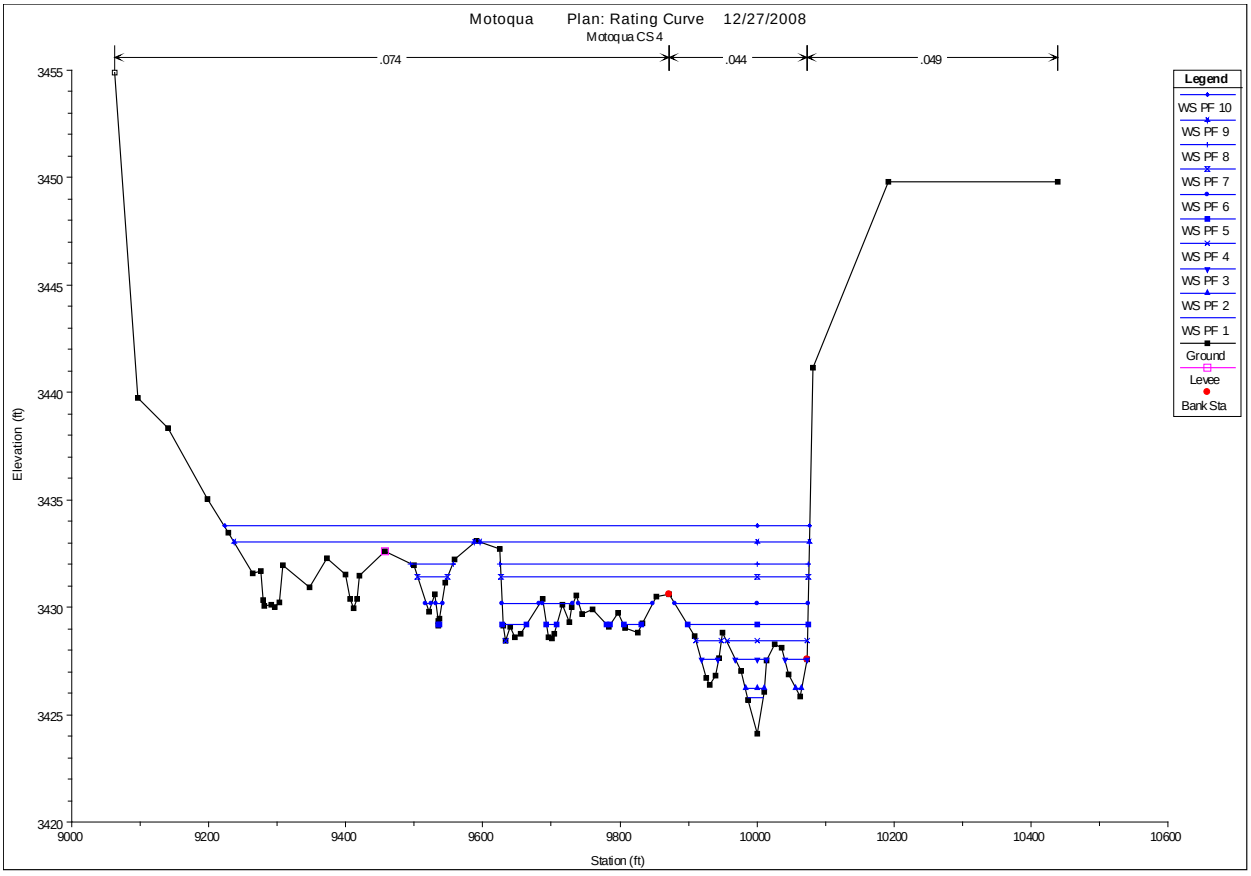


Left Overbank

Channel

Right Overbank

Figure A.13 Motoqua HEC-RAS model cross section 4

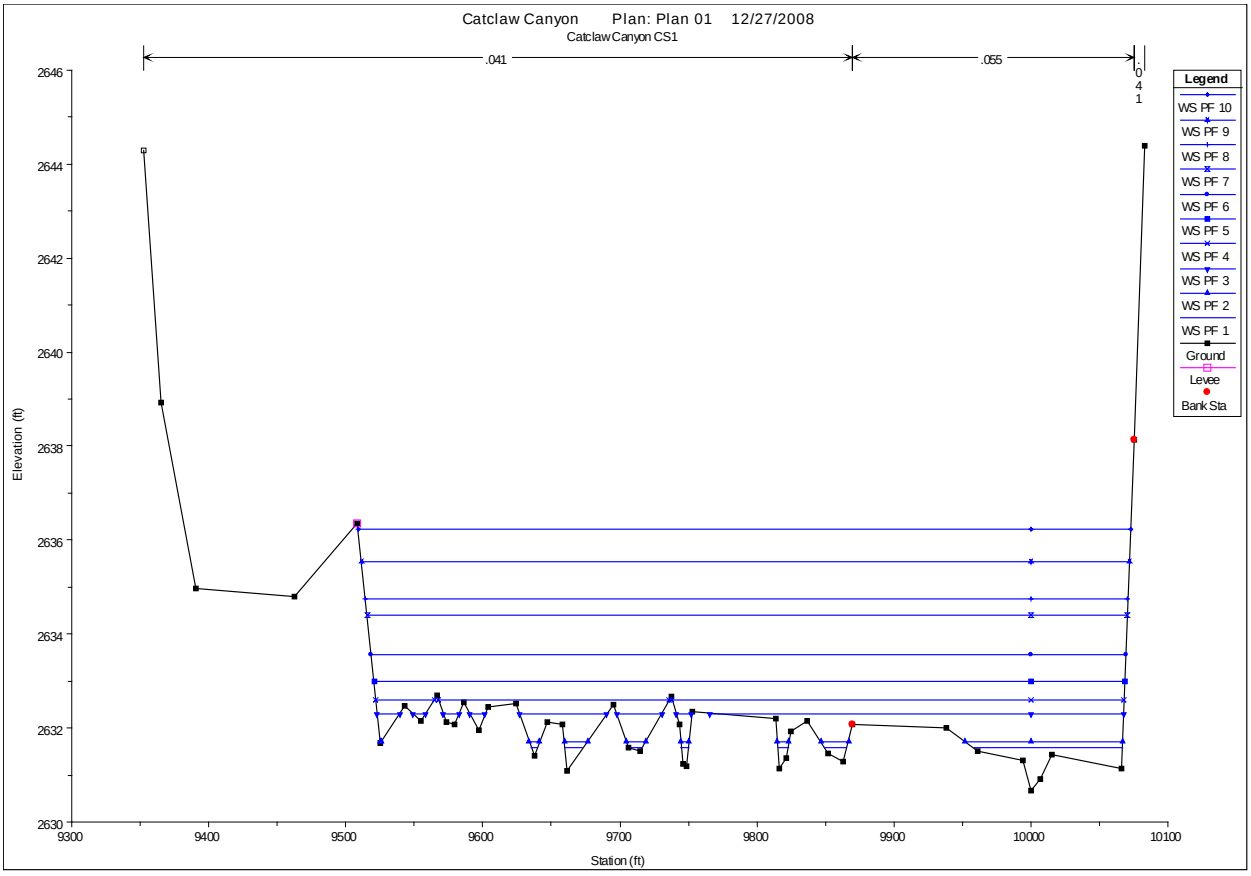


Left Overbank

Channel

Right Overbank

Figure A.14 Catclaw Canyon HEC-RAS model cross section 1

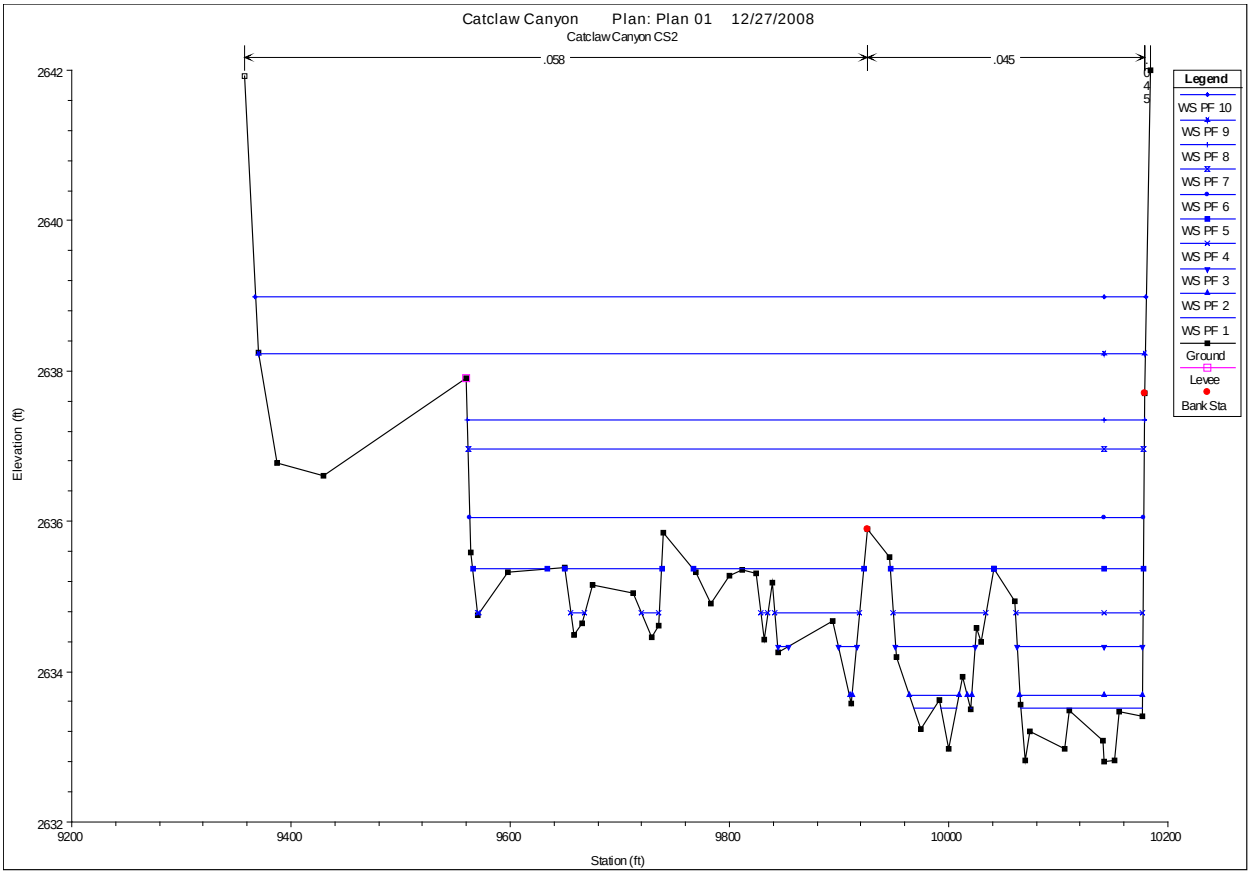


Left Overbank

Channel

Right Overbank

Figure A.15 Catclaw Canyon HEC-RAS model cross section 2

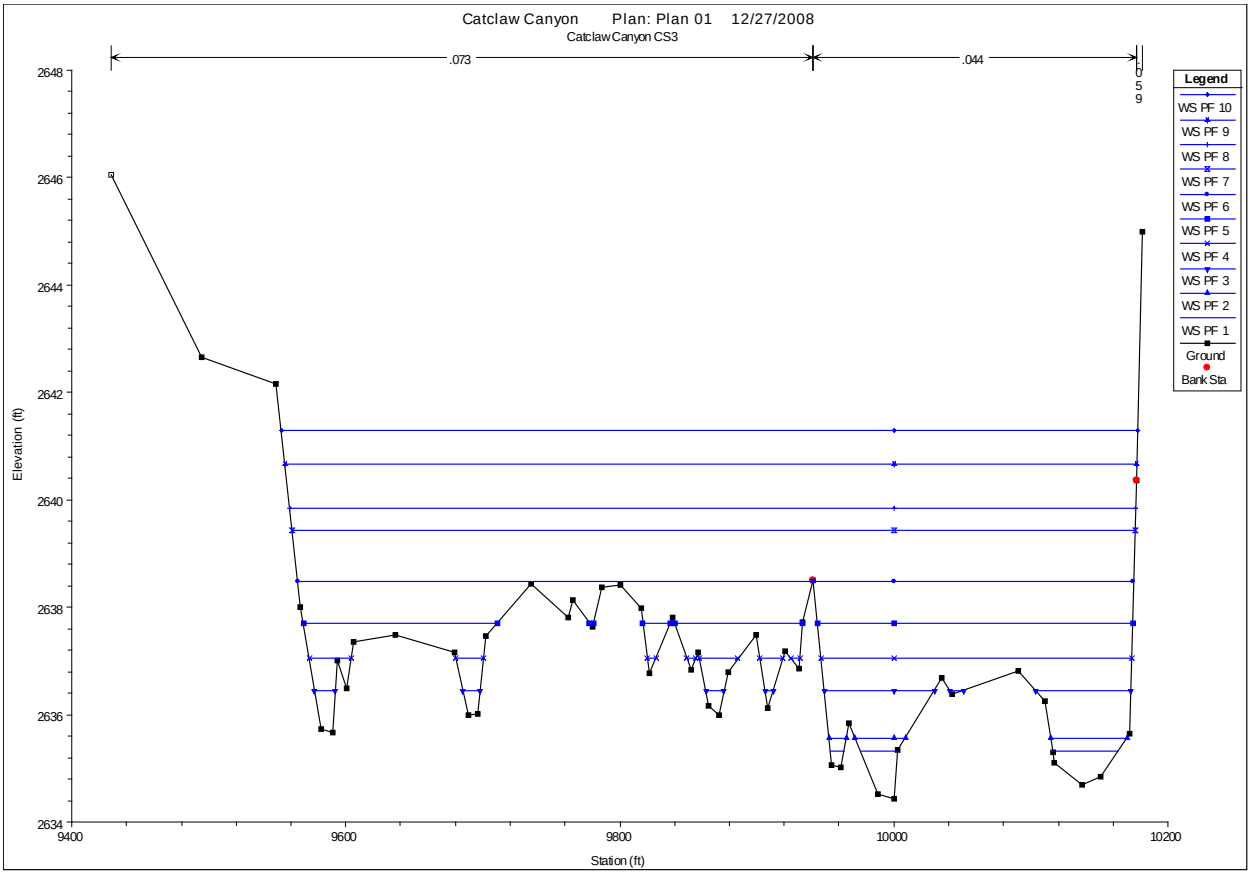


Left Overbank

Channel

Right Overbank

Figure A.16 Catclaw Canyon HEC-RAS model cross section 3

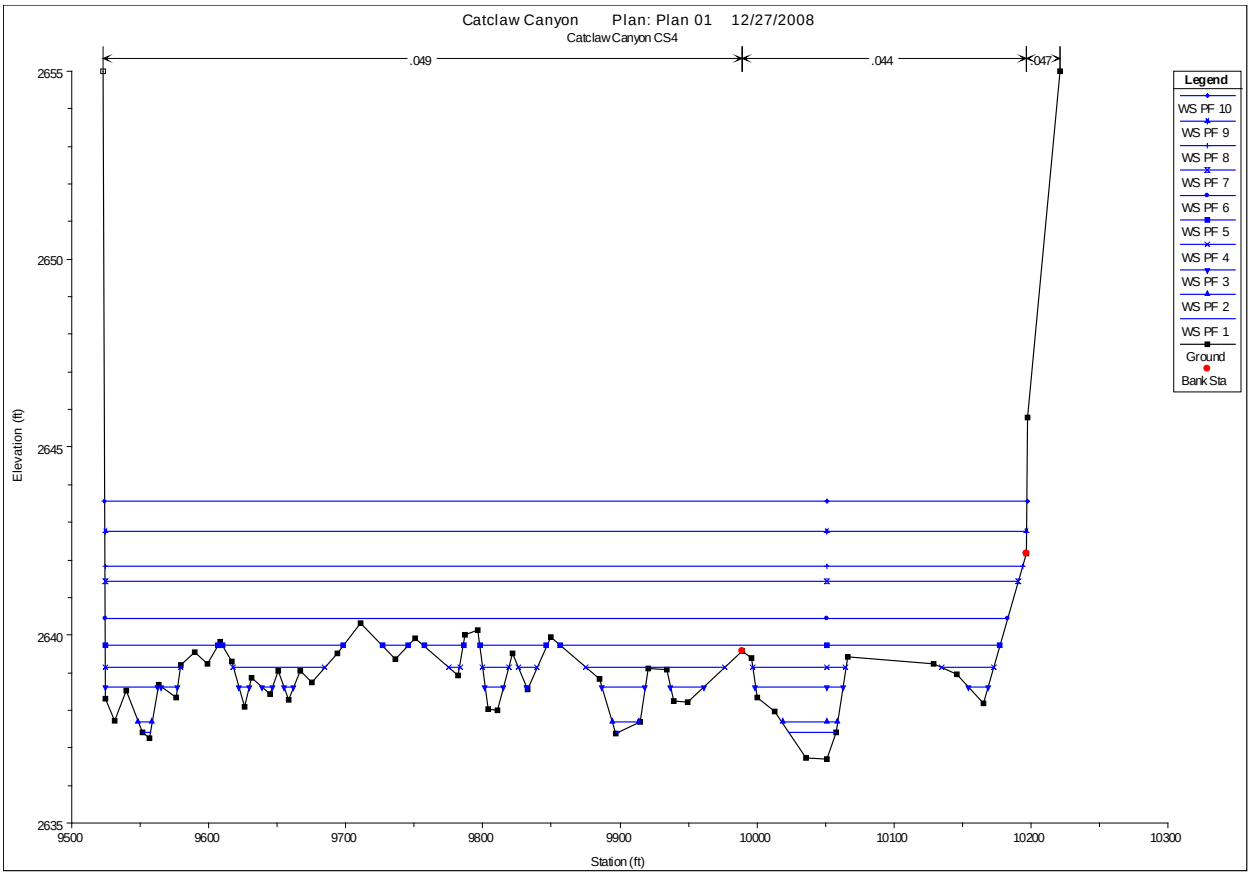


Left Overbank

Channel

Right Overbank

Figure A.17 Catclaw Canyon HEC-RAS model cross section 4

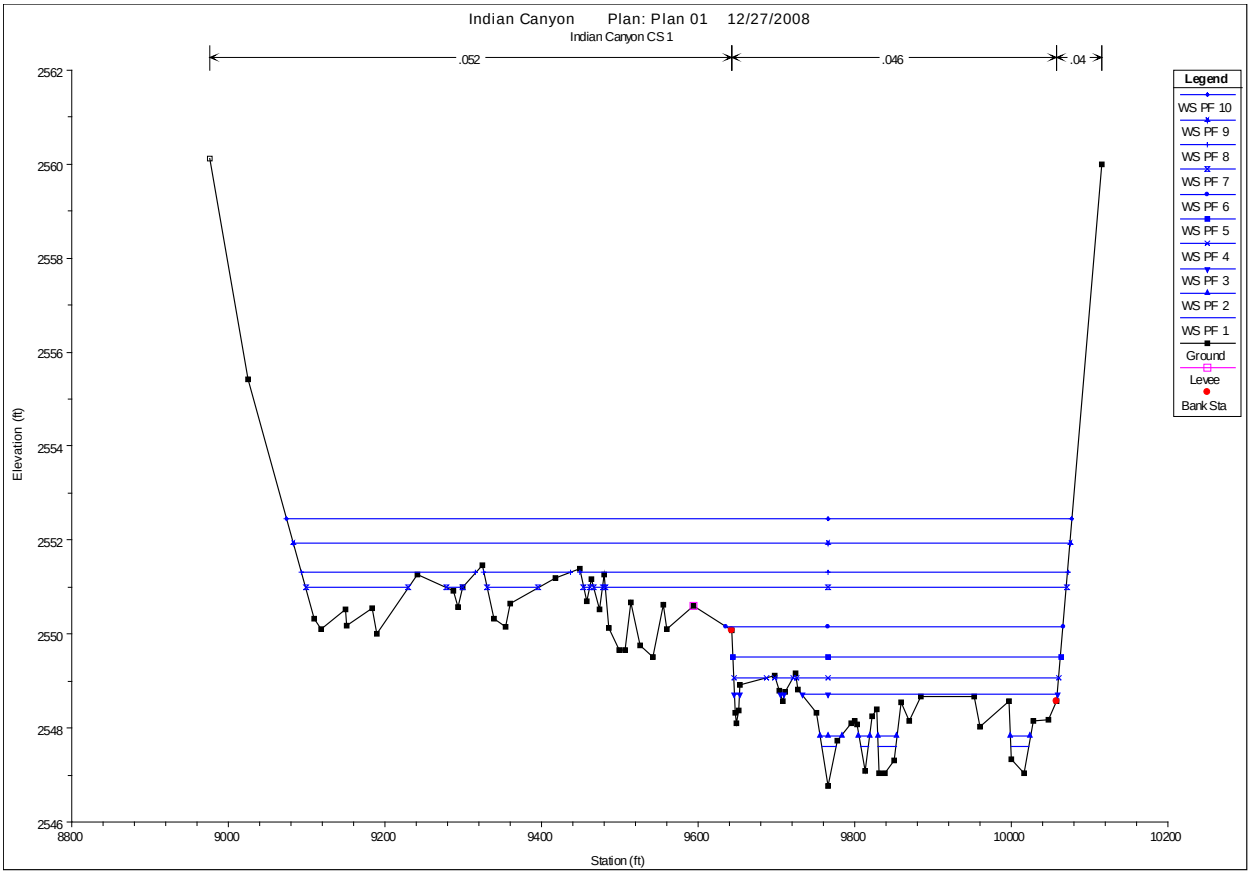


Left Overbank

Channel

Right Overbank

Figure A.18 Indian Canyon HEC-RAS model cross section 1



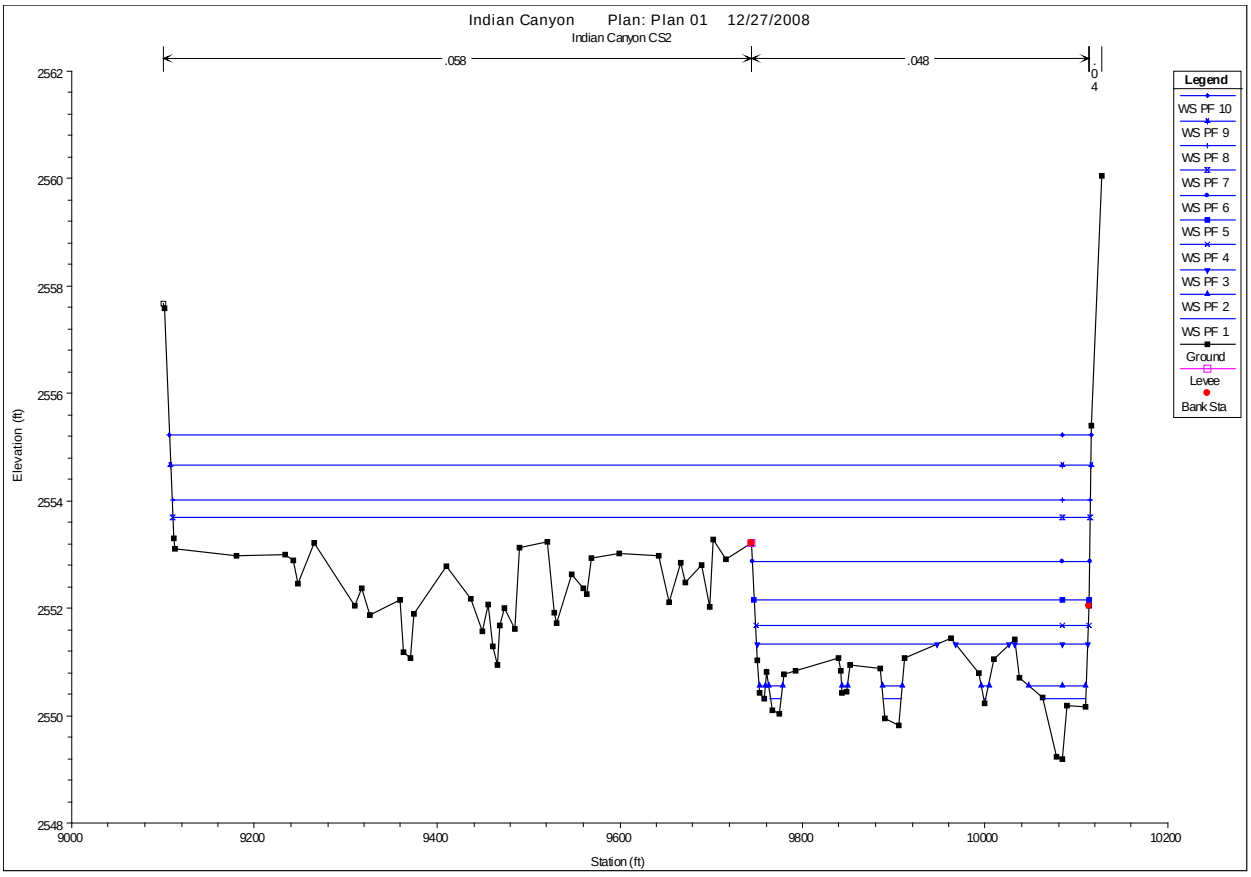
Left Overbank

Channel

No photograph

Right Overbank

Figure A.19 Indian Canyon HEC-RAS model cross section 2

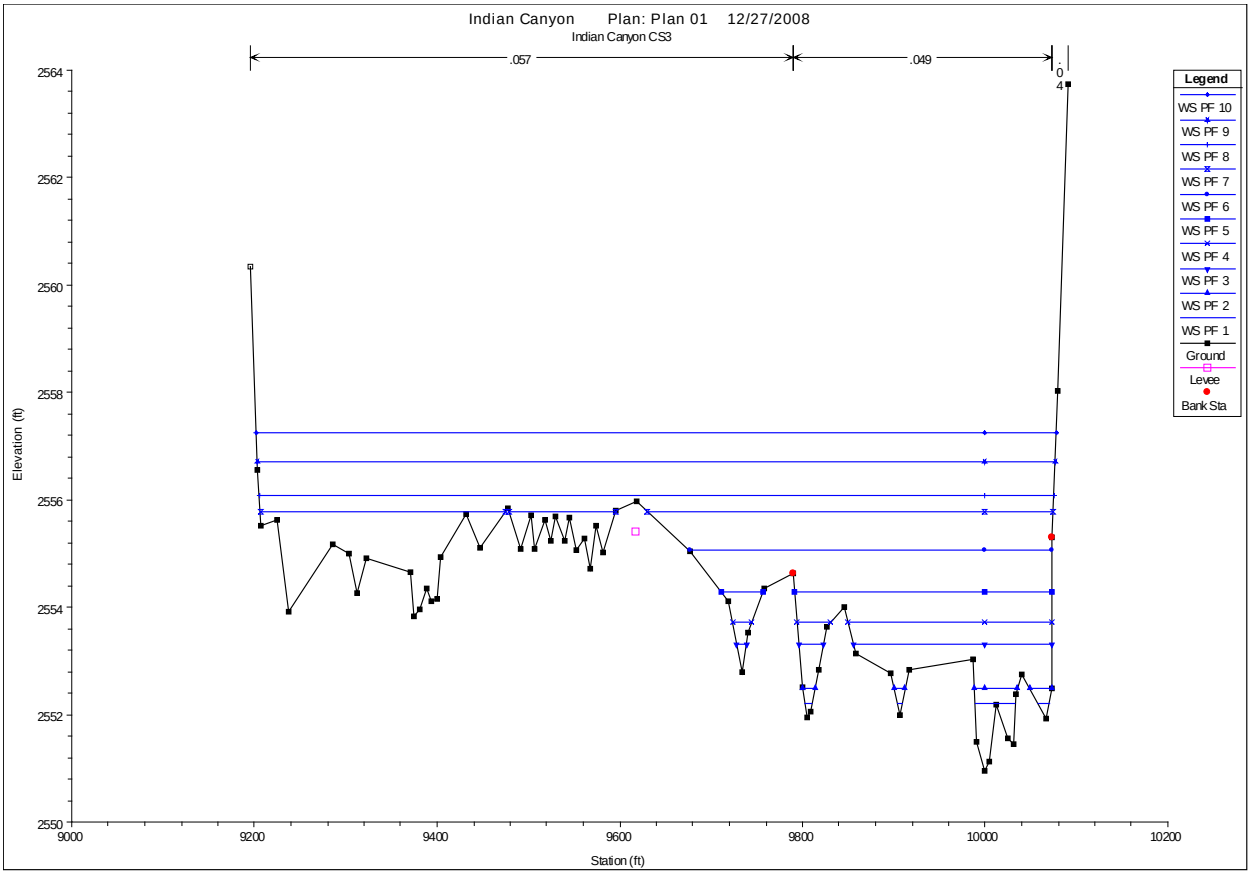


Left Overbank

Channel

Right Overbank

Figure A.20 Indian Canyon HEC-RAS model cross section 3

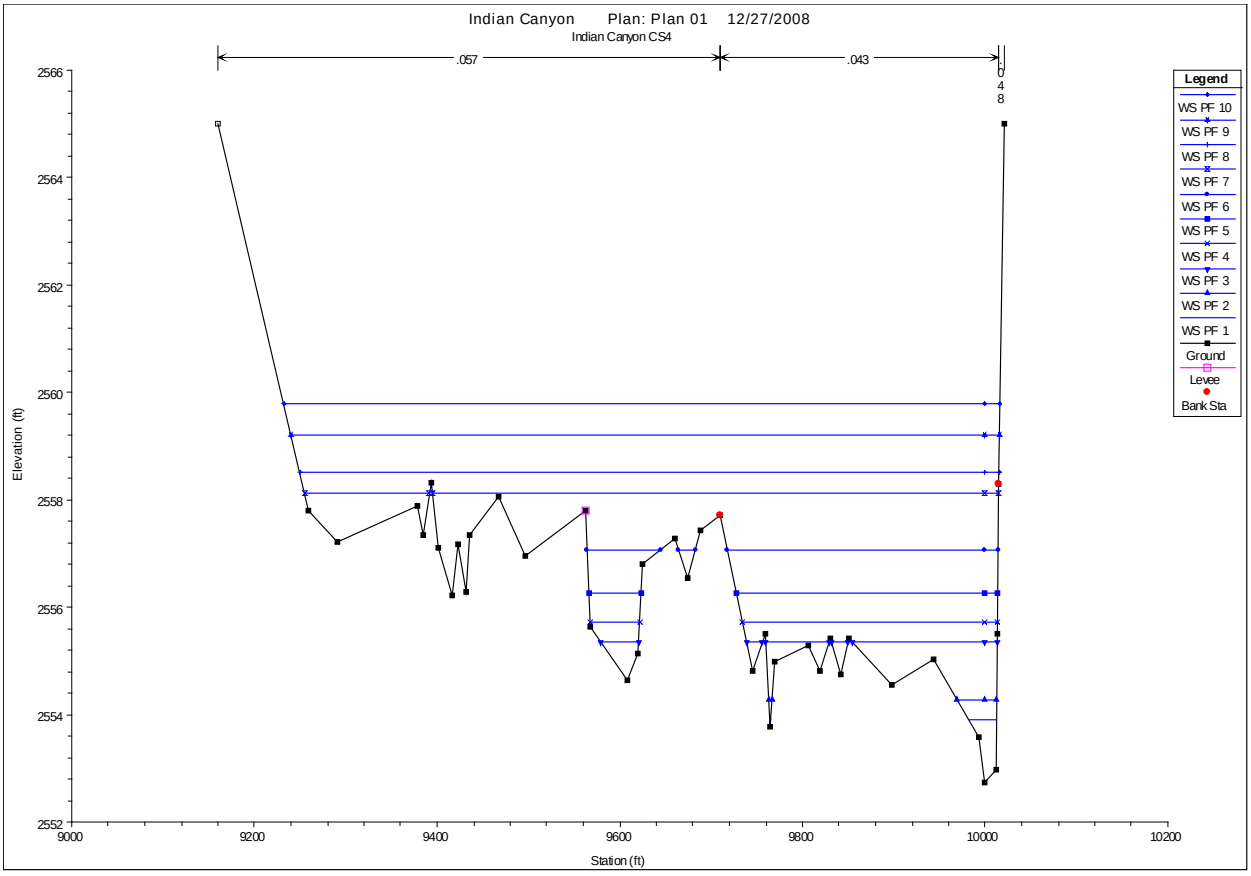


Left Overbank

Channel

Right Overbank

Figure A.21 Indian Canyon HEC-RAS model cross section 4

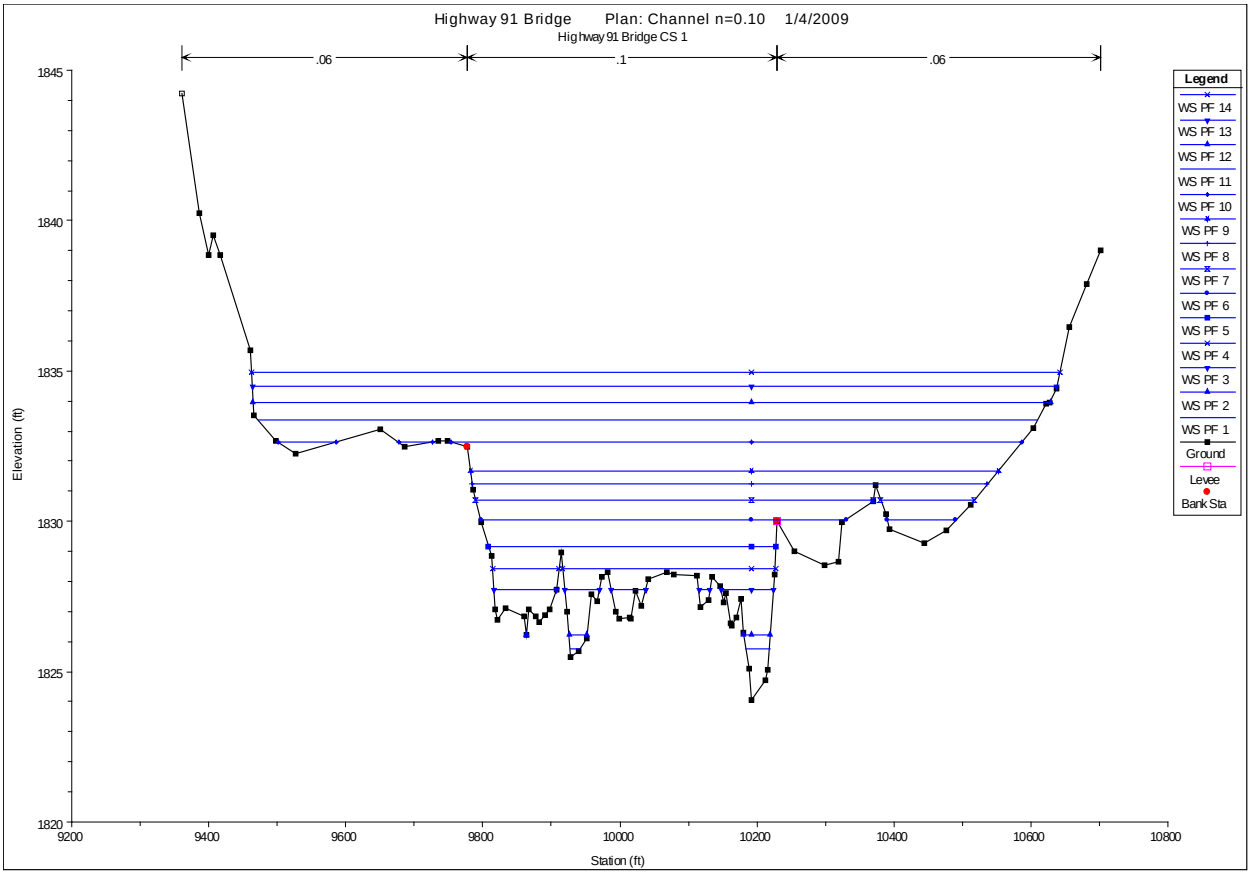


Left Overbank

Channel

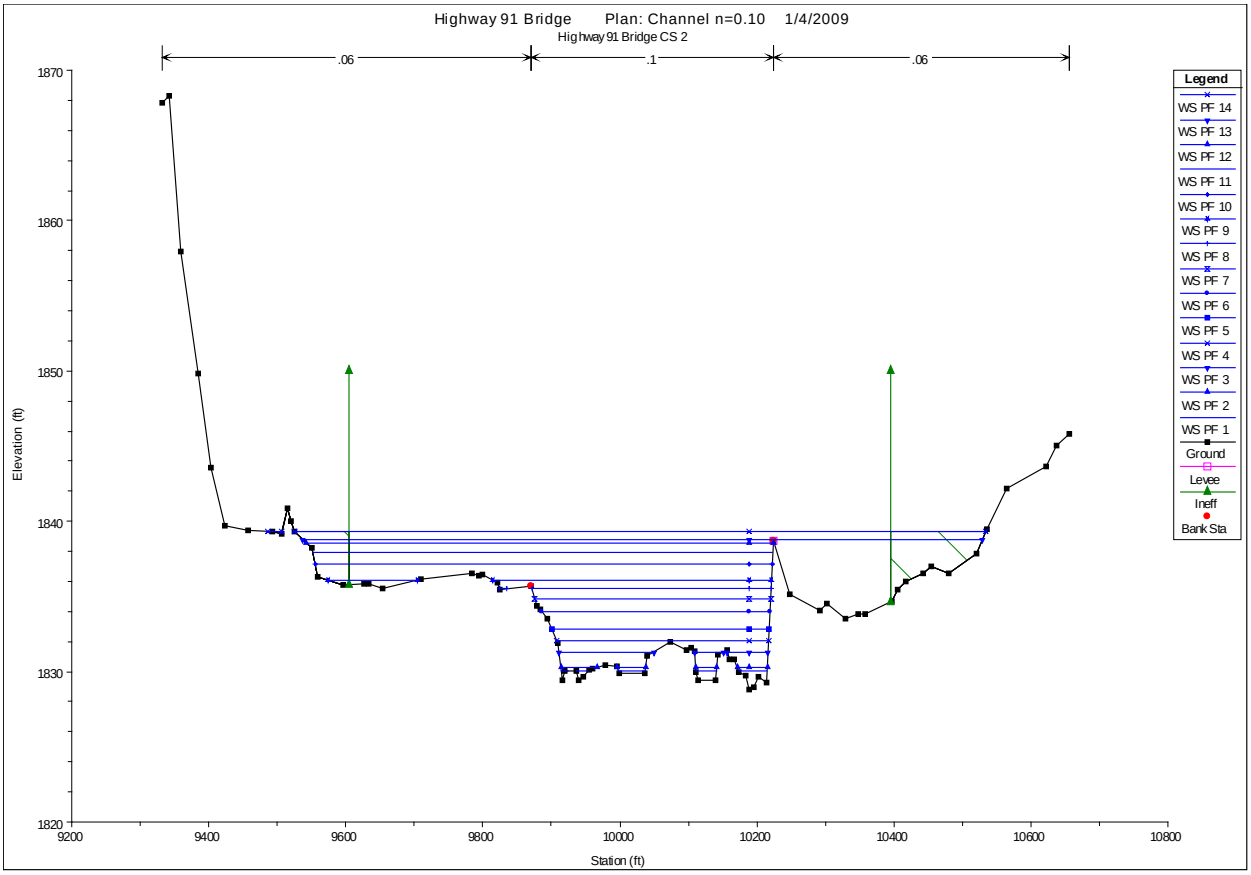
Right Overbank

Figure A.22 Highway 91 Bridge HEC-RAS model cross section 1



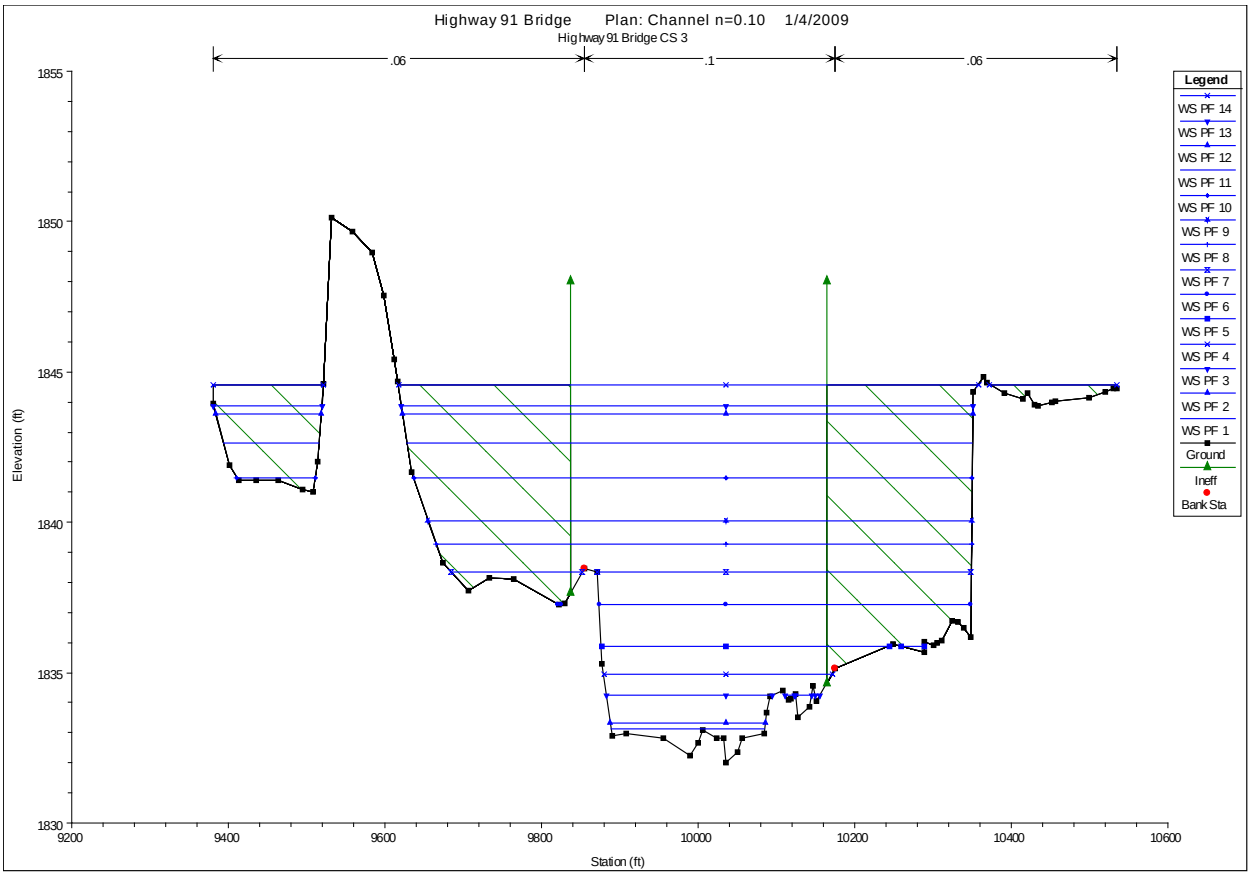
No photograph	No photograph	No photograph
Left Overbank	Channel	Right Overbank

Figure A.23 Highway 91 Bridge HEC-RAS model cross section 2



No photograph	No photograph	No photograph
Left Overbank	Channel	Right Overbank

Figure A.24 Highway 91 Bridge HEC-RAS model cross section 3

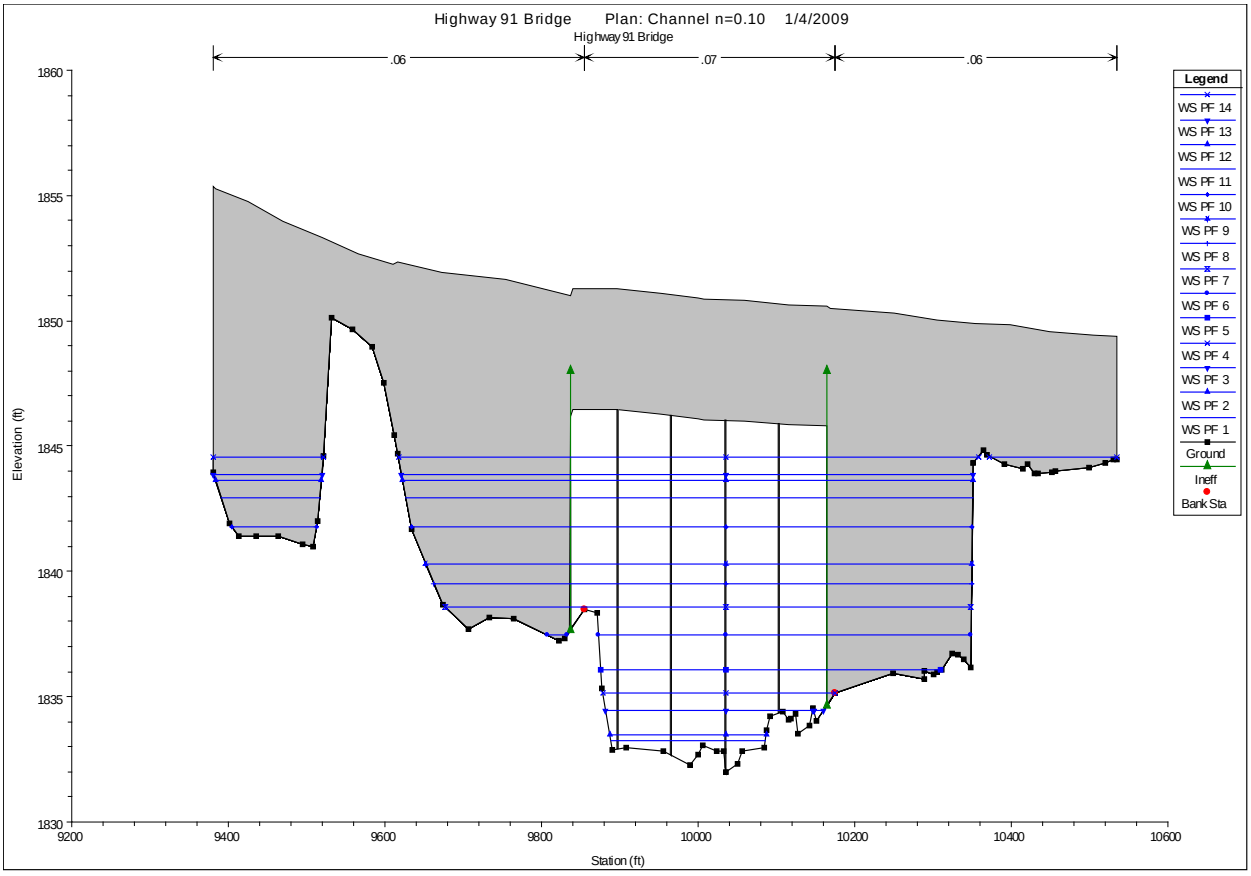


Left Overbank

Channel

Right Overbank

Figure A.25 Highway 91 Bridge HEC-RAS model bridge downstream

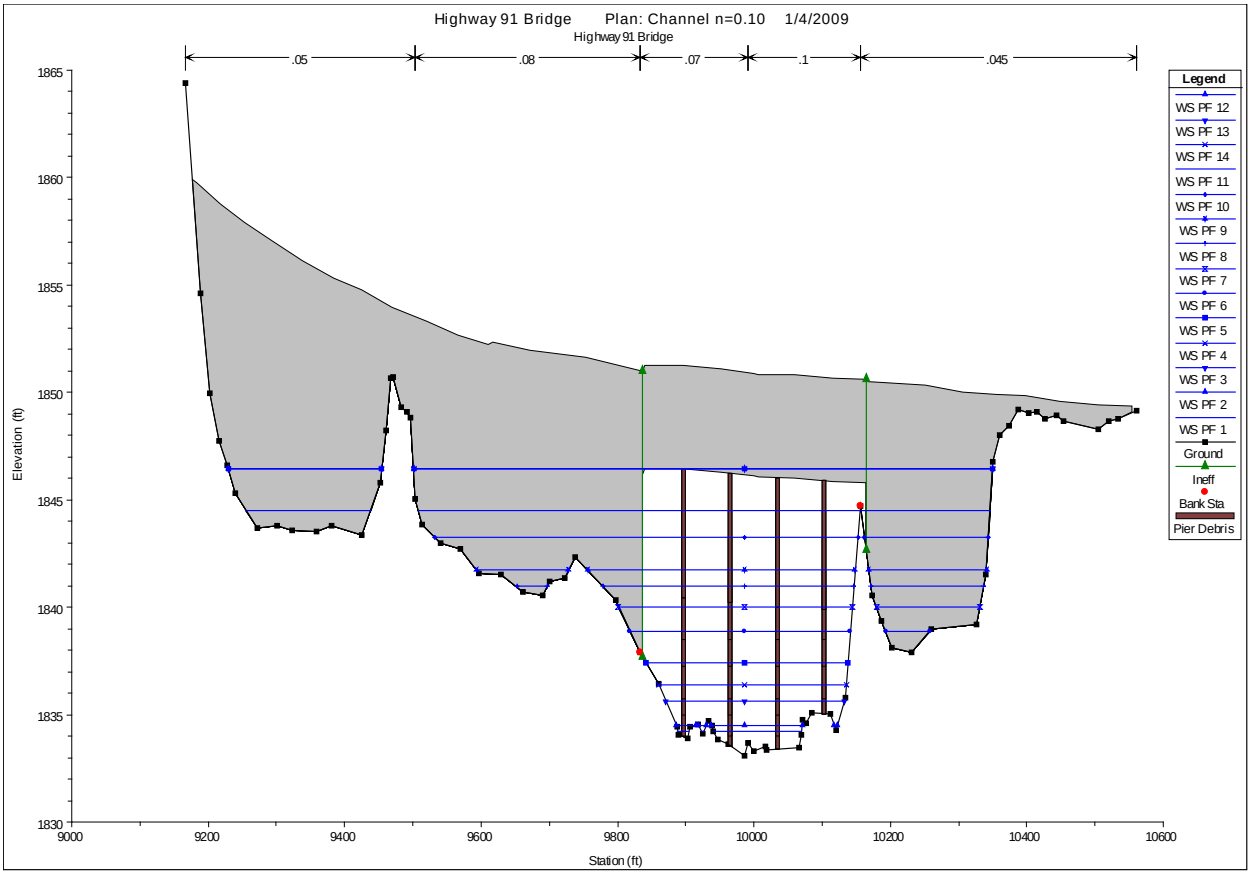


Left Overbank

Channel

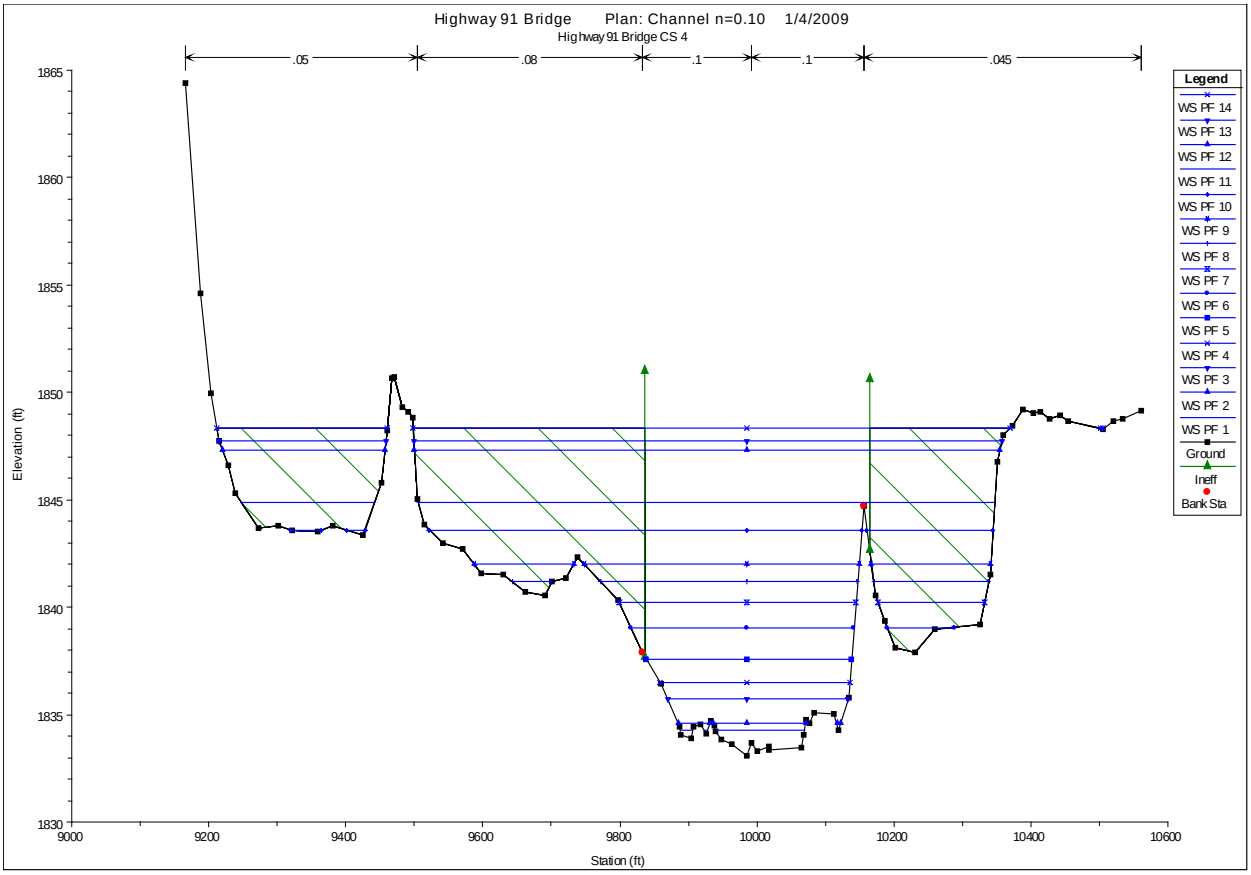
Right Overbank

Figure A.26 Highway 91 Bridge HEC-RAS model bridge upstream



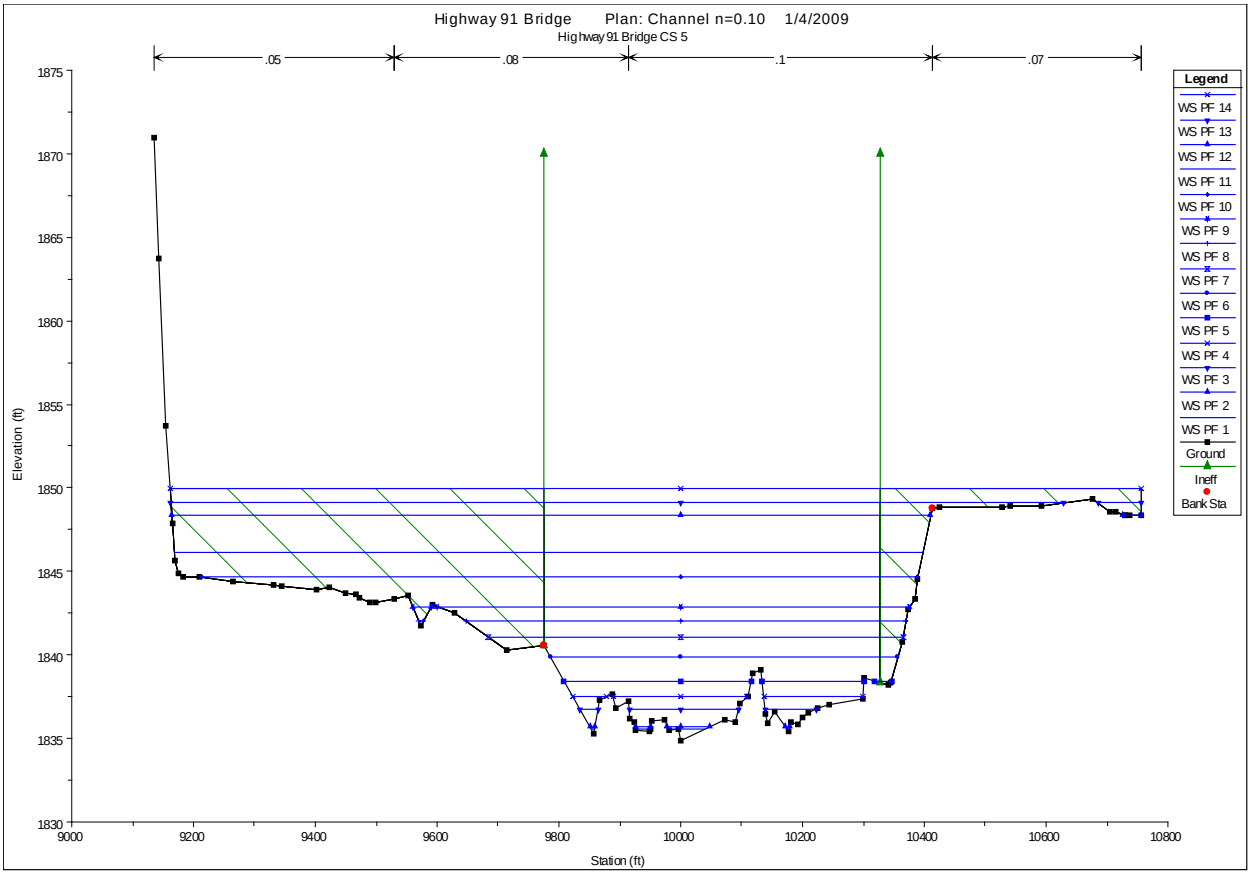
No photograph	No photograph	No photograph
Left Overbank	Channel	Right Overbank

Figure A.27 Highway 91 Bridge HEC-RAS model cross section 4



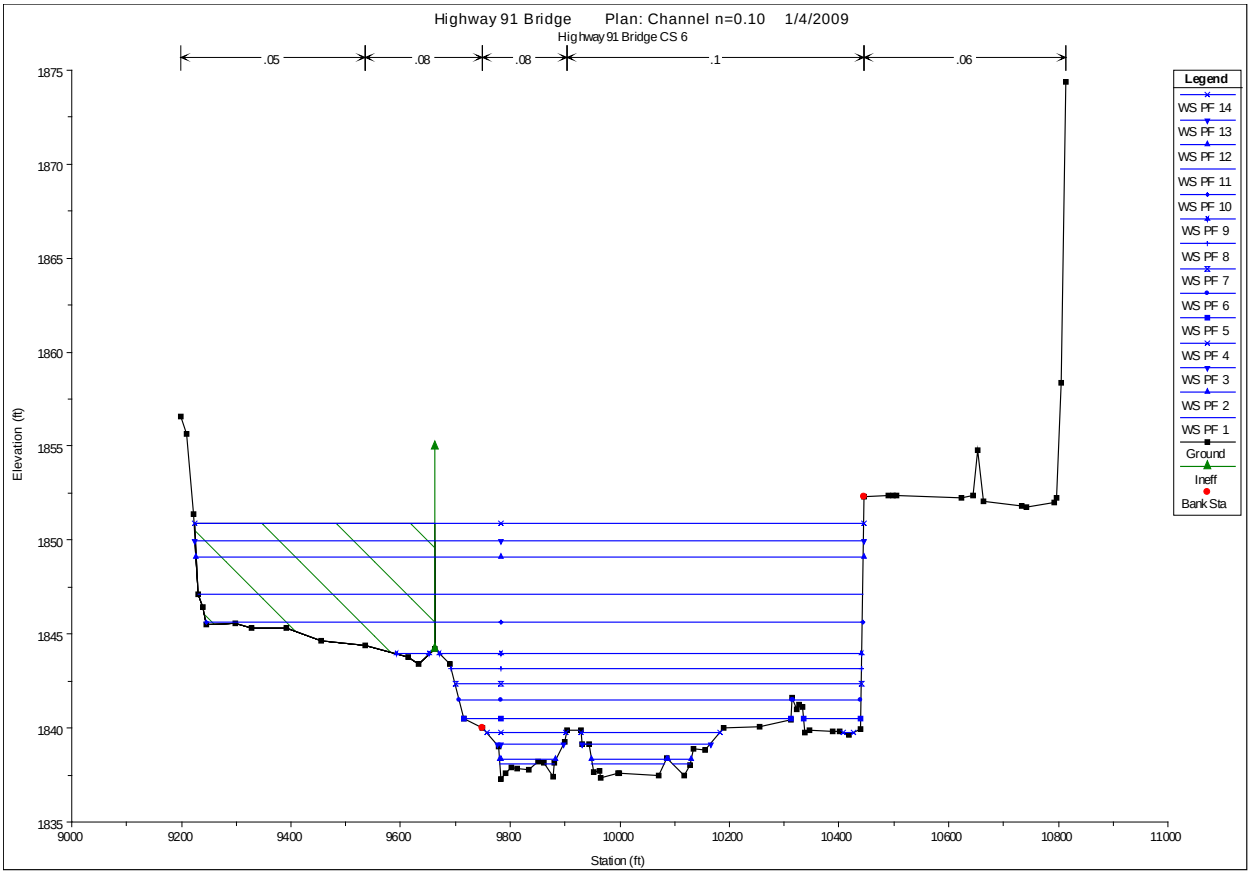
No photograph		
Left Overbank	Channel	Right Overbank

Figure A.28 Highway 91 Bridge HEC-RAS model cross section 5



No photograph	No photograph	No photograph
Left Overbank	Channel	Right Overbank

Figure A.29 Highway 91 Bridge HEC-RAS model cross section 6



No photograph	No photograph	No photograph
Left Overbank	Channel	Right Overbank

A.3 HEC-RAS Results Summary Tables

Motoqua HEC-RAS Model Output Summary Table											
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1102.4	PF 1	50	3424.1	3425.8	3425.4	3425.9	0.0083	2.69	18.56	22.35	0.52
1102.4	PF 2	100	3424.1	3426.2	3425.8	3426.4	0.0113	3.25	30.74	35.21	0.61
1102.4	PF 3	500	3424.1	3427.6	3427.2	3427.8	0.0106	3.96	126.21	103.03	0.63
1102.4	PF 4	1000	3424.1	3428.4	3427.9	3428.7	0.0091	4.25	235.62	155.36	0.61
1102.4	PF 5	2000	3424.1	3429.2	3428.7	3429.7	0.0101	5.48	386.31	255.64	0.67
1102.4	PF 6	4000	3424.1	3430.2	3429.8	3430.8	0.0105	6.83	715.16	418.76	0.72
1102.4	PF 7	8000	3424.1	3431.4	3431.1	3432.3	0.0095	8.16	1315.5	494.52	0.73
1102.4	PF 8	10000	3424.1	3432	3431.5	3432.9	0.0085	8.47	1611.2	512.73	0.7
1102.4	PF 9	15000	3424.1	3433	3432.3	3434	0.0079	9.35	2517.9	831.98	0.7
1102.4	PF 10	20000	3424.1	3433.8	3433.4	3434.9	0.0082	10.38	3137.9	854.07	0.73
957.78	PF 1	50	3424.1	3425.1	3424.8	3425.2	0.0046	1.62	30.94	51.96	0.37
957.78	PF 2	100	3424.1	3425.4	3425	3425.5	0.0052	2.1	47.54	59.13	0.41
957.78	PF 3	500	3424.1	3426.7	3426	3426.9	0.0066	3.57	140.06	93.27	0.51
957.78	PF 4	1000	3424.1	3427.5	3426.7	3427.8	0.0077	4.01	280.75	258.99	0.56
957.78	PF 5	2000	3424.1	3428.2	3427.8	3428.6	0.008	5	496.3	356.07	0.6
957.78	PF 6	4000	3424.1	3429.1	3428.6	3429.6	0.0092	6.59	821.26	406.94	0.68
957.78	PF 7	8000	3424.1	3430.2	3429.7	3431.1	0.0103	8.52	1304.3	437.55	0.75
957.78	PF 8	10000	3424.1	3430.5	3430.2	3431.7	0.0124	9.78	1433.3	459.88	0.84
957.78	PF 9	15000	3424.1	3431.5	3431.2	3432.8	0.0124	11.01	2257.7	760.34	0.86
957.78	PF 10	20000	3424.1	3432.1	3432.1	3433.6	0.013	12.11	2742.8	768.72	0.9
805.41	PF 1	50	3423.1	3424.2	3424	3424.3	0.0076	1.62	30.87	63.88	0.41
805.41	PF 2	100	3423.1	3424.5	3424.2	3424.6	0.0068	1.92	52.11	77.03	0.41
805.41	PF 3	500	3423.1	3425.6	3425	3425.8	0.0075	3.23	156.85	130.14	0.49
805.41	PF 4	1000	3423.1	3426.3	3425.6	3426.5	0.0083	3.58	297.99	246.98	0.52
805.41	PF 5	2000	3423.1	3427.1	3426.4	3427.3	0.0085	4.4	528.55	378.93	0.55
805.41	PF 6	4000	3423.1	3427.9	3427.3	3428.3	0.0089	5.65	867.96	437.76	0.6
805.41	PF 7	8000	3423.1	3429	3428.3	3429.7	0.0092	7.18	1398.3	480.28	0.64
805.41	PF 8	10000	3423.1	3429.4	3428.7	3430.1	0.0091	7.57	1790.4	667.95	0.65
805.41	PF 9	15000	3423.1	3430.3	3429.5	3431.2	0.0098	8.92	2431.2	794.61	0.69
805.41	PF 10	20000	3423.1	3431	3430.1	3432	0.0098	9.69	2983.6	816.42	0.71
715.92*	PF 1	50	3422.3	3423.5	3423.1	3423.5	0.0095	1.98	25.25	45.82	0.47
715.92*	PF 2	100	3422.3	3423.8	3423.4	3423.9	0.0089	2.14	46.75	72.22	0.47

Motoqua HEC-RAS Model Output Summary Table

River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
715.92*	PF 3	500	3422.3	3424.9	3424.4	3425.1	0.008	3.1	166.88	155.49	0.49
715.92*	PF 4	1000	3422.3	3425.6	3425	3425.8	0.0085	3.49	309.34	265.5	0.52
715.92*	PF 5	2000	3422.3	3426.3	3425.7	3426.6	0.0086	4.3	541.03	403.36	0.55
715.92*	PF 6	4000	3422.3	3427.1	3426.6	3427.5	0.0088	5.47	881.74	439.48	0.59
715.92*	PF 7	8000	3422.3	3428.2	3427.5	3428.9	0.0091	7.02	1402.3	481.69	0.63
715.92*	PF 8	10000	3422.3	3428.6	3427.9	3429.3	0.0087	7.31	1825.3	677.75	0.63
715.92*	PF 9	15000	3422.3	3429.5	3428.6	3430.3	0.0096	8.65	2442.1	784.5	0.68
715.92*	PF 10	20000	3422.3	3430.1	3429	3431.1	0.0098	9.49	2976.7	824.26	0.7
626.43*	PF 1	50	3421.4	3422.6	3422.3	3422.7	0.0092	2.12	23.58	37.61	0.47
626.43*	PF 2	100	3421.4	3423	3422.6	3423.1	0.0091	2.57	38.96	46.5	0.49
626.43*	PF 3	500	3421.4	3424.2	3423.7	3424.4	0.0086	2.98	177.07	178.02	0.5
626.43*	PF 4	1000	3421.4	3424.9	3424.3	3425	0.0083	3.35	322.63	276.12	0.51
626.43*	PF 5	2000	3421.4	3425.5	3424.9	3425.8	0.0086	4.18	556.46	412.59	0.55
626.43*	PF 6	4000	3421.4	3426.3	3425.7	3426.7	0.0088	5.33	892.5	441.36	0.58
626.43*	PF 7	8000	3421.4	3427.4	3426.7	3428	0.0101	7.1	1363.4	482.4	0.66
626.43*	PF 8	10000	3421.4	3427.8	3427.1	3428.5	0.0092	7.36	1831.6	744.32	0.65
626.43*	PF 9	15000	3421.4	3428.6	3427.7	3429.4	0.0098	8.55	2432.8	802.09	0.69
626.43*	PF 10	20000	3421.4	3429.2	3428.6	3430.2	0.0099	9.35	2968.2	823.36	0.7
536.94*	PF 1	50	3420.5	3421.8	3421.5	3421.9	0.0094	2.15	23.27	37.04	0.48
536.94*	PF 2	100	3420.5	3422.2	3421.8	3422.3	0.0093	2.61	38.34	45.43	0.5
536.94*	PF 3	500	3420.5	3423.5	3423	3423.6	0.0088	2.89	183.75	189.94	0.5
536.94*	PF 4	1000	3420.5	3424.1	3423.5	3424.2	0.0097	3.4	316.05	288.95	0.54
536.94*	PF 5	2000	3420.5	3424.8	3424.1	3425	0.0091	4.13	556.23	408.99	0.56
536.94*	PF 6	4000	3420.5	3425.6	3424.9	3425.9	0.0087	5.19	900.64	443.46	0.58
536.94*	PF 7	8000	3420.5	3426.6	3425.8	3427.1	0.0091	6.63	1543.3	680.52	0.63
536.94*	PF 8	10000	3420.5	3427	3426.2	3427.6	0.0097	7.34	1833.8	760.77	0.66
536.94*	PF 9	15000	3420.5	3427.7	3426.7	3428.5	0.0099	8.35	2437	800.5	0.68
536.94*	PF 10	20000	3420.5	3428.4	3426.7	3429.3	0.0099	9.14	2962.5	820.3	0.7
447.45*	PF 1	50	3419.7	3421	3420.6	3421	0.0094	2.16	23.16	36.63	0.48
447.45*	PF 2	100	3419.7	3421.3	3420.9	3421.4	0.0095	2.63	38.7	53.36	0.51
447.45*	PF 3	500	3419.7	3422.6	3422	3422.7	0.011	3.14	168.41	176.09	0.56
447.45*	PF 4	1000	3419.7	3423.2	3422.6	3423.4	0.009	3.6	302.76	247.87	0.54
447.45*	PF 5	2000	3419.7	3424	3423.4	3424.2	0.0088	3.98	555.81	382.65	0.54
447.45*	PF 6	4000	3419.7	3424.8	3424	3425.1	0.0087	5.06	905.27	446.05	0.58

Motoqua HEC-RAS Model Output Summary Table

River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
447.45*	PF 7	8000	3419.7	3425.8	3425	3426.3	0.0092	6.49	1581.9	750.19	0.62
447.45*	PF 8	10000	3419.7	3426.1	3425.4	3426.7	0.0097	7.14	1855.2	770.76	0.65
447.45*	PF 9	15000	3419.7	3426.9	3425.8	3427.6	0.0098	8.13	2445.7	796.27	0.68
447.45*	PF 10	20000	3419.7	3427.5	3426.8	3428.4	0.0101	9	2951.4	836.55	0.7
357.96*	PF 1	50	3418.8	3420.1	3419.7	3420.2	0.0097	2.21	22.63	37.06	0.49
357.96*	PF 2	100	3418.8	3420.5	3420.1	3420.6	0.0099	2.65	39.93	60.48	0.51
357.96*	PF 3	500	3418.8	3421.6	3421.2	3421.7	0.0102	3.48	155.52	136.36	0.56
357.96*	PF 4	1000	3418.8	3422.3	3421.7	3422.5	0.0104	3.73	289.4	237.13	0.57
357.96*	PF 5	2000	3418.8	3423.2	3422.5	3423.4	0.0088	3.86	557.26	377.55	0.54
357.96*	PF 6	4000	3418.8	3424	3423.2	3424.3	0.0089	4.99	913.72	475.71	0.58
357.96*	PF 7	8000	3418.8	3424.9	3424.2	3425.4	0.0098	6.49	1602.5	752.3	0.64
357.96*	PF 8	10000	3418.8	3425.3	3424.7	3425.8	0.0098	6.98	1867.8	768.63	0.65
357.96*	PF 9	15000	3418.8	3426	3425.4	3426.7	0.0103	8.07	2433.7	819.03	0.69
357.96*	PF 10	20000	3418.8	3426.6	3425.9	3427.5	0.0103	8.84	2942.2	828.48	0.71
268.47*	PF 1	50	3417.9	3419.2	3418.9	3419.3	0.0098	2.25	23	43.95	0.49
268.47*	PF 2	100	3417.9	3419.6	3419.2	3419.7	0.0101	2.64	41.7	63.97	0.52
268.47*	PF 3	500	3417.9	3420.7	3420.2	3420.8	0.0099	3.34	160.69	142.88	0.54
268.47*	PF 4	1000	3417.9	3421.3	3420.7	3421.6	0.0104	4.13	268.39	192.9	0.58
268.47*	PF 5	2000	3417.9	3422.3	3421.6	3422.5	0.0112	4.01	517.3	376.32	0.6
268.47*	PF 6	4000	3417.9	3423.2	3422.4	3423.5	0.0094	4.93	921.83	516.23	0.59
268.47*	PF 7	8000	3417.9	3424	3423.4	3424.5	0.0105	6.44	1584.6	769.51	0.66
268.47*	PF 8	10000	3417.9	3424.4	3423.8	3424.9	0.0104	6.9	1861.4	797.02	0.67
268.47*	PF 9	15000	3417.9	3425	3424.5	3425.8	0.0108	7.94	2409.5	832.95	0.7
268.47*	PF 10	20000	3417.9	3425.6	3425	3426.5	0.0116	8.95	2878.6	892.6	0.74
178.98*	PF 1	50	3417.1	3418.3	3418	3418.4	0.0107	2.31	23.8	48.83	0.51
178.98*	PF 2	100	3417.1	3418.6	3418.4	3418.7	0.0105	2.64	42.1	62.75	0.53
178.98*	PF 3	500	3417.1	3419.8	3419.3	3419.9	0.0109	3.31	158.74	149.24	0.56
178.98*	PF 4	1000	3417.1	3420.4	3419.8	3420.6	0.0109	4.11	266.86	203.14	0.59
178.98*	PF 5	2000	3417.1	3421.2	3420.6	3421.5	0.0112	4.94	445.46	255.23	0.63
178.98*	PF 6	4000	3417.1	3422.3	3421.6	3422.6	0.0102	4.89	916.63	524.77	0.6
178.98*	PF 7	8000	3417.1	3423.1	3422.6	3423.5	0.0111	6.25	1558.3	820.96	0.67
178.98*	PF 8	10000	3417.1	3423.4	3422.8	3423.9	0.0116	6.88	1830	856.05	0.69
178.98*	PF 9	15000	3417.1	3424	3423.6	3424.7	0.0124	8.01	2381.5	917.99	0.74
178.98*	PF 10	20000	3417.1	3424.5	3424.1	3425.4	0.0128	8.9	2853	984.13	0.77

Motoqua HEC-RAS Model Output Summary Table											
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
89.4899*	PF 1	50	3416.2	3417.4	3417.2	3417.5	0.0092	2.11	26.47	50.14	0.47
89.4899*	PF 2	100	3416.2	3417.7	3417.4	3417.8	0.0097	2.49	44.23	63.28	0.5
89.4899*	PF 3	500	3416.2	3418.8	3418.3	3418.9	0.0112	3.45	156.57	152.09	0.57
89.4899*	PF 4	1000	3416.2	3419.4	3418.9	3419.6	0.012	4.09	263.11	201.78	0.61
89.4899*	PF 5	2000	3416.2	3420.1	3419.5	3420.4	0.0125	5.17	422.5	239.8	0.66
89.4899*	PF 6	4000	3416.2	3421.2	3420.6	3421.6	0.0147	5.17	816.85	554.24	0.7
89.4899*	PF 7	8000	3416.2	3422	3421.7	3422.5	0.0123	6.04	1590	925.71	0.69
89.4899*	PF 8	10000	3416.2	3422.2	3421.9	3422.8	0.0143	6.86	1780.4	983.61	0.75
89.4899*	PF 9	15000	3416.2	3422.8	3422.3	3423.5	0.0147	7.95	2366.6	1027.7	0.78
89.4899*	PF 10	20000	3416.2	3423.3	3422.8	3424.2	0.015	8.81	2859.8	1055.5	0.81
0	PF 1	50	3415.4	3416.4	3416.2	3416.5	0.0135	2.32	23.8	50.9	0.56
0	PF 2	100	3415.4	3416.7	3416.5	3416.8	0.0135	2.72	41.02	70.55	0.58
0	PF 3	500	3415.4	3417.7	3417.3	3417.8	0.0135	3.5	149.83	159.71	0.62
0	PF 4	1000	3415.4	3418.2	3417.8	3418.5	0.0135	4.27	250.94	203.63	0.65
0	PF 5	2000	3415.4	3418.9	3418.5	3419.3	0.0135	5	433.4	311.72	0.68
0	PF 6	4000	3415.4	3419.9	3419.3	3420.3	0.0135	5.77	778.54	546.44	0.7
0	PF 7	8000	3415.4	3420.9	3420.5	3421.3	0.0135	5.64	1566.1	866.15	0.7
0	PF 8	10000	3415.4	3421.1	3420.6	3421.5	0.0135	5.91	1894.7	1008.3	0.71
0	PF 9	15000	3415.4	3421.7	3421.1	3422.3	0.0135	6.87	2501.8	1072	0.73

Catclaw Canyon HEC-RAS Model Output Summary Table											
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
839.17	PF 1	50	2636.71	2637.41	2637.31	2637.55	0.01883	2.92	17.54	42.46	0.73
839.17	PF 2	100	2636.71	2637.69	2637.59	2637.85	0.01725	3.4	32.77	69.8	0.73
839.17	PF 3	500	2636.71	2638.62	2638.42	2638.81	0.01301	3.9	153.25	222.16	0.68
839.17	PF 4	1000	2636.71	2639.14	2638.86	2639.33	0.01196	4.15	302.19	369.52	0.67
839.17	PF 5	2000	2636.71	2639.72	2639.38	2639.91	0.01094	3.9	586.03	587.63	0.64
839.17	PF 6	4000	2636.71	2640.44	2639.87	2640.68	0.00796	4.51	1041.93	658.78	0.59
839.17	PF 7	8000	2636.71	2641.42	2640.54	2641.78	0.00651	5.32	1695.28	666.7	0.57
839.17	PF 8	10000	2636.71	2641.84	2640.82	2642.25	0.00616	5.63	1976.77	670.08	0.56
839.17	PF 9	15000	2636.71	2642.77	2641.42	2643.29	0.00563	6.36	2597.37	672.89	0.56
839.17	PF 10	20000	2636.71	2643.58	2641.94	2644.21	0.00532	6.99	3142.88	673.13	0.56

Catclaw Canyon HEC-RAS Model Output Summary Table

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
577.02	PF 1	50	2634.43	2635.32		2635.35	0.0046	1.33	37.6	84.79	0.35
577.02	PF 2	100	2634.43	2635.57		2635.61	0.005	1.65	60.59	105.06	0.38
577.02	PF 3	500	2634.43	2636.45		2636.57	0.00599	2.76	193.35	207.67	0.47
577.02	PF 4	1000	2634.43	2637.05		2637.19	0.0059	3.11	361.45	341.91	0.48
577.02	PF 5	2000	2634.43	2637.71		2637.92	0.00563	3.94	636.53	487.96	0.5
577.02	PF 6	4000	2634.43	2638.47		2638.82	0.00642	5.19	1053.08	609.67	0.56
577.02	PF 7	8000	2634.43	2639.44		2639.98	0.00725	6.75	1647.84	615.13	0.62
577.02	PF 8	10000	2634.43	2639.84		2640.47	0.00753	7.35	1891.39	617.22	0.65
577.02	PF 9	15000	2634.43	2640.67		2641.52	0.00815	8.66	2407.22	621.63	0.69
577.02	PF 10	20000	2634.43	2641.29		2642.4	0.0091	9.92	2797.69	624.95	0.75
241.15	PF 1	50	2632.8	2633.52	2633.31	2633.54	0.00641	1.17	42.65	144.13	0.38
241.15	PF 2	100	2632.8	2633.68	2633.46	2633.71	0.00644	1.48	67.51	162.66	0.4
241.15	PF 3	500	2632.8	2634.33	2633.93	2634.44	0.00681	2.68	190.55	214.25	0.48
241.15	PF 4	1000	2632.8	2634.78	2634.31	2634.96	0.00776	3.53	309.43	315.9	0.54
241.15	PF 5	2000	2632.8	2635.37	2634.94	2635.64	0.00889	4.44	545.85	541.73	0.6
241.15	PF 6	4000	2632.8	2636.05	2635.73	2636.41	0.00909	5.34	951.91	614.37	0.63
241.15	PF 7	8000	2632.8	2636.97	2636.44	2637.49	0.00889	6.63	1514.82	616.65	0.66
241.15	PF 8	10000	2632.8	2637.36	2636.7	2637.96	0.00879	7.11	1753.33	617.61	0.67
241.15	PF 9	15000	2632.8	2638.24	2637.38	2638.96	0.00842	8.07	2503.82	808.84	0.68
241.15	PF 10	20000	2632.8	2638.98	2638.02	2639.78	0.00767	8.55	3110.65	812.43	0.66
0	PF 1	50	2630.67	2631.57	2631.42	2631.6	0.00955	1.17	41.77	161.5	0.38
0	PF 2	100	2630.67	2631.72	2631.55	2631.75	0.00954	1.47	67.27	189.76	0.4
0	PF 3	500	2630.67	2632.31	2631.99	2632.38	0.00955	2.1	242.73	457.91	0.44
0	PF 4	1000	2630.67	2632.61	2632.3	2632.71	0.00953	2.64	393.32	541.36	0.46
0	PF 5	2000	2630.67	2632.99	2632.63	2633.16	0.00954	3.27	601.17	547.82	0.49
0	PF 6	4000	2630.67	2633.55	2633.06	2633.85	0.00954	4.09	911.04	550.6	0.52
0	PF 7	8000	2630.67	2634.4	2633.76	2634.93	0.00954	5.2	1381.15	554.79	0.55
0	PF 8	10000	2630.67	2634.76	2634.08	2635.4	0.00954	5.62	1579.62	556.54	0.56
0	PF 9	15000	2630.67	2635.54	2634.77	2636.43	0.00955	6.5	2017.02	560.4	0.58
0	PF 10	20000	2630.67	2636.22	2635.38	2637.34	0.00955	7.22	2400.43	563.76	0.6

Catclaw Canyon HEC-RAS Model Output Summary Table

River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
683.53	PF 1	50	2552.73	2553.9	2553.56	2554	0.00958	2.47	20.27	31.98	0.55
683.53	PF 2	100	2552.73	2554.28	2553.97	2554.4	0.01039	2.84	35.19	47.65	0.58
683.53	PF 3	500	2552.73	2555.35	2555.1	2555.46	0.01082	2.72	191.16	305.69	0.59
683.53	PF 4	1000	2552.73	2555.73	2555.43	2555.89	0.00961	3.36	312.37	333.6	0.59
683.53	PF 5	2000	2552.73	2556.27	2555.85	2556.53	0.00873	4.23	497.19	343.52	0.61
683.53	PF 6	4000	2552.73	2557.07	2556.48	2557.51	0.00865	5.48	785.43	396.39	0.64
683.53	PF 7	8000	2552.73	2558.12	2557.53	2558.76	0.00852	6.91	1450.16	756.84	0.68
683.53	PF 8	10000	2552.73	2558.51	2558.06	2559.21	0.00831	7.35	1744.05	765.5	0.68
683.53	PF 9	15000	2552.73	2559.2	2558.82	2560.1	0.00878	8.51	2282.88	775.74	0.72
683.53	PF 10	20000	2552.73	2559.78	2559.35	2560.87	0.00924	9.49	2732.08	784.18	0.76
481.04	PF 1	50	2550.95	2552.21	2551.82	2552.25	0.00778	1.58	31.7	69.58	0.41
481.04	PF 2	100	2550.95	2552.48	2552.13	2552.53	0.00811	1.84	54.31	97.55	0.43
481.04	PF 3	500	2550.95	2553.31	2552.95	2553.41	0.00933	2.52	199.85	255.82	0.5
481.04	PF 4	1000	2550.95	2553.72	2553.32	2553.88	0.00998	3.3	307.69	281.82	0.54
481.04	PF 5	2000	2550.95	2554.28	2553.81	2554.56	0.01061	4.28	482.71	327.36	0.59
481.04	PF 6	4000	2550.95	2555.07	2554.5	2555.53	0.01072	5.57	772.84	397.29	0.63
481.04	PF 7	8000	2550.95	2555.78	2555.58	2556.52	0.01358	7.46	1364.76	829.51	0.75
481.04	PF 8	10000	2550.95	2556.07	2555.93	2556.91	0.01435	8.14	1611.54	869.68	0.78
481.04	PF 9	15000	2550.95	2556.71	2556.61	2557.7	0.01425	9.09	2167.05	873.05	0.8
481.04	PF 10	20000	2550.95	2557.25	2557.1	2558.38	0.01413	9.85	2642.75	875.27	0.81
263.57	PF 1	50	2549.19	2550.31	2550.06	2550.35	0.00978	1.63	30.69	78.75	0.46
263.57	PF 2	100	2549.19	2550.56	2550.29	2550.61	0.00971	1.82	55.1	119.58	0.47
263.57	PF 3	500	2549.19	2551.33	2550.98	2551.4	0.00907	2.24	222.89	334.7	0.48
263.57	PF 4	1000	2549.19	2551.68	2551.31	2551.81	0.00908	2.86	349.36	364.28	0.52
263.57	PF 5	2000	2549.19	2552.16	2551.71	2552.39	0.00936	3.8	526.29	366.87	0.56
263.57	PF 6	4000	2549.19	2552.87	2552.29	2553.27	0.00988	5.08	787.15	369.75	0.61
263.57	PF 7	8000	2549.19	2553.69	2553.28	2554.12	0.00845	5.82	1765.54	1004.4	0.6
263.57	PF 8	10000	2549.19	2554.01	2553.59	2554.48	0.00821	6.16	2093.31	1005.44	0.6
263.57	PF 9	15000	2549.19	2554.67	2554.09	2555.25	0.00819	6.96	2760.71	1007.55	0.62
263.57	PF 10	20000	2549.19	2555.23	2554.5	2555.91	0.0083	7.65	3319.58	1009.32	0.64
0	PF 1	50	2546.76	2547.6	2547.44	2547.65	0.0108	1.77	28.27	73.6	0.5
0	PF 2	100	2546.76	2547.83	2547.6	2547.9	0.01079	2.13	46.86	91.89	0.53
0	PF 3	500	2546.76	2548.71	2548.33	2548.8	0.01079	2.41	207.09	338.67	0.54
0	PF 4	1000	2546.76	2549.07	2548.74	2549.21	0.01078	2.98	335.8	401.48	0.57

Catclaw Canyon HEC-RAS Model Output Summary Table											
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
0	PF 5	2000	2546.76	2549.5	2549.16	2549.74	0.01079	3.87	517.3	418.8	0.61
0	PF 6	4000	2546.76	2550.14	2549.69	2550.55	0.01079	5.1	787.05	430.22	0.66
0	PF 7	8000	2546.76	2550.99	2550.61	2551.61	0.0108	6.53	1385.39	825.27	0.7
0	PF 8	10000	2546.76	2551.31	2551.01	2552.01	0.0108	7.04	1675.32	955.52	0.71
0	PF 9	15000	2546.76	2551.95	2551.75	2552.79	0.01079	7.98	2297.32	992.03	0.73
0	PF 10	20000	2546.76	2552.46	2552.22	2553.44	0.0108	8.72	2814.88	1003.17	0.75

Highway 91 Bridge HEC-RAS Model Output Summary Table, Channel n=0.045											
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1292.47	PF 1	50	1837.28	1837.92	1837.69	1837.93	0.00288	0.76	65.39	222.21	0.25
1292.47	PF 2	100	1837.28	1838.1	1837.78	1838.11	0.00285	0.94	106.3	245.05	0.25
1292.47	PF 3	500	1837.28	1838.8	1838.19	1838.84	0.00312	1.64	304.91	298.72	0.29
1292.47	PF 4	1000	1837.28	1839.33	1838.47	1839.4	0.00365	2.06	485.69	369.27	0.32
1292.47	PF 5	2000	1837.28	1840.07	1838.93	1840.17	0.00535	2.47	811.33	613.98	0.38
1292.47	PF 6	4000	1837.28	1840.63	1839.58	1840.81	0.00683	3.4	1184.38	702.37	0.45
1292.47	PF 7	6000	1837.28	1841.12	1840.21	1841.37	0.00668	3.97	1532.39	715.1	0.47
1292.47	PF 8	8000	1837.28	1841.6	1840.52	1841.89	0.00624	4.34	1876.34	733.76	0.47
1292.47	PF 9	10000	1837.28	1842.08	1840.8	1842.4	0.00546	4.56	2235.74	738.34	0.45
1292.47	PF 10	15000	1837.28	1843.35	1841.39	1843.71	0.00387	4.85	3175.71	750.2	0.41
1292.47	PF 11	20000	1837.28	1844.57	1841.91	1844.96	0.00299	5.03	4116.87	962.66	0.37
1292.47	PF 12	25000	1837.28	1845.71	1842.38	1846.11	0.00248	5.19	5002.38	1198.21	0.35
1292.47	PF 13	30000	1837.28	1846.75	1842.79	1847.18	0.00219	5.37	5815.16	1207.45	0.34
1292.47	PF 14	35000	1837.28	1849.75	1843.23	1850.05	0.00098	4.47	8166.07	1219.3	0.24
985.65	PF 1	50	1834.88	1835.58	1835.58	1835.67	0.04562	2.47	20.26	95.99	0.95
985.65	PF 2	100	1834.88	1835.69	1835.69	1835.84	0.04801	3.12	32.01	110.22	1.02
985.65	PF 3	500	1834.88	1836.23	1836.23	1836.48	0.03966	4.08	122.69	239.6	1
985.65	PF 4	1000	1834.88	1836.59	1836.55	1836.92	0.02913	4.63	216	276.59	0.92
985.65	PF 5	2000	1834.88	1837.37	1837.02	1837.64	0.01406	4.16	480.38	421.2	0.69
985.65	PF 6	4000	1834.88	1838.42	1837.67	1838.69	0.00698	4.17	958.84	498.71	0.52
985.65	PF 7	6000	1834.88	1839.31	1838.09	1839.59	0.00508	4.24	1416.18	557.4	0.46
985.65	PF 8	8000	1834.88	1840.06	1838.49	1840.36	0.00405	4.39	1820.95	574.8	0.42
985.65	PF 9	10000	1834.88	1840.8	1838.84	1841.12	0.00332	4.49	2228.81	669.43	0.39
985.65	PF 10	15000	1834.88	1842.39	1839.57	1842.75	0.00255	4.83	3104.45	753.39	0.36

Highway 91 Bridge HEC-RAS Model Output Summary Table, Channel n=0.045											
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)	
985.65	PF 11	20000	1834.88	1843.75	1840.2	1844.17	0.00223	5.19	3854.15	940.27	0.35
985.65	PF 12	25000	1834.88	1844.94	1840.78	1845.41	0.00208	5.55	4509.11	1214.78	0.34
985.65	PF 13	30000	1834.88	1845.99	1841.29	1846.53	0.00201	5.89	5091.23	1226.79	0.34
985.65	PF 14	35000	1834.88	1849.35	1841.77	1849.74	0.00098	5.04	6943.86	1593.68	0.25
822.64	PF 1	50	1833.09	1834.09	1833.6	1834.1	0.00078	0.63	78.78	141.48	0.15
822.64	PF 2	100	1833.09	1834.31	1833.73	1834.32	0.00114	0.91	110.24	154.44	0.19
822.64	PF 3	500	1833.09	1835.2	1834.27	1835.24	0.00226	1.72	290.03	251.55	0.28
822.64	PF 4	1000	1833.09	1835.8	1834.73	1835.88	0.00231	2.24	445.98	265.19	0.3
822.64	PF 5	2000	1833.09	1836.59	1835.3	1836.73	0.00266	3.03	660.87	278.83	0.35
822.64	PF 6	4000	1833.09	1837.68	1836.04	1837.94	0.00319	4.09	978.36	302.19	0.4
822.64	PF 7	6000	1833.09	1838.53	1836.66	1838.9	0.00335	4.86	1234.71	368.54	0.42
822.64	PF 8	8000	1833.09	1839.21	1837.21	1839.69	0.00358	5.55	1441.95	466.67	0.45
822.64	PF 9	10000	1833.09	1839.92	1837.7	1840.48	0.00353	6.03	1659.43	490.88	0.46
822.64	PF 10	15000	1833.09	1841.33	1838.71	1842.13	0.00371	7.16	2095.61	625.85	0.49
822.64	PF 11	20000	1833.09	1842.48	1839.61	1843.51	0.00396	8.15	2453.14	751.1	0.51
822.64	PF 12	25000	1833.09	1843.42	1840.44	1844.7	0.00428	9.09	2750.04	814.93	0.54
822.64	PF 13	30000	1833.09	1844.19	1841.22	1845.75	0.00467	10.02	2998.48	1003.86	0.58
822.64	PF 14	35000	1833.09	1848.33	1841.94	1849.34	0.00187	8.07	4357.19	1124.41	0.39
751.79		Bridge									
725.79	PF 1	50	1831.99	1832.99	1832.68	1833	0.0063	1.05	47.51	186.47	0.37
725.79	PF 2	100	1831.99	1833.12	1832.91	1833.15	0.00654	1.38	72.59	195.74	0.4
725.79	PF 3	500	1831.99	1833.67	1833.34	1833.79	0.00823	2.74	182.7	208.91	0.52
725.79	PF 4	1000	1831.99	1834.15	1833.69	1834.34	0.00828	3.45	289.89	235.04	0.55
725.79	PF 5	2000	1831.99	1834.85	1834.25	1835.12	0.00806	4.18	478.22	288.84	0.57
725.79	PF 6	4000	1831.99	1835.73	1835.01	1836.2	0.00794	5.47	731.51	359.99	0.6
725.79	PF 7	6000	1831.99	1836.44	1835.57	1837.08	0.00795	6.42	934.51	449.72	0.63
725.79	PF 8	8000	1831.99	1836.9	1836.08	1837.77	0.00903	7.47	1070.42	473.61	0.69
725.79	PF 9	10000	1831.99	1837.62	1836.53	1838.57	0.00784	7.81	1279.64	513.97	0.66
725.79	PF 10	15000	1831.99	1838.93	1837.59	1840.18	0.00783	8.95	1687.28	678.71	0.68
725.79	PF 11	20000	1831.99	1840.02	1838.64	1841.53	0.00749	9.9	2043.99	693.42	0.69
725.79	PF 12	25000	1831.99	1840.77	1839.46	1842.66	0.00808	11.06	2289.83	703.56	0.73
725.79	PF 13	30000	1831.99	1841.09	1840.2	1843.58	0.01004	12.69	2395.97	722.66	0.81
725.79	PF 14	35000	1831.99	1841.64	1840.91	1844.57	0.01077	13.78	2576.18	819.67	0.85

Highway 91 Bridge HEC-RAS Model Output Summary Table, Channel n=0.045											
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)	
379.97	PF 1	50	1828.83	1829.76	1829.64	1829.82	0.01443	1.98	25.29	71.34	0.59
379.97	PF 2	100	1828.83	1830.01	1829.81	1830.07	0.01277	1.98	50.46	129.55	0.56
379.97	PF 3	500	1828.83	1830.72	1830.41	1830.84	0.0088	2.79	179.06	207.45	0.53
379.97	PF 4	1000	1828.83	1831.2	1830.74	1831.4	0.00874	3.52	284.38	231.61	0.56
379.97	PF 5	2000	1828.83	1831.92	1831.32	1832.19	0.00897	4.2	476.03	302.88	0.59
379.97	PF 6	4000	1828.83	1832.69	1832.12	1833.17	0.00968	5.57	717.51	316.01	0.65
379.97	PF 7	6000	1828.83	1833.29	1832.66	1833.97	0.01018	6.6	908.78	322.25	0.69
379.97	PF 8	8000	1828.83	1834.28	1833.14	1834.93	0.00695	6.47	1236.43	339.28	0.6
379.97	PF 9	10000	1828.83	1834.2	1833.59	1835.26	0.01167	8.29	1206.95	337.07	0.77
379.97	PF 10	15000	1828.83	1835.03	1834.59	1836.6	0.01338	10.05	1492.52	345.45	0.85
379.97	PF 11	20000	1828.83	1835.68	1835.43	1837.78	0.01518	11.65	1723.22	415.68	0.93
379.97	PF 12	25000	1828.83	1836.43	1836.43	1838.83	0.01451	12.5	2102.88	629.12	0.93
379.97	PF 13	30000	1828.83	1837.29	1837.29	1839.68	0.01233	12.64	2631.93	668.2	0.87
379.97	PF 14	35000	1828.83	1837.89	1837.89	1840.44	0.01198	13.19	3001.2	671.5	0.87
0	PF 1	50	1824.05	1825.19	1824.93	1825.29	0.01001	2.56	19.56	28.52	0.54
0	PF 2	100	1824.05	1825.66	1825.23	1825.79	0.01001	2.82	35.47	44.66	0.56
0	PF 3	500	1824.05	1827.15	1826.45	1827.29	0.01	2.92	171.39	205.09	0.56
0	PF 4	1000	1824.05	1827.66	1827.23	1827.84	0.01	3.39	294.69	280.98	0.58
0	PF 5	2000	1824.05	1828.35	1827.79	1828.58	0.01	3.86	517.96	407.12	0.6
0	PF 6	4000	1824.05	1829.02	1828.52	1829.41	0.01	5.04	793.51	417.9	0.64
0	PF 7	6000	1824.05	1829.55	1828.97	1830.09	0.01	5.88	1019.96	425.88	0.67
0	PF 8	8000	1824.05	1829.37	1829.37	1830.49	0.02303	8.5	941.24	423.13	1
0	PF 9	10000	1824.05	1830.33	1829.74	1831.06	0.01001	7	1568.69	669.71	0.7
0	PF 10	15000	1824.05	1831.11	1830.59	1832.04	0.01001	8.03	2124.67	744.24	0.72
0	PF 11	20000	1824.05	1831.75	1831.26	1832.85	0.01	8.86	2611.4	772.86	0.74
0	PF 12	25000	1824.05	1832.32	1831.78	1833.58	0.01001	9.57	3055.04	812.79	0.76
0	PF 13	30000	1824.05	1832.82	1832.24	1834.23	0.01001	10.19	3521.09	1050.38	0.77
0	PF 14	35000	1824.05	1833.26	1832.75	1834.8	0.01	10.73	4009.93	1131.35	0.78

Highway 91 Bridge HEC-RAS Model Output Summary Table, Channel n=0.100

River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1292.47	PF 1	50	1837.28	1838.11	1837.69	1838.12	0.00242	0.46	109.78	246.83	0.12
1292.47	PF 2	100	1837.28	1838.35	1837.78	1838.35	0.00251	0.58	172.74	280.77	0.13
1292.47	PF 3	500	1837.28	1839.17	1838.19	1839.19	0.00428	1.18	424.36	356.38	0.19
1292.47	PF 4	1000	1837.28	1839.76	1838.47	1839.8	0.00504	1.54	651	416.36	0.22
1292.47	PF 5	2000	1837.28	1840.51	1838.93	1840.56	0.00643	1.83	1097.9	700.34	0.25
1292.47	PF 6	4000	1837.28	1841.48	1839.58	1841.56	0.00566	2.26	1789.27	730.95	0.25
1292.47	PF 7	6000	1837.28	1842.36	1840.21	1842.45	0.00473	2.49	2436.54	740.89	0.24
1292.47	PF 8	8000	1837.28	1843.19	1840.52	1843.29	0.00405	2.65	3053.95	748.67	0.23
1292.47	PF 9	10000	1837.28	1843.96	1840.8	1844.07	0.00364	2.79	3637.3	830.08	0.22
1292.47	PF 10	15000	1837.28	1845.64	1841.39	1845.78	0.00302	3.07	4949.27	1197.78	0.21
1292.47	PF 11	20000	1837.28	1847.09	1841.9	1847.26	0.00273	3.32	6084.07	1212.35	0.21
1292.47	PF 12	25000	1837.28	1849.11	1842.37	1849.28	0.00199	3.28	7667.69	1217.72	0.18
1292.47	PF 13	30000	1837.28	1849.96	1842.8	1850.17	0.00218	3.61	8333.9	1219.84	0.19
1292.47	PF 14	35000	1837.28	1850.9	1843.2	1851.13	0.00225	3.87	9063.22	1222.15	0.2
985.65	PF 1	50	1834.88	1835.58	1835.58	1835.67	0.21488	2.47	20.26	95.99	0.95
985.65	PF 2	100	1834.88	1835.7	1835.69	1835.84	0.19912	3	33.32	111.7	0.97
985.65	PF 3	500	1834.88	1836.76	1836.23	1836.81	0.01802	1.89	264.05	293.47	0.35
985.65	PF 4	1000	1834.88	1837.48	1836.55	1837.54	0.01175	1.89	528.56	438.27	0.3
985.65	PF 5	2000	1834.88	1838.45	1837.02	1838.52	0.0069	2.05	975.56	503.08	0.25
985.65	PF 6	4000	1834.88	1839.9	1837.67	1839.98	0.00469	2.31	1731.5	570.99	0.23
985.65	PF 7	6000	1834.88	1841.06	1838.09	1841.16	0.00378	2.53	2369.44	680.3	0.22
985.65	PF 8	8000	1834.88	1842.04	1838.49	1842.16	0.00337	2.75	2913.35	729.49	0.21
985.65	PF 9	10000	1834.88	1842.89	1838.84	1843.03	0.0032	2.96	3381.73	805.25	0.21
985.65	PF 10	15000	1834.88	1844.66	1839.57	1844.84	0.00309	3.44	4355.14	1174.59	0.22
985.65	PF 11	20000	1834.88	1846.13	1840.2	1846.36	0.0031	3.87	5168.45	1227.95	0.22
985.65	PF 12	25000	1834.88	1848.37	1840.78	1848.61	0.00236	3.9	6407.22	1276.15	0.2
985.65	PF 13	30000	1834.88	1849.11	1841.28	1849.41	0.00277	4.4	6811.45	1536.73	0.22
985.65	PF 14	35000	1834.88	1849.96	1841.78	1850.32	0.00301	4.8	7285.22	1594.73	0.23
822.64	PF 1	50	1833.09	1834.28	1833.6	1834.28	0.00155	0.47	106.44	152.7	0.1
822.64	PF 2	100	1833.09	1834.58	1833.73	1834.58	0.00224	0.64	155.97	186.95	0.12
822.64	PF 3	500	1833.09	1835.73	1834.27	1835.75	0.00324	1.17	428.45	263.86	0.16
822.64	PF 4	1000	1833.09	1836.5	1834.73	1836.54	0.00372	1.57	635.19	276.85	0.18
822.64	PF 5	2000	1833.09	1837.55	1835.3	1837.62	0.00449	2.13	937.87	299.31	0.21
822.64	PF 6	4000	1833.09	1839.05	1836.04	1839.18	0.00493	2.87	1394.46	424.01	0.24
822.64	PF 7	6000	1833.09	1840.23	1836.66	1840.41	0.00524	3.42	1754.8	501.38	0.25

Highway 91 Bridge HEC-RAS Model Output Summary Table, Channel n=0.100

River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
822.64	PF 8	8000	1833.09	1841.19	1837.21	1841.43	0.00558	3.9	2052.65	598.74	0.27
822.64	PF 9	10000	1833.09	1841.99	1837.7	1842.28	0.00602	4.35	2300.77	718.57	0.28
822.64	PF 10	15000	1833.09	1843.58	1838.71	1844.03	0.00714	5.35	2803.95	884.42	0.32
822.64	PF 11	20000	1833.09	1844.88	1839.61	1845.48	0.0081	6.21	3225.57	1036.53	0.34
822.64	PF 12	25000	1833.09	1847.32	1840.44	1847.92	0.00608	6.21	4024.19	1091.79	0.31
822.64	PF 13	30000	1833.09	1847.74	1841.22	1848.55	0.00782	7.21	4162.32	1101.75	0.35
822.64	PF 14	35000	1833.09	1848.33	1841.94	1849.34	0.00914	8.03	4357.96	1124.94	0.38
751.79		Bridge									
725.79	PF 1	50	1831.99	1833.14	1832.68	1833.15	0.00656	0.65	77.3	196	0.18
725.79	PF 2	100	1831.99	1833.34	1832.91	1833.35	0.00692	0.86	115.82	198.16	0.2
725.79	PF 3	500	1831.99	1834.27	1833.34	1834.3	0.00831	1.58	316.85	251.29	0.25
725.79	PF 4	1000	1831.99	1834.96	1833.69	1835.02	0.00803	1.96	510.36	291.88	0.26
725.79	PF 5	2000	1831.99	1835.89	1834.25	1835.99	0.00808	2.58	775.67	398.69	0.28
725.79	PF 6	4000	1831.99	1837.27	1835.01	1837.45	0.00817	3.4	1176.63	477.67	0.3
725.79	PF 7	6000	1831.99	1838.35	1835.57	1838.6	0.0084	4.02	1496.94	643.95	0.31
725.79	PF 8	8000	1831.99	1839.29	1836.08	1839.6	0.00879	4.45	1804.75	683.56	0.33
725.79	PF 9	10000	1831.99	1840.04	1836.53	1840.41	0.009	4.89	2051.47	693.73	0.34
725.79	PF 10	15000	1831.99	1841.49	1837.6	1842.04	0.01016	5.95	2525.66	813.22	0.37
725.79	PF 11	20000	1831.99	1842.63	1838.67	1843.37	0.01141	6.89	2898.78	843.41	0.4
725.79	PF 12	25000	1831.99	1843.62	1839.45	1844.56	0.0125	7.72	3224.38	863.02	0.43
725.79	PF 13	30000	1831.99	1843.87	1840.21	1845.15	0.01656	9.04	3305.46	867.9	0.5
725.79	PF 14	35000	1831.99	1844.57	1840.89	1846.1	0.01797	9.84	3537.4	1044.25	0.52
379.97	PF 1	50	1828.83	1830.04	1829.64	1830.06	0.01282	0.91	54.98	137.43	0.25
379.97	PF 2	100	1828.83	1830.29	1829.81	1830.31	0.01143	1.06	93.93	169.98	0.25
379.97	PF 3	500	1828.83	1831.3	1830.41	1831.34	0.00878	1.63	307.5	241.18	0.25
379.97	PF 4	1000	1828.83	1832.03	1830.74	1832.09	0.00901	1.96	510.55	309.12	0.27
379.97	PF 5	2000	1828.83	1832.85	1831.32	1832.96	0.00959	2.6	768.17	317.67	0.3
379.97	PF 6	4000	1828.83	1833.99	1832.12	1834.18	0.01103	3.52	1137.98	332.84	0.34
379.97	PF 7	6000	1828.83	1834.83	1832.66	1835.11	0.01228	4.21	1424.34	344.09	0.36
379.97	PF 8	8000	1828.83	1835.5	1833.14	1835.87	0.01345	4.83	1656.9	358.16	0.39
379.97	PF 9	10000	1828.83	1836.06	1833.59	1836.5	0.01441	5.36	1902.52	535.64	0.41
379.97	PF 10	15000	1828.83	1837.12	1834.59	1837.7	0.0156	6.28	2527.05	667.26	0.44
379.97	PF 11	20000	1828.83	1837.92	1835.42	1838.63	0.0164	6.96	3022.64	671.7	0.46
379.97	PF 12	25000	1828.83	1838.59	1836.86	1839.42	0.01724	7.57	3433.28	682.43	0.48

Highway 91 Bridge HEC-RAS Model Output Summary Table, Channel n=0.100											
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
379.97	PF 13	30000	1828.83	1838.81	1837.41	1839.58	0.01446	7.06	4294.38	992.86	0.44
379.97	PF 14	35000	1828.83	1839.3	1837.86	1840.18	0.01481	7.43	4682.34	1030.35	0.45
0	PF 1	50	1824.05	1825.74	1824.93	1825.77	0.01001	1.28	39.11	48.67	0.25
0	PF 2	100	1824.05	1826.22	1825.23	1826.26	0.01001	1.49	67.3	66.8	0.26
0	PF 3	500	1824.05	1827.74	1826.45	1827.78	0.01002	1.58	316.94	288.04	0.27
0	PF 4	1000	1824.05	1828.43	1827.23	1828.48	0.01	1.81	552.4	408.29	0.27
0	PF 5	2000	1824.05	1829.15	1827.79	1829.23	0.01001	2.36	846.79	419.79	0.29
0	PF 6	4000	1824.05	1830.05	1828.52	1830.18	0.00999	2.97	1385.95	634.04	0.31
0	PF 7	6000	1824.05	1830.72	1828.97	1830.88	0.01	3.38	1835.2	716.88	0.32
0	PF 8	8000	1824.05	1831.24	1829.37	1831.44	0.01001	3.69	2220.57	751.73	0.33
0	PF 9	10000	1824.05	1831.69	1829.74	1831.92	0.01001	3.95	2559.13	770.06	0.33
0	PF 10	15000	1824.05	1832.63	1830.54	1832.95	0.01001	4.48	3327.59	967.36	0.34
0	PF 11	20000	1824.05	1833.36	1831.11	1833.75	0.01001	4.88	4119.19	1137.42	0.35
0	PF 12	25000	1824.05	1833.97	1831.58	1834.41	0.01	5.2	4816.16	1163.6	0.36
0	PF 13	30000	1824.05	1834.49	1832.01	1834.99	0.01	5.48	5429.94	1174.34	0.36
0	PF 14	35000	1824.05	1834.96	1832.42	1835.52	0.01	5.72	5988.17	1179.83	0.37

A.4 Field Survey Data Report