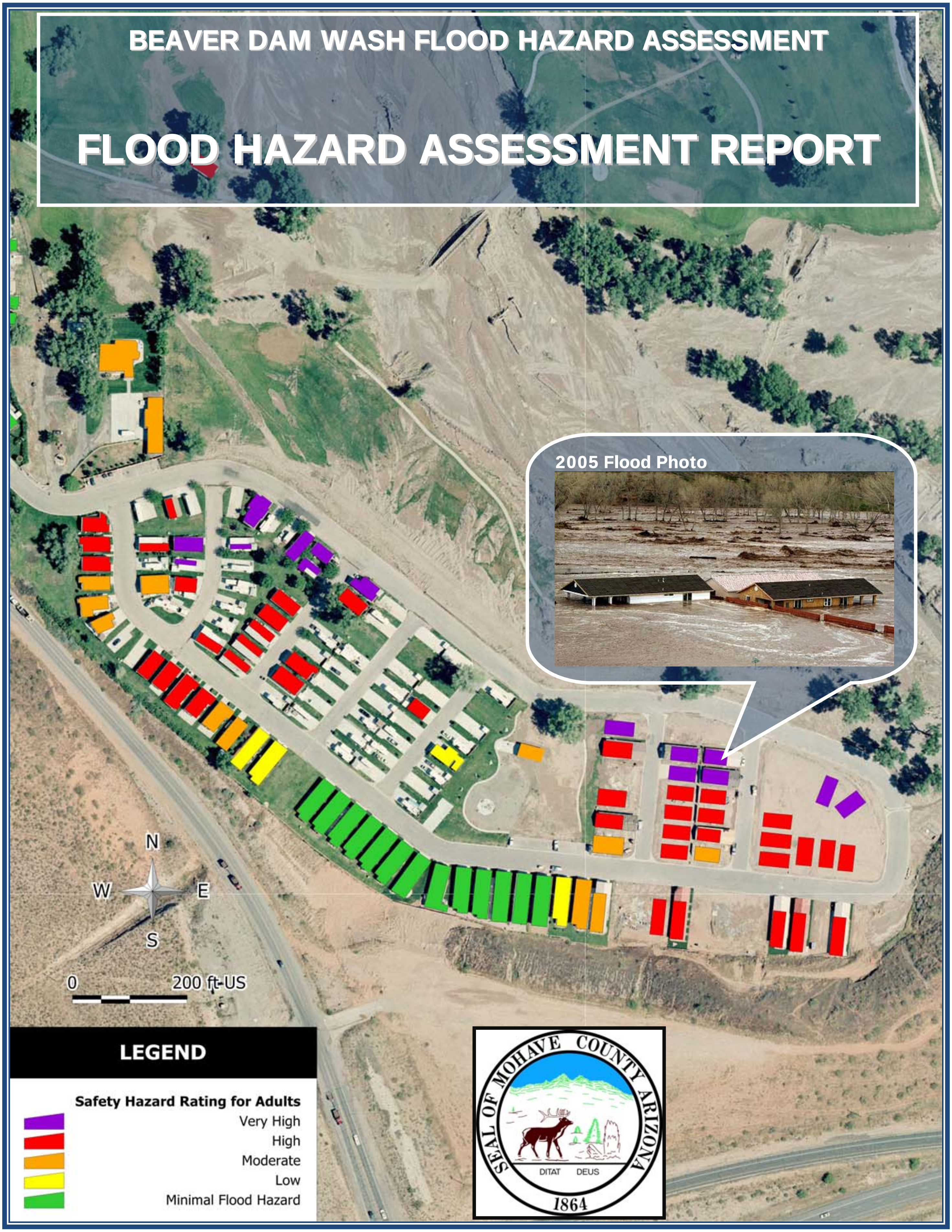
BEAVER DAM WASH FLOOD HAZARD ASSESSMENT

FLOOD HAZARD ASSESSMENT REPORT



BEAVER DAM WASH FLOOD HAZARD ASSESSMENT
Agreement Number 06024

FLOOD HAZARD ASSESSMENT REPORT

Prepared For:

Mohave County Flood Control District
3675 E. Andy Devine, Ste. C
P.O. Box 7000
Kingman, AZ 86401

SEAL OF MOHAVE COUNTY ARIZONA
DITAT DEUS
1864

Prepared By:

Arid Hydrology & Hydraulics, LLC
HC 4 Box 34-Q
Payson, AZ 85541
(602) 320-2762

Registered Professional Engineer (Civil)
CERTIFICATE NO.
12739
THOMAS R.
LOOMIS
Date Signed 9/24/07
ARIZONA, U.S.A.

September 2007
Revised: December 6, 2007

TABLE OF CONTENTS

FLOOD HAZARD ASSESSMENT REPORT 1
BEAVER DAM WASH FLOOD HAZARD ASSESSMENT 3
Agreement Number 06024 3
FLOOD HAZARD ASSESSMENT REPORT 3
TABLE OF CONTENTS i
LIST OF TABLES ii
LIST OF FIGURES iii
1 INTRODUCTION 1
1.1 Project Objective 1
1.2 Summary of Findings 5
1.3 Project Approach 6
1.3.1 General 6
1.3.2 Hydrology 7
1.3.3 Hydraulics 7
1.3.4 January 2005 Flood Assessment 8
1.3.5 Flood Hazard Assessment 8
2 Data Collection 11
2.1 Data Collection List 11
2.1.1 Arizona Department of Transportation 11
2.1.2 FLO-2D Software, Inc. 11
2.1.3 HDR 11
2.1.4 KVL Consulting 11
2.1.5 Mohave County 12
2.1.6 National Oceanic and Atmospheric Administration (NOAA) 13
2.1.7 PBS&J 13
2.1.8 URS Corporation 13
2.1.9 US Bureau of Reclamation 14
2.1.10 US Geological Survey 14
2.1.11 Virgin Valley Water Users Association 14
2.2 Digital Data Re-projection 15
3 Hydrology 17
3.1 General 17
3.2 Base HEC-1 Model 17
3.3 Adjustments Made to Base Model 18
3.3.1 Watershed 18
3.3.2 Precipitation 21
3.3.3 Rainfall Losses 22
3.3.4 Time of Concentration 22
3.3.5 Routing 24
3.4 Base Model Results 26
3.5 Post-Wildfire Hydrology Description and Results 30
4 Hydraulics 37
4.1 General 37
4.2 Limits of Study 38
4.3 FEMA Floodway Analysis 38
4.4 1-Dimensional Modeling 39

Registered Professional Engineer (Civil)
CERTIFICATE NO. 12739
THOMAS R. LOOMIS
Date Signed 9/24/07
ARIZONA, U.S.A.

4.4.1 Base HEC-RAS Model 39
4.4.2 Adjustments Made to the Base Model 39
4.4.3 Results........ 39
4.5 2-Dimensional Modeling 43
4.5.1 Base FLO-2D Model 43
4.5.2 Results........ 51
4.6 Comparison of 1D and 2D Results........ 59
5 January 2005 Flood Assessment 62
6 Flood Hazard Assessment........ 68
6.1 Time to Peak and Recurrence Interval at Finish Floor Elevations........ 68
6.2 Estimate of Hydrologic Lead Time........ 72
6.3 Estimate of Storm Frequency Blocking Access to Residences 74
6.4 Personal Safety Hazard Factor at Each Residence 76
7 Summary, Conclusions, and Recommendations 83
Appendix A Field Survey Supplemental Topographic Data........ A-1
Appendix B NOAA Atlas 14 Precipitation Information........ B-1
Appendix C HEC-1 Hydrologic Modeling Results C-1
Complete HEC-1 Model – All Sub-Basins (pre-fire) C-1
Upper Watershed HEC-1 Model –Sub-Basins 6-10 (pre-fire)........ C-17
Lower Watershed HEC-1 Model –Sub-Basins 1, 2, 4 & 5 (pre-fire) C-25
Lower 2/3 Watershed HEC-1 Model –Sub-Basins 1 - 7 (pre-fire) C-34
Appendix D HEC-RAS Hydraulic Modeling Results........ D-1
Appendix E Digital Data on DVD E-1
Appendix F Proposed Flood Warning System Instrumentation Location Map........ F-1

LIST OF TABLES

Table 3.1 NOAA Atlas 14 24-hour precipitation in inches for each sub-basin.. 21
Table 3.2 Summary of HEC-1 sub-basin parameters........ 24
Table 3.3 Comparison of 100-year HEC-1 routing reach parameters and results 25
Table 3.4 HEC-1 model results at the County Highway 91 bridge........ 26
Table 3.5 Comparison of estimated flood frequency peak discharges at the County Highway 91 bridge........ 28
Table 3.6 100-year peak discharges from previous studies........ 28
Table 3.7 Pre- and Post-Fire Clark unit hydrograph parameters........ 34
Table 3.8 Comparison of post-burn versus pre-burn hydrology results 35
Table 3.9 Excerpt from PBS&J (2007) Table 5........ 36
Table 4.1 Summary of HEC-RAS results........ 41
Table 4.2 Base Manning's n-values related to physical features........ 45
Table 5.2 January 2005 flood surveyed high water marks........ 66
Table 6.1 Analysis results of threshold flooding at finished floor elevations.... 69
Table 6.2 Comparison of FLO-2D water surface elevations with finished floors 70
Table 6.3 Estimate of storm frequency blocking access to residences 74
Table 6.4 Personal safety hazard adjacent to each structure........ 77

LIST OF FIGURES

Figure 1.1 Location Map 3
Figure 1.2 Vicinity Map 4
Figure 3.1 Beaver Dam Wash at County Highway 91 Watershed Map - DEMs . 19
Figure 3.2 Beaver Dam Wash at County Highway 91 Watershed Map - Quads 20
Figure 3.3 100-year 24-hour rainfall distributions for the lower watershed...... 23
Figure 3.4 100-year 24-hour rainfall distributions for the upper watershed 23
Figure 3.5 Peak discharge versus recurrence interval for Beaver Dam Wash at the County Highway 91 bridge 29
Figure 3.6 Adjusted 100-year hydrograph at County Highway 91 bridge......... 30
Figure 3.7 Watershed average 24-hour precipitation versus peak discharge ... 31
Figure 3.8 Sub-basin 10 rainfall distribution and 100-year hydrograph at County Highway 91 bridge........ 31
Figure 3.9 Fire History 2005-2006 (Source: PBS&J, 2007, Figure 2) 32
Figure 3.10 2005 and 2006 fire burn areas for Beaver Dam Wash 33
Figure 4.1 FEMA preliminary work study map 38
Figure 4.2 URS HEC-RAS cross section locations 40
Figure 4.3 Comparison of pre-and post-flood vegetation conditions 45
Figure 4.4 Base Manning's roughness coefficients for 2D modeling 46
Figure 4.5 Final Manning's roughness coefficients used in the 2D models....... 47
Figure 4.6 Structure flow blockages for 2D modeling 49
Figure 4.7 Areas of blocked grid elements 50
Figure 4.8 Grid elements used for inflow hydrograph........ 52
Figure 4.9 FEMA 100-year 24-hour FLO-2D peak discharge results 53
Figure 4.10 FEMA 100-year 24-hour FLO-2D flow depth results........ 54
Figure 4.11 FEMA 100-year 24-hour FLO-2D flow velocity results 55
Figure 4.12 Detailed Study Area FLO-2D cross sections 56
Figure 4.13 FEMA 100-year 24-hour FLO-2D depth-duration results........ 57
Figure 4.14 FLO-2D 100-, 200-, and 500-year floodplain delineations 58
Figure 4.15 FEMA and FLO-2D floodplain delineations comparison........ 60
Figure 4.16 Grid element flow directions at FLO-2D cross section 5 61
Figure 5.1 Unofficial USGS Gage Hydrograph at Old Highway 91 Bridge 63
Figure 5.2 January 2005 post-flood photo (MCFCD)........ 63
Figure 5.3 Structure ID's 7, 9 and 11 (MCFCD) 64
Figure 5.4 Structure washed way (MCFCD)........ 64
Figure 6.1 Pre-burn versus post-burn 100-year 24-hour hydrographs............. 73
Figure 6.2 Location of first point of flooding (CS4) 75
Figure 6.3 Depth-velocity flood danger level relationship for adults (USBR, 1988) 76
Figure 6.4 Personal flood hazard ratings for the Detailed Study Area 81
Figure 6.5 Personal flood hazard ratings in the North study area 82

1 INTRODUCTION

1.1 Project Objective

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, residences of Beaver Dam, AZ were 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 area of highest concern identified by Mohave County staff is the Detailed Study Area (DSA) shown on Figure 2. The January 2005 flood was a major event and, by inspection, greater in magnitude than the 100-year flood estimate used for regulation of new construction in the area prior to 2005. Mohave County recognized that the January 2005 flood indicated that the flood hazards in the area could be much greater than previously thought, and undertook this study to proactively plan for addressing flood hazard related public safety issues. Please refer to Section 2 for a list of references cited in this report.

The history of Mohave County floodplain regulation for Beaver Dam Estates is as follows:

TIMELINE

Used A/E Intra (1986) Floodplain Study for Floodplain Management of Beaver Dam Wash as		Continued use of A/E Intra (1986) Floodplain Study for floodplain Management as "Best Available Technical Information".					Use of URS (July 2005) for Floodplain Management of Beaver Dam Wash as "Best Available Technical Information"							
1986 - 2004	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**2006**	**Present 2007**
	2005													

1986 - January 2005	Regulated using FEMA Zone A and floodplain delineation by A/E Intra Group, Inc. (A/E Intra, 1986), which estimated Q_{100}= 12,300 cfs.
January 2005- July 2005	Continued use of A/E Intra (1986) as best available technical data, but hired URS to prepare interim, conservative, floodplain

	information as a part of the Old Highway 91 Bridge replacement project.
July 2005 – Present	Regulated using the URS report *Beaver Dam Wash Bridge, Hydraulic Report for Existing Bridge* (URS, July 2005), which estimated Q_{100}= 30,400 cfs, as best available technical data. FEMA is currently preparing a new floodplain delineation study for the area using Q_{100}= 21,000 cfs. After acceptance, the new FEMA floodplain delineation study should be used for floodplain management of Beaver Dam Wash.

A new FEMA study is in progress and it is now apparent, after the January 2005 flood, that the 100-year peak discharge used for floodplain management of Beaver Dam Wash fro 1986 through June 2007 is too low. The new base flood elevations in the study area will be higher than determined by A/E Intra (1986). There is concern by Mohave County that new homes constructed in the first 6 months of 2005, as well as many existing homes constructed prior to 2005, lie within a significant hazard area that must be addressed because of concerns for public safety. The area of highest concern identified by Mohave County staff is the DSA.

The project objective is to evaluate the flood risks and corresponding hazards to existing homes in the DSA. The DSA is located along the southwest side of Beaver Dam Wash downstream of the County Highway 91 bridge, north of I-15 and about 1,600 feet upstream of the confluence of the Beaver Dam Wash with the Virgin River. The General Study Area, also shown on Figure 1.2, defines the limits of area that are used for hydraulic analyses necessary to define the flood hazards within the DSA. The evaluation is to:

1. estimate the risk of flooding from the 500-year, 100-year and more frequent storms at each home in the study area, where relative risk is defined by a ranking of the hazard factor assigned to each residence,

2. assess the hazard to the residents and their property,

3. compare the 100-year storm results with the flooding that occurred in the study area in January 2005, and use the available data to attempt to determine if the January 2005 flood was an extreme event, or one that can be expected to occur frequently, and

4. develop recommendations to address the hazards identified.

Figure 1.1 Location Map

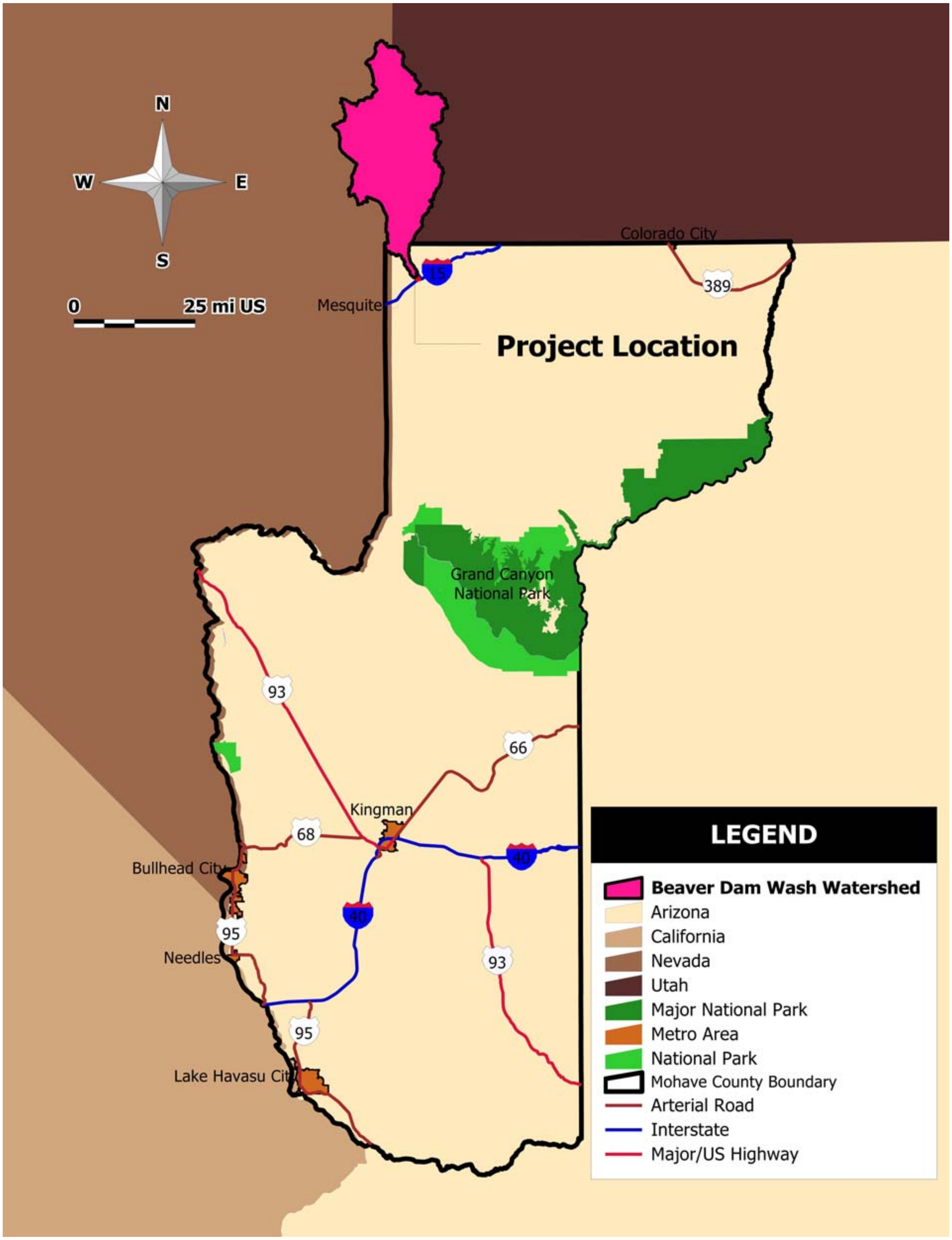
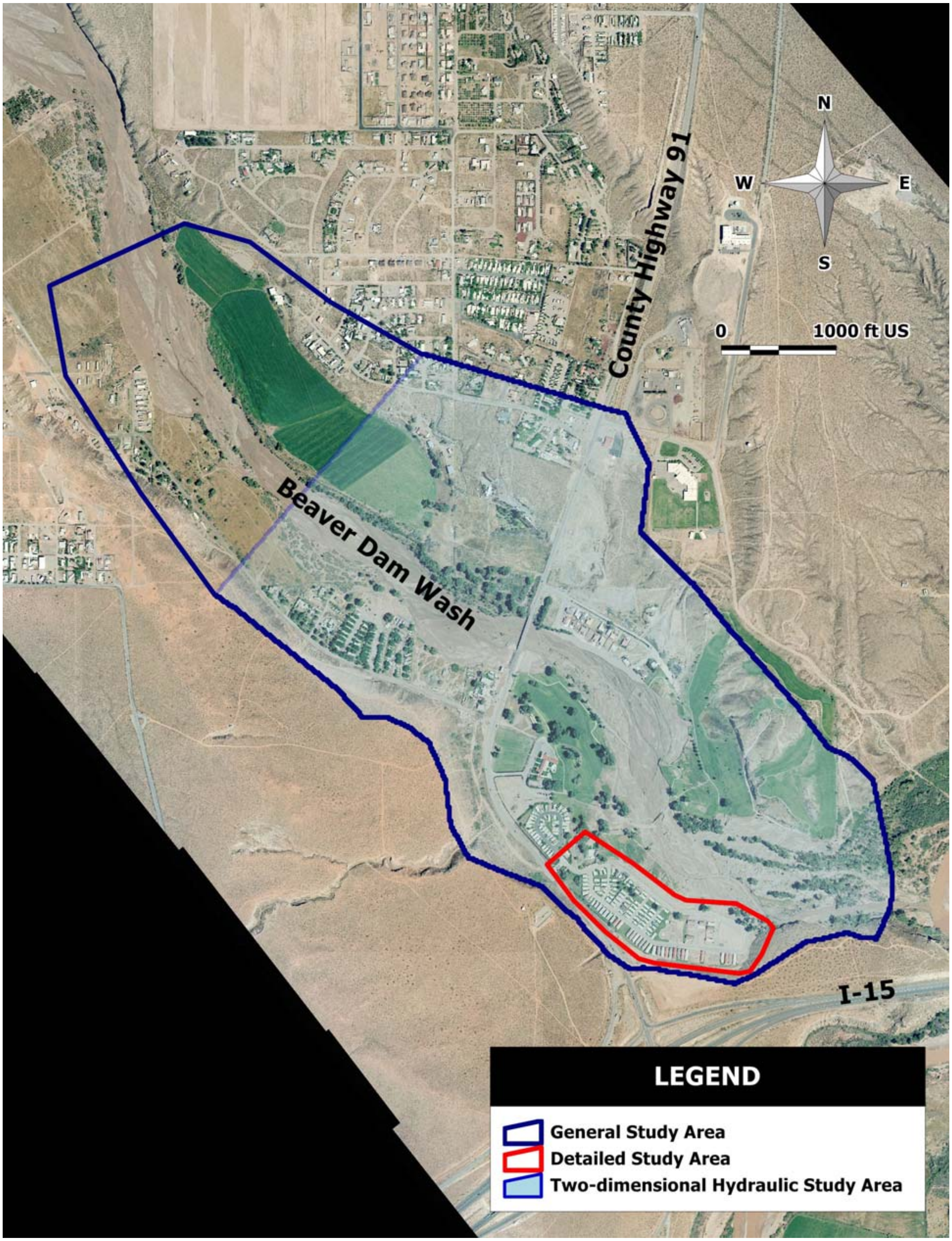


Figure 1.2 Vicinity Map



1.2 Summary of Findings

The results of this study identify fifteen (15) residential structures that are in a very high hazard zone, forty two(42) that are in a high hazard zone, and many others in moderate and low flood hazard zones. The hazard is based on depth-velocity criteria for adults from the U.S. Bureau of Reclamation (USBR, 1988). The existence of these hazards could result in a life threatening situation, based on the information in USBR (1988), if the area is not evacuated in a timely manner during significant flood events. The January 2005 flood was estimated to be in the range of 17,000 to 25,000 cfs. The most likely estimate of the peak discharge is 21,000 cfs, within the limits of the assumptions used as a basis for the evaluation.The maximum available lead time, assuming adequate flood warning facilities and a flood warning plan are in place, is about 6-hours assuming pre-2005 vegetation conditions in the watershed. The current available warning time is significantly shorter than 6 hours due to forest fires that have burned over 40 percent of the watershed since 2005. The current available warning time could be as short as 4 hours, and post-burn peak discharges can be expected to be significantly greater for all storm frequencies than for normal vegetation conditions. Considering these factors, and the number of residents in the area, the conclusion is that flood warning for the Beaver Dam Wash area be given a high priority by the Mohave County Flood Control District. The risk to many homes in the area is high as many of the structure finished floor elevations are below the draft FEMA regulatory water surface elevation and subject to flooding from more frequent storms.

Recommendations for addressing the concerns identified as a result of this study include the following components:

1. Interim regulation of the Beaver Dam Wash floodplain using the technical data from URS (July 2005) as "best available technical data" per FEMA requirements.
2. New flood warning instrumentation in the Beaver Dam Wash watershed.
3. Preparation of a Flood Warning Plan for the residents of Beaver Dam.
4. Investigation into floodproofing, relocation or buyout options that may be available under existing federal programs.
5. Adoption of the new FEMA floodplain delineation study for Beaver Dam Wash as soon as it is approved by FEMA. Regulation of the Beaver Dam Wash floodplain using the technical data from the FEMA study.

1.3 Project Approach

1.3.1 General

A meeting was held with Mohave County staff to discuss the approach to the project. A site visit was also conducted to observe the still-remaining evidence of damage from the January 2005 flood. Data collection became the first order of priority. As a result of the field trip, Arid H&H asked that Mohave County survey: 1) the building locations and finished floor elevations of the residences within the DSA, 2) the location and elevation of high water marks still visible on several of the existing residences, 3) the location and elevation of debris deposited against trees in the area, and 4) as-built the existing bridges including the golf cart bridge, the Highway 91 Bridge, and the I-15 Bridge over the Virgin River. Available hydrologic and hydraulic studies for Beaver Dam Wash, historical topographic mapping and aerial photography in hard copy and/or digital format, and digital hydrologic and hydraulic models of record were obtained. A detailed list of data collected is contained in Section 2. Refer to Section 2 for all references sited in this report.

It was decided at the project coordination meeting that the existing data and computer models of record should be used where possible. The flood risk and hazard evaluation requires a valid design runoff hydrograph in order to evaluate flood warning time at critical locations and flood stages. Also required is a valid hydraulic model of the General Study area. A study by URS for design of the County Highway 91 bridge replacement project was selected as the source for the primary base computer models, topographic mapping, and post-2005 flood aerial photographs. A detailed HEC-1 model of the Beaver Dam Wash watershed was prepared as a part of the URS study and was adapted for use on the project. The URS study also included a HEC-RAS hydraulic model of the Beaver Dam Wash within the General Study Area. URS had the study area flown and prepared post-flood topography of the General Study area, which is available in digital format. This information was used in the flood risk and hazard assessment performed for this project.

This study is intended to assess flood risk, and identify flood hazards based on those risks, for the Beaver Dam area from the Beaver Dam Wash. The hydrologic and hydraulic results are intended for risk assessment and emergency management purposes only. The results of this study should not be considered as “best available technical information” for floodplain management purposes.” Certain limiting assumptions used in the development of the technical basis for this study, including friction loss parameters and model control options designed to produce the upper limit of peak flood stages for a 100-year event, are intentionally very conservative, not reflective of existing conditions, and are therefore not appropriate for regulatory floodplain management uses.

1.3.2 Hydrology

This hydrologic assessment is primarily based on watershed conditions prior to the 2005 and 2006 wildfires that burned over 40 percent of the watershed. The effects of wildfires are relatively short-lived (2- to 10-years), so this information will be valid as a benchmark for estimating the effects of the burned areas on flood hydrology and can also be used after the watershed recovers. Possible effects of the wildfires on flood hydrology and flood hazard are estimated by modifications to the base hydrology models, and then discussed. The approach for the hydrology base model portion of this project was to evaluate the URS HEC-1 model, make adjustments where necessary, and then run the model for multiple frequencies. This information was used to develop a discharge-frequency curve, using values for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storms. FEMA has released a preliminary hydrology report for the new flood insurance study of the Beaver Dam Wash (HDR, 2006). The FEMA study accepts a 100-year peak discharge for the Beaver Dam Wash of 21,000 cfs, based on a statistical analysis of similar watersheds. The relationship between the various storm frequencies from the HEC-1 models was used in conjunction with the FEMA Q_{100} to prepare a revised discharge-frequency curve with Q_{100} equal to 21,000 cfs. The HEC-1 generated hydrograph ordinates for each frequency were then factored to match peak discharges from the new discharge-frequency curve. The adjusted flood hydrographs were then used as input to the hydraulic models. The design storm precipitation distribution was used in conjunction with the runoff hydrograph at the location in question to estimate the hydrologic lead time for emergency response and to relate response time to precipitation on the watershed.

1.3.3 Hydraulics

The approach for hydraulics consisted of preparing hydraulic models that cover the DSA, interpolation of the results to obtain flow depths and velocities at each residence, and use of the model results to estimate at what flow rate and time the critical access routes may be impacted. A review of the URS HEC-RAS model results and the URS topographic mapping show that Beaver Dam Wash in the vicinity of the DSA exhibits two-dimensional (2D) flow characteristics. Flow begins to breakout downstream of the County Highway 91 Bridge and drain into the DSA with the potential for different water surface elevations in the overbank areas than occur in the main wash. Therefore, a 2D model is a more appropriate choice to perform the hydraulics analyses for the purposes of this study.

The FLO-2D computer model was selected for use on this project. FLO-2D is an unsteady, finite difference model with a uniform square grid that works well for situations of this type. The URS topographic mapping includes a digital terrain model (DTM) that was used to generate the Digital Elevation Map (DEM) that FLO-2D requires for input. The FLO-2D model was used to estimate flow depths, velocities, water surface elevations, time of peak, and peak discharges for the 2D study area shown on Figure 1.2. Hydrographs can be computed for every grid element of concern, so the time where each point of interest begins to see flow is automatically generated. The model is accurate to the resolution of the 2D grid and the vertical accuracy of the DTM. The grid size selected for this study was fifteen (15) feet. Very little interpolation was necessary as the required hydraulic parameters are calculated for every 15 foot square grid element. The effects of hydraulic obstructions, such as the structures themselves, were easily included and accounted for in the model.

1.3.4 January 2005 Flood Assessment

The scope of work includes estimation of the peak flow that occurred during the January 2005 flood. The approach is to use the hydraulic models prepared as a part of this study in combination with observed post-flood high marks to estimate a peak discharge. Refer to Section 5.

1.3.5 Flood Hazard Assessment

The flood hazard assessment was accomplished using the results from the hydrology and hydraulics analysis. The following were parameters used to assess the hazard potential at each residence:

6. the storm frequency where flood stage begins to exceed the finished floor elevation,
7. the amount of time between the time of most intense rainfall and the time where flow begins to enter the residence,
8. the depth and velocity of flow at the structure at peak stage, and

9. the depth and velocity of flow near the structure at peak stage that controls emergency access to and from the residence.

These parameters were used in conjunction with evaluation criteria to determine a hazard rating that defines the relative risk between residences. The final products of this report are the hydrologic and hydraulics modeling results, the hazard rating and risk ranking of each residence within the DSA, and GIS coverages that may be used in the second phase of this project. The second phase is the development of methods for addressing and mitigating the identified risks. This will be done in a separate report, if authorized.

2 Data Collection

2.1 Data Collection List

The following sections contain reference listings for the information gathered, organized by source. Refer to this section for citations made in this document. Not all the items listed are directly cited. Those not cited were used to obtain an understanding of changes in the study area over time.

2.1.1 Arizona Department of Transportation

1. Arizona Department of Transportation (ADOT), 1993; *Highway Drainage Design Manual, Hydrology*, Report Number FHWA-AZ93-281.

2.1.2 FLO-2D Software, Inc.

1. FLO-2D Software, Inc (FLO-2D), 2006a; *FLO-2D Data Input Manual, Version 2006.01*; www.flo-2d.com.

2. FLO-2D, 2006b; *FLO-2D Users Manual, Version 2006.01*; www.flo-2d.com.

3. FLO-2D, 2006c; FLO-2D Two-Dimensional Flood Routing Model; www.flo-2d.com.

4. FLO-2D, 2006d; FLO-2D GDS Manual; www.flo-2d.com.

2.1.3 HDR

1. HDR, January 2006; *Draft Technical Memorandum: Hydrologic Analyses, Portions of the Virgin River and Beaver Dam Wash in the Littlefield Area, Mohave County, Arizona*.

2. HDR, December 2006; *Preliminary Hydraulic Work Maps for the Virgin River and Beaver Dam Wash FIS* (7 sheets); Mohave County, AZ. Prepared for FEMA.

2.1.4 KVL Consulting

1. KVL Consulting, 2007; Drainage Design Management System for Windows (DDMSW) Computer Program, version 3.3.2.

2.1.5 Mohave County

1. A/E Intra Group, Inc., August 7, 1986; Beaver Dam Wash Resort and R.V. Park Drainage Report.

2. L.R. Pope Engineering, November 26, 1997; *Flood Study for Beaver Dam Wash in Littlefield*, Arizona.

3. Leslie & Associates, July 1991; *Detailed Drainage Report for Beaver Dam Estates*.

4. Mohave County, fall 2000; 2-foot pixel color aerial ortho-photograph of a portion of the General Study Area; Mohave County records (BMP format, State Plane Ground Coordinates NAD 83 horizontal datum, NV East, US Survey feet).

5. Mohave County, fall 2004; 1-foot pixel color aerial ortho-photograph of a portion of the General Study Area; Mohave County records (MRSid format, State Plane Ground Coordinates NAD 83 horizontal datum, NV East, US Survey feet).

6. Mohave County, spring 2005; 1-foot pixel color aerial ortho-photograph of a portion of the General Study Area; Mohave County records (MRSid format, State Plane Ground Coordinates NAD 83 horizontal datum, NV East, US Survey feet).

7. Owens Surveying Outfit, Inc., April 18, 2007; *Beaver Dam Wash Flood Control Survey*. Field survey data of DSA including building locations, finished floor elevations, high water marks, as-built information at the County Highway 91 Bridge, the Golf Course Bridge, and the I-15 bridge over the Virgin River.

8. U.S. Geological Survey (USGS), 2005; USGS DOQQs, 1-foot pixel color aerial ortho-photograph of the General Study Area; Mohave County records (MRSid format, UTM NAD 83 horizontal datum, Zone 12, meters).

9. R.W. Holmquist & Associates and Kenney Aerial Mapping Inc., January 9, 1997; Virgin River/Beaver Dam Topographic Mapping, 2-foot contour interval, TIFF images scanned from hard copy.

10. Mohave County, September 19, 2006; Mohave County Assessors Parcel Coverage of Book 404; Mohave County GIS in ESRI Shape file format, State Plane Coordinate System, NAD 83 horizontal datum, AZ West, US Survey feet.

2.1.6 National Oceanic and Atmospheric Administration (NOAA)

1. National Geodetic Survey (NGS), October 8, 2006; *NGS Data Sheets for BEAVER, K 55, LITTLEFIELD and ML 9*.

2. Bonnin, G.M. et al, National Oceanic and Atmospheric Administration; 2004; *NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 1: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah), including Appendix A1.* Source: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_docs.html. Digital Adobe PDF file.

2.1.7 PBS&J

1. PBS&J, for Bureau of Land Management, Ely Field Office; *September 2007; Post-Fire Flood Hazard Assessment, Meadow Valley Wash and Beaver Dam Wash*. Source: Mohave County.

2.1.8 URS Corporation

1. URS, July 2005a; *Beaver Dam Wash Bridge Hydrology Report.* This report includes the HEC-1 model used as a base model for the flood hazard assessment.

2. URS, July 2005b; *Beaver Dam Wash Bridge Hydraulic Report for Existing Bridge.* This report includes the HEC-RAS model used as a base model for the one-dimensional (1D) flood hazard assessment.

3. URS, July 2005c; *Beaver Dam Wash Bridge Alternative Analysis Report.* This report includes final HEC-RAS models with the new proposed bridge in place.

4. URS, 2005a; *Aerial mapping major control points in both ground and grid coordinates*. Received September 9, 2006.

5. URS, 2005b; *HEC-RAS cross section alignments, 100-year existing condition floodplain limits, and the HEC-RAS thalweg location*. The data was provided in State Plane Ground Coordinates NAD 83 horizontal datum, AZ West, International feet, NAD88 vertical datum, and in ESRI Shape file and AutoCAD DWG format

6. AMEC Earth & Environmental. Inc. (AMEC), April 21, 2005; *Geotechnical Investigation, Beaver Dam Wash Bridge, Distress Evaluation, Beaver Dam.*

7. AMEC, June 17, 2005; *Geotechnical Investigation Report, Beaver Dam Wash Bridge, Mohave County Highway 91, Mohave County, Arizona*.

8. Cooper Aerial Surveys (Cooper), July 2005; *Topographic mapping of the study area*. The aerial flight date was April 22, 2005. The mapping was provided in State Plane Ground Coordinates NAD 83 horizontal datum, AZ West, International feet, NAD88 vertical datum, and in ESRI Shape file and AutoCAD DWG format, including:

   A. Digital Terrain Model including grid, break line, and spot elevation data.

   B. 100-scale 2-foot contour mapping of the General Study Area.

   C. 40-scale 1-foot contour mapping of the area immediately upstream and downstream of the County Highway 91 bridge over Beaver Dam Wash.

   D. Topography of the study area including wash thalwegs, tree locations, structure outlines, concrete and road outlines, and many other visible features.

   E. 1-foot pixel color aerial photographs of the General Study Area in TIFF format.

2.1.9 US Bureau of Reclamation

1. USBR, *Downstream Hazard Classification Guidelines, ACER Technical Memorandum No. 11*, 1988.

2.1.10 US Geological Survey

1. USGS Quad Maps, various dates; *USGS 7.5 M 1:24,000 Quadrangle Maps Covering the Beaver Dam Watershed*; in GeoTIFF format, UTM NAD83, Zones 11 and 12, meters.

2. USGS DEM's, various dates; *USGS 10-meter Digital Elevation Maps Covering the Beaver Dam Watershed*; in DEM format, UTM NAD83, Zones 11 and 12, meters.

3. USGS Gage Record, February 6, 1993 – September 30, 2006; *USGS Surface-Water Daily Maximum Flow Rate for Gage 09414900 Beaver Dam Wash at Beaver Dam, AZ*; http://.waterdat.usgs.gov.

2.1.11 Virgin Valley Water Users Association

1. Horizon's, Inc., undated; *LIDAR Acquisition/Processing/Quality Control Report, Virgin River.*

2. Horizon's, Inc., July 7, 2005; *Analytical Aerial Triangulation Summary, BOR-Lower Colorado Region: Virgin River, NV.*

3. Horizon's, Inc., June 7-9, 2005; LIDAR raw and post-processed digital elevation spot height data in UTM Zone 11, NAD83, NAVD88, meters.

4. Horizon's, Inc., June 7-9, 2005; 0.6 meter pixel color digital aerial photographs of a portion of the General Study Area.

5. U.S. Bureau of Reclamation (USBR), February 8, 2005; Aerial flight video of the aftereffects of the January 2005 flood on the Virgin River and Beaver Dam Wash taken during a helicopter flight.

2.2 Digital Data Re-projection

Mohave County uses a standard GIS data coordinate system and geographic projection. This is:

State Plane Coordinate System (grid coordinates), NAD 83, AZ West, US Survey feet, X and Y scale factor: 0.99993333, false easting: 699998.60, false northing: 0.00.

Most of the data obtained was in a differing projection and coordinate system. In particular, the URS data was in ground coordinates, not grid coordinates. In order to use this data effectively with the other data collected, all of the URS GIS data was converted to the standard Mohave County projection and coordinate system. This was accomplished using the aerial mapping major control point information (URS, 2005a). The URS data was shifted and transformed using an affine transformation in GIS.

The MRSid and TIFF format aerial photographs were converted to ECW format and re-projected to the Mohave County standard. The USGS quadrangle maps and DEMs were left in the provided format. Data generated using this information was re-projected to the Mohave County standard.

3 Hydrology

3.1 General

The hydrology portion of this study was done with two objectives in mind. The first was to obtain a relationship between precipitation falling on the watershed (and the time that precipitation occurs) and the corresponding runoff versus time at the DSA. This information is needed for estimating available emergency response times for different precipitation scenarios. Second, the frequency of runoff affecting the DSA is needed in order to estimate the severity of the hazard in relation to the largest flood of record that occurred in January 2005. To accomplish the first objective, a rainfall-runoff model of the watershed was needed. The information of record was researched, and it was determined that the existing HEC-1 models prepared by URS (URS, 2005a) could be used for this purpose.

The second objective was met by information provided by FEMA. FEMA has a flood insurance study in progress for the Beaver Dam Wash and the hydrology for that study has been published as a draft technical memorandum (HDR, 2006). Estimates of peak discharge for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storms are provided.

Finally, the results of the HEC-1 modeling were checked against the flood-frequency data provided by FEMA. There needed to be reasonable correlation between the HEC-1 peak discharges and those accepted by FEMA. If a reasonable correlation was found, then the hydrographs from the HEC-1 models could be adjusted to match the FEMA peak discharges estimated for storm frequencies of interest.

3.2 Base HEC-1 Model

An HEC-1 model of the Beaver Dam Wash watershed is needed for the flood hazard analysis for two reasons. First, hydrographs are needed for input to the two-dimensional flow model. Second, the relationship between the time of peak rainfall intensity and the time of various points along the rising limb of the runoff hydrograph is needed for estimating flood warning and emergency response time. Rather than create a new HEC-1 model of the watershed, an existing model of record was evaluated for use in this study.

URS prepared a series of HEC-1 models of the Beaver Dam Wash watershed (URS, 2005a). The lowest concentration point is the County Highway 91 bridge. Models were developed for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storms. The models were prepared using the ADOT Hydrology Manual standard methodology. The models were based on the following parameters and accepted for use for this project, with modifications as described in the following section.

Rainfall:	NOAA Atlas 2 for Arizona.
Losses:	Green and Ampt rainfall loss method.
Routing:	Normal depth-Modified Puls method.
T_c:	ADOT time of concentration method.

3.3 Adjustments Made to Base Model

3.3.1 Watershed

The USGS DEMs covering the Beaver Dam Wash watershed were downloaded and used to re-delineate the watershed. The same sub-basin concentration points established by URS were used. The results were then checked against the URS delineation. There were measurable differences, but none large enough to warrant re-computing the various watershed parameters. The URS sub-basin delineation was accepted for use on this study. The Beaver Dam Wash watershed, using the delineation done as a part of this study, is shown on Figure 3.1 and Figure 3.2.

Figure 3.1 Beaver Dam Wash at County Highway 91 Watershed Map - DEMs

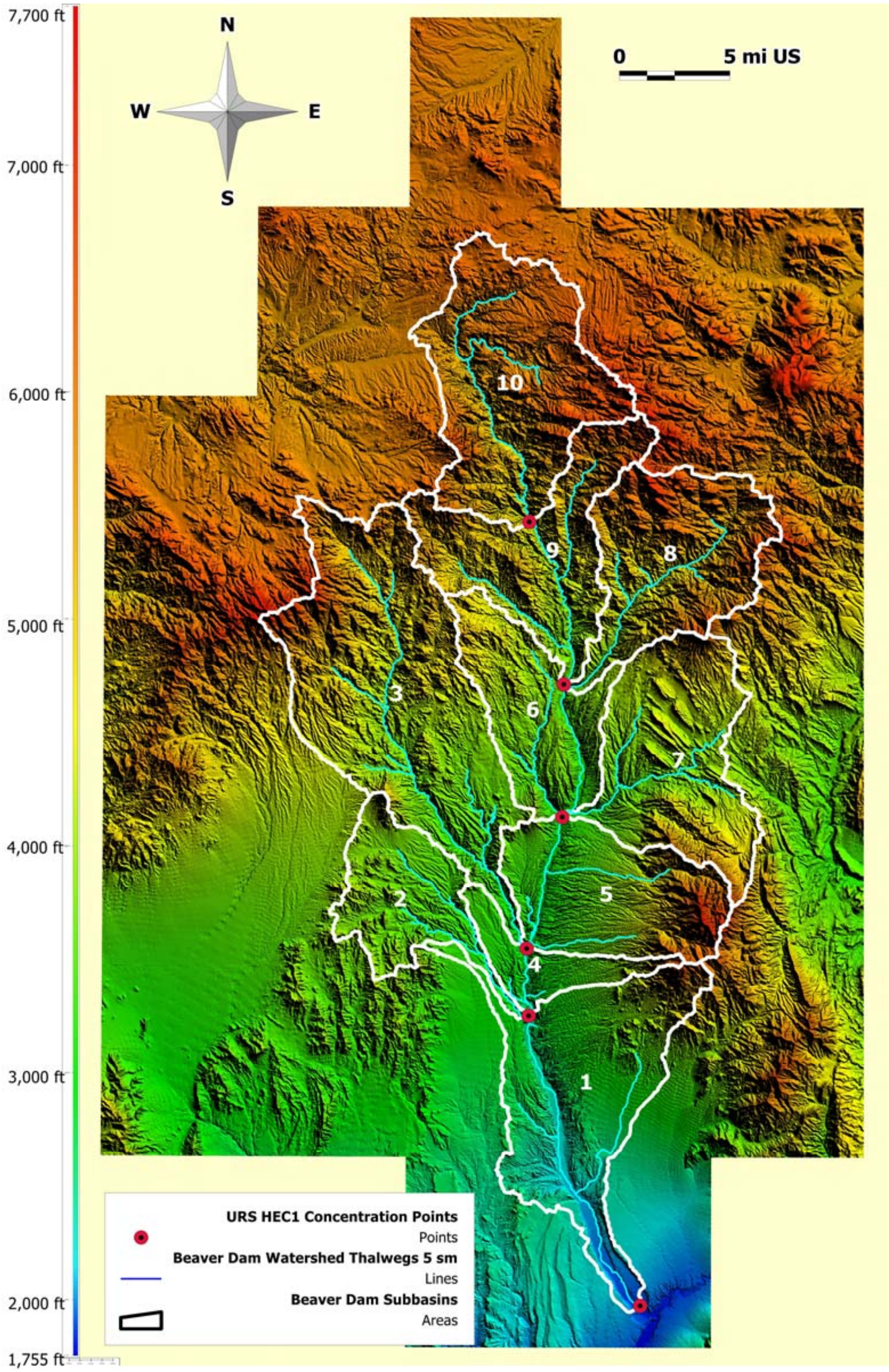
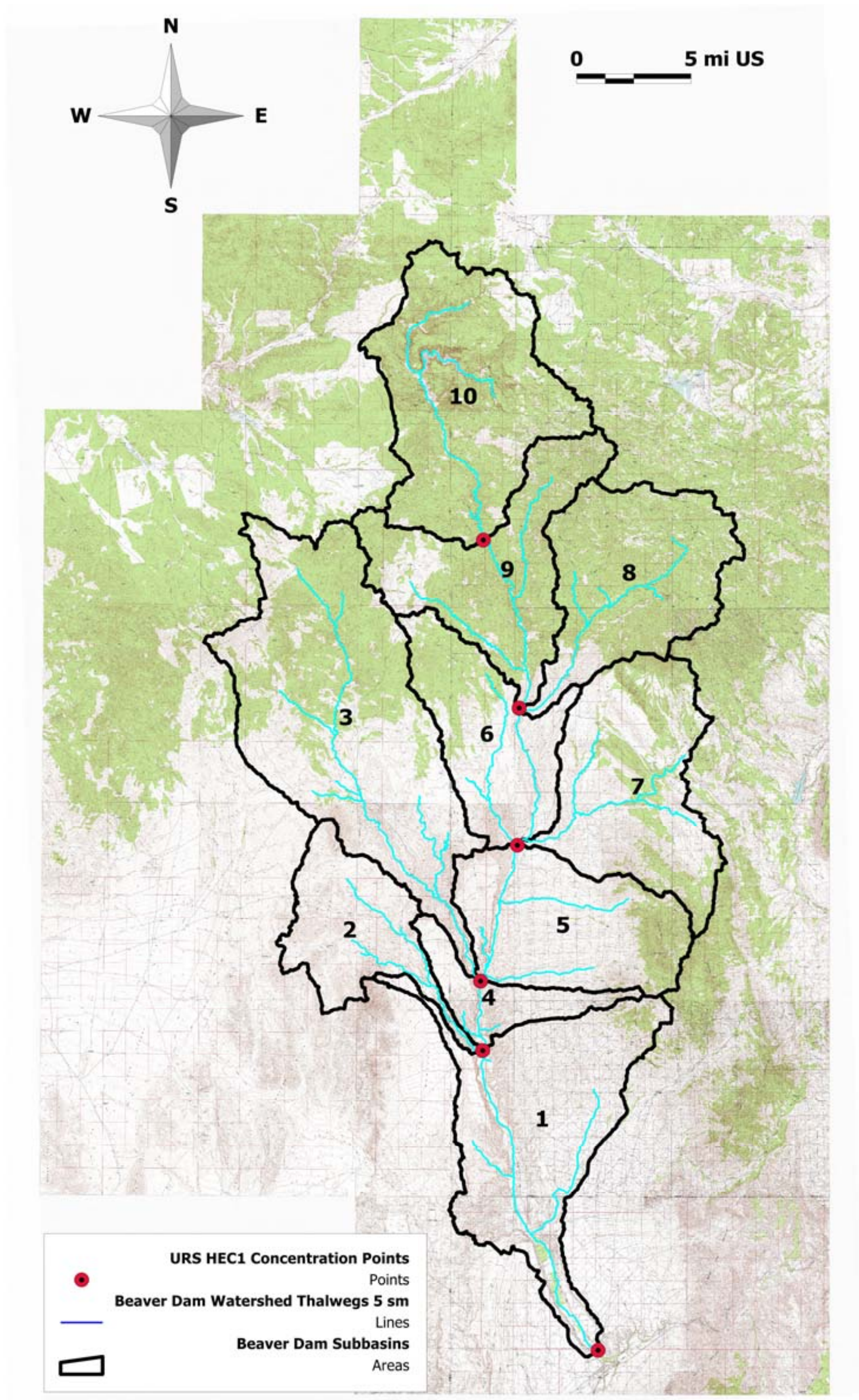


Figure 3.2 Beaver Dam Wash at County Highway 91 Watershed Map - Quads



3.3.2 Precipitation

Precipitation Atlas. It is anticipated that Mohave County will soon be adopting NOAA Atlas 14 for use county-wide. NOAA Atlas 14 is the most current precipitation-frequency atlas produced by NOAA for Arizona, Utah and Nevada. After consultation with Mohave County staff, it was decided to use NOAA Atlas 14 (Bonnin et al, 2004) for this study instead of NOAA Atlas 2. It was also decided to use the 24-hour duration storm for modeling estimates of peak discharge from the Beaver Dam Wash watershed. Average point precipitation values for each sub-basin were obtained from the NOAA Atlas 14 web site. This was done using latitude and longitude coordinates for the centroid of each sub-basin, obtained using GIS to compute the centroid from the sub-basin polygons generated from the work described in Section 3.3.1. Refer to Appendix B for isohyetal maps of the Beaver Dam Wash watershed for each storm recurrence interval of 24-hour duration. The 24-hour point precipitation values for each sub-basin, used in the HEC-1 models of the watershed, are shown in Table 3.1.

Table 3.1 NOAA Atlas 14 24-hour precipitation in inches for each sub-basin

Sub-basin	Area, sm	Recurrence interval in years							
		2	5	10	25	50	100	200	500
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	76.0	1.36	1.73	2.01	2.40	2.70	3.00	3.31	3.73
2	33.4	1.51	1.94	2.26	2.71	3.05	3.40	3.75	4.23
3	111.0	1.56	1.97	2.30	2.75	3.10	3.45	3.82	4.31
4	16.5	1.40	1.78	2.07	2.47	2.78	3.09	3.41	3.84
5	51.5	1.56	1.98	2.31	2.75	3.10	3.46	3.82	4.31
6	41.5	1.49	1.88	2.18	2.60	2.93	3.26	3.60	4.06
7	60.3	1.49	1.87	2.17	2.59	2.91	3.24	3.58	4.04
8	55.7	1.78	2.25	2.62	3.13	3.53	3.94	4.36	4.93
9	54.3	1.57	1.98	2.30	2.75	3.10	3.45	3.81	4.30
10	76.6	1.81	2.30	2.68	3.21	3.63	4.05	4.49	5.08
Total:	**576.8**								
Watershed Average:		**1.57**	**1.99**	**2.31**	**2.76**	**3.12**	**3.47**	**3.84**	**4.33**

Precipitation Distribution. The hypothetical rainfall distribution was used for the HEC-1 modeling (ADOT, 1993). Input was done using the HEC-1 PH record. The NOAA Atlas 14 point rainfall data was used to prepare new HEC-1 PH records for each sub-basin for each frequency. The 50 percent average confidence interval precipitation frequency data for each sub-basin is contained in Appendix B in Table B.1. The 50 percent average precipitation frequency tables were used to prepare the HEC-1 PH records. Refer to the HEC-1 output files in Appendix C for the individual sub-basin PH records. Plots of the hypothetical rainfall distribution for each sub-basin for the 100-year 24-hour storm are shown on Figure 3.3 and Figure 3.4. The rainfall distributions for the lower watershed (sub-basins 1, 2, 4, and 5) are of similar intensity at the center of the storm to the upper watershed (sub-basins 3 and 6-10). The higher elevation sub-basins (sub-basins 8 and 10) have higher precipitation totals leading up to the most intense portion of the storm, and higher total precipitation.

3.3.3 Rainfall Losses

Rainfall losses were estimated by URS in the base models using the Green and Ampt method, as described in ADOT (1993). URS used available soils information from the NRCS to estimate Green and Ampt parameters for each sub-basin (URS, July 2005a). The values selected by URS are listed in columns 3-7 of Table 3.2. The URS XKSAT values were checked for reasonableness and accepted for use in this study. The initial abstraction, IA, was selected by URS assuming all watersheds have a desert/hillslope terrain class.

3.3.4 Time of Concentration

URS estimated time of concentration (T_c) using the desert/mountain equation from ADOT (1993). The values were checked for reasonableness and accepted for use in this study. Refer to Table 3.2 for a listing of the URS T_c estimates and the accompanying storage coefficient, R.

Figure 3.3 100-year 24-hour rainfall distributions for the lower watershed

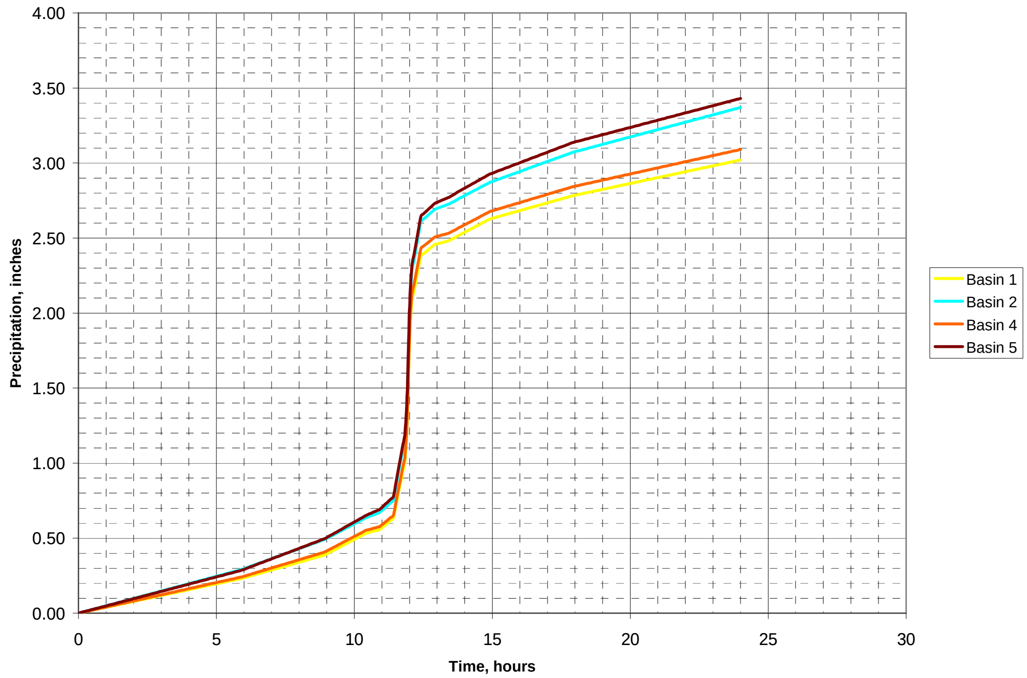


Figure 3.4 100-year 24-hour rainfall distributions for the upper watershed

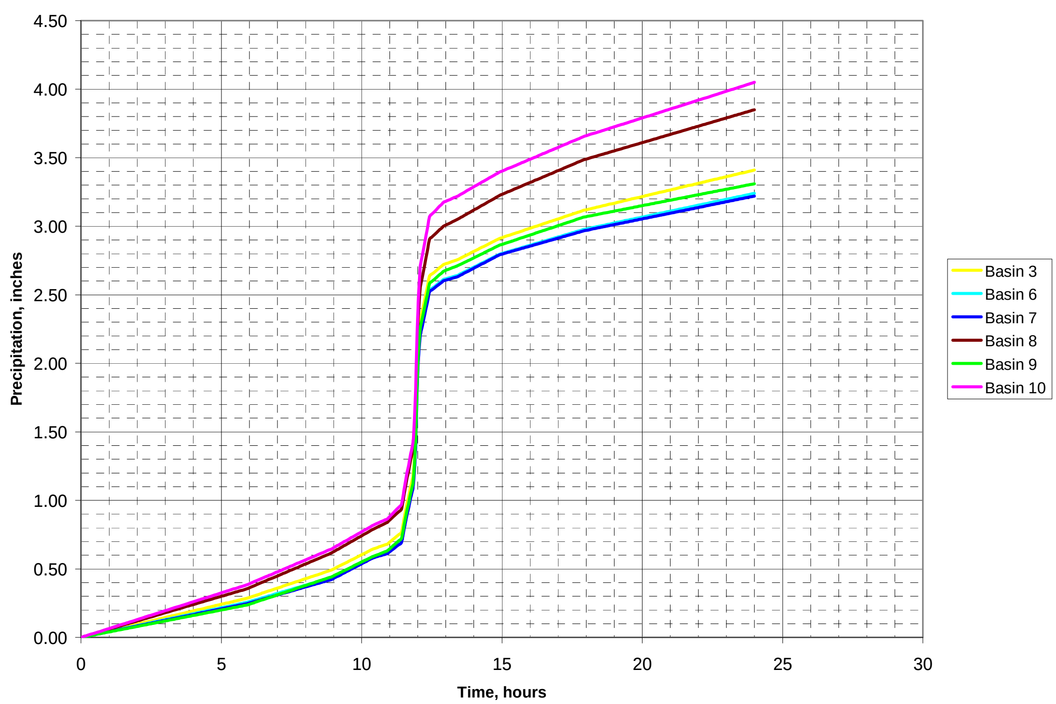


Table 3.2 Summary of HEC-1 sub-basin parameters (URS, July 2005a)								
Sub-basin	Area (sm)	IA (inches)	Adjusted XKSAT (inches)	PSIF (Inches)	DTHETA	RTIMP	T_c (hrs)	R (hrs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	76.0	0.15	0.33	4.5	0.35	2.73	4.8	2.00
2	33.4	0.15	0.34	4.4	0.35	0.00	3.97	2.06
3	111.0	0.15	0.17	6.5	0.38	0.00	6.97	3.13
4	16.5	0.15	0.32	4.5	0.35	1.01	2.38	1.18
5	51.5	0.15	0.37	4.3	0.35	0.00	3.81	1.57
6	41.5	0.15	0.23	5.5	0.38	2.55	3.99	1.83
7	60.3	0.15	0.28	4.9	0.35	14.70	3.89	1.48
8	55.7	0.15	0.48	4.0	0.35	0.00	4.43	1.79
9	54.3	0.15	0.24	5.7	0.39	0.00	3.80	1.62
10	76.6	0.15	0.29	5.1	0.36	11.40	6.07	2.79

3.3.5 Routing

The URS base HEC-1 models use the normal depth Modified Puls method to route sub-basin hydrographs through downstream channel reaches. The 8-point cross sections, slopes, and roughness coefficients were examined for reasonableness and accepted for use in this study. The other key parameter, NSTEPS, required adjustment. NSTEPS is the HEC-1 variable name for the number of sub-sections the routing reach is divided into for performing the Modified Puls reservoir route operation. The value of NSTEPS for each reach was found to be unreasonable, and the NSTEPS value needed to be optimized (refer to ADOT, 1993, Chapter 8). The value of NSTEPS used for the hydrograph routing operation is very important for the purposes of this study as it affects travel time through the watershed, which directly affects the estimated flood warning response time. NSTEPS also affects the peak discharge downstream.

Optimization of NSTEPS can be accomplished by making an initial estimate of NSTEPS for the reach, then running the HEC-1 model. The resulting travel time through the reach computed by HEC-1 is then used to make a new estimate of NSTEPS using the following equation:

$$NSTEPS = \frac{(TT)(60)}{NMIN} \tag{3.1}$$

where:

TT = Reach travel time computed by HEC-1, in hours

NMIN = HEC-1 model main time increment, in minutes

The new estimate of NSTEPS is then entered into the HEC-1 input file, and a new run made. The process is repeated until the NSTEPS value corresponding to the HEC-1 computed travel time matches the previous estimate, plus or minus one time step. This process can be automated using the DDMSW computer program (KVL Consulting, 2007). DDMSW was used to optimize the routing steps for each reach for all seven HEC-1 models. A comparison of results from the URS HEC-1 100-year storm model with that used for this study is shown in Table 3.3. Note that many of the frontal wave celerities from the URS model in column 10 are unreasonable. The optimized results in column 11 are much more reasonable. Also note that the differences in times to peak in columns 6 and 7. They vary by as much as 0.75 hours at reach 4UP, and 0.42 hours at the County Highway 91 Bridge (bottom of reach 1LOW).

Table 3.3 Comparison of 100-year HEC-1 routing reach parameters and results

			NSTEPS		T_p, hours		Routed Q, cfs		Celerity, fps	
Reach	Length, ft	Slope, ft/ft	URS	Arid H&H	URS	Arid H&H	URS	Arid H&H	URS	Arid H&H
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
9UP	41,282	0.0140	2	8	17.50	17.50	6,530	6,701	69	17
9LOW	11,913	0.0104	2	5	18.00	17.92	6,480	6,687	20	8
6UP	14,202	0.0113	2	7	16.20	16.33	12,702	11,586	24	7
6LOW	21,503	0.0102	3	8	16.90	17.00	12,435	11,518	24	9
5UP	18,610	0.0111	2	7	16.60	17.17	20,913	17,192	31	9
5MID	8,769	0.0116	2	2	16.80	17.33	20,842	17,097	15	15
5LOW	8,049	0.0102	2	3	17.00	17.58	20,791	17,059	13	9
4UP	9,425	0.0095	2	4	17.00	17.75	30,783	25,014	16	8

Table 3.3 Comparison of 100-year HEC-1 routing reach parameters and results

Reach	Length, ft	Slope, ft/ft	NSTEPS		T_p, hours		Routed Q, cfs		Celerity, fps	
			URS	Arid H&H	URS	Arid H&H	URS	Arid H&H	URS	Arid H&H
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
4MID	3,665	0.0109	1	1	17.10	17.83	30,767	24,997	12	12
4LOW	4,442	0.0101	1	1	17.20	17.92	30,742	24,973	15	15
1UP	49,818	0.0099	3	19	18.80	19.33	30,126	25,669	55	9
1LOW	29,796	0.0079	3	13	20.00	20.42	29,135	25,473	33	8

3.4 Base Model Results

The results of the modified HEC-1 model for each storm frequency at the County Highway 91 Bridge crossing of Beaver Dam Wash are shown in Table 3.4. Column 2 contains the watershed average precipitation value corresponding with the storm frequency in column 1. Column 3 contains the watershed rainfall excess value corresponding with the runoff volume shown in column 6. The time to peak is listed in column 4 and the corresponding peak discharge in column 5. Note that the time to peak varies from 25.75 hours for the frequent 2-year storm, to 20.33 hours for the infrequent 100-year storm. Also note that the estimated peak discharge of 26,100 cfs corresponding with the 100-year precipitation input is about 24 percent greater than the 100-year peak discharge estimate of 21,000 cfs adopted by FEMA based on a stream gage statistical frequency analysis (refer to HDR, 2006). Refer to Appendix C for HEC-1 input and output files from the various models.

Table 3.4 HEC-1 model results at the County Highway 91 bridge

NOAA Atlas 14		HEC-1 Model Results			
Recurrence Interval, yrs	Precipitation, inches	Rainfall Excess, inches	Time to Peak, hours	Peak Discharge, cfs	Runoff Volume, ac-ft
(1)	(2)	(3)	(4)	(5)	(6)
2	1.57	0.063	25.75	1,580	1,930

Table 3.4 HEC-1 model results at the County Highway 91 bridge					
NOAA Atlas 14		**HEC-1 Model Results**			
Recurrence Interval, yrs	**Precipitation, inches**	**Rainfall Excess, inches**	**Time to Peak, hours**	**Peak Discharge, cfs**	**Runoff Volume, ac-ft**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
5	1.99	0.127	24.00	3,809	3,895
10	2.31	0.192	21.67	6,374	5,913
25	2.76	0.328	21.25	11,464	9,781
50	3.12	0.449	20.67	17,606	13,810
100	3.47	0.623	20.33	26,134	19,172
200	3.84	0.841	19.67	38,380	25,869
500	4.33	1.186	18.83	59,380	36,495

A discharge versus frequency curve is needed for the flood hazard analysis for the purposes of estimating the frequency at which the structures in question and their access routes may be flooded. The results of the HEC-1 models for each frequency are compared with the FEMA estimates in Table 3.5, and are compared graphically in Figure 3.5. As can be seen from Figure 3.5, both sets of frequency results plot in a straight line and compare favorably between the 10- and 100-year frequencies. Outside that range, they begin to diverge. Since the area of interest is predominately between the 25-year and 100-year frequencies, the two sets of results are in close agreement. The FEMA discharge frequency curve will be used for this study, and hydrographs needed are taken from the HEC-1 model results and scaled to match the corresponding FEMA peak discharge. The HEC-1 100-year storm hydrograph, scaled to match the FEMA 100-year peak discharge of 21,000 cfs, is shown on Figure 3.6. Similar hydrographs were prepared for the other storm frequencies.

Estimates of the 100-year peak discharge for Beaver Dam Wash from previous studies of record are listed in Table 3.5 for comparison with the draft FEMA value of 21,000 cfs. Note that previous estimates were significantly lower than the FEMA estimate, except for URS (2006). The FEMA estimate appears more reasonable than the previous studies, especially in light of the January 2005 flood.

Table 3.5 Comparison of estimated flood frequency peak discharges at the County Highway 91 bridge

Recurrence Interval	HEC-1 Peak Discharge, cfs	FEMA Flood Frequency Peak Discharge, cfs (HDR,2006)
(1)	(2)	(5)
2	1,580	2,040
5	3,809	4,860
10	6,374	7,500
25	11,464	11,990
50	17,606	16,040
100	26,134	21,000
200	38,380	---
500	59,380	36,480

Table 3.6 100-year peak discharges from previous studies

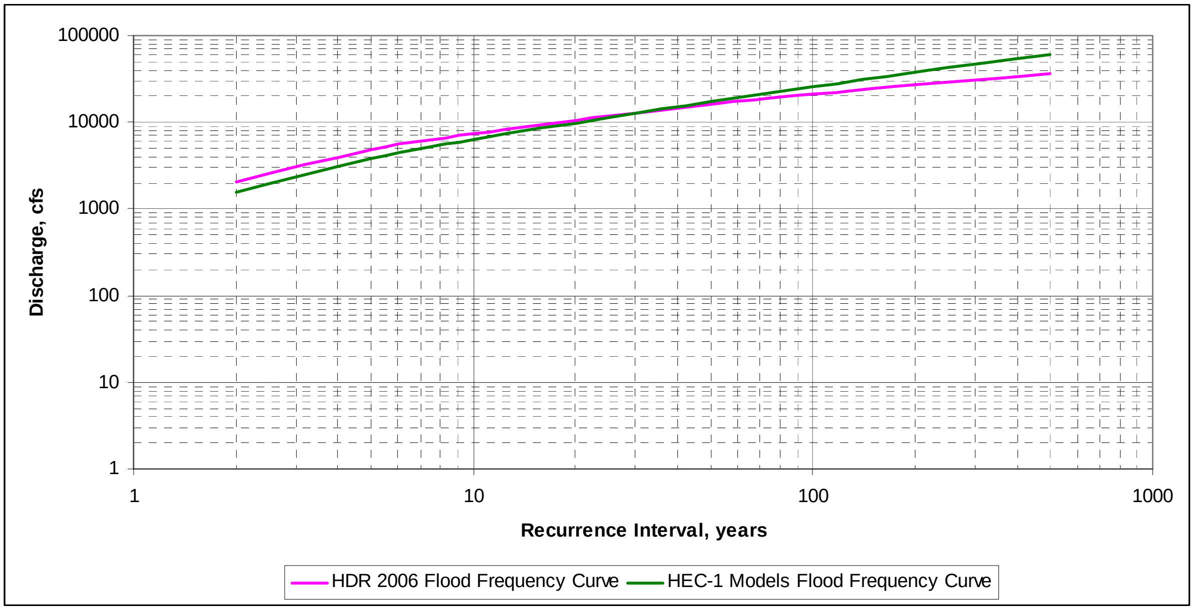
Study	100-year Peak Discharge, cfs	Watershed Area, sm
(1)	(2)	(3)
FEMA (2007)	21,000	575
URS (2006)	30,400	577
L.R. Pope Engineering (1997)	Accepted A/E Intra Group Discharge	586
Leslie & Associates (1991)	12,300	574
U.S. Army Corps of Engineers (1988)[1]	21,000	575
A/E Intra Group, Inv (1986)	12,300	586
FEMA (1982)	Zone A, Q not available	---

The A/E Intra Group stated in their 1986 report that "*The Beaver Dam Wash Resort and R.V. Park drainage study produced a defined flood plain through the development area. That flood plain (both improved and unimproved) is shown on Figures IV-l and IV-2. Without some*

[1] As referenced in FEMA (2007)

channel improvements, the flood plain encroaches on the proposed development in various areas as shown. To modify this circumstance, an embankment along the development's easterly edge is proposed". It is apparent from this statement that the DSA was understood to be subject to flooding from peak flow rates as low as 12,300 cfs unless comprehensive structural features were constructed.

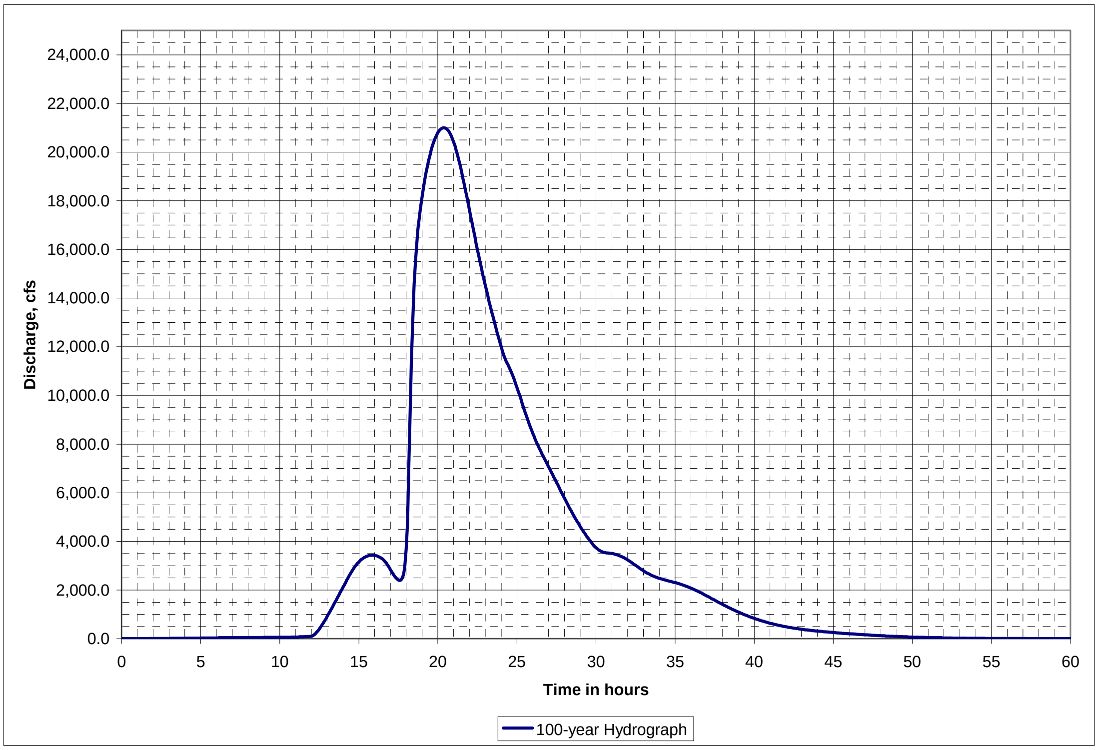
Figure 3.5 Peak discharge versus recurrence interval for Beaver Dam Wash at the County Highway 91 bridge



Another key hydrologic parameter needed for the flood hazard assessment is the relationship between precipitation occurring over the watershed and resulting peak discharges in the Beaver Dam Wash in the DSA. A plot of watershed-averaged 24-hour storm precipitation and resulting peak discharge at the County Highway 91 Bridge is shown on Figure 3.7. This figure can be used for estimating the peak discharge in the DSA from forecast or real-time precipitation, in conjunction with forecast or measured precipitation intensity. Keep in mind that this figure is based on the HEC-1 model results, not the FEMA flood-frequency estimates.

The relationship between rainfall, time and runoff is extremely important for flood warning purposes. A response of the Beaver Dam Wash watershed to precipitation is shown on Figure 3.8. This is a plot of 100-year 24-hour cumulative rainfall in inches for sub-basin 10 with the 100-year 24 hour storm runoff hydrograph at County Highway 91.

Figure 3.6 Adjusted 100-year hydrograph at County Highway 91 bridge



Using this figure, the difference between the time of most intense precipitation and the time various flow rates on the rising limb of the hydrograph can be measured. This graph will be used in conjunction with the hydraulic calculations for estimating hydrologic response time for flood warning purposes.

3.5 Post-Wildfire Hydrology Description and Results

The base HEC-1 models were adjusted to reflect post-fire conditions from the wildfires that occurred on the Beaver Dam Wash watershed in 2005 and 2006. A qualitative analysis of the post-burn conditions was found in PBS&J (2007). Refer to Figure 3.9 for the burn limits for the wildfires occurring in 2005-2006. According to this reference, hydrophobic soils were typically not found, except immediately under the canopy of Pinyon-Juniper vegetation. Primarily, virtually all vegetation canopy cover was removed within the burn areas. The PBS&J investigators found that where the vegetation cover was removed, the watershed has responded with increased sedimentation and the formation of new rills, gullies, and channels. They also noted that surface roughness was dramatically decreased.

Figure 3.7 Watershed average 24-hour precipitation versus peak discharge (at County Highway 91 bridge, using the HEC-1 hypothetical rainfall distribution)

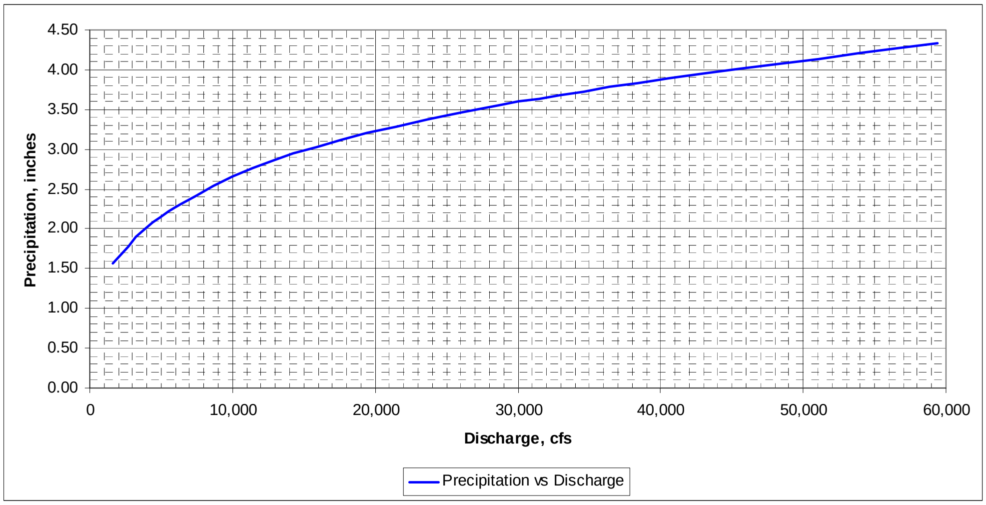


Figure 3.8 Sub-basin 10 rainfall distribution and 100-year hydrograph at County Highway 91 bridge

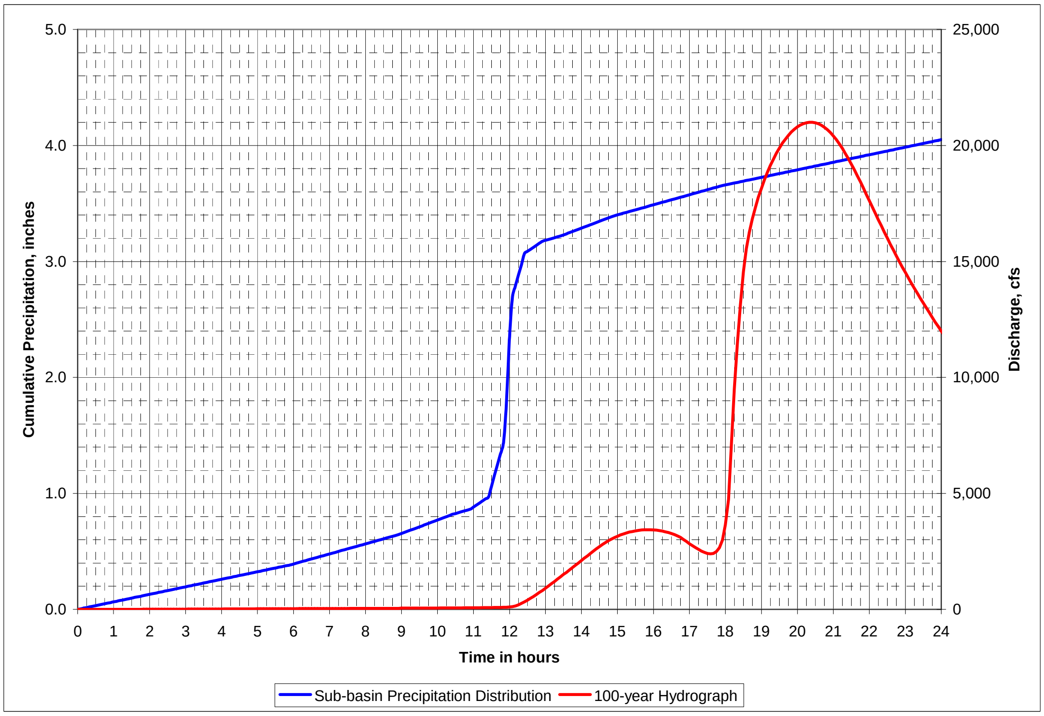


Figure 3.9 Fire History 2005-2006 (Source: PBS&J, 2007, Figure 2)

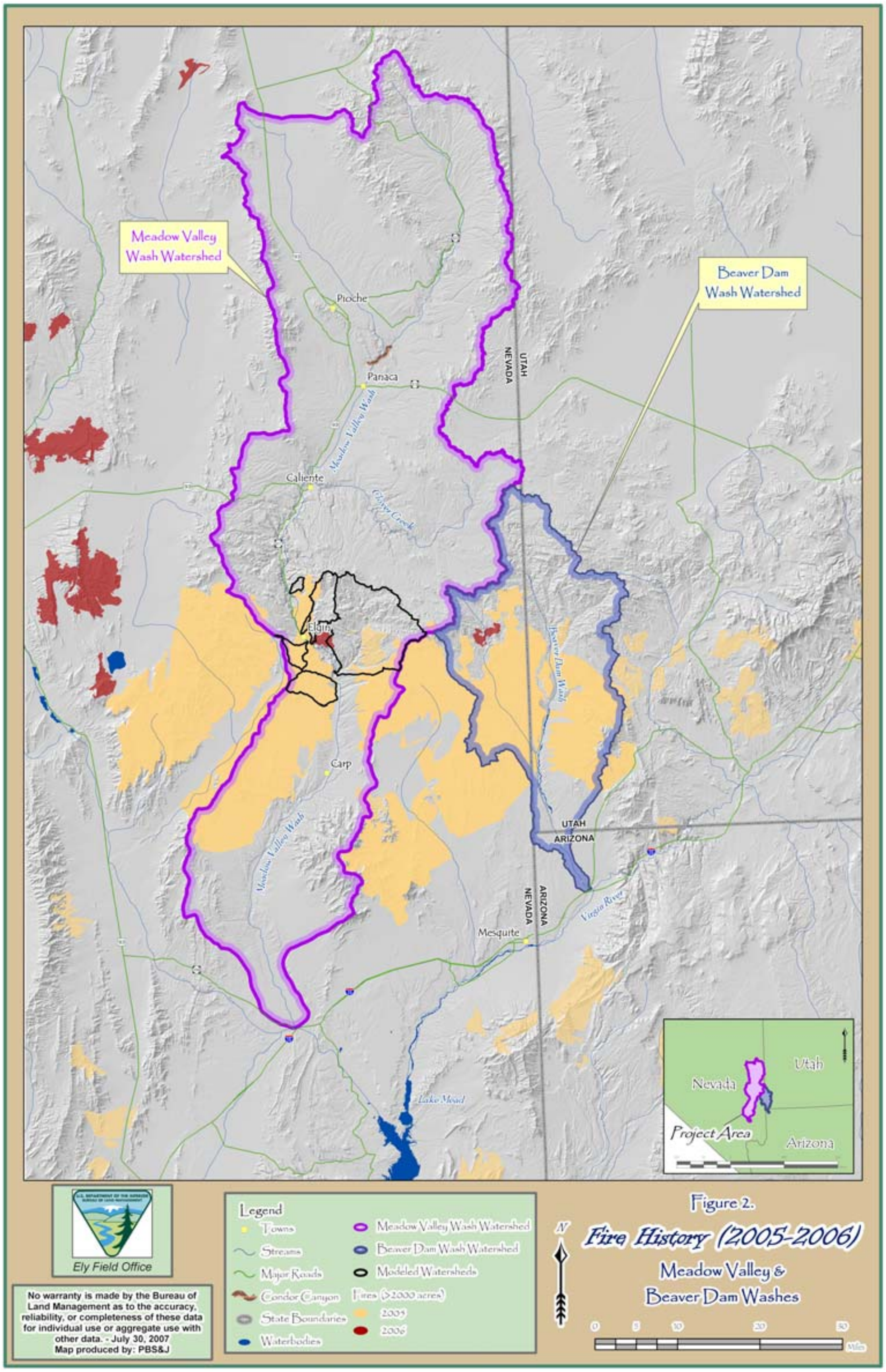
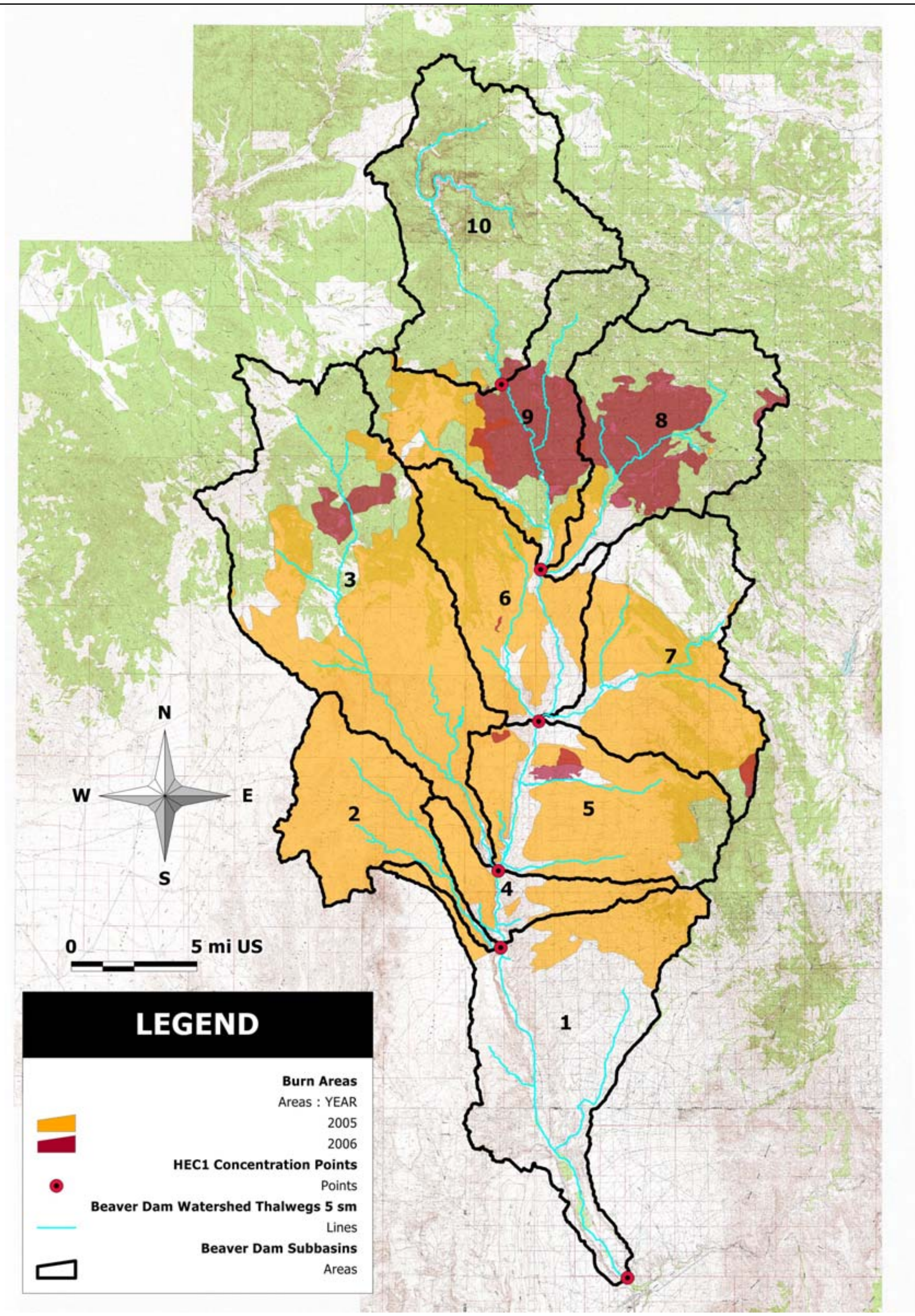


Figure 3.10 2005 and 2006 fire burn areas for Beaver Dam Wash



The combination of removal of the canopy cover and increased hydraulic efficiency results in lower rainfall losses and higher velocities and peak discharges. To simulate the changes in infiltration, the effects of vegetation canopy on XKSAT in the base models should be removed from the affected HEC-1 model sub-basins. There is no documentation of actual vegetation cover densities used in URS (July 2005a). It appears that no vegetation cover correction to bare ground XKSAT was applied. Therefore, this adjustment was not made. To simulate the increased hydraulic efficiency, the ADOT (1993) urban T_c equation for the Clark unit hydrograph was used, assuming natural RTIMP plus a 5 percent increase to account for small areas of hydrophobic soils. An independent review of the possible natural impervious area for each sub-basin was made. This review yielded higher possible RTIMP values for each sub-basin than URS (July 2005a). New Clark unit hydrograph parameters for the post-fire condition were computed and the results are summarized in Table 3.7.

Table 3.7 Pre- and Post-Fire Clark unit hydrograph parameters

Sub-basin	Area, sm	L, mi	L_{ca}, mi	S, ft/mi	RTIMP, %	Pre-Fire		Post-Fire	
						T_c, hrs	R, hrs	T_c, hrs	R, hrs
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	76.00	20.433	10.86	234	17.3	4.80	2.00	4.80	2.00
2	33.35	15.338	7.87	185	11.6	3.97	2.06	2.25	1.10
3	111.28	28.031	14.74	132	10.8	6.52	2.91	3.72	1.56
4	16.50	9.396	4.54	463	15.4	2.38	1.18	1.29	0.59
5	51.47	15.798	7.57	280	14.3	3.81	1.57	2.05	0.79
6	41.51	15.336	6.15	149	14.6	3.99	1.83	2.05	0.87
7	60.33	15.879	6.95	247	23.6	3.89	1.48	1.73	0.60
8	55.69	15.919	8.94	172	5.2	4.43	1.79	3.34	1.31
10	54.26	17.093	5.85	234	8.8	3.80	1.62	2.40	0.97

The modified base HEC-1 models were rerun and the results at the County Highway 91 Bridge are shown in Table 3.8, compared with the base model results. The modified HEC-1 model input and output files are contained in the DVD in Appendix E.

Table 3.8 Comparison of post-burn versus pre-burn hydrology results

Average Watershed-Wide 24-hour Precipitation, inches	Time to Peak, hrs		Change in Hydrologic Lead Time, hrs	Peak Discharge		% Change in Peak Discharge
	Pre	Post		Pre	Post	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.6	25.8	19.3	-6.5	1,600	6,900	4.3
2.0	24.0	18.7	-5.3	3,800	11,500	3.0
2.3	21.7	18.2	-3.5	6,400	16,300	2.5
2.7	21.3	17.8	-3.5	11,500	25,200	2.2
3.1	20.7	17.6	-3.1	17,600	34,700	2.0
3.4	20.3	17.2	-3.1	26,100	47,800	1.8
3.8	19.7	16.7	-3.0	38,400	65,800	1.7
4.3	18.8	16.3	-2.5	59,400	94,300	1.6

These results are not used in the flood hazard assessment hydraulic analyses, but are discussed in the estimation of hydrologic lead times in Section 6.2, and in the Flood Response Plan. The actual effects of the 2005 and 2006 fires on flood response in the Beaver Dam Wash watershed are unknown. The scenario shown is just one possibility. The actual conditions could be much worse, or not as severe. Only a study of the after effects of a large extent severe storm over the watershed will provide the needed data. However, it should be anticipated that there will be increased erosion and debris, and significantly less flood warning time due to watershed response to the burned areas. Recovery time could be quite long as discussed in PBS&J (2007). Refer to Table 3.9 for an excerpt.

Table 3.9 Excerpt from PBS&J (2007) Table 5

Observation	Conclusion
8. Flood damage from the January 2005 storm event was concentrated in the valley bottom of the mainstem creeks over which it occurred.	Long-recurrence-interval floods like that which occurred in January of 2005 do not result from fire impacts but may be substantially exacerbated by those impacts. Due to the lack of available data on hydrologic impacts from fire in the Mojave Desert and the Great Basin, there is no existing model or base of knowledge with which to accurately quantify the proportion of any given flood which is due to fire related changes in a watershed.
9. Red brome is likely to preclude recovery to pre-fire vegetative communities.	Without recovery back to pre-fire vegetation, there can be no recovery back to pre-fire hydrology. Without recovery to pre-fire hydrology the following are likely impacts which will continue to manifest themselves for some extended period of time: • Increase in drainage density leading to higher peak flows. • More frequent and larger floods. • Headward expansion of channel network due to headcut migration. • Lowered base level on trunk streams hit with large storms.

4 Hydraulics

4.1 General

This study is intended to assess flood risks, and identify flood hazards based on those risks, for the Beaver Dam area from the Beaver Dam Wash. The hydrologic and hydraulic results are intended for risk assessment and emergency management purposes only. The results of this study should not be considered as "best available technical information" for floodplain management purposes." Certain limiting assumptions used in the development of the technical basis for this study, including friction loss parameters and model control options designed to produce the upper limit of peak flood stages for a 100-year event, are intentionally very conservative, not reflective of existing conditions, and are therefore not appropriate for regulatory floodplain management uses.

Hydraulic modeling was done as part of this study for the following purposes:

1. Estimate the time and peak discharge where flood waters began to enter the area of concern within the DSA.

2. Estimate the time and peak discharge where flood waters reach the stage of the finished floor elevation of each structure within the DSA. Estimate the recurrence interval of that flow rate.

3. Estimate the time and depth of flooding within each structure in the DSA for the 100-year 24-hour storm, and the depth and velocity of flow near the structure affecting the escape route from the area.

4. Make an estimate of the peak discharge from the January 2005 flood using surveyed high water marks still visible on structures in the area, and estimated high water stages from debris run-ups still present against trees near and inside the DSA.

Examination of the available topography indicates that the Beaver Dam Wash downstream of County Highway 91 exhibits two-dimensional characteristics, particularly within the overbank areas where the structures in question are located. Certainly, the existing structures cause sufficient disruption to flow to result in higher local water surface elevations than present in the adjacent main channel. For these reasons, both one- and two-dimensional hydraulic modeling was done to obtain the information listed above.

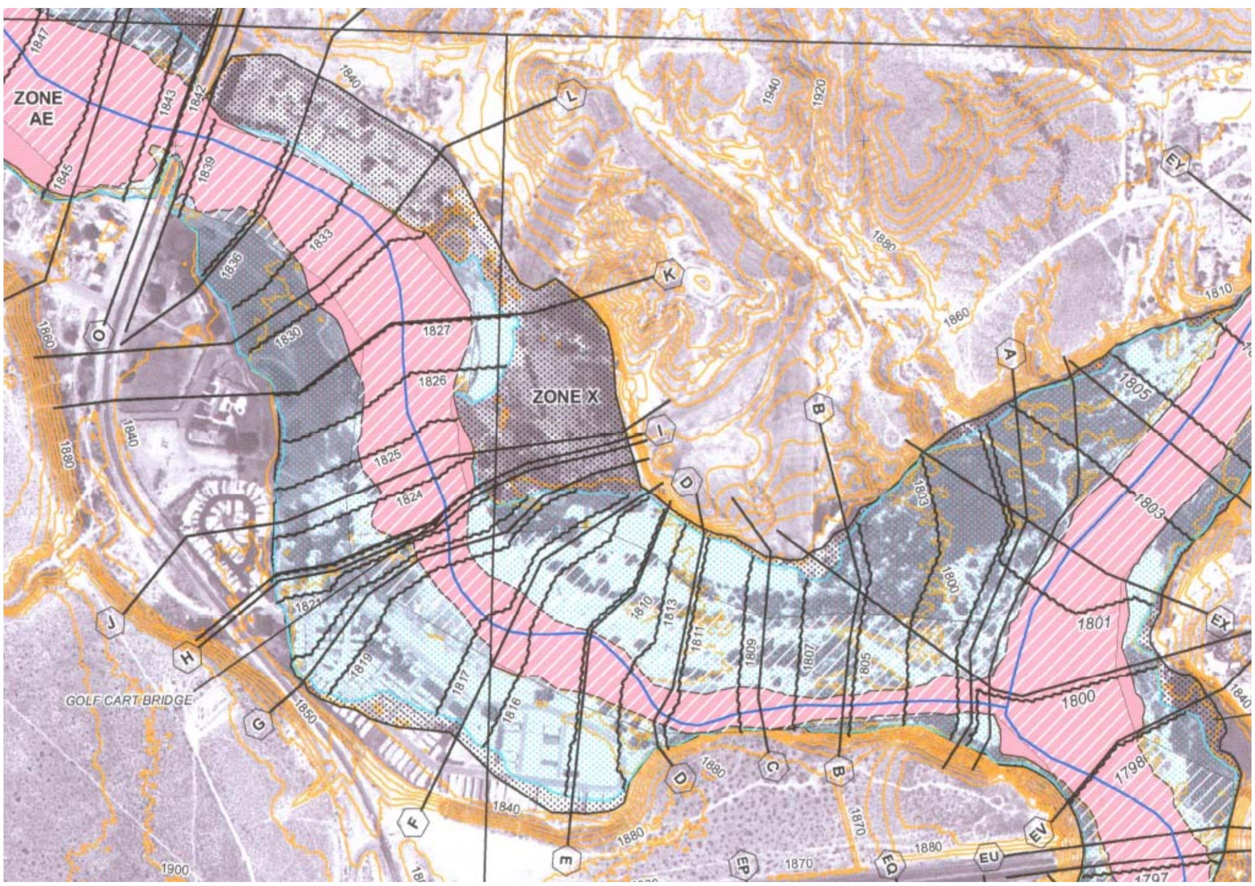
4.2 Limits of Study

The limits of the one-dimensional hydraulic analyses are the General Study Limits as shown on Figure 1.2. The limits of the two-dimensional hydraulic analysis are shown on Figure 1.2 in light blue shading.

4.3 FEMA Floodway Analysis

FEMA has a flood insurance study in progress for the Beaver Dam Wash (HDR, 2006). Preliminary work study maps have been released to Mohave County for review. An excerpt from those maps covering the study area is shown on Figure 4.1. Note that none of the structures in the DSA are included in the draft FEMA floodway.

Figure 4.1 FEMA preliminary work study map



4.4 1-Dimensional Modeling

4.4.1 Base HEC-RAS Model

An HEC-RAS hydraulic model of the Beaver Dam Wash watershed is needed for the flood hazard analysis. HEC-RAS is being used by FEMA to delineate the floodplain and establish a floodway for Beaver Dam Wash. Therefore, it is appropriate to check the results of the two-dimensional hydraulic model against the one-dimensional HEC-RAS model and use the most conservative results for the flood hazard assessment and risk ranking. Where differences between the models are noted, it is also important for Mohave County staff to understand the reasons for those differences to aide in applying proper floodplain management procedures. Rather than create a new HEC-RAS model of the watershed, an existing model of record was evaluated for use in this study.

URS prepared an HEC-RAS model of the future condition Beaver Dam Wash with the new County Highway 91 bridge in place for the January 2005 post-flood conditions (URS, 2005b). The model was based on the 100-year peak discharge from the URS hydrology study (URS, 2005a), which was estimated at 30,400 cfs . This model was accepted as a base model for use in this study.

4.4.2 Adjustments Made to the Base Model

The peak discharge for profile 1 was changed from 30,400 cfs to the FEMA-accepted estimate for the 100-year flood of 21,000 cfs, and the peak discharge for profile 2 was changed to 11,990 cfs for the 25-year flood. The Manning's roughness coefficients and channel bank stations were accepted without modification. The HEC-RAS cross section locations are shown on Figure 4.2.

4.4.3 Results

The results of the modified HEC-RAS 100-year model are shown in Table 4.1. HEC-RAS 3.1.3 was used for this study. Refer to Appendix D for a report containing the input data, results, and summary tables.

Figure 4.2 URS HEC-RAS cross section locations

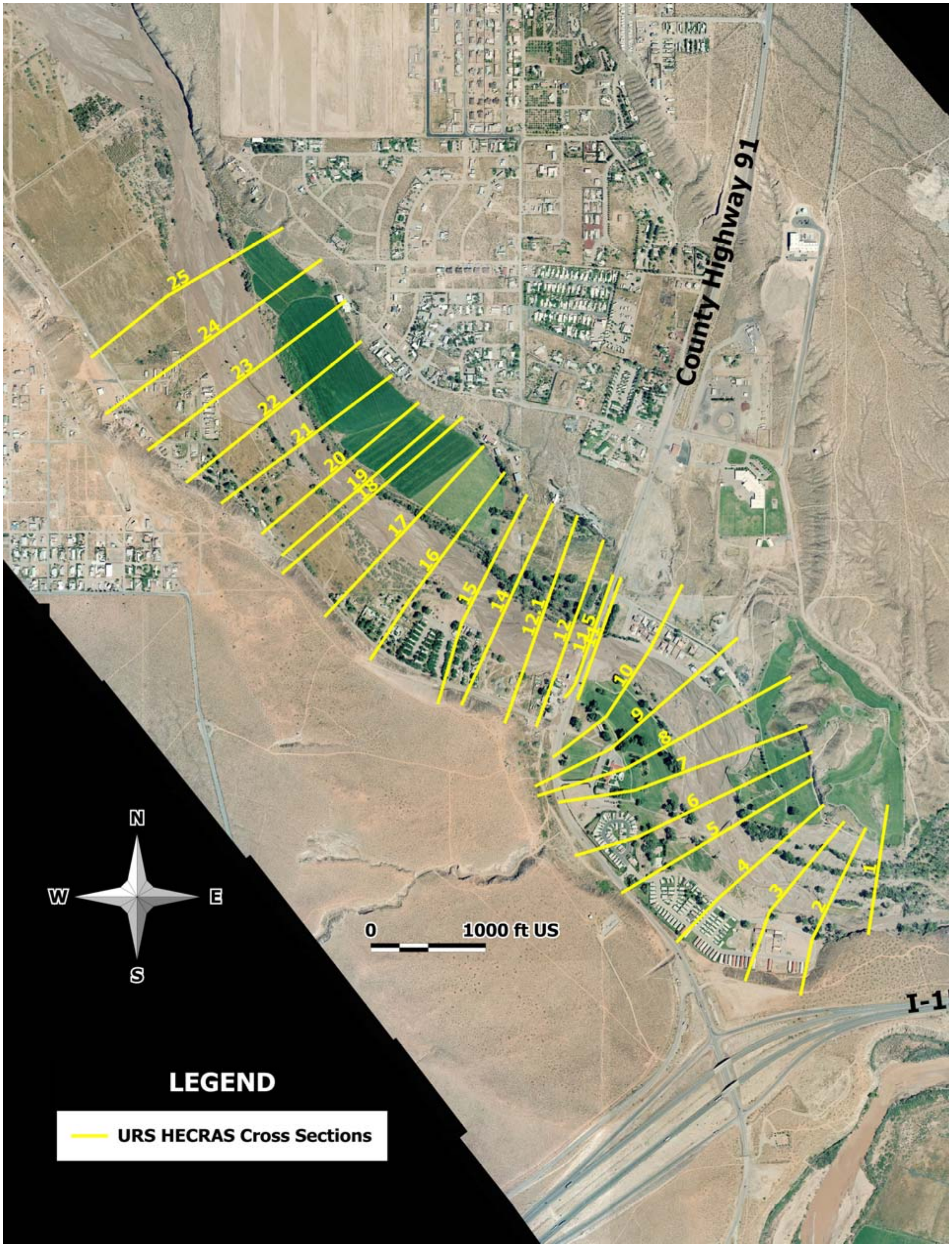


Table 4.1 Summary of HEC-RAS results

Cross Section	Profile	Discharge Total (cfs)	Discharge Left (cfs)	Discharge Chan (cfs)	Discharge Right (cfs)	WS Elev (ft)	Crit. WS (ft)	Velocity Left (ft/s)	Velocity Chan (ft/s)	Velocity Right (ft/s)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
25	100 yr	21,000		21,000		1875.49	1875.01		9.4	
25	25 yr	11,990		11,990		1874.38	1873.90		7.4	
24	100 yr	21,000		21,000		1871.70	1871.70		9.9	
24	25 yr	11,990		11,990		1870.85	1870.73		7.9	
23	100 yr	21,000	2	20,998		1868.36		0.47	8.5	
23	25 yr	11,990		11,990		1866.84	1866.71		8.0	
22	100 yr	21,000	0	21,000		1866.96		0.23	8.3	
22	25 yr	11,990		11,990		1865.21			6.8	
21	100 yr	21,000		21,000		1863.90	1863.86		12.1	
21	25 yr	11,990		11,990		1862.46	1862.39		10.0	
20	100 yr	21,000		21,000		1862.04			10.5	
20	25 yr	11,990		11,990		1860.19			8.9	
19.5	100 yr	21,000		20,968	32	1859.59	1859.59		13.1	1.69
19.5	25 yr	11,990		11,990		1857.83	1857.83		11.0	
19	100 yr	21,000		20,994	6	1858.45	1858.45		12.6	0.97
19	25 yr	11,990		11,990		1856.83	1856.83		10.6	
18	100 yr	21,000		21,000	0	1854.12	1853.97		10.7	0.4
18	25 yr	11,990		11,990		1852.90	1852.68		8.7	
17	100 yr	21,000		21,000		1850.89	1850.75		11.1	
17	25 yr	11,990		11,990		1849.31	1849.27		9.8	
16	100 yr	21,000		21,000		1847.15	1847.15		11.8	
16	25 yr	11,990		11,990		1845.98	1845.74		9.2	
15	100 yr	21,000		21,000		1844.90	1844.90		11.4	
15	25 yr	11,990		11,990		1843.57	1843.53		9.6	
14	100 yr	21,000		21,000		1842.45	1842.11		9.2	
14	25 yr	11,990		11,990		1841.36	1841.08		7.6	
13	100 yr	21,000	18	20,982		1841.12	1840.23	1.41	8.8	

Table 4.1 Summary of HEC-RAS results

Cross Section	Profile	Discharge Total (cfs)	Discharge Left (cfs)	Discharge Chan (cfs)	Discharge Right (cfs)	WS Elev (ft)	Crit. WS (ft)	Velocity Left (ft/s)	Velocity Chan (ft/s)	Velocity Right (ft/s)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
13	25 yr	11,990		11,990		1839.35	1839.02		8.1	
12	100 yr	21,000		21,000		1840.40	1838.75		8.9	
12	25 yr	11,990		11,990		1838.64	1837.33		7.1	
11.5		Bridge								
11	100 yr	21,000		21,000		1837.57	1837.39		11.6	
11	25 yr	11,990		11,990		1836.45	1835.97		8.7	
10	100 yr	21,000		15,639	5361	1834.38	1834.38		11.8	8.07
10	25 yr	11,990		9,059	2931	1833.08	1833.08		10.0	6.92
9	100 yr	21,000		19,892	1108	1830.56	1830.56		10.7	4.33
9	25 yr	11,990		11,744	246	1829.38	1829.30		8.9	2.81
8	100 yr	21,000		19,833	1167	1827.10	1827.10		9.3	3.61
8	25 yr	11,990		11,779	211	1826.00	1826.00		8.5	3.74
7	100 yr	21,000		19,889	1111	1824.97	1824.15		7.3	2.64
7	25 yr	11,990		11,897	93	1823.57	1823.11		6.7	1.46
6	100 yr	21,000		19,169	1831	1822.77	1822.59		10.1	3.65
6	25 yr	11,990		11,499	491	1821.87			7.6	2.17
5	100 yr	21,000	3,347	13,803	3850	1821.40	1821.40	4.65	10.7	3.59
5	25 yr	11,990	1,562	9,672	756	1820.20	1820.20	3.93	9.4	2.08
4	100 yr	21,000	4,958	15,121	921	1815.70	1815.70	4.52	10.5	3.9
4	25 yr	11,990	1,574	10,053	363	1814.62	1814.62	2.96	9.0	3.31
3	100 yr	21,000	2,722	17,147	1131	1813.33		2.83	8.2	2.66
3	25 yr	11,990	613	11,215	161	1811.62		1.82	7.0	1.38
2	100 yr	21,000	2,975	16,703	1322	1811.65	1811.65	3.01	11.2	3.67
2	25 yr	11,990	14	11,966	10	1808.35	1808.35	1.09	12.9	0.93
1	100 yr	21,000	117	20,883		1805.99	1805.99	4.05	14.2	
1	25 yr	11,990	1	11,989		1803.86	1803.86	0.82	12.0	

4.5 2-Dimensional Modeling

4.5.1 Base FLO-2D Model

The FLO-2D 2D computer model was selected for use in this study as described in Section 1.3.3. The 2006.01 version with FLO.EXE executable dated 11/06/2006 was used. Refer to Section 2.1.2. A base FLO-2D dataset was prepared and then different hydrologic conditions imposed to suit the needs of the study. The base model uses the following FLO-2D options and each is discussed in the following paragraphs.

- Overland Floodplain-Only Grid.
- Assignment of Roughness Coefficients to each Grid Element.
- Area and Width Reduction (ARF).
- Limiting Froude Number.
- Assignment of Inflow Hydrographs.

1. **Overland Floodplain-Only Grid.** There are two methods available to simulate the ground surface of the 2D model area. The first is a 1D channel superimposed upon a 2D floodplain grid for modeling the overbank areas. The second is to use an overland floodplain-only grid, which simulates the hydrology and hydraulic conditions for the entire 2D model surface by computing flow parameters between each individual grid element in eight directions. Refer to FLO-2D (2006b), section 4.2. The first method could have been used, but was not selected because the study area is small enough to use a high-resolution floodplain-only grid. The 2D area was divided into 74,714 uniform 15-foot square grids comprising a total study area of about 386 acres. The topography used to simulate the ground surface was the DTM from Cooper (2005). The 40-scale and 100-scale DTM data sets were combined. All of the breakline, grid and spot elevations were used in computing an average ground elevation for each grid element. There are a total of 464,594 DTM data points within the 2D study area, which computes to an average of about 6 spot elevations per grid element. This is a reasonable number of data points to compute an average elevation for the selected grid size. The GDS module of the FLO-2d computer program (FLO-2D, 2006b and FLO-2D, 2006d) was used to compute the average grid element elevations. A second check on grid size is the average fall across each grid.

   The average slope of Beaver Dam Wash from the Highway 91 Bridge to the edge of the Virgin River is about 0.84 percent. The average fall across each grid element is therefore about 0.13 feet. The spot height accuracy for the topographic mapping is +/- 0.5 feet and 0.25 feet for the 100-scale and 40-scale mapping, respectively. A larger grid size could certainly be used, but the 15 foot grid size was selected to provide better resolution in and around the structures being analyzed. A smaller grid size could also be used, but model run times would be unreasonably long.

2. **Assignment of Roughness Coefficients to Each Grid Element.** The topographic mapping and color aerial photographs by Cooper (2005) were used as the basis for assigning a Manning's n-value to each grid element. These photographs were taken after the January 2005 flood, so they reflect existing conditions in the wash at that time. Prior to the flood, vegetation was very dense in certain portions of the Beaver Dam Wash, particularly upstream of the Highway 91 Bridge and at the confluence with the Virgin River. Refer to Figure 4.3 for comparison of pre- and post-flood photographs. Due to the high level of stream power, it is highly probable that the dense vegetation areas were removed prior to the peak discharge. However, an estimated non-maintained vegetation condition in combination with the FLO-2D n-value optimization procedure forcing subcritical flow was used for estimating n-values within the main wash area.

   Polygons defining the various physical features depicted in Figure 4.4 were imported from the ESRI topographic mapping shape files provided by Cooper. Manning's n-values were then assigned to each physical topographic feature as shown in Table 4.2 The assignment of overland flow roughness must account for vegetation, surface irregularity, non-uniform and unsteady flow. Overland roughness can be significantly greater than for conventional prismatic channel steady flow (refer to FLO-2D (2006b), section 4.2). It is also a function of flow depth. The n-value coverage shown on Figure 4.4 was used to assign a base n-value to each grid element, and the values entered into the FPLAIN.DAT FLO-2D input data file. The base n-values were then optimized using the limiting Froude number FLO-2D control setting, which is discussed in more detail in item 3 below.

   Successive FLO-2D runs were made using the limiting Froude number setting. For situations where the limiting Froude number is exceeded, FLO-2D dynamically adjusts the Manning's n-values until the target Froude number is reached. After each run, the resulting adjusted n-values were reviewed and accepted adjustments written to the FPLAIN.DAT file. This process has the added benefit of decreasing the n-values in

FPLAIN.DAT decreases the FLO-2D model run time, and increasing numerical stability of the hydraulic computations. Finally, n-values were adjusted manually near the Virgin River where heavy vegetation growth can be expected. The final n-values are shown graphically on Figure 4.5. Refer to the FPLAIN.DAT FLO-2D input data files on DVD-ROM in Appendix E for final model n-values.

Figure 4.3 Comparison of pre-and post-flood vegetation conditions

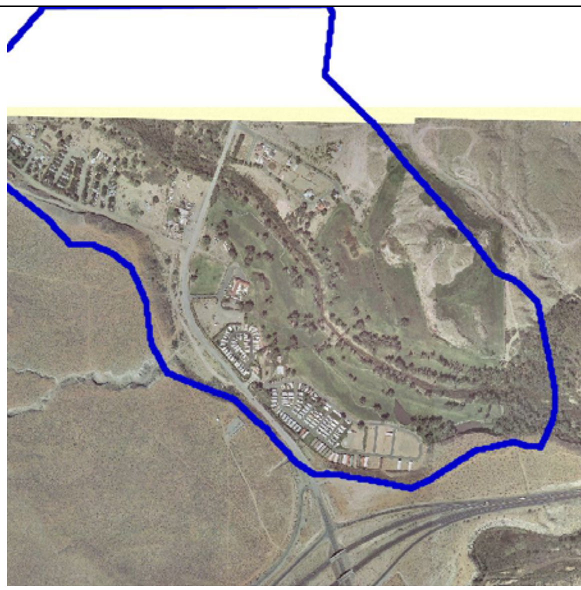
2004 Pre-Flood Photo	2005 Post-Flood Photo
	

Table 4.2 Base Manning's n-values related to physical features

Physical Feature (1)	Manning's n-value (2)
Brush	0.060
Cultivated Fields	0.070
Grass	0.040
Open Space	0.050
Paved Roads	0.025
Trees	0.100
Washes	0.045

Figure 4.4 Base Manning's roughness coefficients for 2D modeling

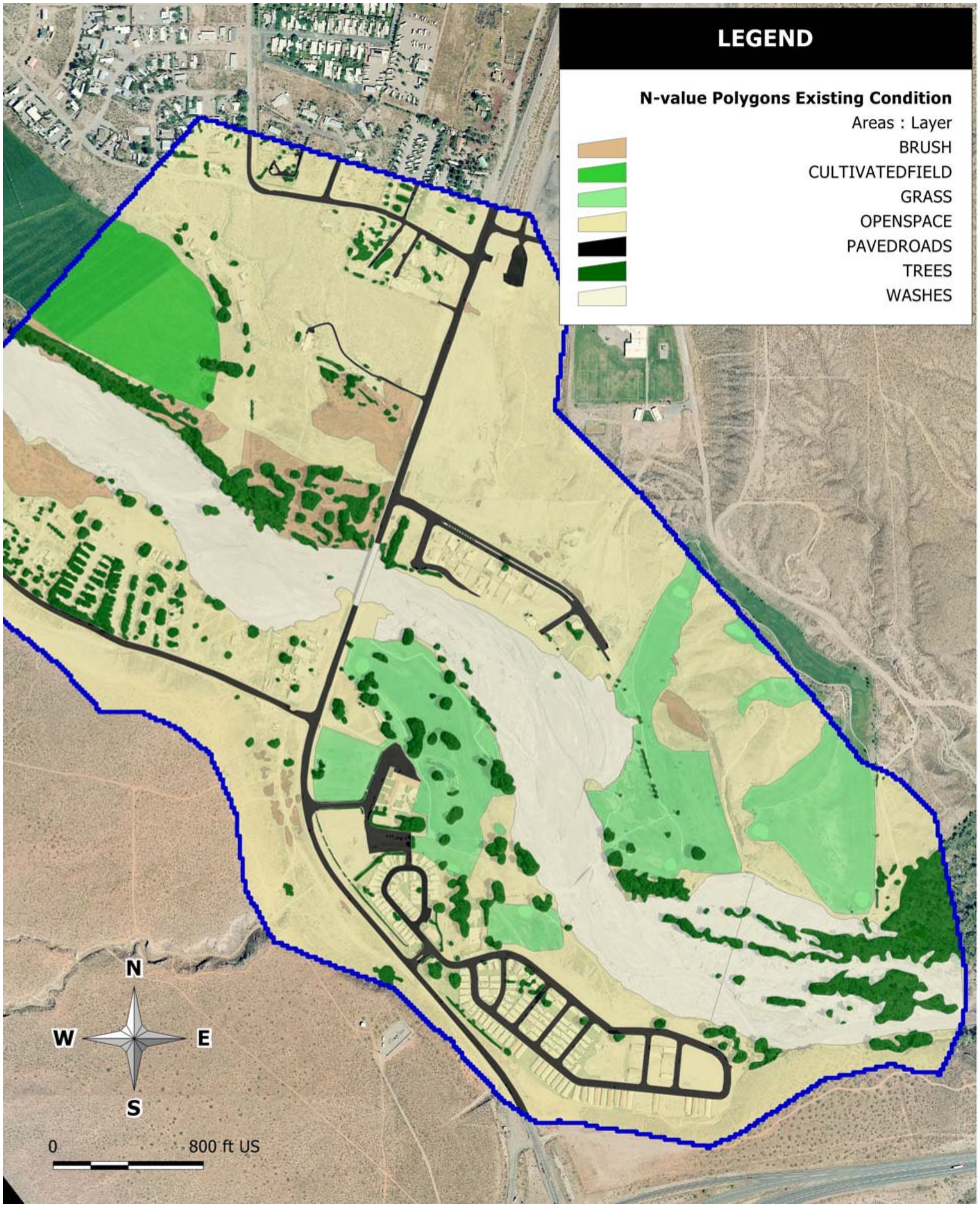
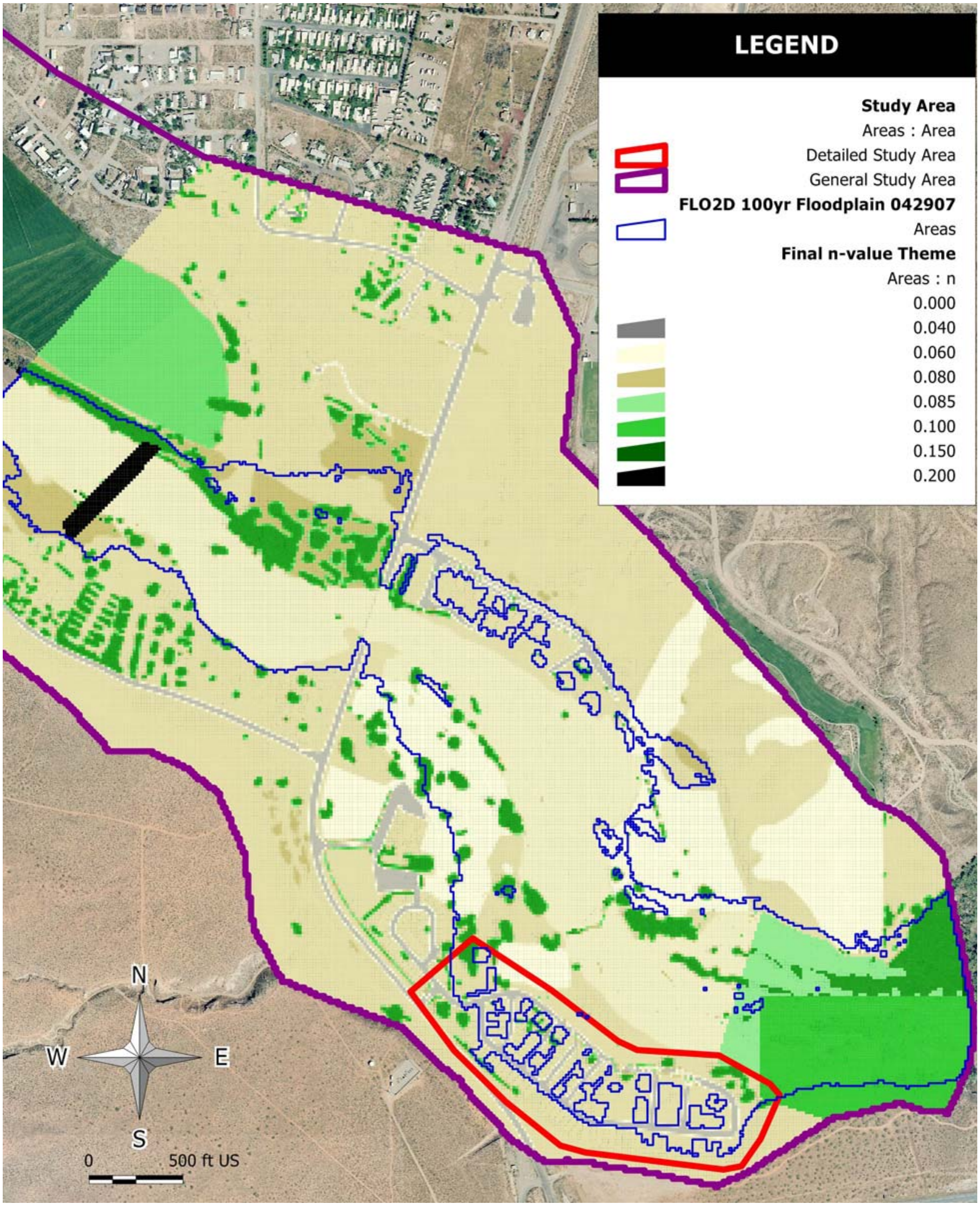


Figure 4.5 Final Manning's roughness coefficients used in the 2D models



3. **Limiting Froude Number.** The flood hazard assessment is based on the water surface elevations at the structures in question. Examination of the HECRAS model results show that flow in the Beaver Dam Wash is often supercritical in the main wash and likely subcritical in the overbanks. The 2D model analyses were done assuming subcritical flow in order to maximize the water surface elevations. To accomplish this, a maximum Froude number of 0.95 was set. When the specified limiting Froude number is exceeded, the floodplain n-value is increased by 0.001 for that grid element for the next time step. This iterative procedure is used to force subcritical flow.

4. **Area and Width Reduction (ARF).** The existing structures, accessory structures, and masonry walls within the Beaver Dam Wash floodplain are obstructions to flow. The effects of these obstructions were modeled using the FLO-2D Area Reduction Factor (ARF) option. The polygons defining the structures present at the time of the 2005 aerial photographs by Cooper, included in the Cooper topography, were used as the basis for assigning ARF factors. Structures constructed since the date of the 2005 aerial photographs were field surveyed (Owens, 2007). The structures used to define ARF factors are shown on Figure 4.6. The grid elements that intersect the building polygons were assigned ARF values in the ARF.DAT FLO-2D input data file. This has the effect of completely blocking that grid element to flow conveyance and storage. The blocked grids are shown on Figure 4.7. Many of the structures have block walls along the rear property line. These have the effect of blocking/redirecting flow that is able to drain between structures. For this reason, many areas between buildings are allowed to be completely blocked for modeling purposes.

   The effects of the golf cart bridge, shown in green on Figure 4.6, were modeled by partially obstructing the grid elements that include the bridge. This bridge was not washed out during the January 2005 flood. It is also not expected to be overtopped during the 100-year storm, based on the Owens (2007) as-built survey data. Therefore, the hydraulic capacity of each grid element was reduced by 10 percent to account for hydraulic losses due to contraction and expansion of flow and for blockage by debris. The blockage was accomplished using the FLO-2D Width Reduction Factor option.

Figure 4.6 Structure flow blockages for 2D modeling

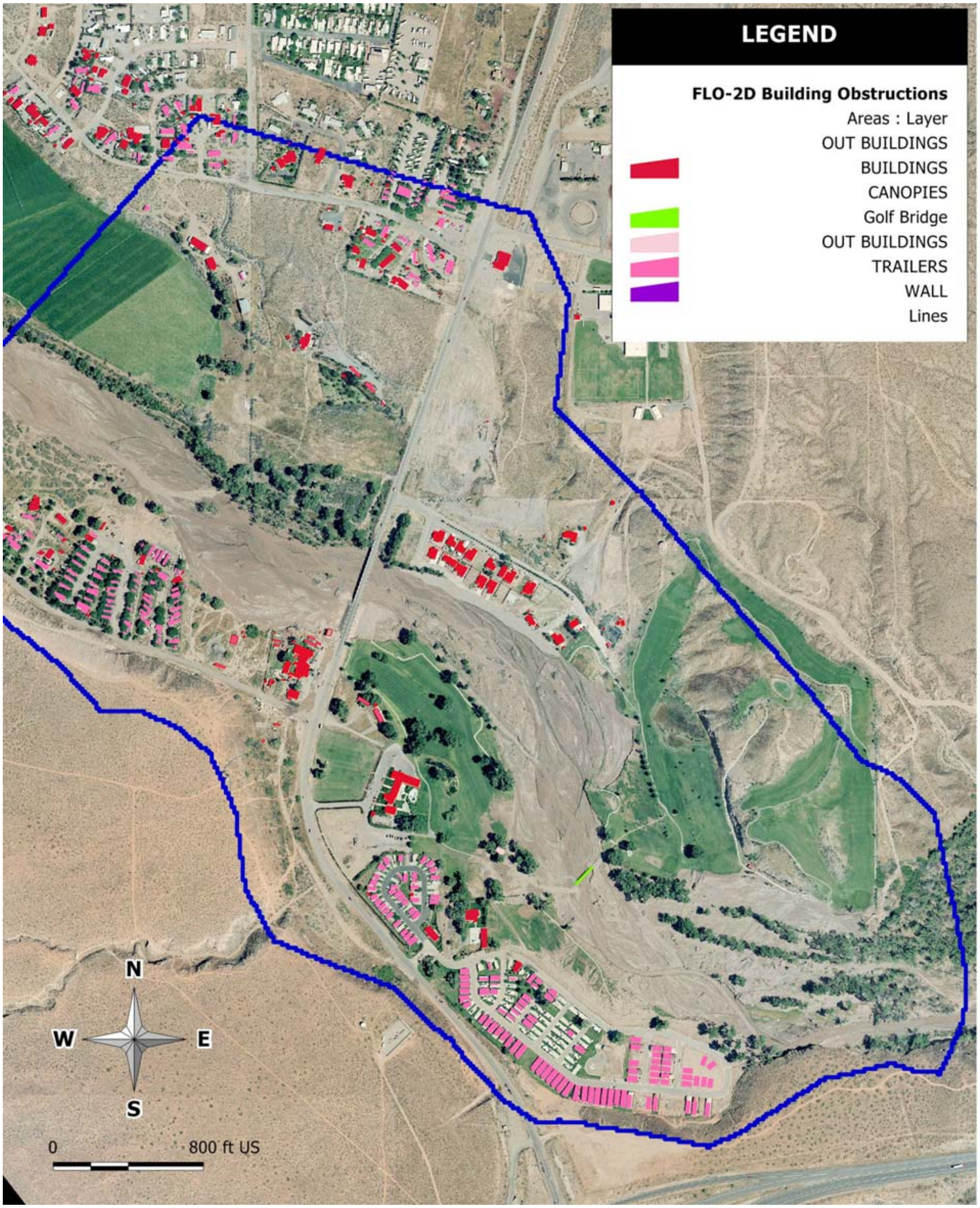
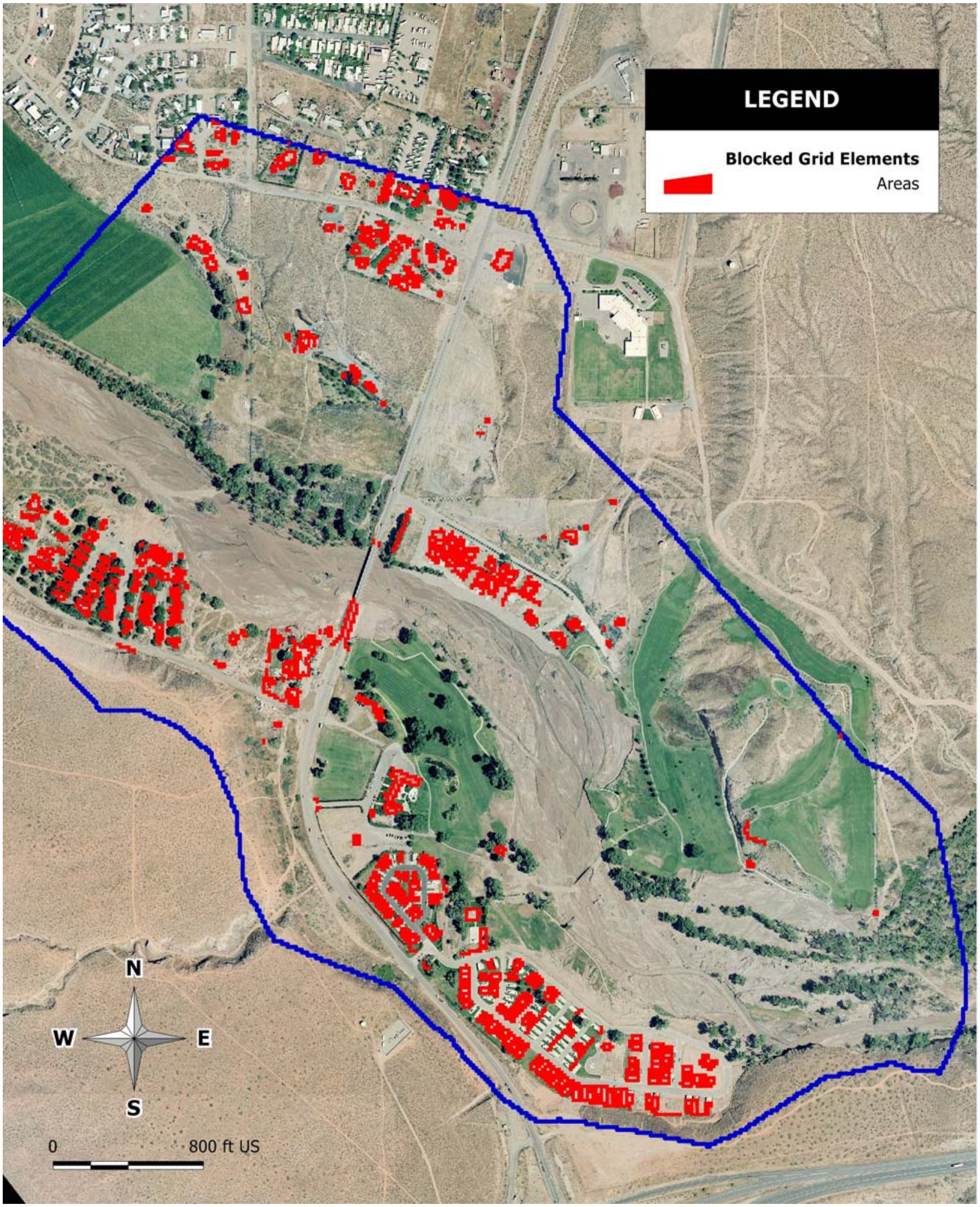


Figure 4.7 Areas of blocked grid elements



5. **Assignment of Inflow Hydrographs.** The adjusted 100-year hydrograph shown on Figure 3.6, which is based on the accepted FEMA peak discharge of 21,000 cfs, was used as the basis for inflow to the FLO-2D models. Twenty eight (28) grid elements, shown on Figure 4.8, were used as inflow grid elements. Each hydrograph ordinate was divided by 28 and the resulting ordinates entered into the FLO-2D INFLOW.DAT input data file for every one of the 28 grid elements shown on Figure 4.8. Two other FLO-2D models were run for this study:

    1. A peak discharge of 26,100 cfs, which is approximately a 230-year frequency, and
    2. The FEMA 500-year storm peak discharge of 36,500 cfs.

    The same procedure was used to create FLO-2D inflow hydrographs for these two peak discharges as was used for the 100-year flood.

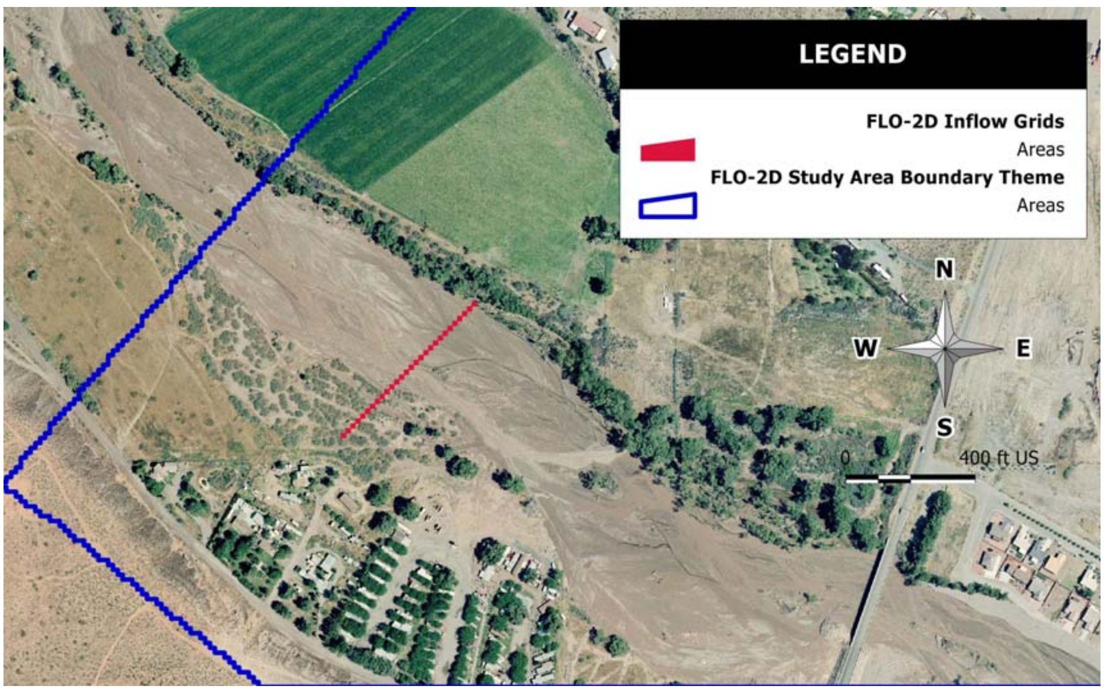
4.5.2 Results

Due to the large number of grid elements (74,714), it is not practical to present the results in a tabular format. Instead, the FLO-2D input and output files are included on DVD in Appendix E. An ESRI GIS polygon shape file is also provided for each FLO-2D model. The table contains the results for every grid element. The FLO-2D peak discharge, depth and velocity results for the 100-year 24-hour flood are shown graphically on Figure 4.9, Figure 4.10, and Figure 4.11. The maximum peak discharge in cubic feet per second crossing each grid element is shown on Figure 4.9. The results are color coded to show a range of discharge values. The maximum average depth of flow in feet at each grid element is shown on Figure 4.10. The maximum average velocity of flow in feet per second at each grid element is shown on Figure 4.11. Note the areas adjacent to and surrounding the structures in question where the flow colors are yellow, light green, and dark green on all three figures. These are the areas of highest hazard at the structures.

Also note that there is significant flow in these areas that is divided from the main flow of Beaver Dam Wash. Flow escapes from the main channel downstream of the County Highway 91 Bridge and drains south and southeast through the DSA. Flow first begins entering the DSA at the most easterly tip of the DSA where it begins backing up from the main wash. Refer to Figure 4.12. Flow first starts draining into the DSA from the Beaver Dam Wash main channel at Cross Section 4 (CS4). The 100-year 24-hour peak discharge in the street at that location is

440 cfs and peaks at 20.44 hours. Overbank flow from the breakout downstream of the County Highway 91 Bridge begins entering the DSA at Cross Section 5 (CS5). The 100-year 24-hour peak flow at that location is 2,730 cfs, peaking at 20.54 hours. Flow peaks a little later at CS5 than at CS4 due to more flow resistance in the long length of overbank. A total runoff volume of 847 acre-feet passes that location. The 100-year 24-hour peak discharge at Cross Section 3 (CS3) is 2,570 cfs, peaking at 20.55 hours. The total runoff volume crossing that location is 878 acre-feet. The flow rates and total runoff volume passing through the DSA are very high with flow depths ranging from 1 to over 6 feet, and velocities ranging from 1 to over 8 feet per second.

Figure 4.8 Grid elements used for inflow hydrograph



The duration of flooding in hours that can be expected during a 100-year 24-hour event is shown on Figure 4.13. The times shown on Figure 4.13 are the duration of flooding where the flow depth exceeds 6-inches. Durations in the DSA meeting this criteria range from 1 to over 7 hours. The 100-, 230-, and 500-year floodplain limits developed using the FLO-2D model results are shown on Figure 4.14. The 100-year floodplain is shown shaded in blue, and the approximate 200-year and the 500-year boundaries are shown as orange and red lines, respectively. The buildings and walls modeled as obstructions to flow are shown in solid red.

Figure 4.9 FEMA 100-year 24-hour FLO-2D peak discharge results

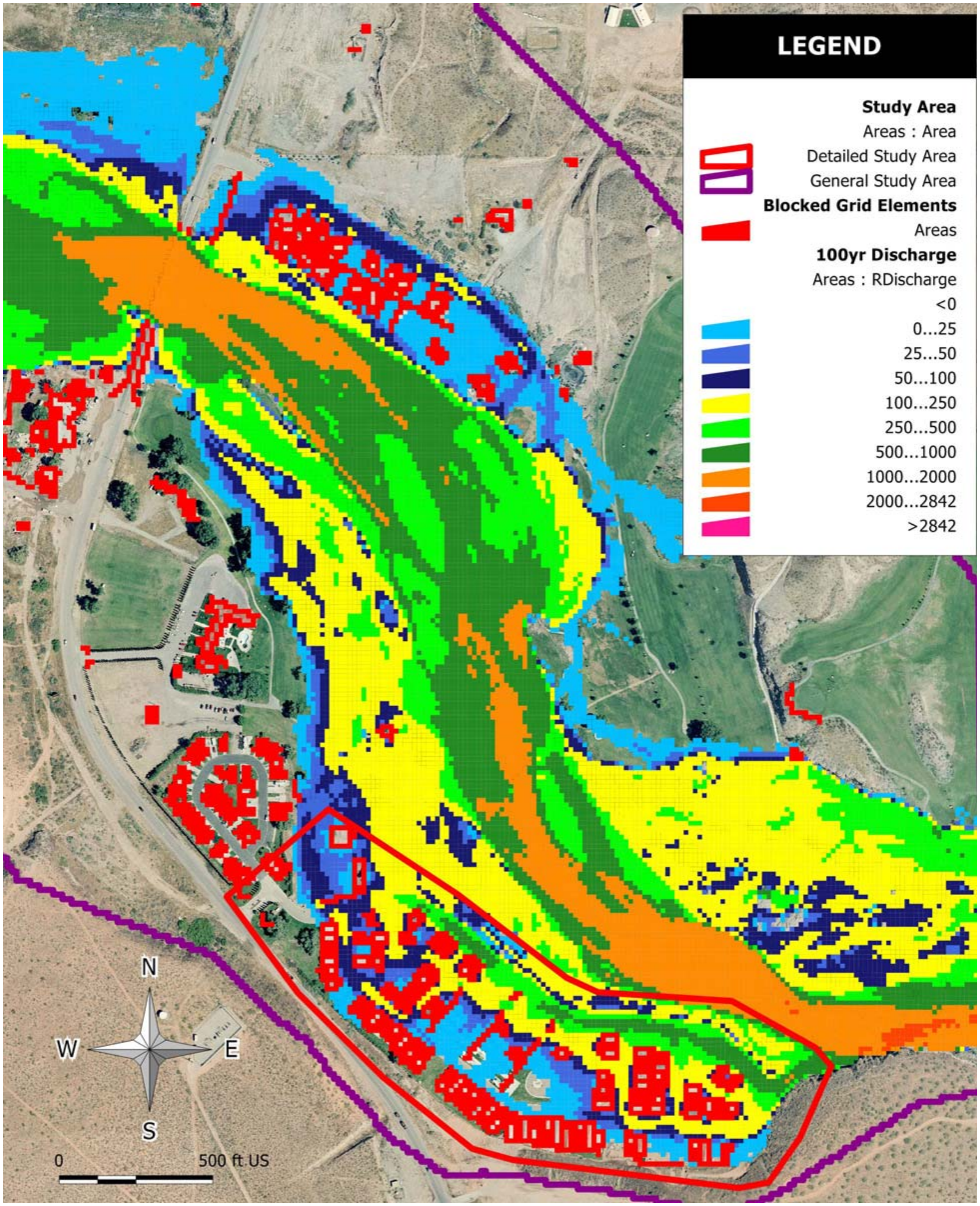


Figure 4.10 FEMA 100-year 24-hour FLO-2D flow depth results

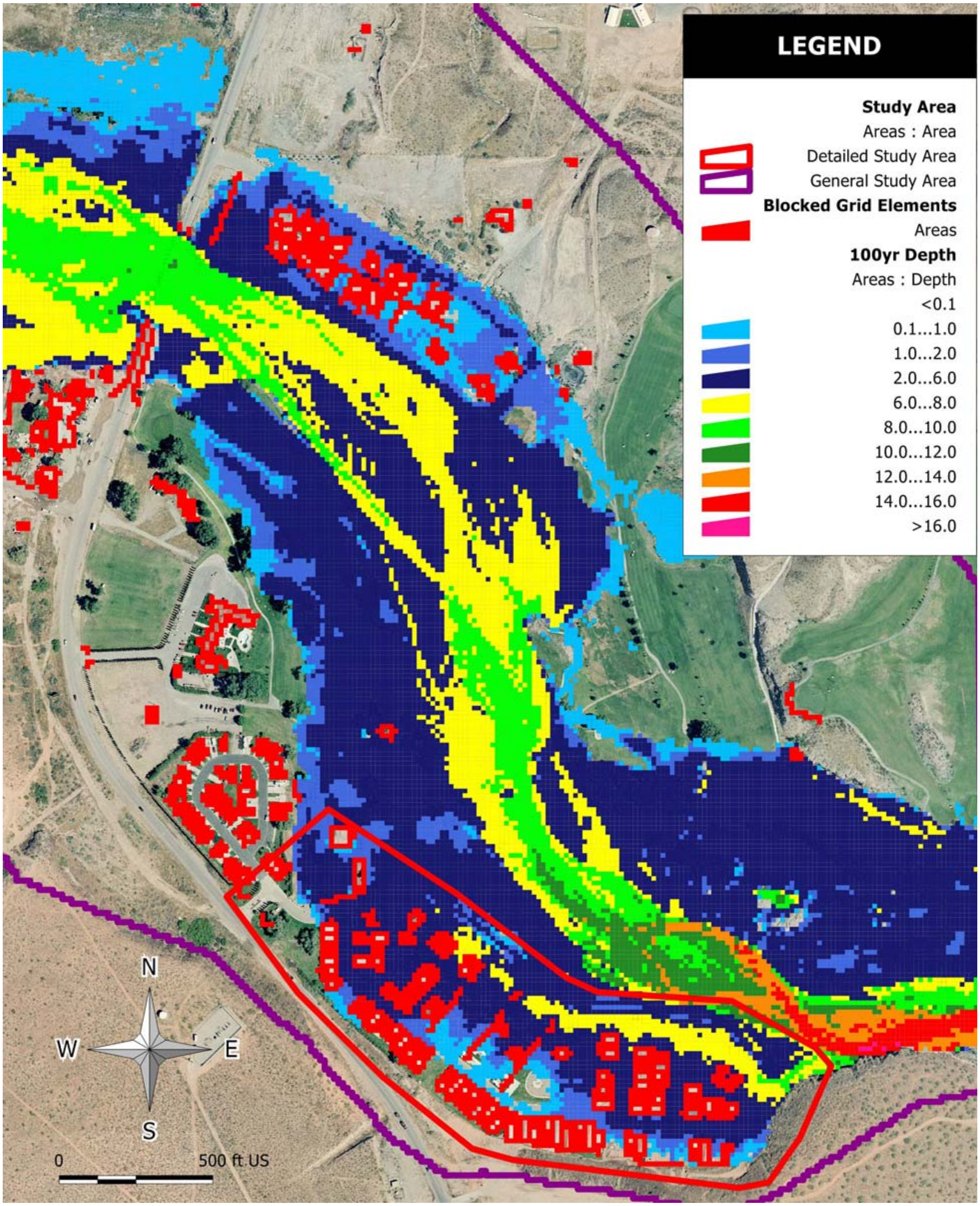


Figure 4.11 FEMA 100-year 24-hour FLO-2D flow velocity results

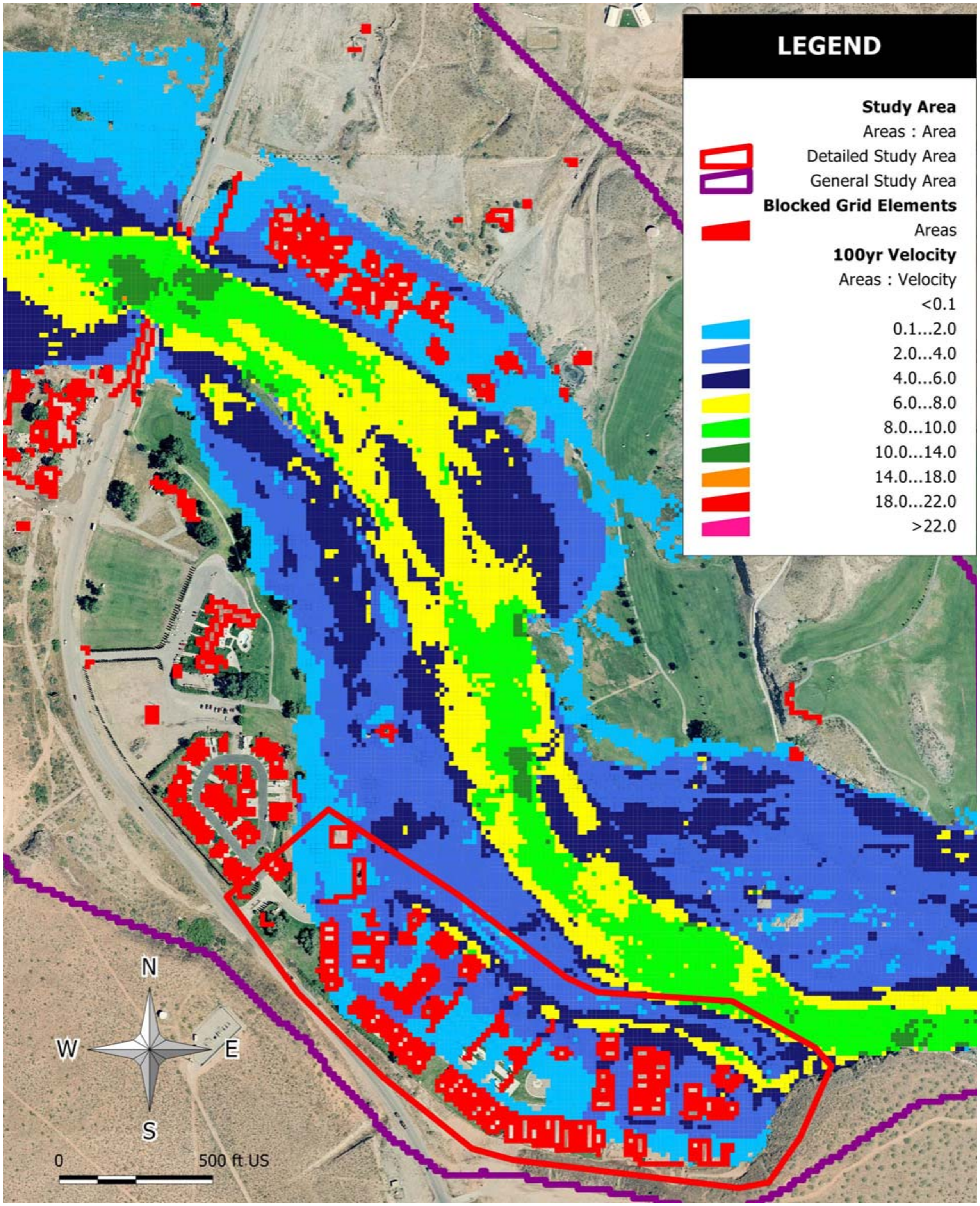


Figure 4.12 Detailed Study Area FLO-2D cross sections

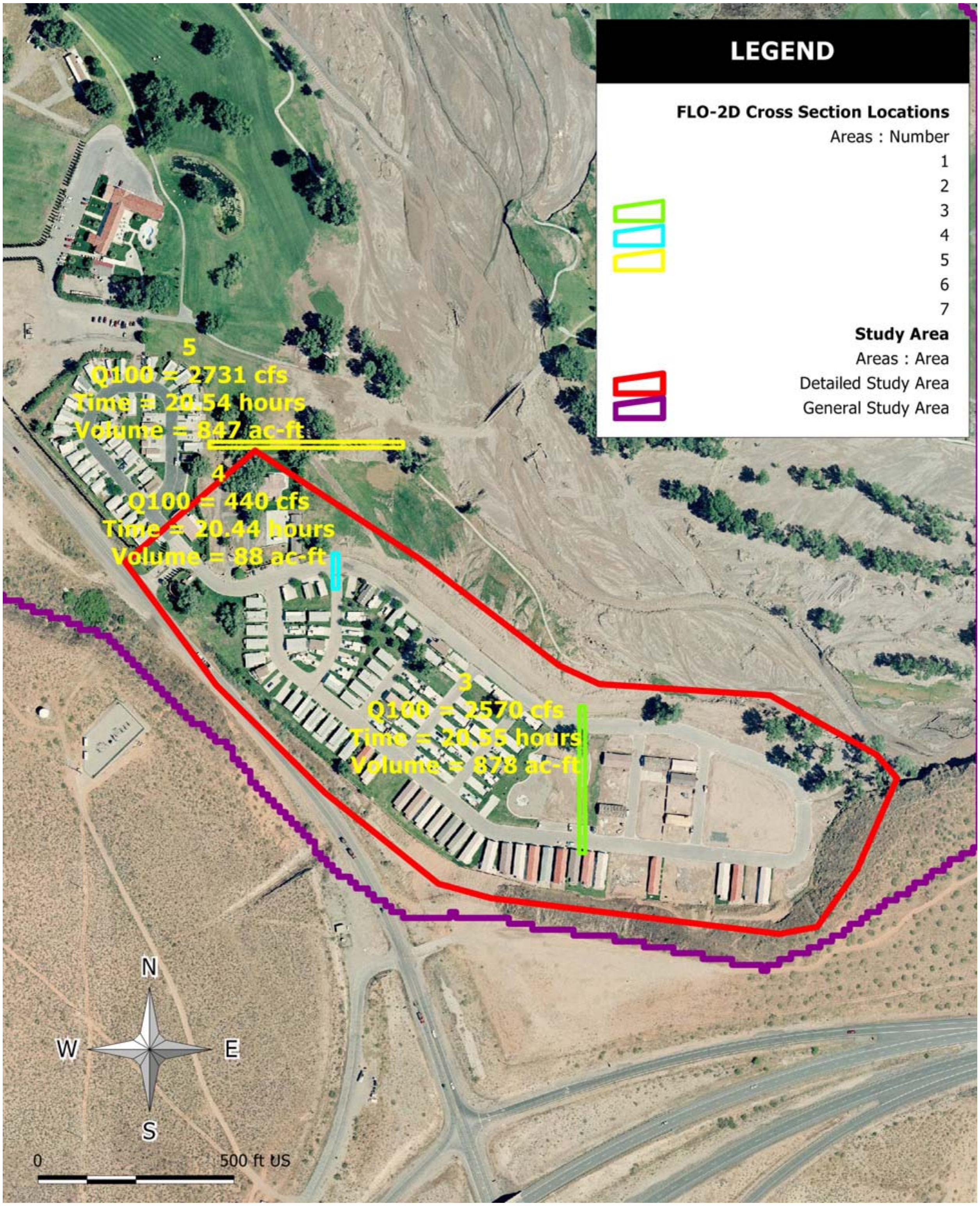


Figure 4.13 FEMA 100-year 24-hour FLO-2D depth-duration results

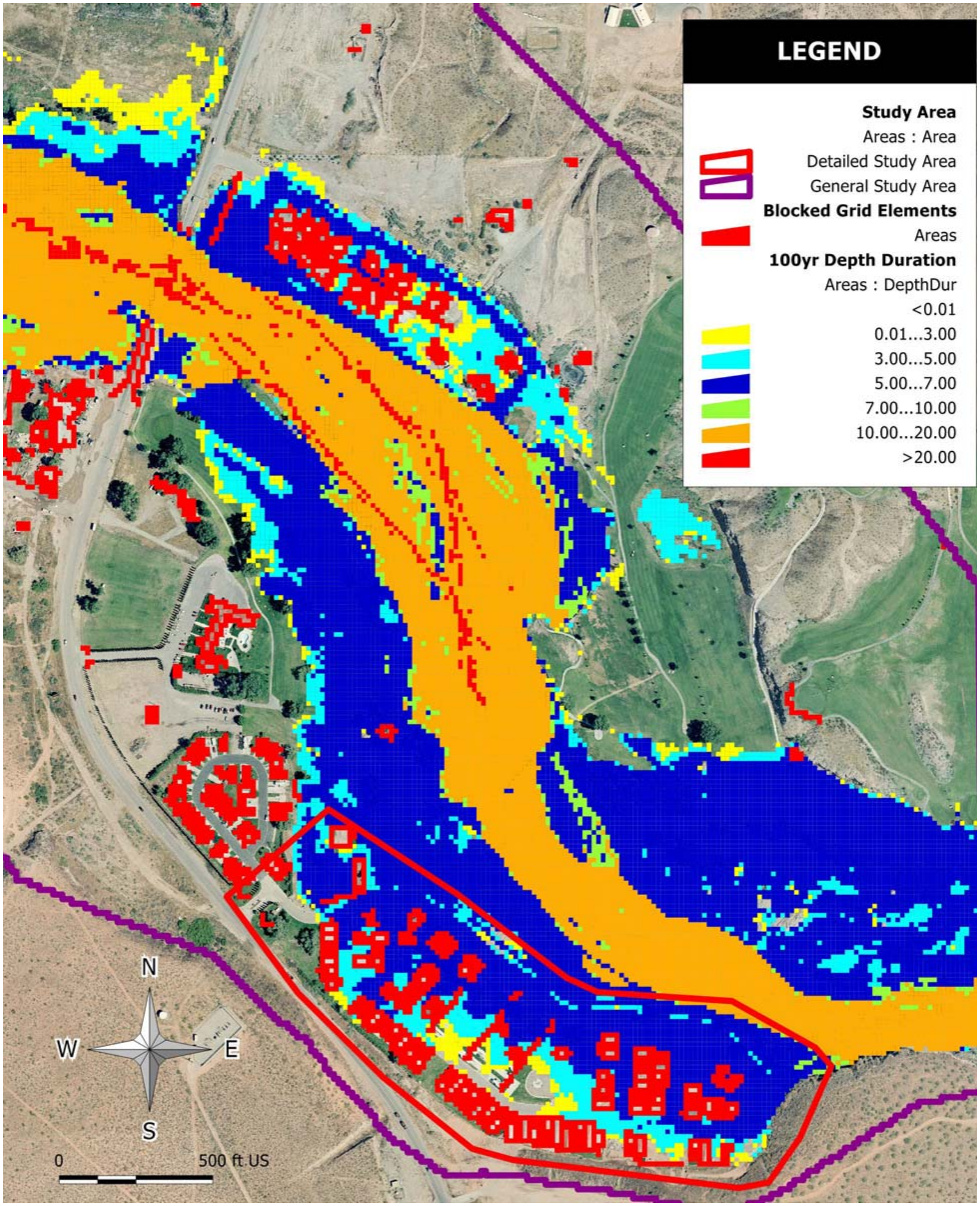
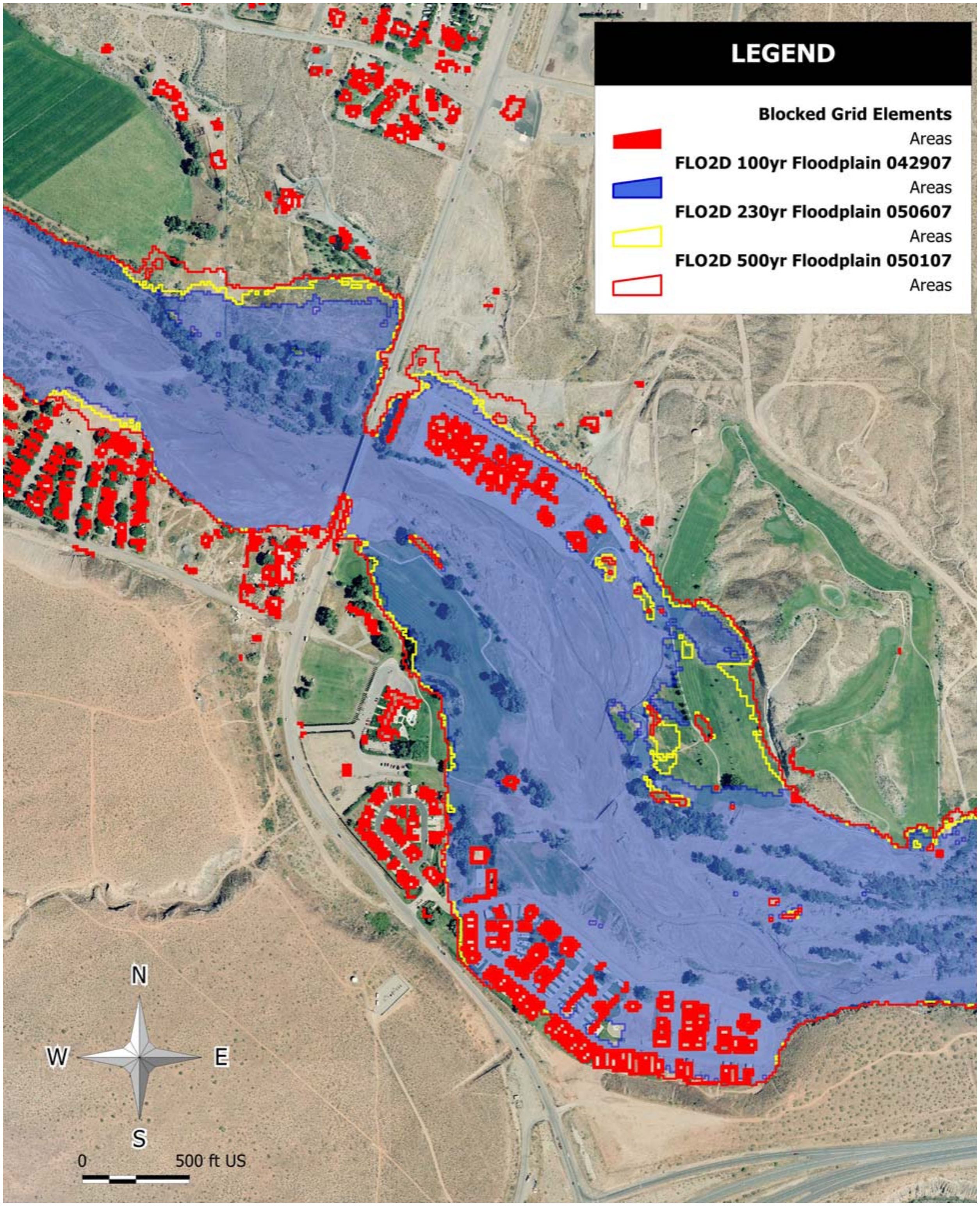


Figure 4.14 FLO-2D 100-, 200-, and 500-year floodplain delineations



4.6 Comparison of 1D and 2D Results

An excerpt from the preliminary 1D floodplain delineation prepared by FEMA (HDR, December 2006) was used as the basis for Figure 4.15. The FLO-2D 100-year and 500-year floodplain delineations are shown overlaid on that base. Note that the FLO-2D 100-year and 500-year floodplain limits are very close to the FEMA limits in most areas. They differ significantly along the north and northeast side of Beaver Dam Wash immediately upstream and downstream of the County Highway 91 Bridge. The FLO-2D water surface elevations vary from 0 to over 2 feet higher than the HECRAS generated elevations, particularly in the backwater area upstream of the County Highway 91 bridge, and downstream of the bridge along the outside of the bend to the south. The 1D model is based on the assumption of a uniform level water surface elevation across the floodplain perpendicular to flow. The FLO-2D model results represent the more realistic condition of a non-uniform water surface elevation across the wash. Also, breakouts into the overbank floodplain occur between FEMA cross sections in both areas. The FLO-2D model picks up these breakouts and routes flow through the overbank system. This affects the existing subdivision immediately downstream of the bridge.

Moving down to the DSA, examine the area around FLO-2D cross section 5 (CS5). CS5 is aligned perpendicular to flow as shown by the FLO-2D grid element flow direction arrows on Figure 4.16. CS5 lays at an angle between FEMA cross sections I and J. The FLO-2D 100-year water surface elevation at CS5 varies from 1823.9 to 1824.2. The FEMA 1D water surface elevations vary from 1823 to 1824 between cross sections I and J. The modified URS HECRAS model (refer to Section 4.4) cross sections 5 and 6 cover this same area. The 100-year water surface elevation between these cross sections varies from 1821.4 to 1822.8. The FLO-2D 100-year water surface elevations in the main channel along FEMA cross section H and modified URS HECRAS cross section 5 vary from 1822.7 to 1823.3. The FEMA water surface elevation at this location is about 1823 and the modified URS water surface elevation at cross section 5 is 1821.4. The FEMA HECRAS model produces water surface elevation results in good agreement with the FLO-2D model within the limiting assumptions of a 1D model. The modified URS model results do not check close enough to either the FEMA HECRAS results or the FLO-2D model results, and are not recommended for use in the flood hazard assessment. The FLO-2D model does a superior job in providing detailed flow rates, depths and velocities at the level of detail needed to perform the flood hazard analysis in the DSA.

Figure 4.15 FEMA and FLO-2D floodplain delineations comparison

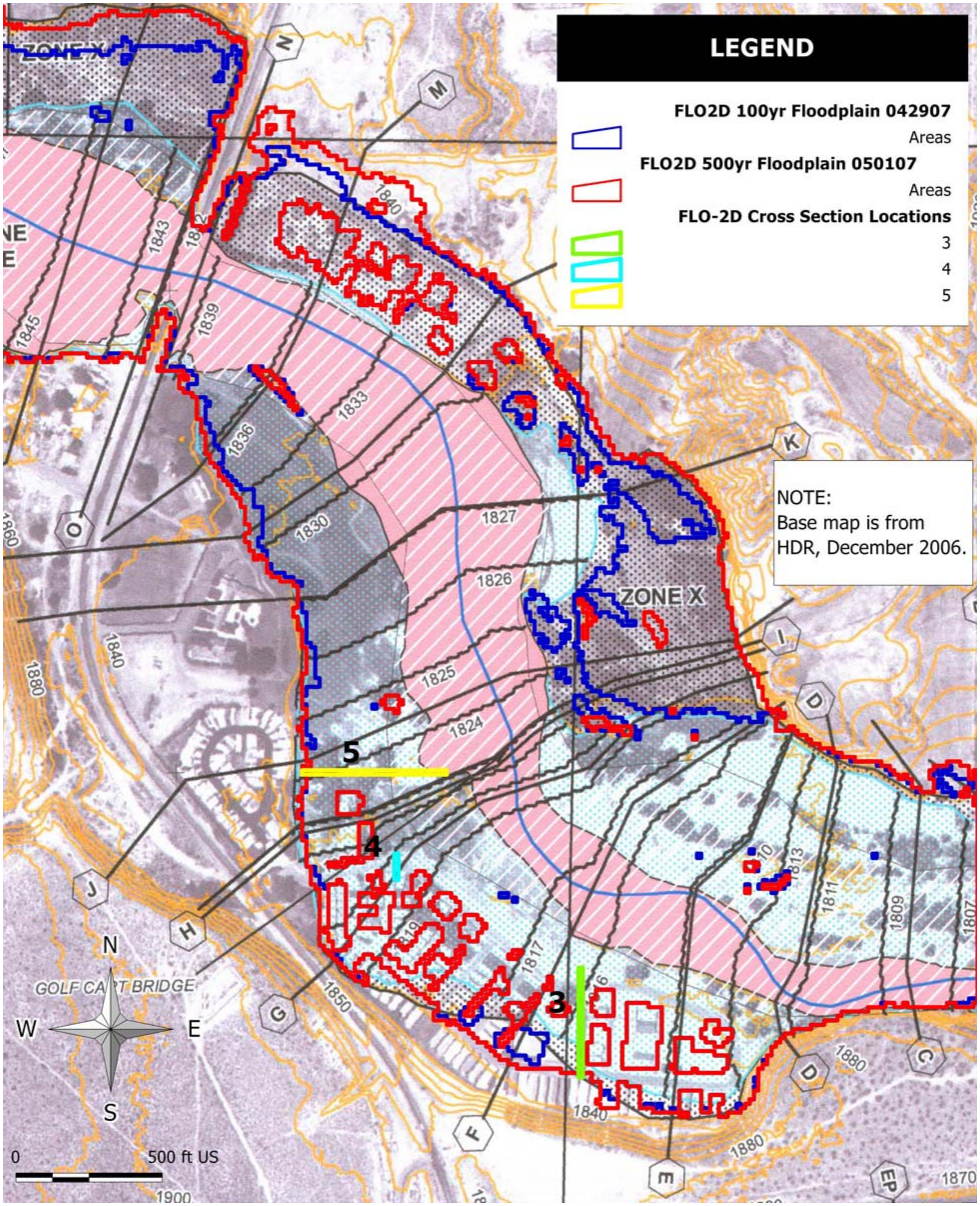
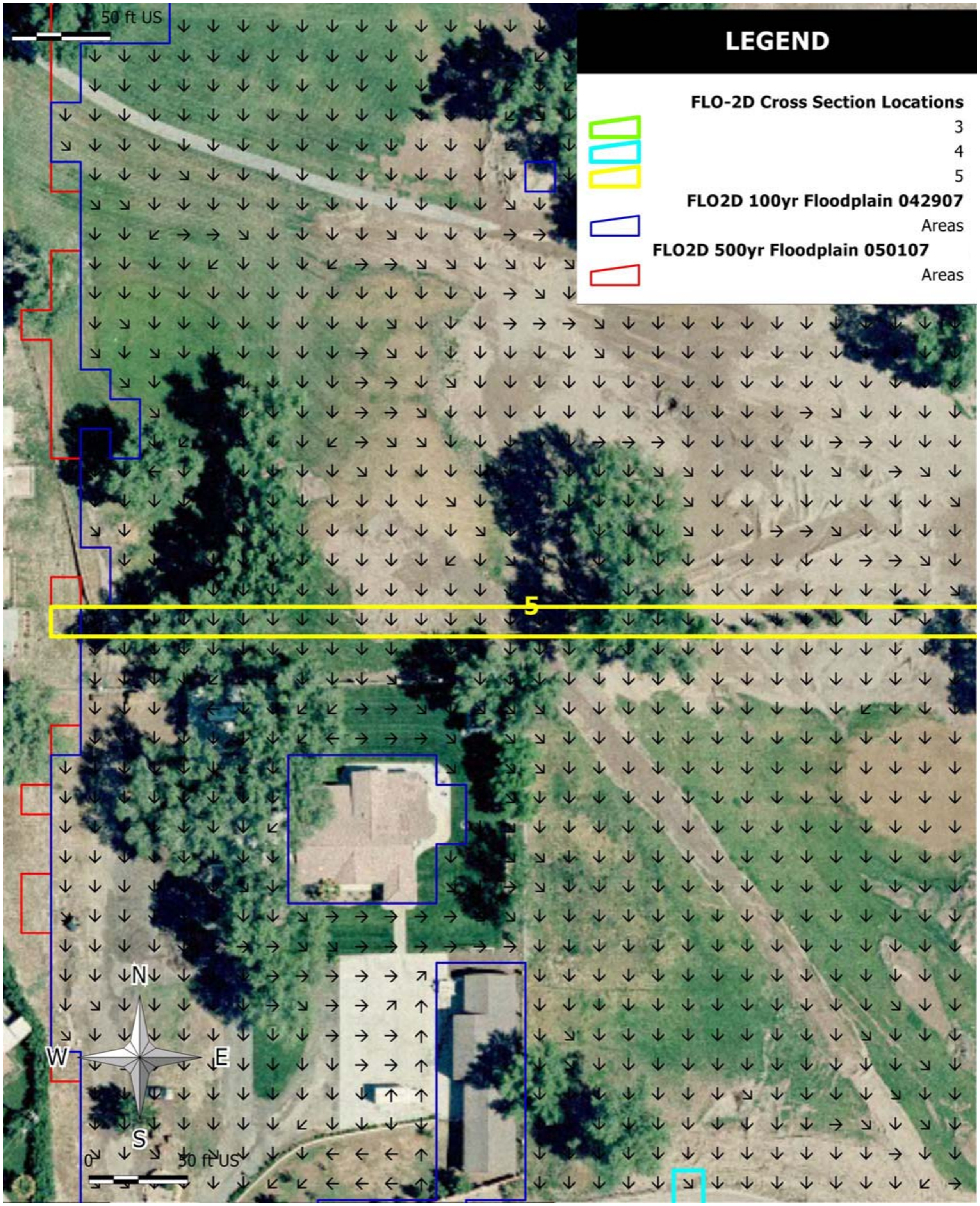


Figure 4.16 Grid element flow directions at FLO-2D cross section 5



5 January 2005 Flood Assessment

The flood of January 2005 commenced on 9 January and extended through 14 January. Mohave County Flood Control District provided the following chronology of events:

- **1-9 National Weather Service warning**: local fire department and sheriff's office contacted.
- **1-10 (01:30 AM)** High flows, door to door evacuations begin.
- **1-10 (06:00 AM)** Traffic control and emergency management staff arrive.
- **1-10 (Noon)** Heavy equipment arrives from Kingman, south bridge approach protected, flood waters begin to recede.
- **1-10 (Evening)** Assistant Public Works Director, public works personnel and 2 ADEM personnel arrive.
- **1-10 (Evening)** Sheriff's sergeant assumes incident command with other divisions acting as staff.
- **1-11 (07:00 AM)** EOC manned, regional emergency communications van arrives on scene.
- **1-11 (Mid-morning)** Utah warns of increased flows, water starts to rise and attack erosion protection, upstream and downstream banks begin to erode.
- **1-11 (Mid-afternoon)** Water channels through the south approach, Park Place Road begins to erode, Beaver Dam Resort begins to flood.
- **1-13 and 1-14** Flood waters recede / incident commander terminates incident management.

Unfortunately, the USGS stream gage at the Old County Highway 91 Bridge failed near the peak stage. The unofficial gage record obtained from the MCFCD is show in Figure 5.1. As can be seen on Figure 5.1, the flow rate did drop on 10 January, and then increased significantly. Towards the end of 10 January, the gage height began showing a level stage and the gage ultimately failed. The flow readings on 11 January are therefore highly suspect. The chronology states that flow did not begin to flood the Beaver Dam Resort in the DSA until mid-afternoon on 11 January. Assuming the gage readings on 10 January are valid, the flow rate would have to be greater than 10,000 cfs, and possibly greater than 15,000 cfs, to begin flooding the DSA.

Post-flood photographs are shown in Figure 5.2, Figure 5.3 and Figure 5.4. Note the evidence of significant erosion in Figure 5.2. The photograph shown on Figure 5.3 provides evidence of the high water stage reached near or at the peak flow rate. From the photographs, it is estimated that the depth of flooding in the structures is in the range of 4 to 6-feet.

Figure 5.1 Unofficial USGS Gage Hydrograph at Old Highway 91 Bridge

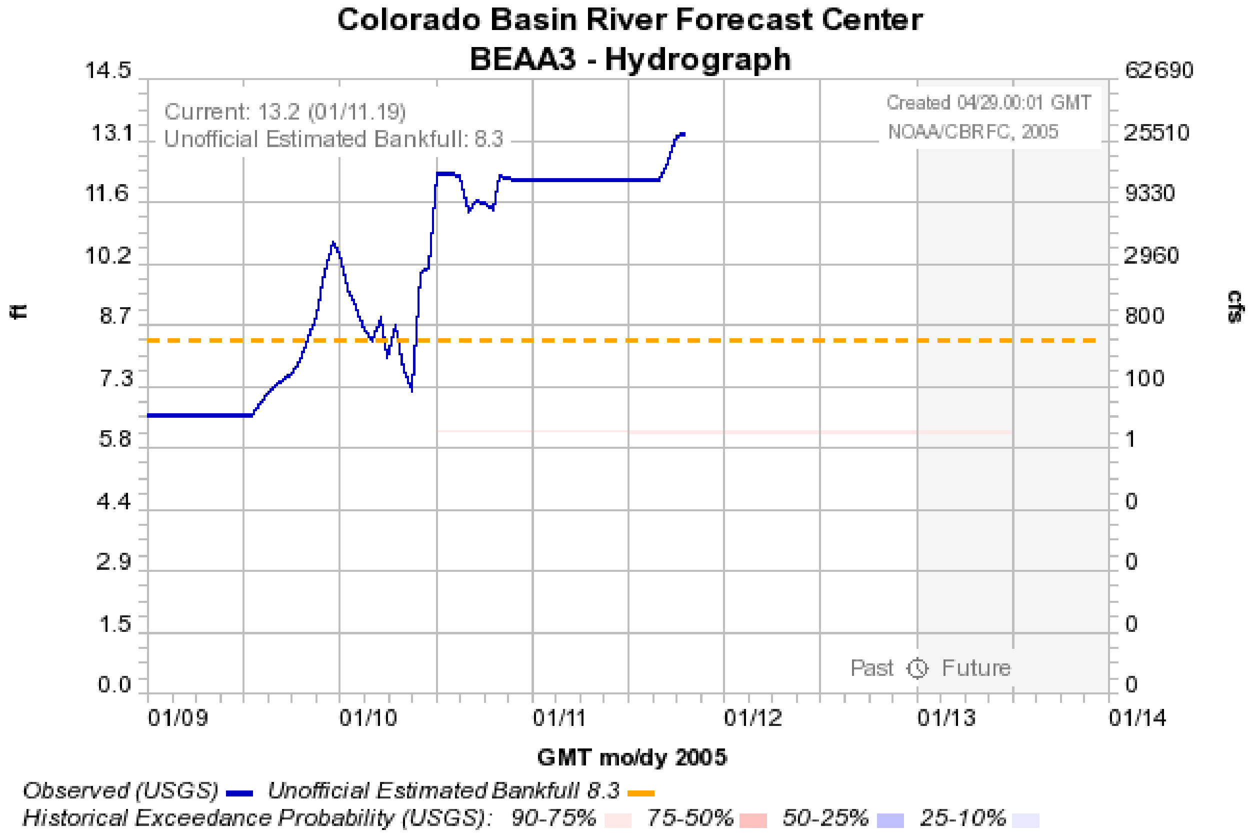


Figure 5.2 January 2005 post-flood photo (MCFCD)

Figure 5.3 Structure ID's 7, 9 and 11 (MCFCD)	Figure 5.4 Structure washed way (MCFCD)
	

Estimation of the peak discharge from the January 2005 flood is problematic due to the many variables for which there is no data. Factors that are unknown and affect the uncertainty of an estimate include:

1. The true ground geometry at the time of peak is unknown due to scour and deposition during the flood event.
2. The effects of vegetation at the time of peak are unknown because there is no data available to determine at what point during the flood vegetation was removed. Vegetation may have been removed prior to the peak but its effects during the rising limb of the hydrograph could actually result in higher water surface elevations than would result during the peak flow without the vegetation.
3. The surveyed elevations on high water indicators such as debris piles in trees are very subjective. Run-up will typically stack the debris higher than the water surface and there is no way to determine how much higher the debris stacks would have been. Also, debris is deposited throughout the flood, so as flood waters recede, debris is deposited at elevations below the peak water surface elevation. It is anticipated that many of the debris shots fall in this category. Therefore, the debris piles deposited at peak are probably higher than the actual water surface elevation at peak, and many others are

below. The best indicators are the high water marks evident on structures and slack water marks along the banks.

The key assumptions made in preparing the hydraulic models used for estimating the peak discharge are:

1. The ground surface at the time of peak was the same as that after the flood event.
2. Most vegetation was not removed prior to the peak.
3. The peak discharge from the January 2005 flood was probably close to the FEMA 100-year discharge. Therefore, the checks were done using a rating curve based on the 100-, 230-, and 500-year FLO-2D hydraulic models. The curve was projected for water surface elevations below the 100-year stage.

The approach for estimating the peak discharge associated with each surveyed high water indicator is as follows:

1. All surveyed elevations were used as is. No attempt was made to infer run-up heights with the debris pile elevations.
2. A nonlinear regression analysis was performed on the water surface elevations for each of the three hydraulic models at the location of every high water mark. The equation form was: $Q = b*m^{Elev}$, which was created using the LOGEST function in MS Excel. The equation was used to estimate the peak discharge at the elevation of the measured high water mark.
3. The results were tabulated, examined, and conclusions drawn.

The results from this analysis are shown in Table 5.2. Column 1 contains the FLO-2D grid element number of the grid containing the surveyed elevation. Also listed in column 1 are the Mohave County Assessor's parcel numbers for the two high water shots taken on the side of existing structures. Column 2 is the description of where the surveyed high water indicator elevation was taken. Columns 3 through 5 are the water surface elevation associated with the 100-, 230-, and 500-year peak discharges. Column 6 is the surveyed high water mark elevation. Column 7 contains the estimated peak discharge associated with the elevation in column 6.

Table 5.2 January 2005 flood surveyed high water marks

GRIDCODE/APN	Shot Description	Water Surface Elevation 100-yr	230-yr	500-yr	01/2005 High Water	Q, cfs
(1)	(2)	(3)	(4)	(5)	(6)	(7)
APN 402-87-058	High Water	1815.80	1816.70	1817.30	1815.55	18,600
APN 402-87-055	High Water	1816.20	1817.10	1817.60	1816.55	23,200
71375	Debris	1809.32	1810.18	1811.39	1814.36	80,500
63871	Debris	1815.71	1816.57	1817.16	1817.50	39,700
64829	Debris	1815.15	1815.99	1816.64	1816.55	34,100
70793	Debris	1810.11	1811.00	1812.06	1811.72	32,800
63682	Debris	1815.54	1816.56	1817.28	1817.04	32,500
71376	Debris	1809.29	1810.15	1811.34	1810.55	29,400
71594	Debris	1809.19	1810.05	1811.23	1809.95	25,700
71488	Debris	1809.18	1810.01	1811.19	1809.83	25,000
71150	Debris	1809.48	1810.41	1811.53	1810.17	25,000
71702	Debris	1809.13	1809.91	1811.16	1809.68	24,500
71619	Debris	1809.67	1810.59	1811.39	1810.18	24,100
65011	Debris	1815.09	1815.97	1816.63	1815.54	24,000
71491	Debris	1806.69	1810.06	1811.12	1808.14	23,900
72113	High Water	1808.60	1809.30	1810.50	1808.68	21,600
70434	Debris	1810.42	1811.39	1812.41	1810.22	19,500
70813	High Water	1810.28	1811.27	1812.16	1810.09	19,400
66777	Debris	1813.93	1814.86	1815.51	1813.66	18,600
70186	Debris	1810.76	1811.72	1812.70	1810.28	17,983
70435	Debris	1810.45	1811.41	1812.41	1809.94	17,900
71267	Debris	1809.23	1810.18	1811.31	1808.43	16,800
70799	Debris	1810.00	1810.94	1812.01	1809.00	15,700
69929	Debris	1811.02	1811.99	1812.96	1810.04	15,600
66095	Debris	1814.32	1815.24	1815.96	1813.42	15,200
71618	Debris	1809.62	1810.54	1811.36	1808.63	15,000

Table 5.2 January 2005 flood surveyed high water marks

GRIDCODE/APN	Shot Description	Water Surface Elevation 100-yr	230-yr	500-yr	01/2005 High Water	Q, cfs
(1)	(2)	(3)	(4)	(5)	(6)	(7)
64823	Debris	1815.30	1816.13	1816.79	1814.38	14,600
70800	Debris	1810.04	1810.94	1811.97	1808.80	14,500
70560	Debris	1810.41	1811.33	1812.33	1809.15	14,400
66776	Debris	1813.95	1814.88	1815.59	1812.84	14,100
70918	Debris	1809.85	1810.74	1811.86	1808.02	12,600
67273	Debris	1813.42	1814.49	1815.10	1811.62	11,600
67786	Debris	1813.09	1814.13	1814.88	1811.14	11,300
71720	High Water	1809.02	1809.80	1810.89	1806.89	11,100
69920	Debris	1811.06	1811.95	1812.92	1808.71	10,300
69548	Debris	1811.99	1813.00	1813.78	1809.41	9,300
69409	Debris	1812.04	1813.04	1813.82	1809.29	8,800
69410	Debris	1812.05	1813.05	1813.83	1809.30	8,800
69680	Debris	1811.91	1812.89	1813.67	1808.99	8,300
69412	Debris	1812.09	1813.10	1813.89	1808.84	7,600
69681	Debris	1811.93	1812.92	1813.70	1808.66	7,500
66438	Debris	1814.16	1815.05	1815.82	1810.98	7,170
69683	Debris	1811.94	1812.93	1813.71	1808.22	6,500
67110	Debris	1813.64	1814.24	1815.15	1808.85	3,600

The average of all the shots taken yielded a peak discharge of 19,100 cfs. Assuming that all locations with a peak discharge of greater than 26,000 cfs are strongly influenced by run-up debris pile height, and that all locations with a peak discharge less than 15,000 cfs occurred before the time to peak, the average is 20,300. Several shots were labeled by the surveyor as “High Water” marks. Only one, at GRIDCODE 72113, is a bank slack water shot. Using the slack water shot and the two shots on structure high water marks, the average discharge is 21,200 cfs. The assumptions used to perform these estimates (ie. higher roughness) should provide estimates on the low end of the possible range. Using this approach, the estimated January 2005 flow rate is at least 21,000 cfs, and the range of possible values, assuming a variation of +/- 20 percent, is from 17,000 to 25,000 cfs. Therefore, the January 2005 flood at peak stage was probably close, in terms of peak discharge, to the FEMA 100-year peak discharge. However, it is important to keep in mind that the peak discharge could have been much greater if the vegetation was removed early in the rising limb of the hydrograph and/or scour was much greater than the post-flood topography would indicate. A flood of the magnitude of the January 2005 flood event can be expected to occur infrequently, but the DSA can expect flooding from much smaller storm events.

6 Flood Hazard Assessment

The flood hazard assessment of the DSA was done using the 100-year 24-hour FLO-2D model results in combination with the HEC-1 model results described in Section 3.4. The assessment is based on several factors:

- Timing, flow rate and flooding frequency at critical locations affecting the ability of residents to be evacuated from the area of hazard.
- Timing, flow rate and flooding frequency where flow would begin to enter individual structures (where the finished floor elevations are known).
- Personal safety hazard factors for adults in and around each residence based on 100-year 24-hour flow depth and velocity.

This information is used as the basis for assessing the flood risk and assigning hazard classifications for the structures in the DSA. Conclusions and recommendations for addressing and mitigating the flood hazards are then defined.

6.1 Time to Peak and Recurrence Interval at Finish Floor Elevations

The time where flow first reaches the finished floor elevation of each residence where the finished floor elevation is known is used to estimate the peak flow in Beaver Dam Wash at that stage The corresponding flooding frequency of that peak discharge is then determined. The results are shown in Table 6.1, sorted in order of decreasing frequency. The ID in column 1 relates to the ID number shown on Figure 6.4 later in this section. The recurrence interval for the structures most susceptible to flooding varies from 35 to 70 years, with an average of about 50 years. This is a 2 percent chance in any given year of flood elevations reaching the threshold of structures in the area. The average expected depth of flooding within these structures during a 100-year 24-hour event is about 2.7 feet. This is sufficient depth to result in severe damage to the structure and contents. The 100-year water surface elevations are based on the FLO-2D model results.

Table 6.1 Analysis results of threshold flooding at finished floor elevations

ID	APN	Finished Floor Elevation	Parameter Values at Flood Stage Equal to Finished Floor Elevation		
			Time to Peak, hours	Discharge, cfs	Recurrence Interval, years
(1)	(2)	(3)	(4)	(5)	(6)
7	402-87-016	1812.05	20.3	13,700	35
9	402-87-013	1813.14	20.9	14,600	42
11	402-87-017	1812.64	20.6	14,600	42
4	402-87-007	1813.84	20.6	14,600	42
1	402-87-034	1812.27	20.3	14,600	42
10	402-87-012	1813.57	20.9	14,600	42
3	402-87-033	1812.37	20.7	14,600	42
17	402-87-006	1813.96	20.5	15,200	45
24	402-87-018	1814.02	20.8	15,900	49
16	402-87-025	1813.74	20.4	15,900	49
34	402-87-011	1814.98	20.2	15,900	49
19	402-87-019	1814.59	21.2	15,900	49
20	402-87-020	1814.62	20	15,900	49
29	402-87-026	1814.33	20.4	15,900	49
36	402-87-028	1814.48	20.4	16,400	49
18	402-87-004	1815.59	20.4	16,100	50
28	402-87-009	1815.41	20.8	16,100	50
21	402-87-010	1815.63	20.1	16,100	50
40	402-87-030	1814.1	20	16,100	50
46	402-87-029	1814.26	20.7	16,300	53
59	402-87-021	1814.79	21.1	16,500	55

Table 6.1 Analysis results of threshold flooding at finished floor elevations

ID	APN	Finished Floor Elevation	Parameter Values at Flood Stage Equal to Finished Floor Elevation		
			Time to Peak, hours	Discharge, cfs	Recurrence Interval, years
(1)	(2)	(3)	(4)	(5)	(6)
33	402-87-027	1814.83	21.2	16,500	55
53	402-87-008	1816.02	21.2	16,500	55
25	402-87-003	1816.16	20.3	16,900	58
60	402-87-002	1816.57	20.4	17,900	69
30	402-87-055	1815.68	20.6	19,000	80
51	402-87-056	1815.51	20.7	19,600	86
27	402-87-058	1815.43	20.1	20,100	91
56	402-87-050	1817.39	20.5	24,500	190
57	402-87-049	1817.72	20.5	24,500	190
71	402-87-046	1817.92	20.5	25,100	205

The known residence finished floor elevations are listed in Table 6.2 for comparison with the results from the FLO-2D model. The results are listed in order by structure ID from Figure 6.4.

Table 6.2 Comparison of FLO-2D water surface elevations with finished floors

ID	APN	Finished Floor Elevation	FLO-2D 100-year Results	
			Water Surface Elevation	Flooding Depth Above FF
(1)	(2)	(3)	(4)	(5)
1	402-87-034	1812.27	1816.2	3.9
3	402-87-033	1812.37	1815.8	3.4
4	402-87-007	1813.84	1818.0	4.2
7	402-87-016	1812.05	1817.1	5.0

Table 6.2 Comparison of FLO-2D water surface elevations with finished floors

ID	APN	Finished Floor Elevation	FLO-2D 100-year Results	
			Water Surface Elevation	Flooding Depth Above FF
(1)	(2)	(3)	(4)	(5)
9	402-87-013	1813.14	1817.4	4.3
10	402-87-012	1813.57	1817.4	3.8
11	402-87-017	1812.64	1816.9	4.3
16	402-87-025	1813.74	1816.4	2.7
17	402-87-006	1813.96	1818.0	4.0
18	402-87-004	1815.59	1818.0	2.4
19	402-87-019	1814.59	1816.9	2.3
20	402-87-020	1814.62	1816.9	2.3
21	402-87-010	1815.63	1817.4	1.8
24	402-87-018	1814.02	1816.9	2.9
25	402-87-003	1816.16	1818.0	1.8
27	402-87-058	1815.43	1815.8	0.4
28	402-87-009	1815.41	1817.4	2.0
29	402-87-026	1814.33	1816.3	2.0
30	402-87-055	1815.68	1816.2	0.5
33	402-87-027	1814.83	1816.3	1.5
34	402-87-011	1814.98	1817.4	2.4
36	402-87-028	1814.48	1816.2	1.7
40	402-87-030	1814.10	1815.8	1.7
46	402-87-029	1814.26	1816.1	1.8
51	402-87-056	1815.51	1816.0	0.5
53	402-87-008	1816.02	1817.3	1.3
56	402-87-050	1817.39	1816.9	-0.5
57	402-87-049	1817.72	1817.2	-0.5
59	402-87-021	1814.79	1816.9	2.1

Table 6.2 Comparison of FLO-2D water surface elevations with finished floors

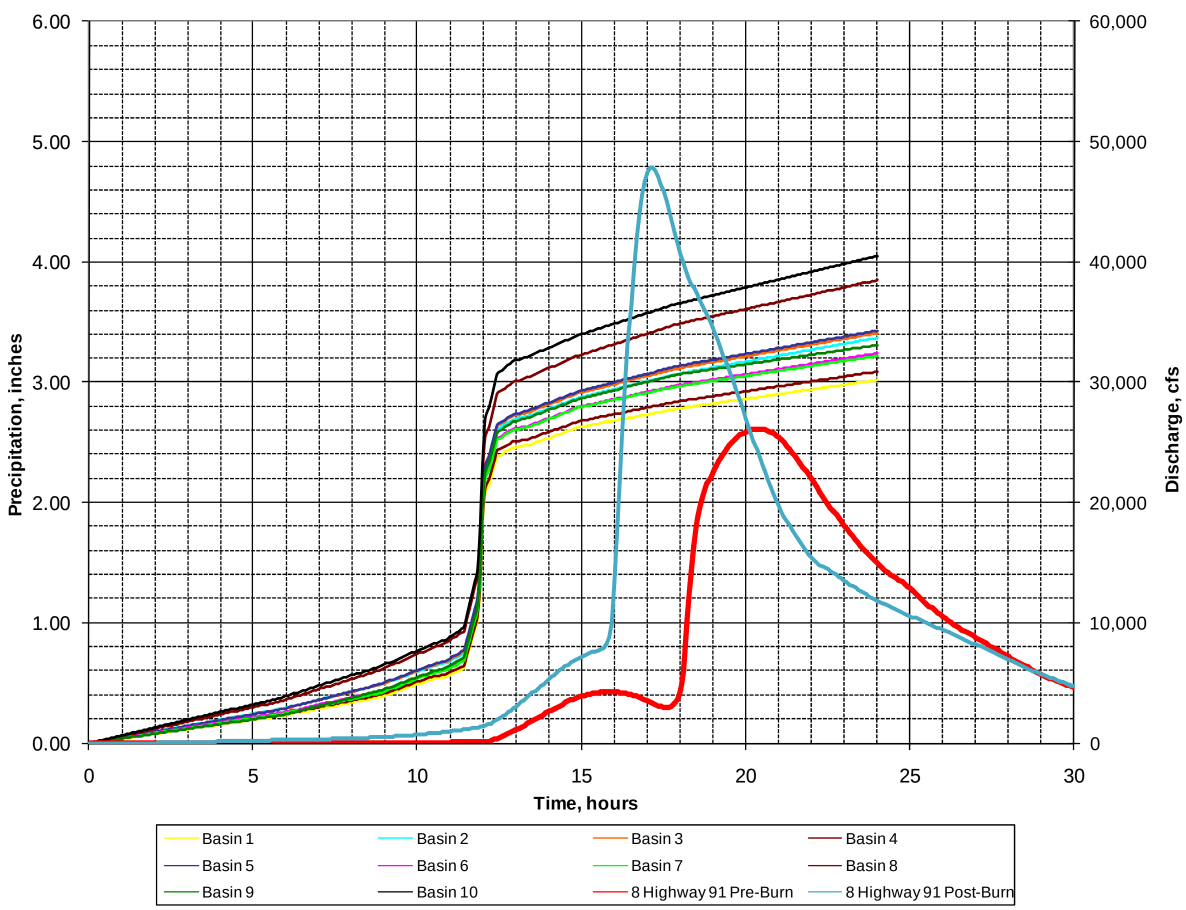
ID	APN	Finished Floor Elevation	FLO-2D 100-year Results	
			Water Surface Elevation	Flooding Depth Above FF
(1)	(2)	(3)	(4)	(5)
60	402-87-002	1816.57	1817.9	1.3
71	402-87-046	1817.92	1817.3	-0.6

6.2 Estimate of Hydrologic Lead Time

An analysis was done to determine if the lower portion of the Beaver Dam Wash watershed can produce a high enough peak discharge to flood the area of concern. A HEC-1 model containing only basins 1-7 (refer to Figure 3.2) was run to determine if sufficient peak discharge can be generated to cut-off access to the DSA and/or to flood the structures. That portion of the watershed can produce over 20,000 cfs from a 100-year point precipitation; therefore, runoff from that area can block the access route and flood structures. The time to peak from the lower watershed is about 19.4 hours, 1-hour less than the complete watershed. The estimate of hydrologic lead time is therefore based on the lower watershed response to precipitation. The time of most intense precipitation for the lower watershed is at 12.0 hours. The flow rate that first begins flooding the access road in the DSA is about 10,900 cfs at 18.3 hours. The estimated hydrologic lead time is therefore 18.3-12.0, or approximately 6.3 hours. The time to 1-foot of flow depth is estimated to be about 18.4 hours, and the time to 2-feet of depth about 18.5 hours. Therefore, once flood water begins enter the DSA, access could be quickly cut-off. The above results are assuming the hydrologic conditions that existed prior to the 2005 and 2006 wildfires discussed in Section 3.5.

The wildfires that occurred on the Beaver Dam Wash watershed could have significant detrimental effects on hydrologic lead time. There is little available data for use in estimating the effects of the burned areas on hydrologic response. The general characterizations described in PBS&J (2007) were used as the basis for assumptions used in modifying the base HEC-1 models to simulate possible effects of the fires. Refer to Section 3.5. The results of that effort lead to the conclusion that hydrologic lead time could be significantly reduced until the watershed can recover. Also, smaller precipitation amounts could result in higher peak discharges. Per PBS&J (2207), the watershed may never fully recover to pre-burn conditions, and continue to exhibit quicker hydrologic response to flood events. The post-fire HEC-1 models were only developed for the general storm over the entire watershed condition. The time of most intense precipitation for the entire watershed is at about 12.0 hours. The flow rate that first begins flooding the access road in the DSA is about 10,900 cfs at 15.9 hours. The estimated hydrologic lead time is therefore 15.3-12.0, or approximately 3.3 hours. The time to 1-foot of flow depth is estimated to be about 16.0 hours, and the time to 2-feet of depth about 16.1 hours. The estimated hydrologic lead time for the post-burn condition could therefore be about 3-hours less than for the pre-burn, or normal watershed condition.

Figure 6.1 Pre-burn versus post-burn 100-year 24-hour hydrographs



6.3 Estimate of Storm Frequency Blocking Access to Residences

The estimates of storm frequency at CS4 that block access to the residences in the DSR, for pre-fire conditions, are listed in Table 6.3. Refer to Figure 6.2 for the location of CS4.

Table 6.3 Estimate of storm frequency blocking access to residences

Flow Depth, feet	Discharge, cfs	Time. hours	Frequency, year
(1)	(2)	(3)	(4)
0	10,900	18.3	20 (5 percent)
1	12,800	18.4	30 (3.33 percent)
2	14,600	18.5	40 (2.5 percent
5.1	21,000	20.44	100 (1 percent)

Figure 6.2 Location of first point of flooding (CS4)

6.4 Personal Safety Hazard Factor at Each Residence

The FLO-2D model results for the 100-year 24-hour storm were used to define personal safety hazard factors for adults in the vicinity of each residence in the study area. The criteria for defining the hazards were derived using Figure 6.3 in combination with the FLO-2D model depth and velocities. The results of the analysis are listed in Table 6.3. Column 8 of the table lists the product of depth x velocity. The table is sorted in decreasing order of hazard. The hazard classification is listed in column 9. If the hazard falls in the "Judgment Zone" from Figure 6.3, a classification of medium hazard was assigned. Locations with a D*V greater than 20 were assigned a very high hazard classification. Refer to Figure 6.4 and Figure 6.5 for maps relating the location of each residential structure to the assigned flood hazard. The ID in column 1 is used to label each structure on the figures.

Note there are 15 structures classified as having a very high hazard for adults. All but one of these is a mobile/manufactured home. All of these locations also meet the high hazard classification for mobile homes (USBR, 1988).

Figure 6.3 Depth-velocity flood danger level relationship for adults (USBR, 1988)

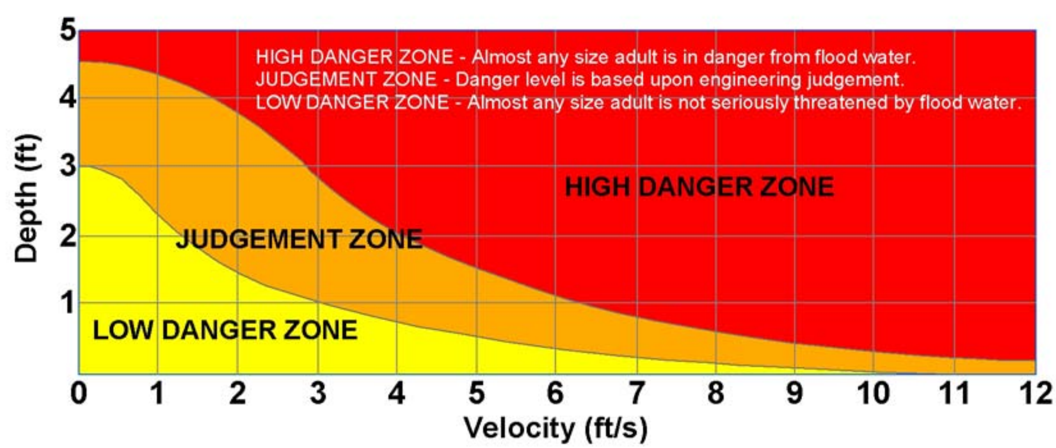


Table 6.4 Personal safety hazard adjacent to each structure

ID	APN	Type	FF	Time, hours	Depth, ft	Velocity, ft/sec	D*V, ft^2/S	Adult Hazard
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	402-87-034	TRAILERS	Y	20.3	7.5	8.9	66.8	Very High
2	402-83-045	TRAILERS	N	20.5	6.4	8.2	52.5	Very High
3	402-87-033	TRAILERS	Y	20.7	7.3	7.1	51.8	Very High
4	402-87-007	TRAILERS	Y	20.6	7.2	6.7	48.2	Very High
5	402-83-037	TRAILERS	N	20.5	6.5	6.2	40.3	Very High
6	402-83-038	TRAILERS	N	20.6	5.6	6.4	35.8	Very High
7	402-87-016	TRAILERS	Y	20.3	6.3	5.2	32.8	Very High
8	402-81-041	BUILDINGS	N	20.6	5.3	5.1	27.0	Very High
9	402-87-013	TRAILERS	Y	20.9	5.6	4.3	24.1	Very High
10	402-87-012	TRAILERS	Y	20.9	5.6	4.3	24.1	Very High
11	402-87-017	TRAILERS	Y	20.6	4.9	4.7	23.0	Very High
12	402-83-021	TRAILERS	N	20.3	4.1	5.0	20.5	Very High
13	402-83-020	TRAILERS	N	20.8	4.3	4.7	20.2	Very High
14	402-83-025	TRAILERS	N	20.8	4.3	4.7	20.2	Very High
15	402-83-036	TRAILERS	N	21.1	6.1	3.2	19.5	Very High
16	402-87-025	TRAILERS	Y	20.4	4.8	4.0	19.2	High
17	402-87-006	TRAILERS	Y	20.5	5.4	3.5	18.9	High
18	402-87-004	TRAILERS	Y	20.4	5.1	3.7	18.9	High
19	402-87-019	TRAILERS	Y	21.2	4.6	4.0	18.4	High
20	402-87-020	TRAILERS	Y	20.0	4.6	3.9	17.9	High
21	402-87-010	TRAILERS	Y	20.1	4.2	3.8	16.0	High
22	402-83-044	TRAILERS	N	21.1	5.4	2.9	15.7	High
23	402-83-035	TRAILERS	N	20.5	4.6	3.4	15.6	High
24	402-87-018	TRAILERS	Y	20.8	4.9	3.1	15.2	High
25	402-87-003	TRAILERS	Y	20.3	4.1	3.7	15.2	High
26	402-83-001	TRAILERS	N	20.5	3.8	3.9	14.8	High
27	402-87-058	TRAILERS	Y	20.1	4.0	3.7	14.8	High

Table 6.4 Personal safety hazard adjacent to each structure

ID	APN	Type	FF	Time, hours	Depth, ft	Velocity, ft/sec	D*V, ft^2/S	Adult Hazard
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
28	402-87-009	TRAILERS	Y	20.8	3.7	4.0	14.8	High
29	402-87-026	TRAILERS	Y	20.4	4.2	3.5	14.7	High
30	402-87-055	TRAILERS	Y	20.6	3.1	4.6	14.3	High
31	402-83-033	TRAILERS	N	20.4	4.1	3.4	13.9	High
32	402-85-003	TRAILERS	N	20.4	4.1	3.4	13.9	High
33	402-87-027	TRAILERS	Y	21.2	3.3	4.2	13.9	High
34	402-87-011	TRAILERS	Y	20.2	5.1	2.7	13.8	High
35	402-83-034	TRAILERS	N	20.8	4.4	3.1	13.6	High
36	402-87-028	TRAILERS	Y	20.4	3.1	4.2	13.0	High
37	402-83-009	TRAILERS	N	20.5	3.8	3.3	12.5	High
38	402-83-010	TRAILERS	N	20.5	3.8	3.3	12.5	High
39	402-83-030	TRAILERS	N	20.5	3.8	3.3	12.5	High
40	402-87-030	TRAILERS	Y	20.0	3.8	3.2	12.2	High
41	402-83-019	TRAILERS	N	21.1	4.1	2.9	11.9	High
42	402-83-023	TRAILERS	N	21.1	4.2	2.8	11.8	High
43	402-85-021	TRAILERS	N	20.3	4.2	2.8	11.8	High
44	402-83-011	TRAILERS	N	20.4	3.3	3.4	11.2	High
45	402-83-031	TRAILERS	N	20.0	2.8	3.8	10.6	High
46	402-87-029	TRAILERS	Y	20.7	3.5	3.0	10.5	High
47	402-83-032	TRAILERS	N	20.4	3.3	3.1	10.2	High
48	402-85-002	TRAILERS	N	20.4	3.3	3.1	10.2	High
49	402-86-005	BUILDINGS	N	20.5	2.8	3.6	10.1	High
51	402-87-056	TRAILERS	Y	20.7	3.3	3.0	9.9	High
52	402-83-012	TRAILERS	N	20.6	3.4	2.9	9.9	High
53	402-87-008	TRAILERS	Y	21.2	3.0	3.1	9.3	High
54	402-83-002	TRAILERS	N	20.3	3.0	3.0	9.0	High
55	402-83-015	TRAILERS	N	20.3	3.0	3.0	9.0	High

Table 6.4 Personal safety hazard adjacent to each structure

ID	APN	Type	FF	Time, hours	Depth, ft	Velocity, ft/sec	D*V, ft^2/S	Adult Hazard
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
56	402-87-050	TRAILERS	Y	20.5	2.5	3.6	9.0	High
57	402-87-049	TRAILERS	Y	20.5	2.5	3.6	9.0	High
58	402-83-003	TRAILERS	N	20.9	2.9	3.0	8.7	High
59	402-87-021	TRAILERS	Y	21.1	3.1	2.6	8.1	Moderate
60	402-87-002	TRAILERS	Y	20.4	3.1	2.4	7.4	Moderate
61	402-83-017	TRAILERS	N	20.8	2.6	2.6	6.8	Moderate
62	402-83-004	TRAILERS	N	20.7	2.6	2.5	6.5	Moderate
63	402-83-005	TRAILERS	N	20.7	2.7	2.4	6.5	Moderate
64	402-83-006	TRAILERS	N	20.7	2.7	2.4	6.5	Moderate
65	402-87-045	TRAILERS	N	20.5	1.9	3.4	6.5	Moderate
66	402-34-113	BUILDINGS	N	20.6	2.1	2.8	5.8	Moderate
67	402-34-113	BUILDINGS	N	20.5	2.1	2.8	5.8	Moderate
68	402-86-004	BUILDINGS	N	20.5	1.7	3.2	5.5	Moderate
69	402-81-041	BUILDINGS	N	20.4	1.8	2.9	5.2	Moderate
70	402-81-040	BUILDINGS	N	20.5	1.5	3.2	4.7	Moderate
71	402-87-046	TRAILERS	Y	20.5	1.7	2.6	4.4	Moderate
72	402-83-013	TRAILERS	N	20.5	1.7	2.3	3.9	Moderate
73	402-83-014	TRAILERS	N	20.6	1.9	1.9	3.6	Moderate
74	402-81-031	BUILDINGS	N	20.4	1.3	2.7	3.5	Moderate
75	402-81-045	BUILDINGS	N	20.3	1.4	2.5	3.4	Moderate
76	402-81-039	BUILDINGS	N	20.5	1.3	2.6	3.4	Moderate
77	402-81-032	BUILDINGS	N	20.5	1.4	2.3	3.2	Moderate
78	402-81-043	BUILDINGS	N	20.4	1.4	2.1	3.1	Moderate
79	402-81-047	BUILDINGS	N	20.2	1.3	2.1	2.6	Moderate
80	402-86-003	BUILDINGS	N	20.4	1.0	2.5	2.6	Low
81	402-87-044	TRAILERS	N	20.6	1.6	1.4	2.2	Low
82	402-81-044	BUILDINGS	N	20.5	1.3	1.6	2.0	Low

Table 6.4 Personal safety hazard adjacent to each structure

ID	APN	Type	FF	Time, hours	Depth, ft	Velocity, ft/sec	D*V, ft^2/S	Adult Hazard
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
83	402-81-038	BUILDINGS	N	20.5	1.1	1.9	2.0	Low
84	402-85-029	TRAILERS	N	20.8	2.4	0.8	1.9	Low
85	402-81-021	BUILDINGS	N	0.0	0.8	2.3	1.9	Low
86	402-85-033	TRAILERS	N	20.6	1.1	1.5	1.7	Low
87	402-85-034	TRAILERS	N	20.6	1.1	1.5	1.7	Low
88	402-81-023	BUILDINGS	N	20.4	0.9	1.4	1.3	Low
89	402-81-027	BUILDINGS	N	20.3	0.8	1.4	1.1	Low

Figure 6.4 Personal flood hazard ratings for the Detailed Study Area

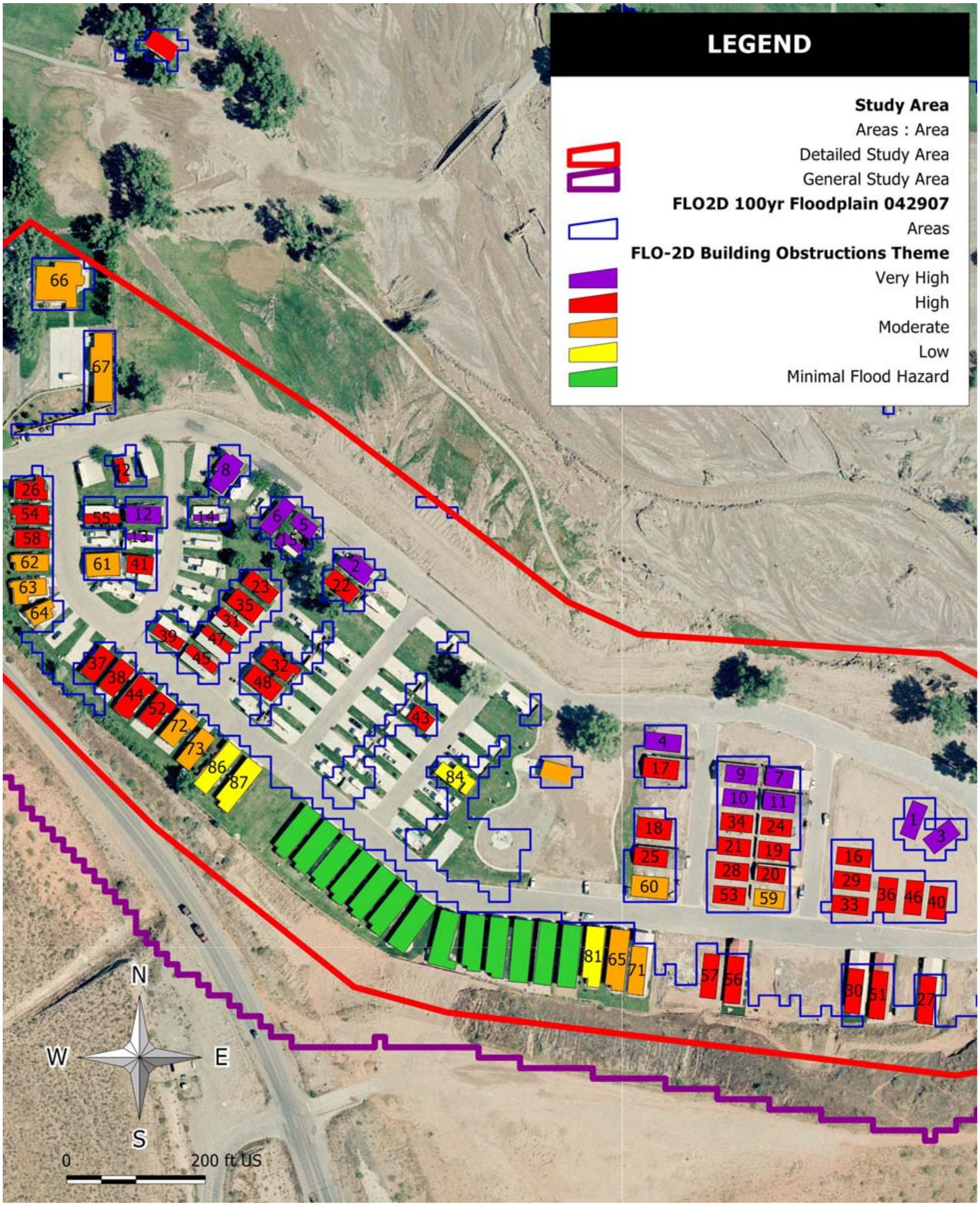
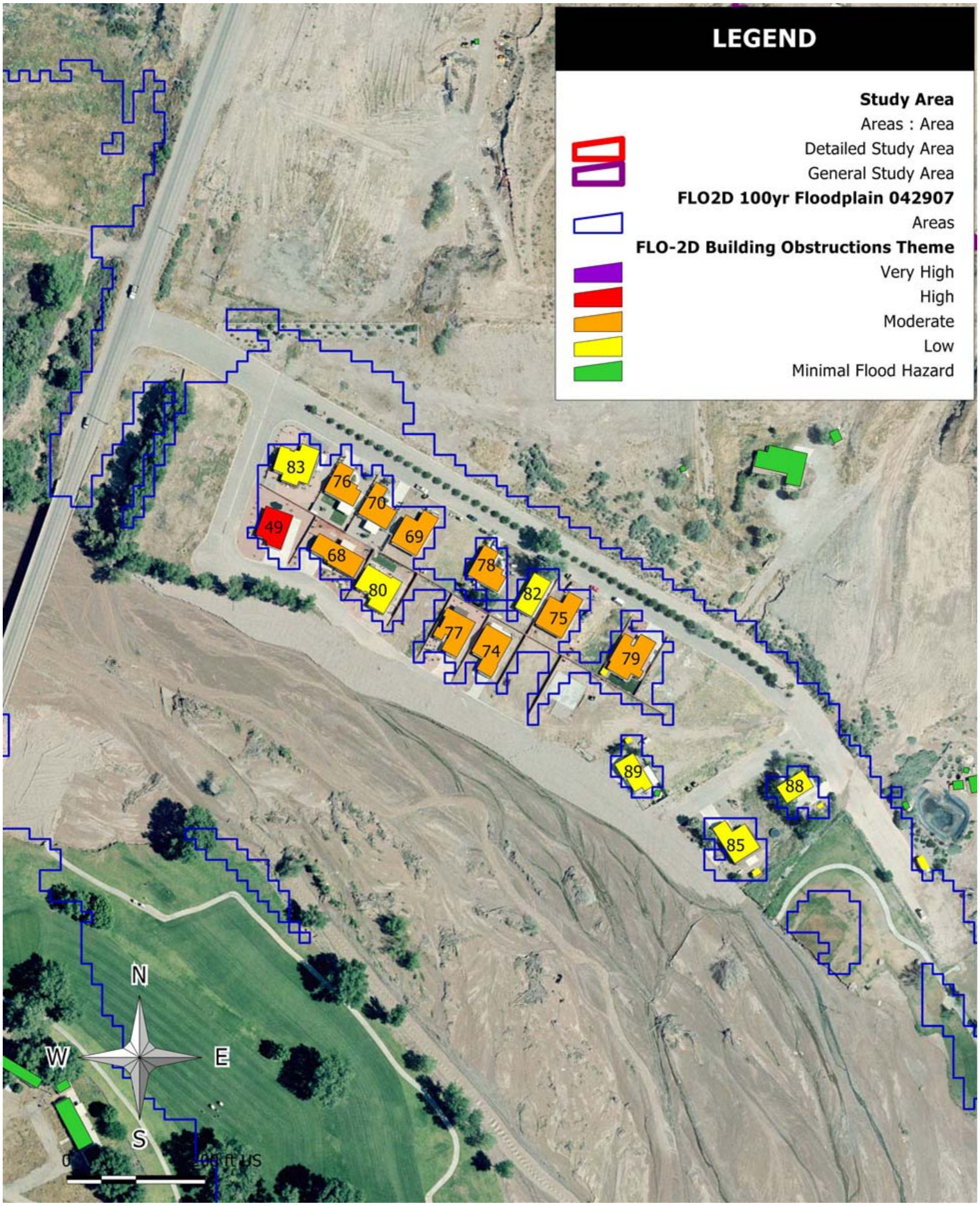


Figure 6.5 Personal flood hazard ratings in the North study area



7 Summary, Conclusions, and Recommendations

This study is intended to assess flood risk and identify flood hazards based on those risks, for the Beaver Dam area from the Beaver Dam Wash. The hydrologic and hydraulic results are intended for risk assessment and emergency management purposes only. The results of this study should not be considered as "best available technical information" for floodplain management purposes." Certain limiting assumptions used in the development of the technical basis for this study, including friction loss parameters and model control options designed to produce the upper limit of peak flood stages for a 100-year event, are intentionally very conservative, not reflective of existing conditions, and are therefore not appropriate for regulatory floodplain management uses.

For pre-fire watershed conditions, the access for evacuation begins being compromised by a storm with a 5 percent chance of occurring in a given year. Structures begin to be flooded by a storm with a 30 percent chance of occurring within any given year. The risk of flooding for the DSA is considered moderate, assuming:

1. flooding from a 10% chance or more frequent flood is high,
2. a flood with a probability between 3% and 10% is moderate, and
3. a flood with a less than 3% probability is low.

The maximum available lead time for a storm over the entire watershed, assuming adequate flood warning facilities and a flood warning plan are in place, is about 6-hours for normal, pre-fire conditions, and about 3-hours for post-fire conditions. Based on the assumptions and technical analyses presented in this study, fifteen of the residential structures in the Beaver Dam area are in a very high hazard zone and forty two are in a high hazard zone. These hazard ratings correspond to a possible life threatening situation, based on criteria from USBR (1988), if the area is not evacuated in a timely manner.

The primary structural alternative for mitigating the flood hazard is an extensive levee system. A levee system is not recommended because of prohibitive cost and because the flood risk will increase due to the threat of failure of the structure. Considering all these factors combined, and the small number of residents in the hazard area, the conclusion is that flood warning and other non-structural alternatives for the Beaver Dam Wash area be given a high priority by the Mohave County Flood Control District.

Recommendations for addressing the concerns identified as a result of this study are as follows:

4. **Flood Warning Instrumentation**: Install new flood warning instrumentation in the Beaver Dam Wash watershed as soon as is practical. At a minimum, add two new combination precipitation and stream flow gages and one new precipitation gage. As future funding permits, add three more precipitation gages. All the gages should be automatic and be connected to the Mohave County and Arizona flood warning systems with real-time telemetry. It is also recommended that real-time cameras be installed at each gage site for the purpose of verifying that precipitation is actually falling and that the gage is not malfunctioning. This could save a verification field trip, which is a full-day round trip from Kingman. Preliminary proposed gage locations are shown on the exhibit map in Appendix F.

5. **Flood Warning Plan**. Prepare a flood warning plan for the area. The plan should research, evaluate and recommend physical components and emergency management procedures for:

   A. Identifying imminent flood hazards.

   B. Establishing operational levels for apprising emergency action personnel and residents regarding the level of threat.

   C. Identifying and recommending physical flood warning components for local implementation that could include a local siren, a reverse 911 system, weather radios, and/or a paging system.

   D. Preparing handouts for residents that identify the recommended flood warning and evacuation procedures.

   E. Conducting a public information and education program to apprise the residents and property owners of the identified hazards and to educate them regarding their responsibilities under the flood warning plan

6. **Floodproofing, Relocation or Buyout.** Investigate possible federal funding from FEMA and the U.S. Army Corps of Engineers for voluntary participation programs for homes with repetitive flood losses. Under such programs, property owners can undertake options

such as flood proofing, relocation of their home, or buyout and demolition of the existing high-hazard repetitive loss structure.

7. **Regulation.** Continue regulating development within the 100-year floodplain using the data from URS (July, 2005) as best available technical data until FEMA publishes, and Mohave County adopts, a new flood insurance study for the area. Then the adopted FEMA technical data should be used.

Appendix A Field Survey Supplemental Topographic Data

The Owens Surveying Outfit, Inc.

James J. Owens
Registered Land Surveyor
United States Mineral Surveyor
Established since 1965

P.O. Box 1330 ~ Mesquite, NV. 89024
Phone: (702) 346-2930 ~ Fax: (702) 346-2940
Administrative email: toso1@mesquiteweb.com
Technical email: toso@mesquiteweb.com

April 18, 2007

Philip G. Wisely
Mohave County Public Works
3675 E. Andy Devine, Suite C
Kingman, Arizona 86402

Re: Beaver Dam Wash Flood Control Survey

Dear Mr. Wisely:

This correspondence serves to advise you that the above referenced survey was conducted under my direct supervision in accordance with our firms proposal dated August 18, 2006 and amended on September 19, 2006 under Mohave County Procurement Dept. Purchase Order No. 20070210-00 and 20070210-01, respectively.

NAD 83 Horizontal Control and NAVD 88 Vertical Control (Arizona West Zone) was furnished to me by the URS Corp. Survey Department, which was used for all observed points within the scope of the flood study. Refer to attached pages 1 thru 12 for detailed observed data, which agrees with the previously submitted email data.

Please distribute this information to those concerned parties. If I may be of further assistance, please do not hesitate to contact me.

Very Truly Yours,

The Owens Surveying Outfit, Inc.

James J. Owens, RLS No. 24528

Encl: (1) August 18, 2006 Proposal
(2) P.O. No. 20070210-00
(3) September 19, 2006 Proposal
(4) P.O. No. 20070210-01
(5) NGS Data Sheet – USGS Beaver
(6) URS Data Sheet
(7) Owens Data Sheets 1 – 12, incl.

The NGS Data Sheet

See file dsdata.txt **for more information about the datasheet.**

```
DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.31
1        National Geodetic Survey,   Retrieval Date = MARCH 13, 2006
 GQ0167 ***********************************************************************
 GQ0167  DESIGNATION -  BEAVER
 GQ0167  PID         -  GQ0167
 GQ0167  STATE/COUNTY-  AZ/MOHAVE
 GQ0167  USGS QUAD   -  LITTLEFIELD (1985)
 GQ0167
 GQ0167                         *CURRENT SURVEY CONTROL
 GQ0167  ___________________________________________________________________
 GQ0167* NAD 83(1992)-  36 54 53.54082(N)     113 53 00.01000(W)     ADJUSTED
 GQ0167* NAVD 88     -       589.057  (meters)     1932.60    (feet)  POSTED
 GQ0167  ___________________________________________________________________
 GQ0167  LAPLACE CORR-           13.77  (seconds)                     DEFLEC99
 GQ0167  GEOID HEIGHT-          -25.55  (meters)                      GEOID03
 GQ0167  DYNAMIC HT  -         588.470 (meters)     1930.67  (feet)  COMP
 GQ0167  MODELED GRAV-     979,621.3   (mgal)                         NAVD 88
 GQ0167
 GQ0167  HORZ ORDER  -  SECOND
 GQ0167  VERT ORDER  -  * POSTED, Code B , SEE BELOW
 GQ0167
 GQ0167.The horizontal coordinates were established by classical geodetic methods
 GQ0167.and adjusted by the National Geodetic Survey in August 1993..
 GQ0167
 GQ0167.The orthometric height was determined by differential leveling
 GQ0167.and adjusted by the National Geodetic Survey in 1992..
 GQ0167.* This is a POSTED BENCH MARK height.  Code B indicates a distribution
 GQ0167.rate of 1.1 thru 2.0 mm/km.
 GQ0167
 GQ0167.The Laplace correction was computed from DEFLEC99 derived deflections.
 GQ0167
 GQ0167.The geoid height was determined by GEOID03.
 GQ0167
 GQ0167.The dynamic height is computed by dividing the NAVD 88
 GQ0167.geopotential number by the normal gravity value computed on the
 GQ0167.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 GQ0167.degrees latitude (g = 980.6199 gals.).
 GQ0167
 GQ0167.The modeled gravity was interpolated from observed gravity values.
 GQ0167
 GQ0167;                  North         East     Units Scale Factor Converg.
 GQ0167;SPC AZ W     -   656,054.028   201,479.101    MT  0.99993507   -0 04 48.3
 GQ0167;SPC AZ W     - 2,152,408.23    661,020.67    iFT  0.99993507   -0 04 48.3
 GQ0167;SPC UT S     - 3,030,253.505   287,628.098    MT  1.00006544   -1 27 36.9
 GQ0167;UTM  12      - 4,089,312.809   243,135.915    MT  1.00041290   -1 43 57.9
 GQ0167
 GQ0167!             -  Elev Factor  x  Scale Factor =   Combined Factor
 GQ0167!SPC AZ W     -   0.99991157  x   0.99993507  =   0.99984665
 GQ0167!SPC UT S     -   0.99991157  x   1.00006544  =   0.99997701
 GQ0167!UTM  12      -   0.99991157  x   1.00041290  =   1.00032444
 GQ0167
 GQ0167:                Primary Azimuth Mark                      Grid Az
 GQ0167:SPC AZ W     -  NEHI                                      005 05 31.4
```

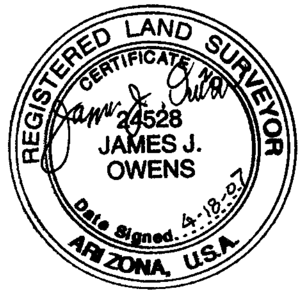
URS Corp. Survey Department

File Name: BEAVER-NGS.XLS
File Date: 02-28-09
Field Team: B. Todorovic / D. Knezevic and D Walkowiak / P. Roth
Operator: D. Knezevic
Client: In House
Reference: Filed Books # 1934 and 1935
Description: NGS Points
Units: International Feet

MEASURED VALUES

	Point Id	***Northing***	***Easting***	***Elevation***	AUTO #
2	LITTLEFIELD	2156033.079	648931.890	2060.01	10
3	LITTLEFIELD RM 2	2156016.506	648954.873	2059.59	
4	LITTLEFIELD RM 1	2156054.186	648947.858	2059.78	
5	K55	2151889.819	648523.339	2020.01	9
6	ML9	2139698.629	643076.935	1959.62	11
1	BEAVER	2152741.830	661123.347	1932.66	12
7	BEAVER RM 2	2152745.852	661085.522	1931.13	

```
new sp
△-1,2152741.830,661123.347,1932.660,BEAVER △
△-8,2148176.490,648295.063,1948.094,CP-8
100,2146341.048,647591.063,1823.766,spot
101,2146327.487,647577.809,1823.093,top bank
102,2146327.204,647577.472,1821.191,step in bank
103,2146326.100,647575.712,1818.176,toe
104,2146309.918,647561.661,1817.868,gb
105,2146278.269,647531.127,1814.811,gb
106,2146265.032,647517.397,1814.358,gb
107,2146250.170,647502.306,1815.050,gb
108,2146234.093,647486.579,1814.355,gb
109,2146224.506,647476.747,1813.162,edge of water
110,2146223.034,647474.040,1812.567,fl
111,2146215.798,647468.701,1813.322,edge of water
112,2146208.645,647460.883,1814.158,gb
113,2146186.563,647440.468,1813.510,gb
114,2146175.657,647428.959,1814.209,gb
115,2146170.875,647423.975,1813.569,gb
116,2146159.512,647414.399,1814.837,gb
117,2146146.382,647401.060,1815.810,gb
118,2146129.433,647385.060,1815.332,gb
119,2146094.743,647350.564,1814.452,gb
120,2146081.762,647338.576,1817.352,gb
121,2146071.751,647328.353,1817.710,gb
122,2146063.135,647320.089,1815.936,gb
123,2146056.837,647314.294,1815.494,toe
124,2146052.318,647310.356,1817.795,top bank
125,2146045.650,647302.985,1818.245,spot
126,2145921.288,647338.090,1819.621,spot
127,2145927.599,647345.037,1819.909,top bank
128,2145928.489,647345.887,1816.071,gb bank
129,2145938.207,647353.241,1814.292,toe
130,2145966.010,647379.580,1814.212,gb
131,2146001.657,647414.969,1814.636,gb
132,2146018.845,647431.082,1813.742,gb
133,2146025.553,647437.325,1812.726,gb
134,2146041.961,647453.512,1813.421,gb
135,2146045.038,647457.194,1811.296,gb
136,2146055.936,647468.610,1810.803,edge of water
137,2146065.192,647477.512,1810.499,fl
138,2146078.683,647488.352,1810.901,edge of water
139,2146079.642,647489.439,1813.439,top
140,2146088.712,647498.514,1813.041,gb
141,2146103.362,647512.586,1814.910,gb
142,2146108.995,647518.728,1817.521,gb
143,2146127.745,647536.830,1820.955,gb
144,2146130.977,647539.723,1819.364,gb
145,2146134.195,647542.591,1820.982,gb
146,2146144.052,647552.261,1817.683,gb
147,2146163.477,647570.475,1816.148,gb
148,2146183.869,647590.721,1815.509,gb
149,2146208.400,647614.627,1817.488,toe
150,2146209.779,647616.663,1820.129,top bank
151,2146212.756,647619.872,1820.158,spot
152,2146200.665,647526.685,1822.407,begin bridge
153,2146194.101,647533.830,1822.147,begin bridge
154,2146179.336,647520.421,1824.516,bridge poc 9.1ft to grd
155,2146185.863,647513.365,1824.689,bridge poc 7.15ft to grd
156,2146166.421,647508.517,1826.078,bridge poc 9.6ft to grd
157,2146172.944,647501.441,1826.224,bridge poc 9.6ft to grd
158,2146155.465,647485.274,1827.286,bridge poc 13.6ft to grd
159,2146149.021,647492.259,1827.023,bridge poc 11.2ft to grd
160,2146131.624,647476.096,1826.996,bridge poc 14.7ft to grd
```



new sp
161,2146138.063,647468.901,1827.108,bridge poc 14.2ft to grd
162,2146118.535,647463.912,1826.056,bridge poc 13.3ft to grd
163,2146124.911,647456.804,1826.150,bridge poc 12.8ft to grd
164,2146107.803,647440.731,1823.957,bridge poc 6.9ft to grd
165,2146101.334,647447.779,1823.902,bridge poc 8.4ft to grd
166,2146091.009,647438.158,1822.122,end bridge
167,2146097.633,647431.153,1822.180,end bridge
168,2146103.471,647436.592,1823.308,5.35ft to top of rail all along bridge
169,2146096.479,647416.846,1816.387,toe
170,2146090.191,647420.730,1818.978,top
171,2146079.546,647427.347,1818.732,top
172,2146060.499,647428.765,1813.586,toe
173,2146055.206,647406.682,1813.772,toe
174,2146066.661,647404.324,1816.704,top
175,2146080.310,647400.388,1816.410,top
176,2146088.415,647399.271,1814.377,toe
177,2146089.047,647370.545,1814.633,toe
178,2146081.135,647370.374,1816.611,top
179,2146068.297,647370.571,1816.791,top
180,2146059.727,647369.635,1814.551,toe
181,2146061.277,647333.579,1815.426,toe
182,2146070.465,647333.598,1817.342,top
183,2146082.836,647333.055,1817.742,top
184,2146090.991,647333.504,1815.352,toe
185,2146096.492,647287.319,1816.418,toe
186,2146090.270,647286.368,1817.949,top
187,2146075.721,647283.915,1818.047,top
188,2146072.026,647283.380,1817.189,toe
189,2146219.365,647530.017,1816.395,toe
190,2146212.626,647538.584,1821.279,top
191,2146204.328,647547.866,1820.881,top
192,2146196.389,647555.453,1816.538,toe
193,2146225.272,647575.610,1816.410,toe
194,2146228.798,647571.223,1819.944,top
195,2146239.271,647562.549,1820.203,top
196,2146248.789,647555.123,1817.089,toe
197,2146276.080,647581.402,1818.548,toe
198,2146263.528,647590.175,1820.982,top
199,2146255.687,647594.063,1820.960,top
200,2146236.016,647602.583,1817.859,toe
201,2145150.190,650383.188,1790.510,cp 201
202,2145177.528,650207.244,1785.927,cp 202
203,2144842.3190,650709.3660,1789.0240,TOP
204,2144848.1830,650691.9880,1780.2480,TOE-EW
205,2144844.5810,650675.3840,1780.0780,TOE-EW
206,2144849.6100,650682.3800,1779.5820,FL
207,2144844.1450,650670.8680,1781.0480,GB
208,2144840.4180,650655.9830,1781.8690,GB
209,2144839.5820,650652.0570,1781.2240,EW
210,2144835.1740,650644.5180,1780.8650,FL
211,2144835.3550,650628.7250,1780.9990,GB
212,2144835.5550,650617.4840,1780.6940,FL
213,2144835.7230,650609.5150,1781.3110,GB
214,2144826.1370,650581.4130,1779.7850,EW
215,2144826.1640,650560.8070,1778.6720,FL
216,2144826.8190,650533.3340,1780.2940,EW
217,2144826.6550,650516.3090,1782.3960,GB
218,2144820.4980,650465.8590,1784.5700,GB
219,2144820.8210,650416.6120,1783.9570,GB
220,2144815.9540,650395.3430,1782.5550,GB
221,2144815.3910,650373.5670,1789.7400,GB
222,2144730.7480,650242.6810,1800.0190,NW PILLAR
223,2144731.7520,650247.9550,1796.8560,NE PILLAR

REGISTERED LAND SURVEYOR
CERTIFICATE NO
24528
JAMES J.
OWENS
Date Signed 4-18-07
ARIZONA, U.S.A.

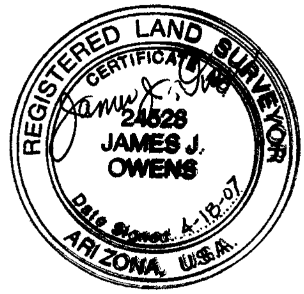
new sp
224,2144712.6490,650250.5750,1795.6730,SE PILLAR
225,2144771.7360,650295.7250,1792.7580,HI-WTR
226,2144755.1410,650421.2960,1786.9590,NW PILLAR
227,2144756.1330,650426.0450,1783.2960,NE PILLAR
228,2144735.4310,650429.0500,1787.1290,SE PILLAR
229,2144754.7790,650421.2280,1791.2190,HI-WTR
230,2144681.0980,650447.7930,1790.0050,TOP
231,2144686.7160,650466.0940,1782.8420,TOE
232,2144689.3510,650483.4930,1782.3230,GB
233,2144688.6790,650513.8160,1783.4330,GB
234,2144698.6030,650551.4010,1784.6010,GB
235,2144698.8210,650583.7160,1783.9170,TOP
236,2144702.5970,650622.0890,1779.8600,EW
237,2144713.9710,650641.0230,1778.7070,FL
238,2144712.7340,650668.6460,1779.8950,EW
239,2144762.3520,650638.1550,1779.8170,SW PILLAR
240,2144783.8040,650640.3410,1790.3610,NE PILLAR
241,2144783.0170,650635.4640,1792.8570,NW PILLAR
242,2144783.0170,650635.4640,1792.8570,NW PILLAR HW
243,2144711.3790,650708.8440,1781.7640,GB
244,2144719.5630,650733.7490,1779.6970,EW
245,2144726.1790,650743.7330,1778.3010,FL
246,2144727.7530,650753.4270,1780.4060,EW
247,2144734.8290,650759.7730,1787.5340,TOP
248,2144854.571,650725.441,1791.485,gb
249,2144862.253,650762.005,1789.136,gb
250,2144862.631,650797.965,1789.960,gb
251,2144862.373,650808.421,1784.064,toe
252,2144710.305,650678.485,1781.406,gb
253,2144669.116,650400.126,1784.884,gb
254,2144669.821,650343.044,1790.845,gb
255,2144660.334,650276.995,1791.021,gb
256,2144806.170,650322.261,1786.416,gb
257,2144800.556,650295.500,1791.987,gb
258,2144799.736,650282.791,1792.088,gb
259,2144796.183,650268.204,1794.979,gb
260,2144794.575,650252.874,1794.576,gb
261,2144786.952,650224.042,1803.324,spot
262,2144655.246,650202.178,1814.791,spot
263,2144728.230,650682.971,1782.064,cp-263
264,2144853.662,650646.915,1782.406,cp-264
265,2144874.758,650920.218,1855.047,spot
266,2144750.239,650911.699,1851.449,spot
267,2144731.175,650837.992,1813.461,spot
268,2145631.895,649009.413,1806.451,cp-268
269,2145392.463,649009.870,1803.734,cp-269
270,2145971.765,648993.113,1814.398,top
271,2145938.125,648996.535,1807.537,gb
272,2145934.917,648997.054,1805.306,gb
273,2145906.446,648999.505,1806.381,gb
274,2145834.790,649006.676,1803.700,gb
275,2145735.584,649019.645,1800.518,gb
276,2145702.502,649017.393,1801.603,new banking toe
277,2145686.453,649018.480,1806.502,new banking top
278,2145674.834,649020.100,1801.476,new banking toe
279,2145652.815,649019.938,1801.900,gb
280,2145643.787,649021.934,1806.020,gb
281,2145598.009,649027.817,1802.065,gb
282,2145572.810,649033.473,1801.912,gb
283,2145448.175,649039.739,1799.420,gb
284,2145366.163,649036.312,1799.556,gb
285,2145364.717,649035.799,1793.561,edge of water
286,2145342.592,649041.438,1792.684,edge of water

REGISTERED LAND SURVEYOR
CERTIFICATE NO
24528
JAMES J.
OWENS
Date Signed 4-18-97
ARIZONA, U.S.A.

new sp
287,2145294.042,649052.085,1795.045,new banking toe
288,2145280.360,649054.873,1801.607,new banking top
289,2145262.595,649064.700,1803.767,new banking top
290,2145249.347,649071.630,1799.787,toe
291,2145237.993,649059.647,1808.682,possible mud level
292,2146201.308,647709.456,1825.005,cp-292
293,2146049.604,648114.172,1813.697,cp-293
294,2145841.381,648270.621,1812.917,cp-294
295,2145742.864,648670.603,1808.735,cp-295
296,2145847.531,648863.092,1806.664,cp-295
500,2146095.930,647939.196,1814.594,1ft dia tree #46
501,2146037.192,647892.441,1815.323,2ft dia tree #47
502,2146046.236,647912.817,1814.880,2ft dia tree #48
503,2146042.431,647929.412,1814.628,2ft dia tree #49
504,2146038.885,647927.447,1814.799,2ft dia tree #50
505,2146036.275,647961.637,1814.574,2ft dia tree #51
506,2146090.709,647968.896,1814.081,3ft dia tree #52
507,2146080.667,647986.328,1814.235,1ft dia tree #53
508,2146087.491,647989.964,1814.518,1ft dia tree #54
509,2146099.745,647990.977,1814.043,3ft dia tree #55
510,2146043.180,647983.384,1814.380,2ft dia tree #56
511,2146028.385,647993.124,1814.428,2ft dia tree #57
512,2146020.400,648006.261,1814.537,2ft dia tree #58
513,2146012.127,648024.418,1814.319,2ft dia tree #59
514,2146051.325,648029.167,1814.544,1ft dia tree #60
515,2146057.261,648031.029,1815.737,1ft dia tree #61
516,2145925.540,647925.444,1816.173,1ft dia tree #62
517,2145921.255,647923.830,1816.270,1ft dia tree #63
518,2145926.483,647932.546,1815.884,3ft dia tree #64
519,2145915.416,647950.163,1815.778,2ft dia tree #65
520,2145878.787,647997.239,1814.951,1ft dia tree #66
521,2145882.719,648011.329,1814.702,3ft dia tree #67
522,2145869.976,648014.466,1815.116,2ft dia tree #68
523,2145866.232,648018.462,1814.585,2ft dia tree #69
524,2145871.661,648034.292,1814.223,2ft dia tree #70
525,2145852.021,648052.096,1814.686,2ft dia tree #71
526,2145840.544,648062.684,1814.601,3ft dia tree #72
527,2145826.906,648095.467,1813.762,1ft dia tree #73
528,2145825.178,648093.339,1813.850,1ft dia tree #74
529,2145954.135,648123.097,1813.506,2ft dia tree #75
530,2145834.217,648142.866,1813.902,1ft dia tree #76
531,2145821.562,648145.810,1813.842,2ft dia tree #77
532,2145814.238,648174.468,1814.394,2ft dia tree #78
533,2145799.905,648214.107,1813.431,1ft dia tree #79
534,2145795.150,648217.848,1813.622,1ft dia tree #80
535,2145810.906,648235.565,1812.877,1ft dia tree #81
536,2145808.732,648243.576,1813.193,1ft dia tree #82
537,2145801.690,648264.158,1812.610,1ft dia tree #83
538,2145796.177,648271.366,1812.172,1ft dia tree #84
539,2145791.128,648265.859,1812.922,1ft dia tree #85
540,2145783.228,648266.745,1813.223,1ft dia tree #86
541,2145778.650,648288.620,1811.514,1ft dia tree #87
542,2145789.524,648298.193,1812.519,1ft dia tree #88
543,2145773.417,648296.595,1811.892,1ft dia tree #89
544,2145769.791,648302.298,1811.807,1ft dia tree #90
545,2145772.796,648316.738,1811.633,1ft dia tree #91
546,2145958.468,648244.496,1812.268,1ft dia tree #92
547,2145956.077,648256.638,1812.118,1 ft dia tree #93
548,2145957.311,648260.833,1811.824,1 ft dia tree #94
549,2145937.893,648285.916,1811.892,1 ft dia tree #95
550,2145927.269,648307.100,1812.091,1 ft dia tree #96
551,2145932.902,648331.036,1811.595,1 ft dia tree #97
552,2145954.351,648339.389,1811.059,1 ft dia tree #98

REGISTERED LAND SURVEYOR
CERTIFICATE
24528
JAMES J.
OWENS
Date Signed 4-18-07
ARIZONA, U.S.A.

553,2145942.640,648346.516,1811.429,1 ft dia tree #99
554,2145959.711,648346.834,1810.705,1 ft dia tree #100
555,2145927.330,648419.012,1810.906,1 ft dia tree #101
556,2145929.173,648421.706,1810.903,2ft dia tree #102
557,2145911.632,648433.572,1811.491,1ft dia tree #103
558,2145910.636,648444.888,1810.328,1ft dia tree #104
559,2145895.939,648450.497,1810.085,1ft dia tree #105
560,2145890.976,648465.138,1810.495,1ft dia tree #106
561,2145881.650,648469.744,1810.417,1ft dia tree #107
562,2145883.543,648471.108,1809.992,1ft dia tree #108
563,2145894.713,648476.638,1810.201,1ft dia tree #109
564,2145874.058,648484.874,1809.572,1ft dia tree #110
565,2145864.978,648480.758,1809.980,1ft dia tree #111
566,2145863.458,648487.727,1810.667,1ft dia tree #112
567,2145862.426,648498.329,1810.223,1ft dia tree #113
568,2145860.524,648502.188,1809.804,1ft dia tree #114
569,2145895.640,648518.968,1809.502,1ft dia tree #115
570,2145882.396,648521.597,1809.500,1ft dia tree #116
571,2145861.317,648515.014,1810.459,1ft dia tree #117
572,2145854.269,648514.926,1810.636,1ft dia tree #118
573,2145846.452,648519.370,1810.731,1 ft dia tree #119
574,2145854.294,648526.089,1810.245,1 ft dia tree #120
575,2145845.542,648528.682,1810.429,1 ft dia tree #121
576,2145866.446,648540.238,1810.242,1 ft dia tree #122
577,2145860.058,648553.532,1809.678,1 ft dia tree #123
578,2145865.032,648562.407,1809.842,1 ft dia tree #124
579,2145849.761,648561.497,1809.518,1 ft dia tree #125
580,2145768.398,648359.643,1813.250,1 ft dia tree #126
581,2145773.094,648367.785,1811.444,1 ft dia tree #127
582,2145762.618,648369.910,1814.066,1 ft dia tree #128
583,2145764.619,648374.551,1812.716,1 ft dia tree #129
584,2145762.189,648417.793,1811.440,1 ft dia tree #130
585,2145755.750,648424.373,1811.713,1 ft dia tree #131
586,2145743.808,648428.333,1811.679,1 ft dia tree #132
587,2145614.819,648201.285,1814.259,1 ft dia tree #133
588,2145608.847,648203.715,1814.393,1 ft dia tree #134
589,2145595.234,648295.808,1813.653,2 ft dia tree #135
590,2145576.815,648310.805,1813.445,2 ft dia tree #136
591,2145584.526,648320.982,1813.390,1 ft dia tree #137
592,2145735.292,648448.257,1811.516,1ft dia tree #138
593,2145734.181,648457.959,1810.609,1ft dia tree #139
594,2145736.644,648486.860,1810.466,1ft dia tree #140
595,2145734.879,648491.847,1810.621,1ft dia tree #141
596,2145746.756,648492.907,1810.157,1ft dia tree #142
597,2145745.262,648522.955,1810.128,1ft dia tree #143
598,2145736.465,648530.342,1810.080,1ft dia tree #144
599,2145739.656,648550.550,1810.038,1ft dia tree #145
600,2145736.427,648552.752,1810.014,1ft dia tree #146
601,2145719.257,648551.699,1810.290,1ft dia tree #147
602,2145714.557,648549.811,1811.136,debris
603,2145721.421,648561.932,1809.895,1ft dia tree #148
604,2145707.311,648580.917,1810.178,1ft dia tree #149
605,2145705.966,648609.410,1810.225,1ft dia tree #150
606,2145722.769,648624.387,1809.781,1ft dia tree #151
607,2145713.693,648648.616,1809.686,1ft dia tree #152
608,2145842.431,648557.213,1810.489,1ft dia tree #153
609,2145874.401,648576.133,1809.279,1ft dia tree #154
610,2145848.361,648568.514,1809.991,1ft dia tree #155
611,2145833.991,648565.452,1810.223,1ft dia tree #156
612,2145829.810,648567.395,1810.117,1ft dia tree #157
613,2145818.729,648573.004,1809.883,1ft dia tree #158
614,2145815.968,648569.705,1810.060,1ft dia tree #159
615,2145869.341,648591.840,1810.171,1ft dia tree #160



616,2145864.878,648602.435,1809.700,1ft dia tree #161
617,2145863.148,648608.579,1809.494,1ft dia tree #162
618,2145847.185,648608.534,1809.923,1ft dia tree #163
619,2145837.953,648593.674,1809.683,1ft dia tree #164
620,2145830.599,648607.502,1809.337,1ft dia tree #165
621,2145805.103,648585.435,1809.839,1ft dia tree #166
622,2145800.594,648597.470,1809.600,2ft dia tree #167
623,2145803.162,648602.823,1809.820,1ft dia tree #168
624,2145811.306,648629.417,1809.363,1ft dia tree #169
625,2145846.576,648638.462,1809.202,1ft dia tree #170
626,2145852.998,648635.182,1809.646,1ft dia tree #171
627,2145842.887,648669.961,1809.053,1ft dia tree #172
628,2145785.261,648684.114,1809.039,1ft dia tree #173
629,2145837.232,648705.687,1808.868,1ft dia tree #174
630,2145829.609,648706.469,1809.049,1ft dia tree #175
631,2145824.935,648707.269,1809.334,1ft dia tree #176
632,2145837.053,648711.839,1808.243,1ft dia tree #177
633,2145827.964,648716.232,1808.962,1ft dia tree #178
634,2145827.870,648732.571,1808.556,1ft dia tree #179
635,2145837.910,648743.246,1808.522,1ft dia tree #180
636,2145826.530,648741.775,1808.031,1ft dia tree #181
637,2145825.452,648748.324,1807.514,1ft dia tree #182
638,2145811.399,648745.395,1807.196,1ft dia tree #183
639,2145813.833,648743.174,1808.217,debris
640,2145804.016,648728.800,1809.413,debris
641,2145807.817,648725.934,1808.843,debris
642,2145802.268,648731.652,1808.314,1ft dia tree #184
643,2145806.597,648729.837,1808.716,1ft dia tree #185
644,2145776.377,648714.760,1808.105,1ft dia tree #186
645,2145773.914,648714.054,1809.297,debris
646,2145755.834,648721.067,1809.293,debris
647,2145755.699,648723.222,1808.357,1ft dia tree #187
648,2145755.978,648737.446,1808.534,1ft dia tree #188
649,2145780.178,648742.491,1807.646,1ft dia tree #189
650,2145791.373,648744.718,1807.328,1ft dia tree #190
651,2145773.067,648755.458,1808.134,1ft dia tree #191
652,2145779.566,648744.276,1808.660,debris
653,2145789.237,648744.797,1808.444,debris
654,2145771.993,648754.545,1808.990,debris
655,2145711.625,648687.300,1809.205,2ft dia tree #192
656,2145706.827,648732.072,1808.880,2ft dia tree #193
657,2145713.367,648759.651,1808.025,2ft dia tree #194
658,2145660.493,648752.842,1809.285,cp-658
659,2146100.748,647922.505,1814.487,3ft dia tree #45
660,2146085.008,647914.206,1814.925,2ft dia tree #44
661,2146079.497,647912.278,1815.065,2ft dia tree #43
662,2146011.056,647803.502,1816.628,2ft dia tree #42
663,2146045.222,647809.544,1816.111,2ft dia tree #41
664,2146048.534,647806.013,1815.943,1ft dia tree #40
665,2146102.049,647878.046,1815.137,2ft dia tree #39
666,2146092.617,647857.958,1815.360,1ft dia tree #38
667,2146096.178,647841.150,1815.615,1ft dia tree #37
668,2146085.206,647850.159,1815.195,2ft dia tree #36
669,2146078.439,647850.634,1815.642,1ft dia tree #35
670,2146069.848,647845.839,1815.675,1ft dia tree #34
671,2146077.779,647834.012,1815.915,1ft dia tree #33
672,2146086.370,647826.012,1816.068,1ft dia tree #32
673,2146087.444,647828.617,1815.398,1ft dia tree #31
674,2146091.051,647831.183,1815.659,1ft dia tree #30
675,2146093.869,647827.239,1815.670,1ft dia tree #29
676,2146090.663,647810.039,1816.605,1ft dia tree #28
677,2146097.859,647804.126,1816.343,1ft dia tree #27
678,2146081.072,647783.895,1816.628,2ft dia tree #26

REGISTERED LAND SURVEYOR
CERTIFICATE
24528
JAMES J.
OWENS
Date Signed 4-18-07
ARIZONA, U.S.A.

new sp
679,2146065.152,647776.244,1816.900,2ft dia tree #25
680,2146067.175,647774.822,1816.908,1ft dia tree #24
681,2146068.233,647774.135,1816.870,1ft dia tree #23
682,2146020.975,647744.422,1817.043,2ft dia tree #22
683,2146030.057,647741.423,1817.122,2ft dia tree #21
684,2146085.285,647709.069,1818.599,3ft dia tree #20
685,2146113.493,647742.737,1817.416,2ft dia tree #19
686,2146108.611,647749.447,1817.386,2ft dia tree #18
687,2146096.637,647754.850,1817.539,1ft dia tree #17
688,2146100.913,647757.784,1816.763,1ft dia tree #16
689,2146102.775,647767.997,1817.047,2ft dia tree #15
690,2146119.785,647784.551,1816.150,3ft dia tree #14
691,2146152.793,647816.518,1816.965,1ft dia tree #13
692,2146169.984,647754.006,1818.279,1ft dia tree #12
693,2146169.108,647752.490,1818.057,1ft dia tree #11
694,2146136.872,647709.567,1817.817,3ft dia tree #10
695,2146106.720,647694.628,1818.231,2ft dia tree #9
696,2146157.363,647688.900,1817.186,2ft dia tree #8
697,2146145.909,647667.456,1817.658,2ft dia tree #7
698,2146211.712,647674.496,1822.884,1ft dia tree #6
699,2146212.540,647668.093,1821.948,1ft dia tree #5
700,2146231.999,647629.534,1820.670,1ft dia tree #4
701,2146235.237,647627.489,1820.798,2ft dia tree #3
702,2146236.263,647657.606,1821.549,3ft dia tree #2
703,2146248.584,647652.557,1821.622,3ft dia tree #1
704,2145712.166,648769.642,1808.094,1ft dia tree #195
705,2145738.948,648808.530,1808.362,1ft dia tree #196
706,2145755.509,648793.956,1808.634,1ft dia tree #197
707,2145759.686,648798.869,1808.089,1ft dia tree #198
708,2145781.572,648772.654,1807.456,1ft dia tree #199
709,2145785.715,648758.133,1807.825,1ft dia tree #200
710,2145797.677,648763.179,1807.862,1ft dia tree #201
711,2145791.114,648774.265,1807.629,1ft dia tree #202
712,2145784.943,648792.233,1808.315,1ft dia tree #203
713,2145782.286,648797.280,1808.687,1ft dia tree #204
714,2145757.715,648817.951,1808.005,1ft dia tree #205
715,2145755.496,648826.916,1808.487,1ft dia tree #206
718,2145762.512,648875.895,1807.595,2ft dia tree #208
719,2145730.500,648856.657,1807.405,2ft dia tree #207
720,2145769.803,648863.546,1807.967,1ft dia tree #209
721,2145774.522,648851.735,1808.273,1ft dia tree #210
722,2145787.299,648848.925,1808.016,1ft dia tree #211
723,2145795.708,648837.169,1808.296,1ft dia tree #212
724,2145788.480,648824.694,1808.196,1ft dia tree #213
725,2145794.749,648817.632,1808.229,1ft dia tree #214
726,2145806.425,648803.977,1807.372,1ft dia tree #215
727,2145819.333,648798.959,1807.954,1ft dia tree #216
728,2145824.082,648848.077,1807.009,1ft dia tree #217
729,2145810.138,648844.526,1806.749,1ft dia tree #218
730,2145799.283,648853.488,1806.886,1ft dia tree #219
731,2145790.785,648865.804,1807.689,1ft dia tree #220
732,2145796.211,648867.333,1807.572,1ft dia tree #221
733,2145793.680,648883.070,1807.682,1ft dia tree #222
734,2145806.590,648885.977,1807.492,1ft dia tree #223
735,2145795.661,648896.851,1807.293,1ft dia tree #224
736,2145807.317,648902.159,1807.236,1ft dia tree #225
737,2145744.104,648886.182,1810.085,mud lvl
738,2145746.559,648887.146,1807.483,2ft dia tree #226
739,2145731.786,648899.257,1806.136,1ft dia tree #227
740,2145703.152,648882.805,1809.109,1ft dia tree #228
741,2145774.068,648914.977,1807.943,1ft dia tree #229
742,2145771.743,648919.447,1807.494,1ft dia tree #230
743,2145814.416,648937.292,1804.578,1ft dia tree #231

REGISTERED LAND SURVEYOR
CERTIFICATE
24528
JAMES J.
OWENS
Date Signed 4-18-07
ARIZONA, U.S.A.

new sp

744,2145901.846,648979.076,1805.809,1ft dia tree #232
745,2145875.913,648981.694,1804.880,1ft dia tree #233
746,2145878.889,648982.818,1810.177,debris
747,2145858.631,648995.600,1808.626,debris
748,2145859.179,648994.451,1804.526,2ft dia tree #234
749,2145790.804,649009.841,1802.805,2ft dia tree #235
750,2145783.972,649015.637,1802.424,2ft dia tree #236
751,2145767.950,649017.944,1801.615,1ft dia tree #237
752,2145758.088,648997.346,1804.824,1ft dia tree #238
753,2145790.680,648992.115,1802.673,1ft dia tree #239
754,2145780.128,648984.664,1801.639,1ft dia tree #240
755,2145783.858,648975.853,1802.173,1ft dia tree #241
756,2145774.652,648967.379,1801.267,1ft dia tree #242
757,2145771.517,648950.361,1806.185,1ft dia tree #243
758,2145750.476,648997.865,1806.890,mud level on cabin
759,2145657.946,648573.255,1810.421,1ft dia tree #244
760,2145476.310,648492.597,1810.885,2ft dia tree #245
761,2145478.808,648533.971,1810.521,2ft dia tree #247
762,2145469.346,648538.948,1810.541,2ft dia tree #248
763,2145480.452,648563.777,1811.042,2ft dia tree #249
764,2145463.156,648631.681,1809.800,2ft dia tree #250
765,2145463.809,648637.462,1809.763,2ft dia tree #251
766,2145543.150,648706.915,1809.381,2ft dia tree #252
767,2145541.296,648716.876,1808.625,2ft dia tree #253
768,2145555.008,648712.457,1809.555,2ft dia tree #254
769,2145551.582,648731.411,1809.001,2ft dia tree #256
770,2145537.026,648743.192,1808.805,2ft dia tree #257
771,2145532.158,648781.767,1808.796,2ft dia tree #258
772,2145568.546,648778.587,1806.796,2ft dia tree #259
773,2145569.358,648801.551,1807.207,2ft dia tree #260
774,2145563.509,648778.586,1810.042,debri
775,2145565.455,648801.966,1810.284,debri
776,2145534.336,648783.034,1808.749,2ft dia tree #261
777,2145542.956,648816.799,1809.763,2ft dia tree #262
778,2145562.235,648826.637,1809.221,2ft dia tree #263
779,2145557.175,648849.972,1807.126,2ft dia tree #264
780,2145535.985,648843.922,1807.605,2ft dia tree #265
781,2145523.746,648844.678,1810.224,debri
782,2145533.183,648843.113,1809.936,debri
783,2145558.898,648850.810,1809.146,debri
784,2145549.996,648886.042,1808.800,debri
785,2145537.220,648887.814,1809.001,debri
786,2145524.657,648896.610,1808.019,debri
787,2145524.948,648895.930,1804.307,2ft dia tree #267
788,2145536.134,648887.102,1807.210,2ft dia tree #268
789,2145547.637,648884.811,1806.639,2ft dia tree #269
790,2145588.653,648870.254,1808.592,2ft dia tree #270
791,2145595.001,648864.853,1808.474,2ft dia tree #271
792,2145602.344,648852.606,1808.154,2ft dia tree #272
793,2145607.768,648855.123,1807.201,2ft dia tree #273
794,2145610.552,648855.493,1807.956,2ft dia tree #274
795,2145609.554,648851.261,1806.375,2ft dia tree #275
796,2145606.687,648916.412,1808.487,cp 796
797,2145443.315,648886.689,1803.233,2ft dia tree #276
798,2145438.518,648886.234,1811.717,debri
799,2145424.811,648780.056,1808.709,debri
800,2145419.229,648784.009,1801.759,3ft dia tree #277
801,2145365.355,648850.324,1801.305,3ft dia tree #278
802,2145580.168,648912.486,1808.311,2ft dia tree #279
803,2145576.552,648917.233,1808.283,2ft dia tree #280
804,2145550.716,648906.806,1808.100,2ft dia tree #281
805,2145526.093,648932.639,1804.802,2ft dia tree #282
806,2145487.232,649002.052,1803.671,2ft dia tree #283

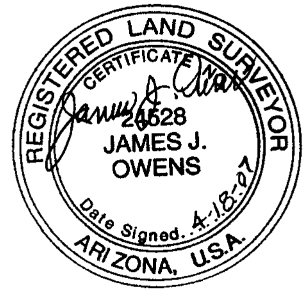
REGISTERED LAND SURVEYOR
CERTIFICATE NO.
24528
JAMES J.
OWENS
Date Signed 4-18-07
ARIZONA, U.S.A.

new sp

807,2145498.863,648989.732,1805.578,2ft dia tree #284
808,2145523.942,648975.699,1805.290,2ft dia tree #285
809,2145520.129,648963.243,1804.827,2ft dia tree #286
810,2145539.892,648960.221,1806.722,2ft dia tree #287
811,2145550.457,648975.272,1804.855,2ft dia tree #288
812,2145585.219,648993.672,1805.866,2ft dia tree #289
813,2145574.003,648944.173,1805.319,2ft dia tree #290
814,2145686.233,648891.677,1805.463,1ft dia tree #291
815,2145728.629,649007.988,1802.246,1ft dia tree #292
816,2145695.104,648970.808,1806.327,1ft dia tree #293
817,2145571.836,648942.153,1808.434,debris
818,2145591.282,648977.167,1808.141,debris
819,2145546.969,648978.766,1809.832,debris
820,2145537.281,648956.979,1810.553,debris
821,2145517.767,648959.240,1814.364,debris
822,2145525.258,648934.198,1810.172,debris
823,2145495.785,648983.098,1809.946,debris
824,2145483.623,648998.926,1809.685,debris
825,2145190.776,648270.286,1813.032,cp-825
826,2145084.491,648170.790,1812.567,cp-826
827,2145148.662,647993.601,1811.606,cp-827
828,2145005.266,648057.209,1812.934,cp-828
829,2144962.459,648186.284,1812.050,cp-829
830,2144820.835,647550.602,1876.044,cp-830
831,2145031.343,647832.086,1814.770,cp-831
832,2145331.990,647912.073,1810.216,cp-832
833,2145211.052,647827.192,1812.365,cp-833
834,2145204.137,648512.727,1804.436,2ft dia tree #294
835,2145219.051,648492.763,1805.171,2ft dia tree #295
836,2145194.637,648459.158,1806.369,2ft dia tree #296
837,2145181.155,648460.968,1805.112,2ft dia tree #297
838,2145187.883,648430.347,1806.647,2ft dia tree #298
839,2145246.526,648429.509,1807.625,2ft dia tree #299
840,2145230.018,648402.737,1808.453,2ft dia tree #300
841,2145211.004,648372.114,1810.217,2ft dia tree #301
842,2145165.344,648381.325,1806.216,2ft dia tree #302
843,2145176.843,648315.735,1809.446,2ft dia tree #303
844,2145179.127,648309.842,1812.072,2ft dia tree #304
845,2145183.568,648311.162,1812.056,2ft dia tree #305
846,2145168.773,648294.716,1812.829,2ft dia tree #306
847,2145259.809,648304.508,1811.564,3ft dia tree #307
848,2145309.729,648264.724,1809.459,3ft dia tree #308
849,2145319.110,648215.851,1810.538,3ft dia tree #309
850,2145312.227,648168.622,1811.409,3ft dia tree #310
851,2145235.958,648222.649,1813.268,3ft dia tree #311
852,2145237.660,648220.600,1817.495,debris
853,2145316.910,648213.608,1817.038,debris
854,2145259.340,648300.738,1816.549,debris
855,2145183.900,648313.230,1815.542,debris
856,2145166.527,648294.744,1814.383,debris
857,2145228.617,648405.758,1813.425,debris
858,2145189.192,648432.399,1810.979,debris
859,2145194.917,648461.233,1813.662,debris
860,2145184.311,648460.946,1812.841,debris
861,2145217.213,648495.403,1808.845,debris
862,2145204.083,648514.821,1811.620,debris
863,2145142.251,648192.428,1810.288,?bld box cor
864,2145163.679,648176.011,1810.234,?bld box cor
865,2145151.648,648178.867,1812.369,?ff
866,2145168.380,648179.274,1809.653,?low grade
867,2145182.218,648144.961,1810.564,?bld box cor
868,2145194.087,648123.279,1810.205,?low grade
869,2144866.661,648128.088,1817.332,3 off bld cor

REGISTERED LAND SURVEYOR
CERTIFICATE
24528
JAMES J.
OWENS
Date Signed 4-18-07
ARIZONA, U.S.A.

new sp
871,2144864.036,648151.254,1816.927,3 off bld cor
872,2144871.147,648081.538,1815.390,3 off bld cor
873,2144873.406,648058.555,1815.523,3 off bld cor
874,2144879.573,648047.334,1815.795,3 off bld cor
875,2144884.739,648024.269,1815.621,bld box cor
876,2144892.315,647872.666,1817.441,3 off bld cor
877,2144894.681,647849.492,1817.059,3 off bld cor
878,2144901.013,647838.539,1817.516,3 off bld cor
879,2144903.135,647815.194,1817.537,3 off bld cor
880,2144906.175,647733.471,1817.881,3 off bld cor
881,2144908.477,647710.205,1817.972,3 off bld cor
882,2145053.407,647712.482,1816.291,3 off bld cor
883,2145084.385,647715.655,1816.263,3 off bld cor
884,2145098.912,647717.037,1816.041,3 off bld cor
885,2145124.167,647719.487,1815.807,3 off bld cor
886,2145138.356,647720.967,1815.678,3 off bld cor
887,2145167.516,647723.896,1815.320,3 off bld cor
888,2145225.342,647729.874,1814.427,3 off bld cor
889,2145253.646,647732.786,1813.660,3 off bld cor
890,2145265.369,647733.531,1813.693,3 off bld cor
891,2145290.581,647735.988,1813.989,3 off bld cor
892,2145067.767,648174.614,1813.301,3 off bld cor
893,2145070.250,648149.319,1813.656,3 off bld cor
894,2145076.265,648140.359,1813.687,3 off bld cor
895,2145078.877,648115.193,1813.906,3 off bld cor
896,2145080.117,648102.756,1813.772,3 off bld cor
897,2145082.873,648075.345,1814.029,3 off bld cor
898,2145093.815,648064.739,1813.407,3 off bld cor
899,2145119.054,648067.243,1813.068,3 off bld cor
900,2145138.660,648103.279,1811.666,3 off bld cor
901,2145130.081,648124.838,1812.011,3 off bld cor
902,2145132.473,648135.406,1811.813,3 off bld cor
903,2145110.887,648152.091,1812.227,3 off bld cor
905,2145186.446,647949.070,1812.640,ff
906,2145199.059,647956.291,1811.716,low grade
907,2145207.805,647951.995,1811.839,3 off bld cor
908,2145234.236,647954.463,1811.668,low grade
909,2145233.124,647952.003,1811.776,bld box cor
910,2145172.648,647951.578,1812.250,bld box cor
911,2145197.524,647954.141,1812.095,bld box cor
912,2145162.997,647947.660,1813.197,2 in bld box cor
913,2145165.112,647958.496,1811.978,low grade
914,2145149.793,647945.512,1814.020,ff
915,2145138.043,647946.948,1813.417,bld box cor
916,2145127.878,647946.680,1813.863,bld box cor
917,2145129.023,647949.108,1813.308,low grade
918,2145103.003,647943.773,1814.143,bld box cor
919,2145116.472,647941.691,1814.592,ff
920,2145092.327,647939.868,1813.794,bld box cor
921,2145093.298,647942.414,1813.645,low grade
922,2145086.035,647933.744,1814.621,ff
923,2145069.122,647942.822,1813.901,5 off bld cor
924,2145058.079,647942.068,1813.961,3 off bld box cor
925,2145033.414,647939.374,1813.984,3 off bld box cor
926,2145059.449,647942.799,1813.865,low grade
927,2145046.078,647935.185,1814.787,ff
928,2145030.252,648001.550,1814.207,4 off bld cor
930,2145054.501,648008.132,1814.199,bld box cor
931,2145055.972,648007.498,1814.023,low grade
932,2145044.065,648009.126,1814.832,ff
933,2145089.811,648007.286,1813.726,3 off bld box cor
934,2145076.744,648010.488,1814.327,ff
935,2145064.717,648007.676,1813.948,bld box cor



new sp
936,2145096.852,648011.158,1813.165,low grade
937,2145099.321,648012.260,1813.412,bld box cor
938,2145112.911,648018.010,1813.742,ff
939,2145124.135,648014.899,1813.272,bld box cor
940,2145125.581,648015.630,1813.109,low grade
941,2145218.525,647948.614,1812.049,ff
942,2145190.909,648123.478,1810.582,bld box cor
943,2145181.870,648124.762,1812.274,ff
944,2145083.794,648063.305,1813.205,3 off bld cor
945,2145059.233,648060.669,1813.872,3 off bld cor
946,2145049.512,648059.985,1814.004,3 off bld cor
947,2145024.459,648057.512,1814.066,3 off bld cor
948,2145030.797,648070.079,1814.217,bld box cor
949,2145028.188,648097.021,1814.122,bld box cor
950,2145032.954,648085.162,1814.478,ff
951,2145025.491,648098.490,1813.761,low grade
952,2145025.024,648109.552,1813.927,3 off bld box cor
953,2145023.734,648108.164,1813.759,low grade
954,2145028.637,648121.796,1814.263,ff
955,2145023.485,648134.497,1814.026,2 off bld cor
956,2145020.610,648144.354,1813.466,2 off bld box cor
957,2145020.694,648142.836,1813.238,low grade
958,2145023.356,648156.986,1814.103,ff
959,2145016.893,648169.130,1813.618,3 off bld cor
960,2144935.733,648158.257,1814.109,bld box cor
961,2144938.220,648135.473,1814.089,bld box cor
962,2144927.083,648140.456,1815.434,ff
963,2144938.948,648135.795,1813.947,low grade
965,2144942.921,648088.503,1814.103,bld box cor
966,2144945.541,648066.196,1814.061,bld box cor
967,2144947.678,648066.540,1813.970,low grade
968,2144934.712,648071.859,1815.513,ff
969,2144948.819,648031.425,1814.623,bld box cor
970,2144953.731,648030.274,1814.378,low grade
971,2144937.623,648032.342,1815.677,ff
973,2144964.166,647879.688,1816.032,bld box cor
974,2144966.218,647856.782,1816.151,bld box cor
975,2144971.955,647857.269,1815.900,low grade
976,2144970.703,647845.021,1816.302,3 off bld box cor
977,2144972.992,647822.534,1816.353,3 off bld box cor
978,2144977.463,647821.619,1816.030,low grade
979,2144981.139,647740.825,1816.604,3 off bld box cor
980,2144983.570,647718.246,1816.873,3 off bld box cor
981,2144991.134,647718.665,1816.416,low grade
982,2144946.237,648053.799,1814.466,bld box cor
983,2144954.830,647861.902,1817.388,ff
984,2144958.939,647827.280,1817.719,ff
985,2144979.201,647731.386,1817.923,ff
986,2145047.329,647771.108,1816.107,2 off bld cor
987,2145062.413,647767.194,1816.569,ff
988,2145078.066,647775.174,1815.669,3 off bld box cor
989,2145081.872,647772.121,1815.360,low grade
990,2145093.823,647767.522,1815.493,bld box cor
991,2145118.602,647770.023,1815.324,bld box cor
992,2145120.880,647771.089,1815.048,low grade
993,2145133.293,647772.589,1815.039,bld box cor
994,2145161.863,647777.234,1814.754,2 off bld box cor
995,2145166.159,647775.809,1814.468,low grade
996,2145220.111,647783.359,1813.405,bld box cor
997,2145234.779,647776.268,1813.958,ff
998,2145247.846,647786.088,1813.561,bld box cor
999,2145250.045,647789.731,1813.199,low grade
1000,2145259.866,647787.221,1813.171,bld box cor

REGISTERED LAND SURVEYOR
CERTIFICATE No.
24528
JAMES J.
OWENS
Date Signed 4-18-07
ARIZONA, U.S.A.

```
                                        new sp
1001,2145284.824,647789.546,1813.167,bld box cor
1002,2145286.143,647795.944,1812.680,low grade
1003,2145243.207,647851.269,1812.853,3 off bld cor
1004,2145218.267,647848.742,1812.677,3 off bld box cor
1005,2145208.409,647847.670,1813.119,3 off bld box cor
1006,2145183.652,647846.082,1813.357,bld box cor
1007,2145173.664,647845.095,1814.511,3 off bld cor
1008,2145148.714,647843.597,1814.466,2 off bld box cor
1009,2145138.805,647839.949,1814.775,3 off bld box cor
1010,2145126.244,647843.452,1815.626,ff
1011,2145113.710,647840.807,1814.931,bld box cor
1012,2145112.230,647838.506,1814.690,low grade
1013,2145103.469,647839.887,1814.865,bld box cor
1014,2145091.561,647840.694,1815.410,ff
1015,2145078.456,647839.900,1814.858,bld box cor
1016,2145076.441,647835.361,1814.318,low grade
1017,2145068.481,647836.305,1815.448,bld box cor
1018,2145056.444,647837.190,1816.022,ff
1019,2145043.426,647836.501,1815.418,bld box cor
1020,2145042.140,647832.430,1814.923,low grade
1021,2145038.869,647885.083,1815.569,5 off bld cor/top wall
1022,2145063.835,647887.717,1815.590,5 off bld cor
1023,2145073.473,647888.756,1814.675,5 off bld cor
1024,2145098.552,647891.068,1814.661,5 off bld cor
1025,2145108.547,647892.106,1814.644,5 off bld cor
1026,2144944.270,648038.395,1816.545,water mark on house
1027,2144932.556,648142.774,1816.546,water mark on house
1028,2145237.740,647905.057,1812.706,5 off bld cor
1029,2145212.533,647902.671,1812.760,5 off bld cor
1030,2145202.934,647901.807,1813.450,5 off bld cor
1031,2145177.784,647899.197,1813.575,5 off bld cor
1032,2145168.305,647898.230,1813.841,5 off bld cor
1033,2145143.136,647895.690,1814.127,5 off bld cor
1034,2145133.339,647894.609,1814.510,5 off bld cor
1035,2145107.397,647765.443,1816.156,ff
1036,2145148.432,647771.423,1815.588,ff
1037,2145144.942,647837.414,1813.789,low grade
1038,2145164.377,647846.958,1814.978,ff
1039,2145179.120,647842.793,1813.148,low grade
1040,2145194.185,647851.739,1813.565,ff
1041,2145216.192,647847.451,1812.564,low grade
1042,2145228.883,647855.222,1813.142,ff
1043,2145278.424,647782.424,1813.838,ff
```

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
24528
JAMES J.
OWENS
Date Signed 4-18-07
ARIZONA, U.S.A.

Appendix B NOAA Atlas 14 Precipitation Information

Figure B.1 NOAA 2-year 24-hour Isohyetal Map

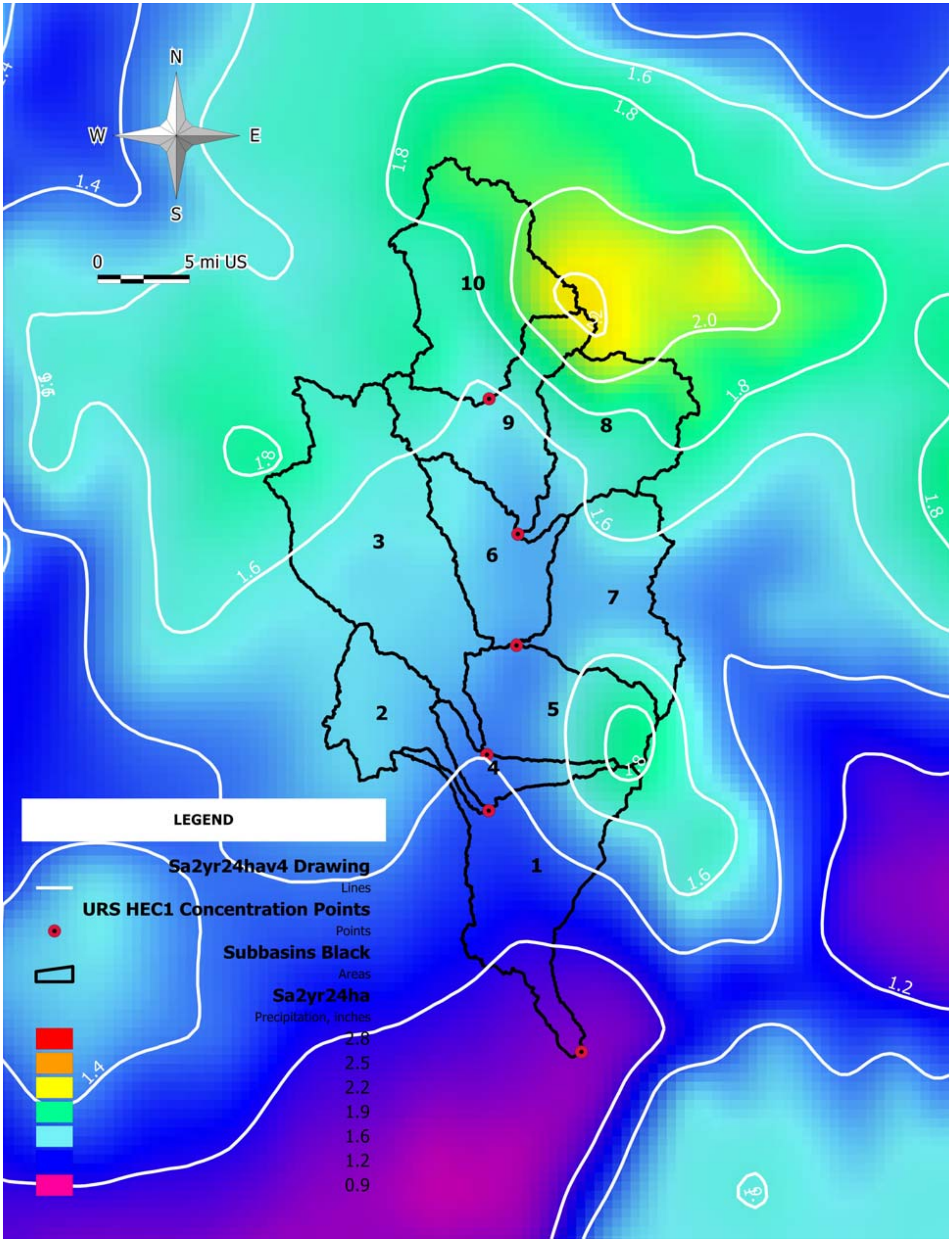


Figure B.2 NOAA 5-year 24-hour Isohyetal Map

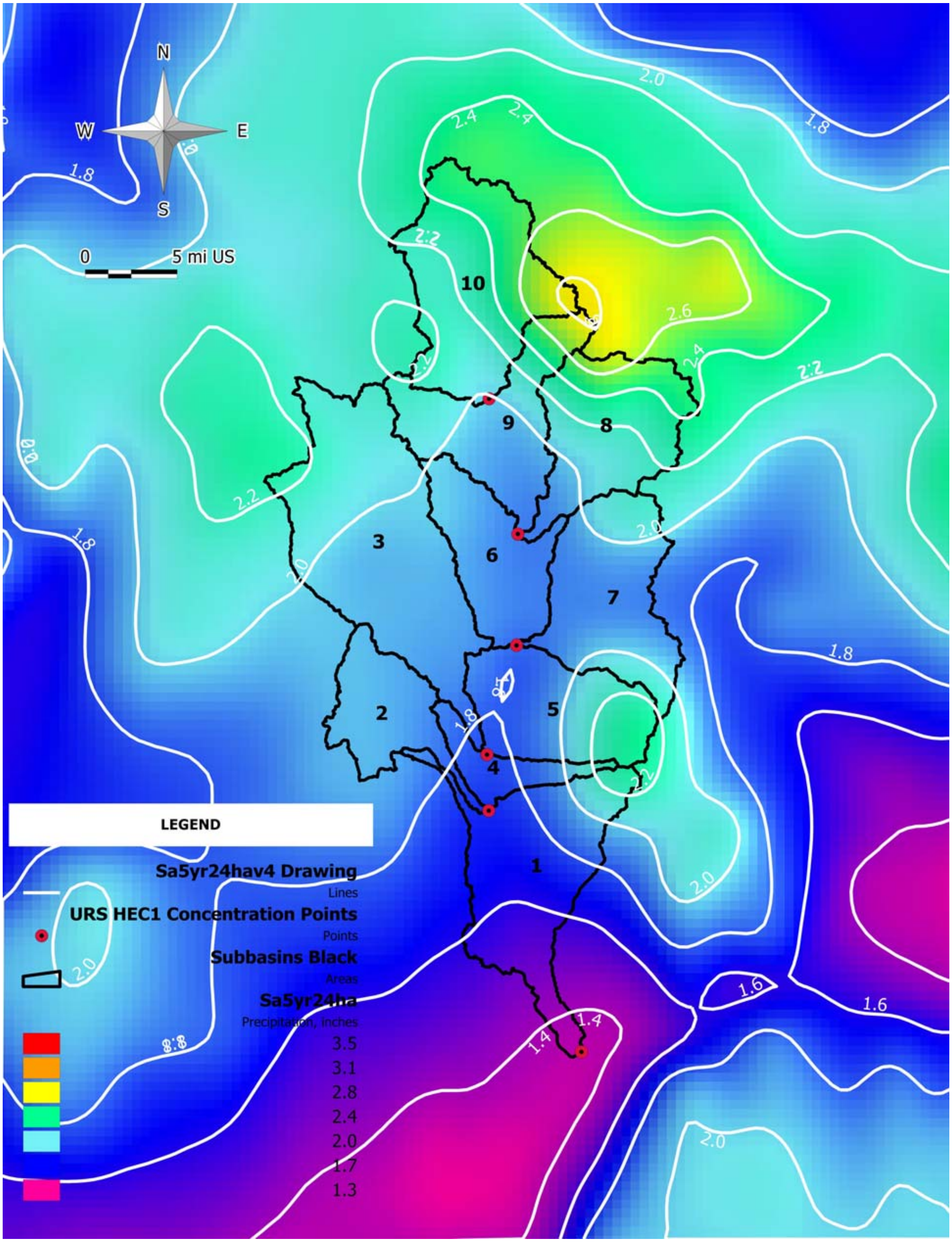


Figure B.3 NOAA 10-year 24-hour Isohyetal Map

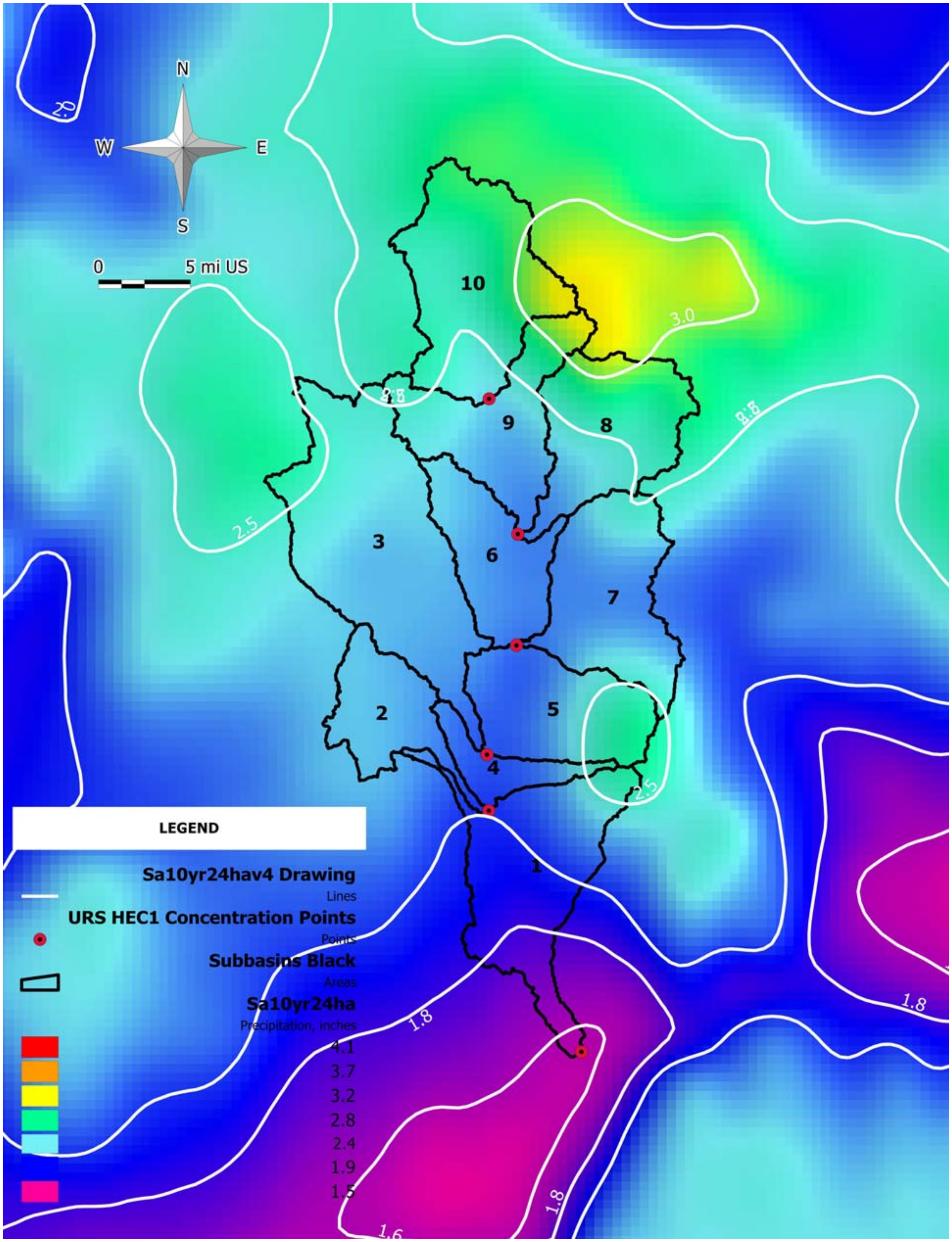


Figure B.4 NOAA 25-year 24-hour Isohyetal Map

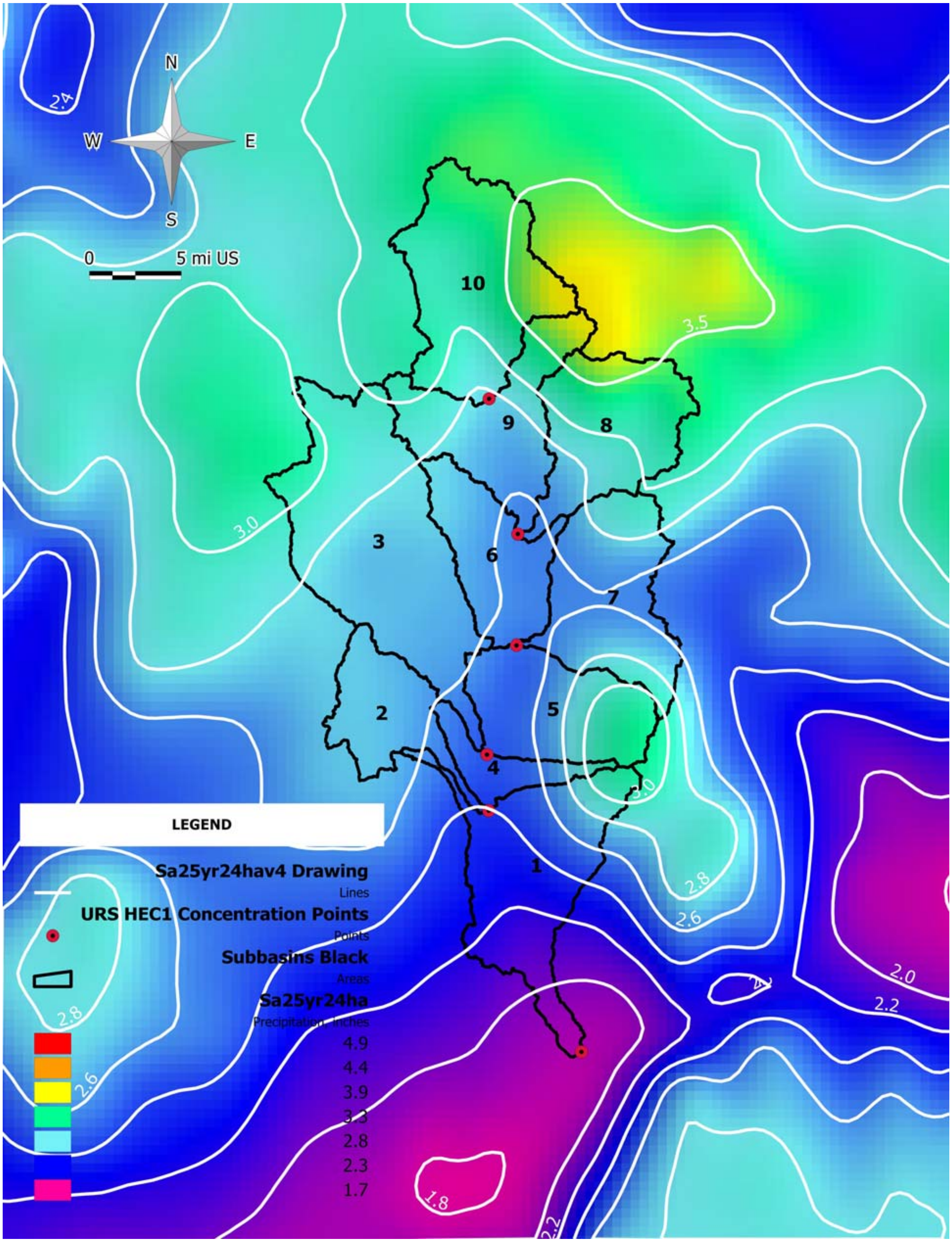


Figure B.5 NOAA 50-year 24-hour Isohyetal Map

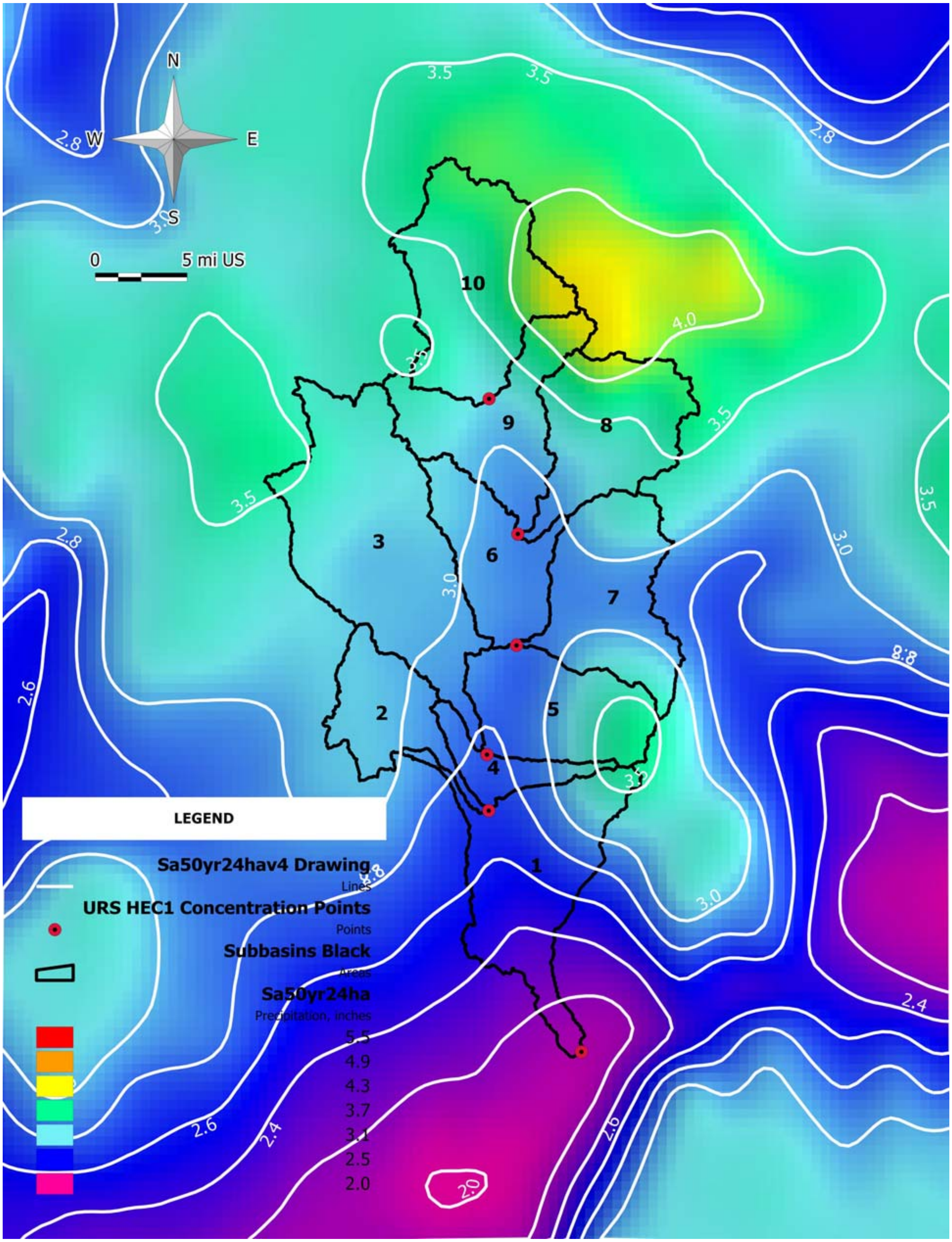


Figure B.6 NOAA 100-year 24-hour Isohyetal Map

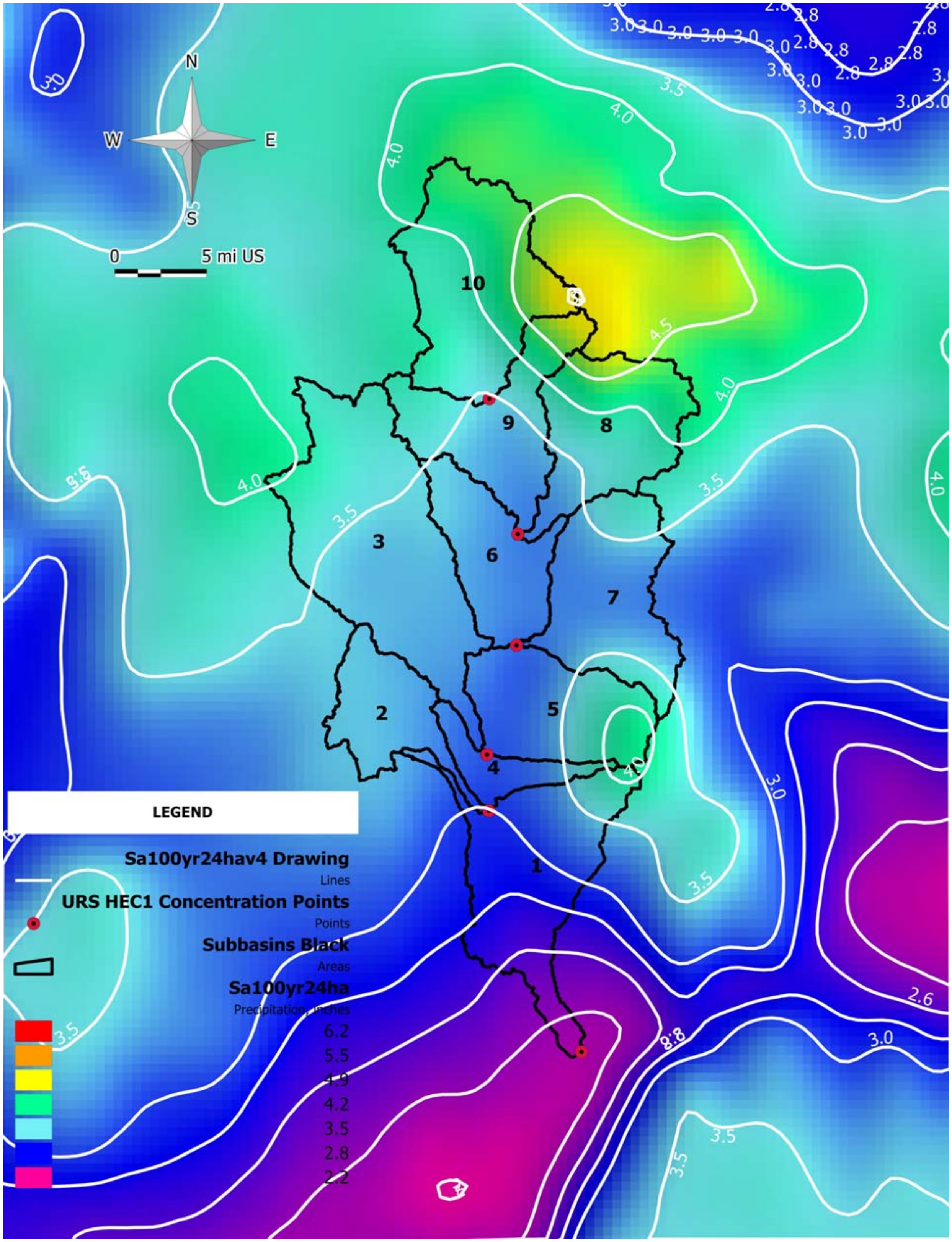


Figure B.7 NOAA 200-year 24-hour Isohyetal Map

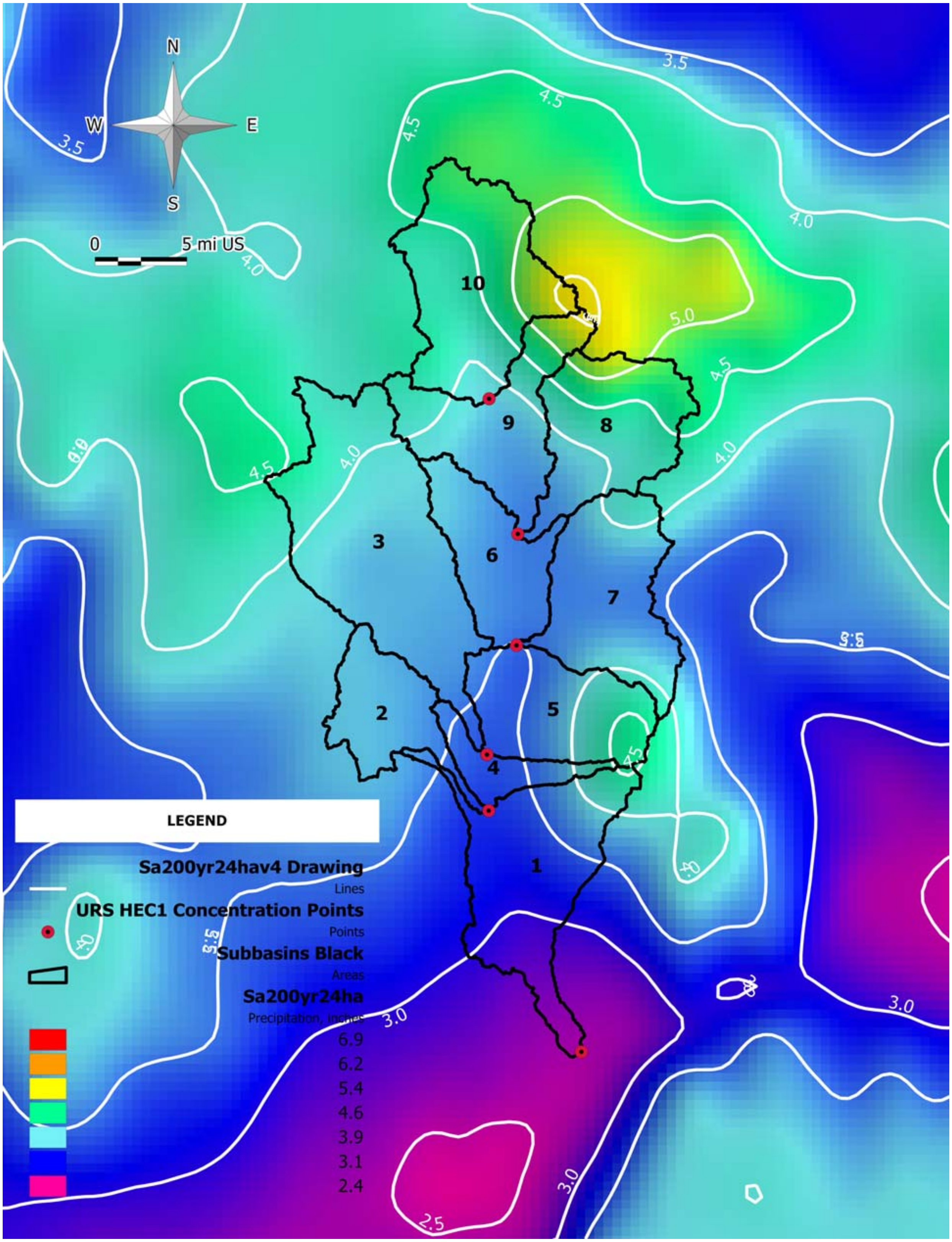


Figure B.8 NOAA 500-year 24-hour Isohyetal Map

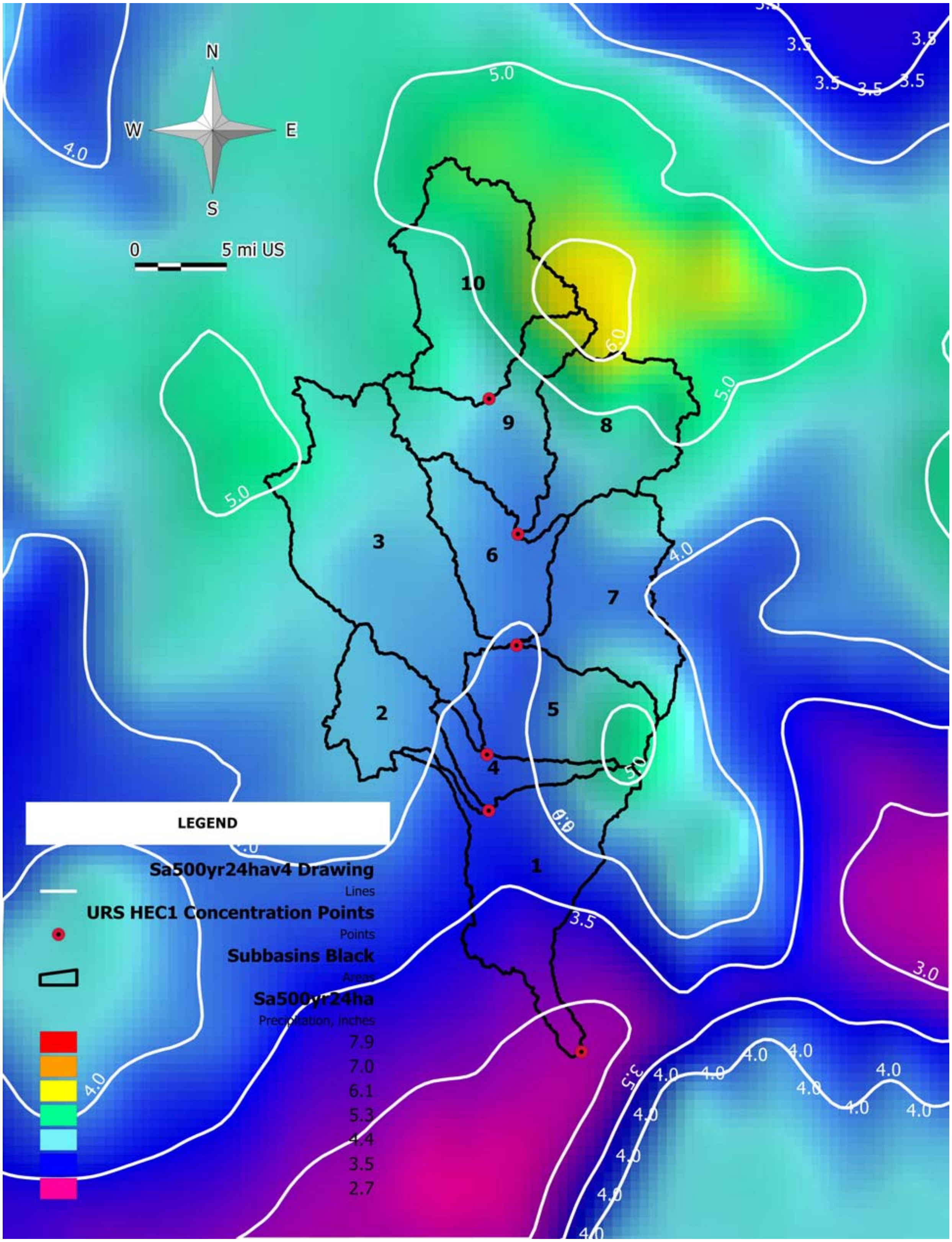


Table B.1 NOAA Atlas 14 precipitation-frequency data for Beaver Dam Wash

Sub-basin 1 **Utah 37.0492 N 113.9782 W 2890 feet**

Precipitation Frequency Estimates (inches)																	
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.14	0.21	0.26	0.35	0.43	0.52	0.58	0.72	0.88	1.08	1.19	1.39	1.63	1.82	2.31	2.77	3.28	3.77
2	0.18	0.27	0.34	0.45	0.56	0.66	0.73	0.91	1.11	1.36	1.50	1.76	2.07	2.31	2.93	3.52	4.18	4.82
5	0.24	0.37	0.46	0.62	0.77	0.88	0.96	1.18	1.43	1.73	1.92	2.25	2.64	2.94	3.71	4.48	5.36	6.19
10	0.30	0.46	0.57	0.77	0.95	1.07	1.15	1.39	1.67	2.01	2.24	2.63	3.09	3.43	4.28	5.19	6.24	7.19
25	0.39	0.59	0.74	0.99	1.23	1.36	1.43	1.70	2.01	2.40	2.68	3.15	3.69	4.07	4.99	6.10	7.38	8.48
50	0.47	0.71	0.88	1.18	1.46	1.60	1.67	1.96	2.27	2.70	3.03	3.56	4.15	4.56	5.51	6.78	8.23	9.44
100	0.55	0.84	1.04	1.40	1.73	1.88	1.93	2.22	2.53	3.00	3.38	3.98	4.62	5.06	6.03	7.45	9.09	10.39
200	0.65	0.98	1.22	1.65	2.04	2.18	2.23	2.53	2.81	3.31	3.75	4.41	5.11	5.56	6.52	8.10	9.95	11.34
500	0.80	1.21	1.50	2.02	2.50	2.65	2.68	3.00	3.20	3.73	4.25	5.00	5.76	6.23	7.16	8.95	11.08	12.58
1000	0.93	1.41	1.75	2.36	2.92	3.06	3.08	3.39	3.57	4.05	4.64	5.46	6.26	6.74	7.62	9.58	11.95	13.52

Sub-basin 2 **Nevada 37.1694 N 114.1315 W 3704 feet**

Precipitation Frequency Estimates (inches)																	
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.15	0.23	0.29	0.39	0.48	0.58	0.65	0.79	0.98	1.20	1.34	1.60	1.89	2.12	2.69	3.25	3.86	4.46
2	0.20	0.30	0.37	0.50	0.62	0.73	0.82	1.00	1.24	1.51	1.71	2.03	2.40	2.70	3.43	4.14	4.93	5.71
5	0.27	0.41	0.52	0.69	0.86	0.97	1.07	1.29	1.58	1.94	2.20	2.61	3.10	3.46	4.36	5.30	6.34	7.36
10	0.34	0.51	0.63	0.85	1.06	1.18	1.28	1.52	1.86	2.26	2.58	3.06	3.63	4.06	5.04	6.16	7.39	8.56
25	0.43	0.65	0.81	1.09	1.35	1.49	1.58	1.86	2.23	2.71	3.12	3.69	4.37	4.84	5.91	7.28	8.78	10.13
50	0.51	0.78	0.96	1.29	1.60	1.75	1.83	2.13	2.52	3.05	3.54	4.19	4.94	5.45	6.55	8.11	9.83	11.30
100	0.60	0.91	1.13	1.52	1.89	2.05	2.12	2.41	2.81	3.40	3.97	4.70	5.54	6.07	7.18	8.94	10.90	12.48
200	0.70	1.07	1.32	1.78	2.21	2.38	2.43	2.73	3.11	3.75	4.41	5.23	6.15	6.70	7.80	9.76	11.98	13.67
500	0.86	1.31	1.62	2.18	2.70	2.88	2.92	3.22	3.55	4.23	5.03	5.96	6.99	7.56	8.62	10.84	13.43	15.25
1000	1.00	1.52	1.89	2.54	3.14	3.31	3.35	3.64	3.94	4.60	5.51	6.54	7.65	8.22	9.22	11.66	14.57	16.46

Sub-basin 3 **Nevada 37.3046 N 114.135 W 4340 feet**

Precipitation Frequency Estimates (inches)																		
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.15	0.23	0.29	0.39	0.48	0.58	0.65	0.81	1.00	1.24	1.40	1.68	2.00	2.24	2.86	3.46	4.13	4.78
2	0.20	0.30	0.38	0.51	0.63	0.74	0.83	1.03	1.27	1.56	1.77	2.12	2.52	2.83	3.61	4.37	5.22	6.05
5	0.27	0.42	0.52	0.70	0.86	0.98	1.08	1.31	1.62	1.97	2.25	2.69	3.20	3.59	4.51	5.49	6.56	7.60
10	0.34	0.52	0.64	0.86	1.06	1.19	1.29	1.55	1.90	2.30	2.64	3.16	3.74	4.18	5.19	6.33	7.57	8.74
25	0.43	0.66	0.82	1.10	1.36	1.51	1.59	1.89	2.27	2.75	3.18	3.79	4.49	4.99	6.06	7.42	8.88	10.21
50	0.52	0.79	0.97	1.31	1.62	1.78	1.85	2.17	2.57	3.10	3.60	4.30	5.07	5.61	6.71	8.23	9.87	11.30
100	0.61	0.93	1.15	1.54	1.91	2.08	2.15	2.46	2.87	3.45	4.04	4.83	5.68	6.25	7.35	9.05	10.86	12.38
200	0.71	1.09	1.35	1.81	2.24	2.42	2.48	2.80	3.19	3.82	4.50	5.38	6.30	6.90	7.97	9.85	11.84	13.44
500	0.88	1.33	1.66	2.23	2.76	2.94	2.99	3.31	3.66	4.31	5.14	6.14	7.16	7.78	8.79	10.89	13.12	14.82
1000	1.02	1.56	1.93	2.60	3.22	3.40	3.44	3.76	4.08	4.70	5.64	6.74	7.84	8.46	9.39	11.68	14.11	15.86

Sub-basin 4 **Utah 37.1264 N 114.0209 W 2998 feet**

Precipitation Frequency Estimates (inches)																		
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.14	0.22	0.27	0.36	0.45	0.54	0.60	0.75	0.91	1.11	1.24	1.45	1.70	1.89	2.39	2.87	3.40	3.89
2	0.18	0.28	0.35	0.47	0.58	0.69	0.76	0.94	1.15	1.40	1.56	1.83	2.15	2.40	3.04	3.64	4.32	4.96
5	0.25	0.39	0.48	0.65	0.80	0.91	1.00	1.21	1.47	1.78	1.99	2.33	2.74	3.05	3.83	4.63	5.52	6.35
10	0.31	0.48	0.59	0.80	0.99	1.11	1.19	1.44	1.72	2.07	2.32	2.73	3.20	3.56	4.42	5.35	6.41	7.36
25	0.40	0.61	0.76	1.02	1.27	1.40	1.47	1.75	2.06	2.47	2.78	3.27	3.83	4.22	5.15	6.29	7.57	8.66
50	0.48	0.73	0.90	1.22	1.50	1.64	1.71	2.00	2.33	2.78	3.15	3.69	4.31	4.73	5.69	6.98	8.43	9.63
100	0.57	0.86	1.07	1.44	1.78	1.93	1.98	2.27	2.60	3.09	3.52	4.13	4.80	5.25	6.22	7.67	9.30	10.59
200	0.66	1.01	1.25	1.69	2.09	2.24	2.28	2.58	2.88	3.41	3.90	4.58	5.31	5.77	6.73	8.34	10.17	11.54
500	0.82	1.24	1.54	2.07	2.56	2.71	2.74	3.05	3.29	3.84	4.42	5.19	5.99	6.47	7.39	9.21	11.31	12.78
1000	0.95	1.44	1.79	2.41	2.98	3.12	3.15	3.45	3.66	4.17	4.83	5.67	6.52	7.01	7.86	9.86	12.18	13.71

Sub-basin 5 **Utah 37.1728 N 113.9621 W 3864 feet**

Precipitation Frequency Estimates (inches)																		
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.16	0.24	0.29	0.40	0.49	0.59	0.66	0.82	1.02	1.24	1.40	1.66	1.97	2.21	2.84	3.43	4.10	4.75
2	0.20	0.31	0.38	0.51	0.64	0.75	0.84	1.04	1.28	1.56	1.77	2.10	2.50	2.81	3.61	4.37	5.23	6.07
5	0.28	0.42	0.52	0.70	0.87	0.99	1.09	1.33	1.63	1.98	2.26	2.70	3.21	3.60	4.57	5.56	6.68	7.78
10	0.34	0.52	0.64	0.86	1.07	1.20	1.30	1.56	1.91	2.31	2.65	3.18	3.77	4.21	5.27	6.45	7.78	9.03
25	0.43	0.66	0.82	1.10	1.36	1.51	1.60	1.90	2.29	2.75	3.19	3.83	4.54	5.03	6.17	7.62	9.22	10.66
50	0.51	0.78	0.97	1.30	1.61	1.77	1.86	2.17	2.58	3.10	3.62	4.34	5.14	5.67	6.84	8.48	10.31	11.87
100	0.60	0.92	1.14	1.53	1.90	2.07	2.15	2.46	2.88	3.46	4.06	4.88	5.76	6.32	7.50	9.35	11.42	13.10
200	0.71	1.07	1.33	1.79	2.22	2.40	2.47	2.80	3.19	3.82	4.52	5.43	6.40	6.97	8.14	10.21	12.55	14.32
500	0.86	1.31	1.63	2.19	2.71	2.90	2.95	3.30	3.64	4.31	5.16	6.19	7.28	7.87	8.99	11.34	14.06	15.95
1000	1.00	1.53	1.89	2.55	3.15	3.33	3.39	3.72	4.05	4.69	5.66	6.80	7.97	8.57	9.62	12.20	15.25	17.21

Sub-basin 6 **Utah 37.2941 N 114.0227 W 3825 feet**

Precipitation Frequency Estimates (inches)																		
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.15	0.23	0.28	0.38	0.47	0.56	0.63	0.79	0.97	1.18	1.33	1.58	1.86	2.08	2.64	3.18	3.80	4.37
2	0.19	0.29	0.36	0.49	0.60	0.71	0.80	0.99	1.22	1.49	1.67	1.98	2.34	2.62	3.33	4.00	4.79	5.52
5	0.26	0.40	0.50	0.67	0.83	0.95	1.04	1.27	1.55	1.88	2.12	2.50	2.95	3.30	4.15	5.01	5.99	6.91
10	0.33	0.49	0.61	0.83	1.02	1.15	1.24	1.50	1.82	2.18	2.47	2.92	3.44	3.84	4.76	5.77	6.90	7.93
25	0.42	0.64	0.79	1.06	1.31	1.46	1.54	1.82	2.17	2.60	2.96	3.50	4.11	4.56	5.54	6.74	8.07	9.24
50	0.50	0.76	0.94	1.26	1.56	1.71	1.79	2.09	2.45	2.93	3.35	3.95	4.63	5.11	6.11	7.46	8.94	10.20
100	0.59	0.90	1.11	1.49	1.85	2.01	2.07	2.38	2.74	3.26	3.75	4.43	5.17	5.67	6.67	8.17	9.80	11.15
200	0.69	1.05	1.30	1.76	2.17	2.34	2.39	2.70	3.05	3.60	4.17	4.92	5.71	6.24	7.22	8.87	10.65	12.07
500	0.85	1.29	1.60	2.16	2.67	2.85	2.88	3.20	3.50	4.06	4.73	5.59	6.46	7.00	7.92	9.77	11.74	13.24
1000	0.99	1.51	1.87	2.52	3.12	3.29	3.32	3.63	3.90	4.42	5.18	6.12	7.04	7.59	8.43	10.44	12.56	14.11

Sub-basin 7 **Utah 37.2611 N 113.9029 W 3989 feet**

Precipitation Frequency Estimates (inches)																		
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.15	0.23	0.28	0.38	0.47	0.56	0.64	0.80	0.98	1.19	1.33	1.58	1.86	2.08	2.65	3.20	3.82	4.39
2	0.19	0.29	0.36	0.49	0.61	0.72	0.80	1.00	1.23	1.49	1.67	1.98	2.34	2.62	3.34	4.03	4.81	5.54
5	0.26	0.40	0.50	0.67	0.83	0.95	1.04	1.28	1.56	1.87	2.10	2.49	2.95	3.30	4.15	5.03	6.03	6.93
10	0.33	0.50	0.61	0.83	1.02	1.15	1.24	1.51	1.82	2.17	2.45	2.90	3.43	3.83	4.75	5.78	6.93	7.96
25	0.42	0.64	0.79	1.06	1.31	1.45	1.54	1.83	2.18	2.59	2.94	3.47	4.09	4.54	5.52	6.74	8.12	9.29
50	0.50	0.76	0.94	1.26	1.56	1.71	1.79	2.10	2.46	2.91	3.31	3.92	4.60	5.09	6.08	7.45	8.99	10.25
100	0.59	0.90	1.11	1.49	1.85	2.01	2.07	2.39	2.74	3.24	3.71	4.38	5.13	5.65	6.63	8.15	9.87	11.21
200	0.69	1.05	1.30	1.76	2.17	2.34	2.39	2.71	3.05	3.58	4.11	4.85	5.66	6.21	7.16	8.84	10.72	12.14
500	0.85	1.29	1.60	2.16	2.67	2.84	2.88	3.22	3.49	4.04	4.66	5.50	6.39	6.97	7.84	9.71	11.82	13.32
1000	0.99	1.51	1.87	2.52	3.12	3.28	3.32	3.65	3.90	4.39	5.10	6.02	6.95	7.55	8.33	10.36	12.64	14.19

Sub-basin 8 **Utah 37.397 N 113.91 W 5101 feet**

Precipitation Frequency Estimates (inches)																		
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.17	0.26	0.32	0.44	0.54	0.64	0.73	0.92	1.15	1.42	1.63	1.94	2.33	2.63	3.41	4.18	5.04	5.88
2	0.22	0.34	0.42	0.56	0.70	0.81	0.92	1.15	1.45	1.78	2.06	2.45	2.94	3.33	4.32	5.29	6.38	7.46
5	0.30	0.46	0.57	0.77	0.95	1.07	1.19	1.46	1.83	2.25	2.62	3.13	3.75	4.24	5.41	6.66	8.03	9.39
10	0.37	0.56	0.70	0.94	1.17	1.30	1.42	1.72	2.14	2.62	3.08	3.67	4.41	4.96	6.23	7.70	9.29	10.83
25	0.47	0.72	0.89	1.20	1.48	1.64	1.75	2.08	2.55	3.13	3.72	4.43	5.31	5.93	7.29	9.06	10.95	12.70
50	0.56	0.85	1.05	1.42	1.75	1.92	2.03	2.38	2.88	3.53	4.23	5.04	6.02	6.69	8.08	10.08	12.21	14.09
100	0.66	1.00	1.24	1.66	2.06	2.25	2.35	2.70	3.22	3.94	4.76	5.67	6.76	7.48	8.87	11.10	13.49	15.49
200	0.77	1.17	1.45	1.95	2.41	2.61	2.70	3.07	3.57	4.36	5.32	6.34	7.54	8.29	9.65	12.12	14.78	16.88
500	0.94	1.43	1.77	2.38	2.95	3.16	3.24	3.63	4.10	4.93	6.10	7.26	8.60	9.39	10.68	13.45	16.51	18.72
1000	1.09	1.66	2.06	2.78	3.44	3.65	3.73	4.10	4.57	5.38	6.72	7.99	9.45	10.25	11.45	14.47	17.86	20.14

Sub-basin 9 **Utah 37.3989 N 114.0069 W 4363 feet**

Precipitation Frequency Estimates (inches)																	
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.15	0.23	0.29	0.39	0.48	0.58	0.65	0.81	1.01	1.25	1.41	1.68	1.99	2.23	2.84	3.44	4.12	4.77
2	0.20	0.30	0.37	0.50	0.62	0.73	0.82	1.02	1.27	1.57	1.77	2.11	2.50	2.81	3.58	4.34	5.20	6.03
5	0.27	0.41	0.51	0.69	0.85	0.97	1.07	1.31	1.62	1.98	2.25	2.67	3.17	3.55	4.48	5.44	6.52	7.56
10	0.33	0.51	0.63	0.85	1.05	1.18	1.28	1.55	1.89	2.30	2.63	3.13	3.71	4.14	5.14	6.27	7.51	8.68
25	0.43	0.65	0.81	1.09	1.35	1.50	1.59	1.88	2.26	2.75	3.17	3.76	4.44	4.92	6.00	7.34	8.79	10.13
50	0.51	0.78	0.96	1.29	1.60	1.76	1.85	2.15	2.56	3.10	3.59	4.25	5.01	5.53	6.63	8.14	9.76	11.19
100	0.60	0.92	1.14	1.53	1.89	2.07	2.15	2.45	2.86	3.45	4.03	4.78	5.61	6.16	7.26	8.93	10.71	12.25
200	0.71	1.08	1.34	1.80	2.23	2.41	2.47	2.79	3.17	3.81	4.48	5.32	6.22	6.79	7.87	9.72	11.67	13.28
500	0.87	1.33	1.64	2.21	2.74	2.93	2.98	3.31	3.65	4.30	5.11	6.06	7.06	7.64	8.66	10.73	12.91	14.62
1000	1.02	1.55	1.92	2.58	3.20	3.39	3.44	3.76	4.08	4.69	5.60	6.65	7.71	8.31	9.25	11.49	13.85	15.62

Sub-basin 10 **Utah 37.5091 N 114.0427 W 5774 feet**

Precipitation Frequency Estimates (inches)																	
ARI*	**5**	**10**	**15**	**30**	**60**	**120**	**3**	**6**	**12**	**24**	**48**	**4**	**7**	**10**	**20**	**30**	**45**	**60**
(years)	**min**	**min**	**min**	**min**	**min**	**min**	**hr**	**hr**	**hr**	**hr**	**hr**	**day**	**day**	**day**	**day**	**day**	**day**	**day**
1	0.17	0.26	0.33	0.44	0.54	0.65	0.74	0.92	1.16	1.44	1.67	2.00	2.38	2.70	3.50	4.28	5.16	6.04
2	0.22	0.34	0.42	0.57	0.70	0.83	0.93	1.16	1.46	1.81	2.11	2.52	3.02	3.42	4.42	5.42	6.53	7.67
5	0.31	0.47	0.58	0.78	0.96	1.10	1.21	1.48	1.85	2.30	2.69	3.23	3.87	4.37	5.57	6.85	8.23	9.66
10	0.38	0.57	0.71	0.96	1.19	1.33	1.44	1.75	2.17	2.68	3.17	3.81	4.56	5.12	6.43	7.93	9.52	11.15
25	0.48	0.73	0.91	1.22	1.51	1.68	1.78	2.12	2.59	3.21	3.84	4.62	5.51	6.15	7.55	9.36	11.23	13.08
50	0.57	0.87	1.07	1.45	1.79	1.98	2.07	2.42	2.93	3.63	4.38	5.26	6.27	6.95	8.40	10.44	12.53	14.53
100	0.67	1.02	1.26	1.70	2.10	2.31	2.40	2.75	3.27	4.05	4.94	5.95	7.07	7.79	9.26	11.53	13.86	15.99
200	0.78	1.19	1.48	1.99	2.46	2.69	2.77	3.13	3.64	4.49	5.53	6.66	7.89	8.65	10.11	12.62	15.21	17.46
500	0.96	1.46	1.81	2.44	3.02	3.26	3.33	3.70	4.18	5.08	6.34	7.65	9.05	9.83	11.23	14.05	17.02	19.41
1000	1.12	1.70	2.11	2.85	3.52	3.77	3.84	4.19	4.67	5.55	7.00	8.45	9.97	10.77	12.09	15.16	18.45	20.92

Appendix C HEC-1 Hydrologic Modeling Results

Complete HEC-1 Model – All Sub-Basins (pre-fire)

```
1***************************************                                             **************************************
 *                                      *                                            *                                    *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                            *    U.S. ARMY CORPS OF ENGINEERS    *
 *               JUN   1998             *                                            *    HYDROLOGIC ENGINEERING CENTER   *
 *            VERSION 4.1               *                                            *          609 SECOND STREET         *
 *                                      *                                            *       DAVIS, CALIFORNIA 95616      *
 *  RUN DATE   20JUN07  TIME  07:37:12  *                                            *            (916) 756-1104          *
 *                                      *                                            *                                    *
 ***************************************                                             **************************************



                                                  X     X  XXXXXXX   XXXXX          X
                                                  X     X  X        X     X        XX
                                                  X     X  X        X               X
                                                  XXXXXXX  XXXX     X        XXXXX  X
                                                  X     X  X        X               X
                                                  X     X  X        X     X         X
                                                  X     X  XXXXXXX   XXXXX         XXX



            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
1                                              HEC-1 INPUT                                              PAGE  1

 LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1            ID        Mohave County
   2            ID        BDNOAA14MID100 - Beaver Dam Hydrology NOAA 14 Mid100 w Routing Optimized
   3            ID        Major Basin: 01
   4            ID        100 Year - Return Period
   5            ID        24 Hour Storm
   6            ID        Single Storm
   7            ID        Unit Hydrograph: Clark
   8            ID        11/11/2006
                *DIAGRAM
   9            IT       5 31MAY05    0000    1500
  10            IO       5
                *

  11            KK   SUB10BASIN
  12            KM    RUNOFF CALCULATION FOR SUBBASIN 10
  13            BA   76.58
  14            PH            575    0.67    1.26    2.10    2.31    2.40    2.75    3.27    4.05
  15            LG    0.15    0.36   5.102   0.288    11.4
  16            UC    6.07    2.79
                *

  17            KK     9UPROUTE
  18            KM   ROUTE SUBBASIN 10 RUNOFF THROUGH REACH BASIN 9 - UPPER
  19            RS       8    FLOW       0       0
  20            RC   0.060   0.060   0.060   41282  0.0140
  21            RX       0      45      89      94     130     135     160     185
  22            RY    4160    4142    4125    4120    4120    4125    4142    4160
                *

  23            KK    9LOWROUTE
```

```
          24            KM   ROUTE SUBBASIN 10 RUNOFF THROUGH REACH BASIN 9 - LOWER
          25            RS       5    FLOW       0       0
          26            RC   0.055   0.055   0.055   11913  0.0104
          27            RX       0     140     285     300     380     395    1020    1260
          28            RY    3600    3560    3559    3556    3556    3559    3560    3600
                        *

          29            KK   SUB09BASIN
          30            KM    RUNOFF CALCULATION FOR SUBBASIN 9
          31            BA   54.25
          32            PH             575    0.60    1.14    1.89    2.07    2.15    2.45    2.86    3.45
          33            LG    0.15   0.387    5.67    0.24      0.
          34            UC    3.80    1.62
                        *

          35            KK   SUB08BASIN
          36            KM    RUNOFF CALCULATION FOR SUBBASIN 8
          37            BA   55.69
          38            PH             575    0.66    1.24    2.06    2.25    2.35    2.70    3.22    3.94
          39            LG    0.15    0.35   3.984   0.478      0.
          40            UC    4.43    1.79
                        *
1                                                        HEC-1 INPUT                                              PAGE  2

        LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

          41            KK   CONC1COMBINE
          42            KM    COMBINE SUBBASINS 09 AND 08 WITH ROUTED 9LOW
          43            HC       3
                        *

          44            KK     6UPROUTE
          45            KM   ROUTE SUBBASIN 9+8 RUNOFF THROUGH REACH BASIN 6 - UPPER
          46            RS       7    FLOW       0
          47            RC   0.075   0.075   0.075   14202  0.0113
```

```
48          RX       0     170     685     700     765     780     930    1130
49          RY    3580    3540    3539    3536    3536    3539    3540    3580
            *

50          KK    6LOWROUTE
51          KM   ROUTE SUBBASIN 9+8 RUNOFF THROUGH REACH BASIN 6 - LOWER
52          RS       8    FLOW       0
53          RC   0.045   0.045   0.045   21503  0.0102
54          RX       0     160     885     900    1000    1015    1500    1760
55          RY    3320    3280    3279    3276    3276    3279    3280    3320
            *

56          KK   SUB07BASIN
57          KM    RUNOFF CALCULATION FOR SUBBASIN 7
58          BA   60.32
59          PH             575    0.59    1.11    1.85    2.01    2.07    2.39    2.74    3.24
60          LG    0.15    0.35   4.849   0.284   14.71
61          UC    3.89    1.48
            *

62          KK   SUB06BASIN
63          KM    RUNOFF CALCULATION FOR SUBBASIN 6
64          BA   41.51
65          PH             575    0.59    1.11    1.85    2.01    2.07    2.38    2.74    3.26
66          LG    0.15    0.38   5.475   0.229    2.55
67          UC    3.99    1.83
            *

68          KK   CONC2COMBINE
69          KM    COMBINE SUBBASINS 07 AND 06 WITH ROUTED 6LOW
70          HC       3
            *

71          KK     5UPROUTE
72          KM   ROUTE SUBBASIN 6+7 RUNOFF THROUGH REACH BASIN 5 - UPPER
73          RS       7    FLOW       0       0
```

```
          74            RC   0.055   0.055   0.055   18610  0.0111
          75            RX       0     180     685     700     810     825     940    1190
          76            RY    3020    3000    2999    2996    2996    2999    3000    3020
                        *
1                                           HEC-1 INPUT                                               PAGE  3

        LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10



          77            KK    5MIDROUTE
          78            KM   ROUTE SUBBASIN 6+7 RUNOFF THROUGH REACH BASIN 5 - MIDDLE
          79            RS       2    FLOW       0       0
          80            RC   0.055   0.055   0.055    8769  0.0116
          81            RX       0     260     585     600     660     675     900     950
          82            RY    2880    2860    2859    2856    2856    2859    2860    2880
                        *

          83            KK    5LOWROUTE
          84            KM   ROUTE SUBBASIN 6+7 RUNOFF THROUGH REACH BASIN 5 - LOWER
          85            RS       3    FLOW       0       0
          86            RC   0.045   0.045   0.045    8049  0.0102
          87            RX       0     340     697     700     730     735    1190    1220
          88            RY    2820    2800    2797    2794    2794    2797    2800    2820
                        *

          89            KK   SUB05BASIN
          90            KM    RUNOFF CALCULATION FOR SUBBASIN 5
          91            BA   51.47
          92            PH             575    0.60    1.14    1.90    2.07    2.15    2.46    2.88    3.46
          93            LG    0.15    0.35   4.278   0.374      0.
          94            UC    3.81    1.57
                        *

          95            KK   SUB03BASIN
          96            KM    RUNOFF CALCULATION FOR SUBBASIN 3
          97            BA   111.2
```

```
          98           PH           575    0.61    1.15    1.91    2.08    2.15    2.46    2.87    3.45
          99           LG    0.15   0.375   6.495   0.168      0.
         100           UC    6.97    3.13
                       *

         101           KK   CONC3COMBINE
         102           KM    COMBINE SUBBASINS 05 AND 03 WITH ROUTED 5LOW
         103           HC       3
                       *

         104           KK     4UPROUTE
         105           KM   ROUTE SUBBASIN 3+5 RUNOFF THROUGH REACH BASIN 4 - UPPER
         106           RS       4    FLOW       0       0
         107           RC   0.070   0.070   0.070    9425  0.0095
         108           RX       0      90     297     300     330     333     870     910
         109           RY    2720    2700    2697    2694    2694    2697    2700    2720
                       *

         110           KK    4MIDROUTE
         111           KM   ROUTE SUBBASIN 3+5 RUNOFF THROUGH REACH BASIN 4 - MIDDLE
         112           RS       1    FLOW       0       0
         113           RC   0.070   0.070   0.070    3665  0.0109
         114           RX       0      70     385     400     480     495     610     670
         115           RY    2620    2600    2599    2596    2596    2599    2600    2620
                       *
1                                                 HEC-1 INPUT                                             PAGE  4

        LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


         116           KK    4LOWROUTE
         117           KM   ROUTE SUBBASIN 3+5 RUNOFF THROUGH REACH BASIN 4 - LOWER
         118           RS       1    FLOW       0       0
         119           RC   0.060   0.060   0.060    4442  0.0101
         120           RX       0     590     685     700     770     795     890     950
         121           RY    2600    2580    2579    2576    2576    2579    2580    2600
```

```
                    *

122                 KK   SUB04BASIN
123                 KM    RUNOFF CALCULATION FOR SUBBASIN 4
124                 BA   16.50
125                 PH             575    0.57    1.07    1.78    1.93    1.98    2.27    2.60    3.09
126                 LG    0.15    0.35   4.505   0.322    1.01
127                 UC    2.38    1.18
                    *

128                 KK   SUB02BASIN
129                 KM    RUNOFF CALCULATION FOR SUBBASIN 2
130                 BA   33.34
131                 PH             575    0.60    1.13    1.89    2.05    2.12    2.41    2.81    3.40
132                 LG    0.15    0.35   4.394   0.343      0.
133                 UC    3.97    2.06
                    *

134                 KK   CONC4COMBINE
135                 KM    COMBINE SUBBASINS 04 AND 02 WITH ROUTED 4LOW
136                 HC       3
                    *

137                 KK     1UPROUTE
138                 KM   ROUTE SUBBASIN 2+4 RUNOFF THROUGH REACH BASIN 1 - UPPER
139                 RS      19    FLOW       0       0
140                 RC   0.052   0.052   0.052   49818  0.0099
141                 RX       0     190     285     300    1000    1015    1600    2050
142                 RY    2320    2300    2299    2296    2296    2299    2300    2320
                    *

143                 KK    1LOWROUTE
144                 KM   ROUTE SUBBASIN 2+4 RUNOFF THROUGH REACH BASIN 1 - LOWER
145                 RS      13    FLOW       0       0
146                 RC   0.058   0.058   0.058   29796  0.0079
147                 RX       0      90     485     500    1800    1815    2220    2400
```

```
         148           RY    2000    1980    1979    1976    1976    1979    1980    2000
                       *

         149           KK   SUB01BASIN
         150           KM    RUNOFF CALCULATION FOR SUBBASIN 1
         151           BA   76.00
         152           PH             575    0.55    1.04    1.73    1.88    1.93    2.22    2.53    3.00
         153           LG    0.15    0.35    4.47   0.331    2.73
         154           UC    4.80    2.00
                       *
1                                                        HEC-1 INPUT                                        PAGE  5

        LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

         155           KK   CONC5COMBINE
         156           KM    COMBINE SUBBASIN 01 WITH ROUTED 1LOW
         157           KO       3                             21
         158           HC       2
         159           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    11       SUB10
                 V
                 V
    17         9UP
                 V
                 V
    23        9LOW
                 .
                 .
```

```
29           .       SUB09
             .           .
             .           .
35           .           .       SUB08
             .           .           .
             .           .           .
41       CONC1.......................
             V
             V
44         6UP
             V
             V
50        6LOW
             .
             .
56           .       SUB07
             .           .
             .           .
62           .           .       SUB06
             .           .           .
             .           .           .
68       CONC2.......................
             V
             V
71         5UP
             V
             V
77        5MID
             V
             V
83        5LOW
             .
             .
89           .       SUB05
             .           .
             .           .
```

```
  95          .           .       SUB03
              .           .           .
              .           .           .
 101      CONC3.......................
              V
              V
 104        4UP
              V
              V
 110       4MID
              V
              V
 116       4LOW
              .
              .
 122          .       SUB04
              .           .
              .           .
 128          .           .       SUB02
              .           .           .
              .           .           .
 134      CONC4.......................
              V
              V
 137        1UP
              V
              V
 143       1LOW
              .
              .
 149          .       SUB01
              .           .
              .           .
 155      CONC5...........

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
1***************************************                      ***************************************
 *                                     *                      *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                      *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998             *                      *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1               *                      *          609 SECOND STREET          *
 *                                     *                      *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   20JUN07  TIME  07:37:12   *                      *           (916) 756-1104            *
 *                                     *                      *                                     *
 ***************************************                      ***************************************




                                 Mohave County
                                 BDNOAA14MID100 - Beaver Dam Hydrology NOAA 14 Mid100 w Routing Optimized
                                 Major Basin: 01
                                 100 Year - Return Period
                                 24 Hour Storm
                                 Single Storm
                                 Unit Hydrograph: Clark
                                 11/11/2006

   10 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           5  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN           5  MINUTES IN COMPUTATION INTERVAL
                        IDATE     31MAY 5  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ        1500  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      5JUN 5  ENDING DATE
                       NDTIME        0455  ENDING TIME
                       ICENT           19  CENTURY MARK
```

```
               COMPUTATION INTERVAL     .08 HOURS
                    TOTAL TIME BASE  124.92 HOURS

      ENGLISH UNITS
           DRAINAGE AREA         SQUARE MILES
           PRECIPITATION DEPTH   INCHES
           LENGTH, ELEVATION     FEET
           FLOW                  CUBIC FEET PER SECOND
           STORAGE VOLUME        ACRE-FEET
           SURFACE AREA          ACRES
           TEMPERATURE           DEGREES FAHRENHEIT

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

             **************
             *            *
 155 KK      *    CONC5   *    COMBINE
             *            *
             **************

 157 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                        IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        1500  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        .083  TIME INTERVAL IN HOURS

 158 HC          HYDROGRAPH COMBINATION
```

```
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                        ***

        ***             ***             ***             ***             ***

                          HYDROGRAPH AT STATION    CONC5

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR    124.92-HR
+   (CFS)       (HR)
                                (CFS)
+   26134.     20.33              21446.       9266.       3222.        1857.
                        (INCHES)      .346        .597        .623         .623
                         (AC-FT)    10634.      18379.      19172.       19172.

                         CUMULATIVE AREA =  576.86 SQ MI

1
                                                                  RUNOFF SUMMARY
                                                          FLOW IN CUBIC FEET PER SECOND
                                                       TIME IN HOURS,  AREA IN SQUARE MILES

                                           PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
          OPERATION       STATION       FLOW     PEAK                                              AREA       STAGE     MAX STAGE
+                                                             6-HOUR     24-HOUR     72-HOUR

          HYDROGRAPH AT
+                           SUB10      6725.   16.83        5390.       2061.        699.      76.58

          ROUTED TO
+                             9UP      6701.   17.50        5371.       2058.        699.      76.58
+                                                                                                      4130.89       17.50

          ROUTED TO
+                            9LOW      6687.   17.92        5344.       2058.        699.      76.58
```

+									3560.73	17.92
	HYDROGRAPH AT									
+		SUB09	4877.	15.00	2881.	777.	259.	54.25		
	HYDROGRAPH AT									
+		SUB08	3651.	15.50	2370.	662.	221.	55.69		
	3 COMBINED AT									
+		CONC1	11695.	15.75	9397.	3496.	1178.	186.52		
	ROUTED TO									
+		6UP	11586.	16.33	9368.	3496.	1178.	186.52		
+									3542.16	16.33
	ROUTED TO									
+		6LOW	11518.	17.00	9262.	3495.	1178.	186.52		
+									3280.75	17.00
	HYDROGRAPH AT									
+		SUB07	6826.	15.00	4258.	1355.	456.	60.32		
	HYDROGRAPH AT									
+		SUB06	3611.	15.25	2269.	656.	219.	41.51		
	3 COMBINED AT									
+		CONC2	17552.	16.58	13608.	5435.	1853.	288.35		
	ROUTED TO									
+		5UP	17192.	17.17	13556.	5434.	1853.	288.35		
+									3002.22	17.17
	ROUTED TO									
+		5MID	17097.	17.33	13525.	5434.	1853.	288.35		
+									2862.73	17.33

	ROUTED TO									
+		5LOW	17059.	17.58	13503.	5434.	1853.	288.35		
+									2801.15	17.58
	HYDROGRAPH AT									
+		SUB05	3777.	15.00	2216.	594.	198.	51.47		
	HYDROGRAPH AT									
+		SUB03	6881.	17.58	5672.	2048.	683.	111.20		
	3 COMBINED AT									
+		CONC3	25065.	17.42	20293.	8076.	2734.	451.02		
	ROUTED TO									
+		4UP	25014.	17.75	20262.	8075.	2734.	451.02		
+									2703.44	17.75
	ROUTED TO									
+		4MID	24997.	17.83	20249.	8075.	2734.	451.02		
+									2604.96	17.75
	ROUTED TO									
+		4LOW	24973.	17.92	20234.	8075.	2734.	451.02		
+									2586.07	17.92
	HYDROGRAPH AT									
+		SUB04	1699.	14.00	720.	187.	62.	16.50		
	HYDROGRAPH AT									
+		SUB02	2254.	15.33	1429.	407.	136.	33.34		
	3 COMBINED AT									
+		CONC4	25911.	17.75	21225.	8666.	2932.	500.86		
	ROUTED TO									
+		1UP	25669.	19.33	21095.	8658.	2932.	500.86		

```
+                                                                                                     2300.34      19.33


         ROUTED TO
+                          1LOW     25473.   20.42      20855.       8645.       2932.     500.86
+                                                                                                     1979.57      20.42


         HYDROGRAPH AT
+                         SUB01      4083.   15.75       2837.        867.        290.      76.00


         2 COMBINED AT
+                         CONC5     26134.   20.33      21446.       9266.       3222.     576.86



 *** NORMAL END OF HEC-1 ***
```

Upper Watershed HEC-1 Model –Sub-Basins 6-10 (pre-fire)

```
1***************************************                                        **************************************
 *                                      *                                       *                                    *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                       *    U.S. ARMY CORPS OF ENGINEERS    *
 *               JUN   1998             *                                       *    HYDROLOGIC ENGINEERING CENTER   *
 *            VERSION 4.1               *                                       *          609 SECOND STREET         *
 *                                      *                                       *       DAVIS, CALIFORNIA 95616      *
 *  RUN DATE   20JUN07  TIME  07:52:46  *                                       *           (916) 756-1104           *
 *                                      *                                       *                                    *
 ***************************************                                        **************************************


                      X     X  XXXXXXX   XXXXX         X
                      X     X  X        X     X       XX
                      X     X  X        X              X
                      XXXXXXX  XXXX     X        XXXXX  X
                      X     X  X        X              X
                      X     X  X        X     X        X
                      X     X  XXXXXXX   XXXXX        XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
1                                                     HEC-1 INPUT                                                PAGE  1

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

             1          ID        Mohave County
             2          ID        BDNOAA14MID100 - Beaver Dam Hydrology NOAA 14 Mid100 w Routing Optimized
             3          ID        Basins 6-10
             4          ID        100 Year - Return Period
             5          ID        24 Hour Storm
             6          ID        Single Storm
             7          ID        Unit Hydrograph: Clark
             8          ID        11/11/2006
                        *DIAGRAM
             9          IT       5 31MAY05    0000    1500
            10          IO       5
                        *

            11          KK   SUB10BASIN
            12          KM    RUNOFF CALCULATION FOR SUBBASIN 10
            13          BA   76.58
            14          PH            575    0.67    1.26    2.10    2.31    2.40    2.75    3.27    4.05
            15          LG    0.15    0.36   5.102   0.288    11.4
            16          UC    6.07    2.79
                        *

            17          KK     9UPROUTE
            18          KM   ROUTE SUBBASIN 10 RUNOFF THROUGH REACH BASIN 9 - UPPER
            19          RS       8    FLOW       0       0
            20          RC   0.060   0.060   0.060   41282  0.0140
            21          RX       0      45      89      94     130     135     160     185
            22          RY    4160    4142    4125    4120    4120    4125    4142    4160
                        *

            23          KK    9LOWROUTE
            24          KM   ROUTE SUBBASIN 10 RUNOFF THROUGH REACH BASIN 9 - LOWER
            25          RS       5    FLOW       0       0
```

```
      26           RC   0.055   0.055   0.055   11913  0.0104
      27           RX       0     140     285     300     380     395    1020    1260
      28           RY    3600    3560    3559    3556    3556    3559    3560    3600
                   *

      29           KK   SUB09BASIN
      30           KM    RUNOFF CALCULATION FOR SUBBASIN 9
      31           BA   54.25
      32           PH             575    0.60    1.14    1.89    2.07    2.15    2.45    2.86    3.45
      33           LG    0.15   0.387    5.67    0.24      0.
      34           UC    3.80    1.62
                   *

      35           KK   SUB08BASIN
      36           KM    RUNOFF CALCULATION FOR SUBBASIN 8
      37           BA   55.69
      38           PH             575    0.66    1.24    2.06    2.25    2.35    2.70    3.22    3.94
      39           LG    0.15    0.35   3.984   0.478      0.
      40           UC    4.43    1.79
                   *
1                                                        HEC-1 INPUT                                          PAGE  2

    LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


      41           KK   CONC1COMBINE
      42           KM    COMBINE SUBBASINS 09 AND 08 WITH ROUTED 9LOW
      43           HC       3
                   *

      44           KK     6UPROUTE
      45           KM   ROUTE SUBBASIN 9+8 RUNOFF THROUGH REACH BASIN 6 - UPPER
      46           RS       7    FLOW       0
      47           RC   0.075   0.075   0.075   14202  0.0113
      48           RX       0     170     685     700     765     780     930    1130
      49           RY    3580    3540    3539    3536    3536    3539    3540    3580
```

```
                    *

          50        KK    6LOWROUTE
          51        KM   ROUTE SUBBASIN 9+8 RUNOFF THROUGH REACH BASIN 6 - LOWER
          52        RS       8    FLOW       0
          53        RC   0.045   0.045   0.045   21503  0.0102
          54        RX       0     160     885     900    1000    1015    1500    1760
          55        RY    3320    3280    3279    3276    3276    3279    3280    3320
                    *

          56        KK   SUB07BASIN
          57        KM    RUNOFF CALCULATION FOR SUBBASIN 7
          58        BA   60.32
          59        PH             575    0.59    1.11    1.85    2.01    2.07    2.39    2.74    3.24
          60        LG    0.15    0.35   4.849   0.284   14.71
          61        UC    3.89    1.48
                    *

          62        KK   SUB06BASIN
          63        KM    RUNOFF CALCULATION FOR SUBBASIN 6
          64        BA   41.51
          65        PH             575    0.59    1.11    1.85    2.01    2.07    2.38    2.74    3.26
          66        LG    0.15    0.38   5.475   0.229    2.55
          67        UC    3.99    1.83
                    *

          68        KK   CONC2COMBINE
          69        KM    COMBINE SUBBASINS 07 AND 06 WITH ROUTED 6LOW
          70        HC       3
                    *
          71        ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW
```

```
  NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW


   11       SUB10
                V
                V
   17         9UP
                V
                V
   23        9LOW
                .
                .
   29           .       SUB09
                .           .
                .           .
   35           .           .       SUB08
                .           .           .
                .           .           .
   41       CONC1........................
                V
                V
   44         6UP
                V
                V
   50        6LOW
                .
                .
   56           .       SUB07
                .           .
                .           .
   62           .           .       SUB06
                .           .           .
                .           .           .
   68       CONC2........................


 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ***************************************
```

```
*                                      *                                                   *                                     *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
*              JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
*           VERSION 4.1                *                                                   *         609 SECOND STREET           *
*                                      *                                                   *      DAVIS, CALIFORNIA 95616        *
*  RUN DATE   20JUN07  TIME  07:52:46  *                                                   *          (916) 756-1104             *
*                                      *                                                   *                                     *
****************************************                                                   ***************************************




                               Mohave County
                               BDNOAA14MID100 - Beaver Dam Hydrology NOAA 14 Mid100 w Routing Optimized
                               Basins 6-10
                               100 Year - Return Period
                               24 Hour Storm
                               Single Storm
                               Unit Hydrograph: Clark
                               11/11/2006

  10 IO          OUTPUT CONTROL VARIABLES
                       IPRNT          5  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN          5  MINUTES IN COMPUTATION INTERVAL
                       IDATE    31MAY 5  STARTING DATE
                       ITIME       0000  STARTING TIME
                          NQ       1500  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE     5JUN 5  ENDING DATE
                      NDTIME       0455  ENDING TIME
                      ICENT          19  CENTURY MARK
```

```
                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE  124.92 HOURS


          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT
1
                                                          RUNOFF SUMMARY
                                                  FLOW IN CUBIC FEET PER SECOND
                                               TIME IN HOURS,  AREA IN SQUARE MILES

                                         PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN     MAXIMUM     TIME OF
         OPERATION       STATION         FLOW     PEAK                                            AREA       STAGE     MAX STAGE
+                                                            6-HOUR     24-HOUR     72-HOUR


         HYDROGRAPH AT
+                          SUB10        6725.    16.83        5390.       2061.        699.      76.58


         ROUTED TO
+                            9UP        6701.    17.50        5371.       2058.        699.      76.58
+                                                                                                          4130.89       17.50


         ROUTED TO
+                           9LOW        6687.    17.92        5344.       2058.        699.      76.58
+                                                                                                          3560.73       17.92


         HYDROGRAPH AT
+                          SUB09        4877.    15.00        2881.        777.        259.      54.25


         HYDROGRAPH AT
+                          SUB08        3651.    15.50        2370.        662.        221.      55.69
```

```
          3 COMBINED AT
+                            CONC1     11695.   15.75       9397.       3496.       1178.     186.52

          ROUTED TO
+                              6UP     11586.   16.33       9368.       3496.       1178.     186.52
+                                                                                                         3542.16       16.33

          ROUTED TO
+                             6LOW     11518.   17.00       9262.       3495.       1178.     186.52
+                                                                                                         3280.75       17.00

          HYDROGRAPH AT
+                            SUB07      6826.   15.00       4258.       1355.        456.      60.32

          HYDROGRAPH AT
+                            SUB06      3611.   15.25       2269.        656.        219.      41.51

          3 COMBINED AT
+                            CONC2     17552.   16.58      13608.       5435.       1853.     288.35


 *** NORMAL END OF HEC-1 ***
```

Lower Watershed HEC-1 Model –Sub-Basins 1, 2, 4 & 5 (pre-fire)

```
1*****************************************                                                  ***************************************
 *                                       *                                                  *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                  *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                  *          609 SECOND STREET          *
 *                                       *                                                  *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   20JUN07  TIME  07:54:07   *                                                  *           (916) 756-1104            *
 *                                       *                                                  *                                     *
 *****************************************                                                  ***************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X       XXXXX   X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.

THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION

NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,

DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION

KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
1                                        HEC-1 INPUT                                       PAGE  1

      LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

         1          ID        Mohave County
         2          ID        BDNOAA14MID100 - Beaver Dam Hydrology NOAA 14 Mid100 w Routing Optimized
         3          ID        Basins 1, 2, 4 and 5
         4          ID        100 Year - Return Period
         5          ID        24 Hour Storm
         6          ID        Single Storm
         7          ID        Unit Hydrograph: Clark
         8          ID        04/22/07
                    *DIAGRAM
         9          IT       5 31MAY05    0000    1500
        10          IO       5
                    *

        11          KK   SUB05BASIN
        12          KM    RUNOFF CALCULATION FOR SUBBASIN 5
        13          BA   51.47
        14          PH             575    0.60    1.14    1.90    2.07    2.15    2.46    2.88    3.46
        15          LG    0.15    0.35   4.278   0.374      0.
        16          UC    3.81    1.57
                    *

        17          KK     4UPROUTE
        18          KM   ROUTE SUBBASIN 3+5 RUNOFF THROUGH REACH BASIN 4 - UPPER
        19          RS       4    FLOW       0       0
        20          RC   0.070   0.070   0.070    9425  0.0095
        21          RX       0      90     297     300     330     333     870     910
        22          RY    2720    2700    2697    2694    2694    2697    2700    2720
                    *

        23          KK    4MIDROUTE
        24          KM   ROUTE SUBBASIN 3+5 RUNOFF THROUGH REACH BASIN 4 - MIDDLE
```

```
         25           RS       1    FLOW       0       0

         26           RC   0.070   0.070   0.070    3665  0.0109

         27           RX       0      70     385     400     480     495     610     670

         28           RY    2620    2600    2599    2596    2596    2599    2600    2620

                      *


         29           KK    4LOWROUTE

         30           KM   ROUTE SUBBASIN 3+5 RUNOFF THROUGH REACH BASIN 4 - LOWER

         31           RS       1    FLOW       0       0

         32           RC   0.060   0.060   0.060    4442  0.0101

         33           RX       0     590     685     700     770     795     890     950

         34           RY    2600    2580    2579    2576    2576    2579    2580    2600

                      *


         35           KK   SUB04BASIN

         36           KM    RUNOFF CALCULATION FOR SUBBASIN 4

         37           BA   16.50

         38           PH             575    0.57    1.07    1.78    1.93    1.98    2.27    2.60    3.09

         39           LG    0.15    0.35   4.505   0.322    1.01

         40           UC    2.38    1.18

                      *
1                                      HEC-1 INPUT                                        PAGE  2


      LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10



         41           KK   SUB02BASIN

         42           KM    RUNOFF CALCULATION FOR SUBBASIN 2

         43           BA   33.34

         44           PH             575    0.60    1.13    1.89    2.05    2.12    2.41    2.81    3.40

         45           LG    0.15    0.35   4.394   0.343      0.

         46           UC    3.97    2.06

                      *


         47           KK   CONC4COMBINE

         48           KM    COMBINE SUBBASINS 04 AND 02 WITH ROUTED 4LOW
```

```
          49           HC       3
                       *


          50           KK     1UPROUTE
          51           KM   ROUTE SUBBASIN 2+4 RUNOFF THROUGH REACH BASIN 1 - UPPER
          52           RS      19    FLOW       0       0
          53           RC   0.052   0.052   0.052   49818  0.0099
          54           RX       0     190     285     300    1000    1015    1600    2050
          55           RY    2320    2300    2299    2296    2296    2299    2300    2320
                       *


          56           KK    1LOWROUTE
          57           KM   ROUTE SUBBASIN 2+4 RUNOFF THROUGH REACH BASIN 1 - LOWER
          58           RS      13    FLOW       0       0
          59           RC   0.058   0.058   0.058   29796  0.0079
          60           RX       0      90     485     500    1800    1815    2220    2400
          61           RY    2000    1980    1979    1976    1976    1979    1980    2000
                       *


          62           KK   SUB01BASIN
          63           KM    RUNOFF CALCULATION FOR SUBBASIN 1
          64           BA   76.00
          65           PH             575    0.55    1.04    1.73    1.88    1.93    2.22    2.53    3.00
          66           LG    0.15    0.35    4.47   0.331    2.73
          67           UC    4.80    2.00
                       *


          68           KK   CONC5COMBINE
          69           KM    COMBINE SUBBASIN 01 WITH ROUTED 1LOW
          70           KO       3                              21
          71           HC       2
          72           ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW
```

```
 NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW


  11       SUB05
               V
               V
  17         4UP
               V
               V
  23        4MID
               V
               V
  29        4LOW
               .
               .
  35           .       SUB04
               .           .
               .           .
  41           .           .       SUB02
               .           .           .
               .           .           .
  47       CONC4.......................
               V
               V
  50         1UP
               V
               V
  56        1LOW
               .
               .
  62           .       SUB01
               .           .
               .           .
  68       CONC5...........


(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

```
1*****************************************                              ***************************************
 *                                       *                              *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                              *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                              *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                              *          609 SECOND STREET          *
 *                                       *                              *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   20JUN07  TIME  07:54:07   *                              *           (916) 756-1104            *
 *                                       *                              *                                     *
 *****************************************                              ***************************************




                                 Mohave County
                                 BDNOAA14MID100 - Beaver Dam Hydrology NOAA 14 Mid100 w Routing Optimized
                                 Basins 1, 2, 4 and 5
                                 100 Year - Return Period
                                 24 Hour Storm
                                 Single Storm
                                 Unit Hydrograph: Clark
                                 04/22/07

   10 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           5  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN           5  MINUTES IN COMPUTATION INTERVAL
                        IDATE     31MAY 5  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ        1500  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      5JUN 5  ENDING DATE
                       NDTIME        0455  ENDING TIME
                       ICENT           19  CENTURY MARK
```

```
            COMPUTATION INTERVAL     .08 HOURS
                 TOTAL TIME BASE  124.92 HOURS

   ENGLISH UNITS
        DRAINAGE AREA         SQUARE MILES
        PRECIPITATION DEPTH   INCHES
        LENGTH, ELEVATION     FEET
        FLOW                  CUBIC FEET PER SECOND
        STORAGE VOLUME        ACRE-FEET
        SURFACE AREA          ACRES
        TEMPERATURE           DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** 


         **************
         *            *
 68 KK   *    CONC5   *    COMBINE
         *            *
         **************


 70 KO        OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE
                    IPNCH          0  PUNCH COMPUTED HYDROGRAPH
                     IOUT         21  SAVE HYDROGRAPH ON THIS UNIT
                    ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
                    ISAV2       1500  LAST ORDINATE PUNCHED OR SAVED
                   TIMINT       .083  TIME INTERVAL IN HOURS


 71 HC        HYDROGRAPH COMBINATION
```

ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

*** *** *** *** ***

HYDROGRAPH AT STATION CONC5

	PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
				6-HR	24-HR	72-HR	124.92-HR
+	(CFS)	(HR)					
			(CFS)				
+	5639.	20.00		4056.	2047.	686.	396.
			(INCHES)	.213	.429	.432	.432
			(AC-FT)	2011.	4059.	4083.	4083.

CUMULATIVE AREA = 177.31 SQ MI

1

RUNOFF SUMMARY

FLOW IN CUBIC FEET PER SECOND

TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+					6-HOUR	24-HOUR	72-HOUR			
	HYDROGRAPH AT									
+		SUB05	3777.	15.00	2216.	594.	198.	51.47		
	ROUTED TO									
+		4UP	3723.	15.58	2192.	594.	198.	51.47		
+									2699.69	15.58
	ROUTED TO									
+		4MID	3677.	15.83	2186.	594.	198.	51.47		

+									2600.46	15.83
	ROUTED TO									
+		4LOW	3636.	16.00	2177.	594.	198.	51.47		
+									2580.67	16.00
	HYDROGRAPH AT									
+		SUB04	1699.	14.00	720.	187.	62.	16.50		
	HYDROGRAPH AT									
+		SUB02	2254.	15.33	1429.	407.	136.	33.34		
	3 COMBINED AT									
+		CONC4	6266.	15.67	4178.	1188.	396.	101.31		
	ROUTED TO									
+		1UP	6014.	17.58	3895.	1188.	396.	101.31		
+									2297.86	17.58
	ROUTED TO									
+		1LOW	4842.	20.00	3631.	1187.	396.	101.31		
+									1977.32	20.00
	HYDROGRAPH AT									
+		SUB01	4083.	15.75	2837.	867.	290.	76.00		
	2 COMBINED AT									
+		CONC5	5639.	20.00	4056.	2047.	686.	177.31		

*** NORMAL END OF HEC-1 ***

Lower 2/3 Watershed HEC-1 Model –Sub-Basins 1 - 7 (pre-fire)

```
1***************************************                        ***************************************
 *                                      *                        *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                        *   U.S. ARMY CORPS OF ENGINEERS      *
 *               JUN   1998             *                        *   HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1               *                        *         609 SECOND STREET           *
 *                                      *                        *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   20JUN07  TIME  07:53:36  *                        *          (916) 756-1104             *
 *                                      *                        *                                     *
 ****************************************                        ***************************************


                                      X     X  XXXXXXX   XXXXX          X
                                      X     X  X        X     X        XX
                                      X     X  X        X               X
                                      XXXXXXX  XXXX     X        XXXXX  X
                                      X     X  X        X               X
                                      X     X  X        X     X         X
                                      X     X  XXXXXXX   XXXXX         XXX


            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
1                                    HEC-1 INPUT                                  PAGE  1

     LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

        1      ID       Mohave County
        2      ID       BDNOAA14MID100 - Beaver Dam Hydrology NOAA 14 Mid100 w Routing Optimized
        3      ID       Basins 1-7
        4      ID       100 Year - Return Period
        5      ID       24 Hour Storm
        6      ID       Single Storm
        7      ID       Unit Hydrograph: Clark
        8      ID       11/11/2006
               *DIAGRAM
        9      IT       5 31MAY05    0000    1500
       10      IO       5
               *

       11      KK   SUB07BASIN
       12      KM    RUNOFF CALCULATION FOR SUBBASIN 7
       13      BA   60.32
       14      PH            575    0.59    1.11    1.85    2.01    2.07    2.39    2.74    3.24
       15      LG    0.15    0.35   4.849   0.284   14.71
       16      UC    3.89    1.48
               *

       17      KK   SUB06BASIN
       18      KM    RUNOFF CALCULATION FOR SUBBASIN 6
       19      BA   41.51
       20      PH            575    0.59    1.11    1.85    2.01    2.07    2.38    2.74    3.26
       21      LG    0.15    0.38   5.475   0.229    2.55
       22      UC    3.99    1.83
               *

       23      KK   CONC2COMBINE
       24      KM    COMBINE SUBBASINS 07 AND 06
```

```
   25          HC       2
               *


   26          KK     5UPROUTE
   27          KM   ROUTE SUBBASIN 6+7 RUNOFF THROUGH REACH BASIN 5 - UPPER
   28          RS       7    FLOW       0       0
   29          RC   0.055   0.055   0.055   18610  0.0111
   30          RX       0     180     685     700     810     825     940    1190
   31          RY    3020    3000    2999    2996    2996    2999    3000    3020
               *


   32          KK    5MIDROUTE
   33          KM   ROUTE SUBBASIN 6+7 RUNOFF THROUGH REACH BASIN 5 - MIDDLE
   34          RS       2    FLOW       0       0
   35          RC   0.055   0.055   0.055    8769  0.0116
   36          RX       0     260     585     600     660     675     900     950
   37          RY    2880    2860    2859    2856    2856    2859    2860    2880
               *
1                                     HEC-1 INPUT                                       PAGE  2

         LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10



   38          KK    5LOWROUTE
   39          KM   ROUTE SUBBASIN 6+7 RUNOFF THROUGH REACH BASIN 5 - LOWER
   40          RS       3    FLOW       0       0
   41          RC   0.045   0.045   0.045    8049  0.0102
   42          RX       0     340     697     700     730     735    1190    1220
   43          RY    2820    2800    2797    2794    2794    2797    2800    2820
               *


   44          KK   SUB05BASIN
   45          KM    RUNOFF CALCULATION FOR SUBBASIN 5
   46          BA   51.47
   47          PH             575    0.60    1.14    1.90    2.07    2.15    2.46    2.88    3.46
   48          LG    0.15    0.35   4.278   0.374      0.
```

```
49          UC    3.81    1.57
            *

50          KK   SUB03BASIN
51          KM    RUNOFF CALCULATION FOR SUBBASIN 3
52          BA   111.2
53          PH             575    0.61    1.15    1.91    2.08    2.15    2.46    2.87    3.45
54          LG    0.15   0.375   6.495   0.168      0.
55          UC    6.97    3.13
            *

56          KK   CONC3COMBINE
57          KM    COMBINE SUBBASINS 05 AND 03 WITH ROUTED 5LOW
58          HC       3
            *

59          KK     4UPROUTE
60          KM   ROUTE SUBBASIN 3+5 RUNOFF THROUGH REACH BASIN 4 - UPPER
61          RS       4    FLOW       0       0
62          RC   0.070   0.070   0.070    9425  0.0095
63          RX       0      90     297     300     330     333     870     910
64          RY    2720    2700    2697    2694    2694    2697    2700    2720
            *

65          KK    4MIDROUTE
66          KM   ROUTE SUBBASIN 3+5 RUNOFF THROUGH REACH BASIN 4 - MIDDLE
67          RS       1    FLOW       0       0
68          RC   0.070   0.070   0.070    3665  0.0109
69          RX       0      70     385     400     480     495     610     670
70          RY    2620    2600    2599    2596    2596    2599    2600    2620
            *

71          KK    4LOWROUTE
72          KM   ROUTE SUBBASIN 3+5 RUNOFF THROUGH REACH BASIN 4 - LOWER
73          RS       1    FLOW       0       0
74          RC   0.060   0.060   0.060    4442  0.0101
```

```
           75           RX       0     590     685     700     770     795     890     950
           76           RY    2600    2580    2579    2576    2576    2579    2580    2600
                        *
1                                             HEC-1 INPUT                                          PAGE  3

         LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10



           77           KK   SUB04BASIN
           78           KM    RUNOFF CALCULATION FOR SUBBASIN 4
           79           BA   16.50
           80           PH             575    0.57    1.07    1.78    1.93    1.98    2.27    2.60    3.09
           81           LG    0.15    0.35   4.505   0.322    1.01
           82           UC    2.38    1.18
                        *

           83           KK   SUB02BASIN
           84           KM    RUNOFF CALCULATION FOR SUBBASIN 2
           85           BA   33.34
           86           PH             575    0.60    1.13    1.89    2.05    2.12    2.41    2.81    3.40
           87           LG    0.15    0.35   4.394   0.343      0.
           88           UC    3.97    2.06
                        *

           89           KK   CONC4COMBINE
           90           KM    COMBINE SUBBASINS 04 AND 02 WITH ROUTED 4LOW
           91           HC       3
                        *

           92           KK     1UPROUTE
           93           KM   ROUTE SUBBASIN 2+4 RUNOFF THROUGH REACH BASIN 1 - UPPER
           94           RS      19    FLOW       0       0
           95           RC   0.052   0.052   0.052   49818  0.0099
           96           RX       0     190     285     300    1000    1015    1600    2050
           97           RY    2320    2300    2299    2296    2296    2299    2300    2320
                        *
```

```
          98            KK    1LOWROUTE
          99            KM   ROUTE SUBBASIN 2+4 RUNOFF THROUGH REACH BASIN 1 - LOWER
         100            RS      13    FLOW       0       0
         101            RC   0.058   0.058   0.058   29796  0.0079
         102            RX       0      90     485     500    1800    1815    2220    2400
         103            RY    2000    1980    1979    1976    1976    1979    1980    2000
                        *

         104            KK   SUB01BASIN
         105            KM    RUNOFF CALCULATION FOR SUBBASIN 1
         106            BA   76.00
         107            PH             575    0.55    1.04    1.73    1.88    1.93    2.22    2.53    3.00
         108            LG    0.15    0.35    4.47   0.331    2.73
         109            UC    4.80    2.00
                        *

         110            KK   CONC5COMBINE
         111            KM    COMBINE SUBBASIN 01 WITH ROUTED 1LOW
         112            KO       3                             21
         113            HC       2
         114            ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    11       SUB07
                 .
                 .
    17           .       SUB06
                 .           .
                 .           .
    23       CONC2............
```

```
              V
              V
 26          5UP
              V
              V
 32         5MID
              V
              V
 38         5LOW
              .
              .
 44           .       SUB05
              .           .
              .           .
 50           .           .       SUB03
              .           .           .
              .           .           .
 56        CONC3.......................
              V
              V
 59          4UP
              V
              V
 65         4MID
              V
              V
 71         4LOW
              .
              .
 77           .       SUB04
              .           .
              .           .
 83           .           .       SUB02
              .           .           .
              .           .           .
 89        CONC4.......................
```

```
               V
               V
   92         1UP
               V
               V
   98        1LOW
               .
               .
  104          .       SUB01
               .           .
               .           .
  110       CONC5............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                      ***************************************
 *                                        *                                                     *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                                                     *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998               *                                                     *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                 *                                                     *          609 SECOND STREET          *
 *                                        *                                                     *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   20JUN07  TIME  07:53:36    *                                                     *           (916) 756-1104            *
 *                                        *                                                     *                                     *
 *****************************************                                                      ***************************************



                                       Mohave County
                                       BDNOAA14MID100 - Beaver Dam Hydrology NOAA 14 Mid100 w Routing Optimized
                                       Basins 1-7
                                       100 Year - Return Period
                                       24 Hour Storm
                                       Single Storm
                                       Unit Hydrograph: Clark
                                       11/11/2006
```

```
  10 IO         OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT         HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE    31MAY 5  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ       1500  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE     5JUN 5  ENDING DATE
                     NDTIME       0455  ENDING TIME
                     ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE  124.92 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT

*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** 

            **************
            *            *
 110 KK     *    CONC5   *     COMBINE
            *            *
```

```
          **************


 112 KO          OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE
                       IPNCH           0  PUNCH COMPUTED HYDROGRAPH
                        IOUT          21  SAVE HYDROGRAPH ON THIS UNIT
                       ISAV1           1  FIRST ORDINATE PUNCHED OR SAVED
                       ISAV2        1500  LAST ORDINATE PUNCHED OR SAVED
                      TIMINT        .083  TIME INTERVAL IN HOURS



 113 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                   ***

     ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION    CONC5

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    124.92-HR
+   (CFS)       (HR)
                          (CFS)
+   20792.     19.42               15064.       6031.       2044.        1178.
                       (INCHES)      .359        .575        .584         .584
                        (AC-FT)     7470.      11962.      12161.       12161.

                        CUMULATIVE AREA =  390.34 SQ MI

1
                                                      RUNOFF SUMMARY
                                               FLOW IN CUBIC FEET PER SECOND
                                            TIME IN HOURS,  AREA IN SQUARE MILES
```

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
	HYDROGRAPH AT									
+		SUB07	6826.	15.00	4258.	1355.	456.	60.32		
	HYDROGRAPH AT									
+		SUB06	3611.	15.25	2269.	656.	219.	41.51		
	2 COMBINED AT									
+		CONC2	10420.	15.08	6521.	2011.	675.	101.83		
	ROUTED TO									
+		5UP	10330.	15.67	6474.	2010.	675.	101.83		
+									3001.24	15.67
	ROUTED TO									
+		5MID	10238.	16.00	6436.	2009.	675.	101.83		
+									2861.68	16.00
	ROUTED TO									
+		5LOW	10168.	16.33	6413.	2009.	675.	101.83		
+									2800.26	16.25
	HYDROGRAPH AT									
+		SUB05	3777.	15.00	2216.	594.	198.	51.47		
	HYDROGRAPH AT									
+		SUB03	6881.	17.58	5672.	2048.	683.	111.20		
	3 COMBINED AT									
+		CONC3	18929.	16.17	13838.	4642.	1555.	264.50		
	ROUTED TO									

+		4UP	18871.	16.50	13792.	4642.	1555.	264.50		
+									2702.61	16.50
	ROUTED TO									
+		4MID	18845.	16.58	13776.	4642.	1555.	264.50		
+									2603.97	16.58
	ROUTED TO									
+		4LOW	18805.	16.67	13758.	4641.	1555.	264.50		
+									2584.95	16.67
	HYDROGRAPH AT									
+		SUB04	1699.	14.00	720.	187.	62.	16.50		
	HYDROGRAPH AT									
+		SUB02	2254.	15.33	1429.	407.	136.	33.34		
	3 COMBINED AT									
+		CONC4	20574.	16.58	15124.	5234.	1753.	314.34		
	ROUTED TO									
+		1UP	20081.	18.25	14950.	5231.	1753.	314.34		
+									2299.88	18.25
	ROUTED TO									
+		1LOW	19763.	19.50	14445.	5229.	1753.	314.34		
+									1979.05	19.50
	HYDROGRAPH AT									
+		SUB01	4083.	15.75	2837.	867.	290.	76.00		
	2 COMBINED AT									
+		CONC5	20792.	19.42	15064.	6031.	2044.	390.34		

```
*** NORMAL END OF HEC-1 ***
```

Appendix D HEC-RAS Hydraulic Modeling Results

```
HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California
```

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X         X
X     X  X        X    X       X   X    X    X         X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

```
PROJECT DATA
Project Title: Beaver Dam Wash Bridge
Project File : BEAVER_RMS_NEW_CS.prj
Run Date and Time: 1/28/2007 11:23:21 AM

Project in English units

Project Description:
Beaver Dam Wash bridge hydraulic study.
```

```
PLAN DATA

Plan Title: Plan 32
Plan File : d:\P\Mohave County\Beaver Dam Wash\Models\HEC-RAS\BEAVER_RMS_NEW_CS.p32

           Geometry Title: 400 Bridge W Chl Exc
           Geometry File : d:\P\Mohave County\Beaver Dam Wash\Models\HEC-
RAS\BEAVER_RMS_NEW_CS.g02

           Flow Title    : 100-year flow
           Flow File     : d:\P\Mohave County\Beaver Dam Wash\Models\HEC-
RAS\BEAVER_RMS_NEW_CS.F01

Plan Summary Information:
Number of:  Cross Sections =   26    Multiple Openings  =    0
            Culverts       =    0    Inline Structures  =    0
            Bridges        =    1    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow
```

FLOW DATA

Flow Title: 100-year flow

Flow File : d:\P\Mohave County\Beaver Dam Wash\Models\HEC-RAS\BEAVER_RMS_NEW_CS.F01

Flow Data (cfs)

River	Reach	RS	100 yr	25 yr
Reach #1	Beaver Dam Wash	25	21000	11990

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Reach #1	Beaver Dam Wash	100 yr	Normal S = 0.01	Normal S = 0.01

GEOMETRY DATA

Geometry Title: 400 Bridge W Chl Exc

Geometry File : d:\P\Mohave County\Beaver Dam Wash\Models\HEC-RAS\BEAVER_RMS_NEW_CS.g02

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash   RS: 25

```
INPUT
Description:
Station Elevation Data    num=      28
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
3526.439 1913.07 3653.98 1887.39 3661.93 1886.96 3668.47 1888.17 3675.65 1887.72
 3703.49 1878.223966.769  1878.6 3978.67 1877.05 3988.47 1876.78 4003.57 1872.89
 4059.68 1873.41 4082.28 1869.92 4187.91 1869.89 4195.77 1871.42 4278.78 1871.27
4284.089 1872.95 4386.81  1872.4 4393.16    18714430.209 1871.11 4546.93 1870.99
4575.291 1883.38 4697.14 1883.71 4838.25 1883.72 5047.45  1883.65243.009 1883.29
 5474.28 1884.61 5495.39 1893.78 5553.17 1894.85

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
3526.439     .073966.769     .034575.291     .05

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
      3966.7694575.291           481.74  506.65  552.44             .1       .3

CROSS SECTION OUTPUT  Profile #100 yr

  E.G. Elev (ft)          1876.86    Element                   Left OB    Channel   Right OB
  Vel Head (ft)              1.36    Wt. n-Val.                             0.030
  W.S. Elev (ft)          1875.49    Reach Len. (ft)           481.74      506.65     552.44
  Crit W.S. (ft)          1875.01    Flow Area (sq ft)                    2241.36
  E.G. Slope (ft/ft)     0.005710    Area (sq ft)                         2241.36
  Q Total (cfs)          21000.00    Flow (cfs)                          21000.00
  Top Width (ft)           563.77    Top Width (ft)                        563.77
  Vel Total (ft/s)           9.37    Avg. Vel. (ft/s)                        9.37
  Max Chl Dpth (ft)          5.60    Hydr. Depth (ft)                        3.98
  Conv. Total (cfs)      277916.0    Conv. (cfs)                         277916.0
  Length Wtd. (ft)         506.65    Wetted Per. (ft)                      565.87
  Min Ch El (ft)          1869.89    Shear (lb/sq ft)                        1.41
  Alpha                      1.00    Stream Power (lb/ft s)                 13.23
```

Frctn Loss (ft)	3.60	Cum Volume (acre-ft)	30.32	393.98	37.37
C & E Loss (ft)	0.02	Cum SA (acres)	16.72	90.75	22.87

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1875.24	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.85	Wt. n-Val.		0.030	
W.S. Elev (ft)	1874.38	Reach Len. (ft)	481.74	506.65	552.44
Crit W.S. (ft)	1873.90	Flow Area (sq ft)		1620.20	
E.G. Slope (ft/ft)	0.005398	Area (sq ft)		1620.20	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	556.93	Top Width (ft)		556.93	
Vel Total (ft/s)	7.40	Avg. Vel. (ft/s)		7.40	
Max Chl Dpth (ft)	4.49	Hydr. Depth (ft)		2.91	
Conv. Total (cfs)	163200.9	Conv. (cfs)		163200.9	
Length Wtd. (ft)	506.65	Wetted Per. (ft)		558.66	
Min Ch El (ft)	1869.89	Shear (lb/sq ft)		0.98	
Alpha	1.00	Stream Power (lb/ft s)		7.23	
Frctn Loss (ft)	3.42	Cum Volume (acre-ft)	9.97	272.83	12.26
C & E Loss (ft)	0.01	Cum SA (acres)	8.47	88.08	13.76

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 24

INPUT

Description:

Station Elevation Data num= 94

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1908	7.18	1906	15.48	1904	24.13	1902	33.37	1900
43.88	1898	46.27	1896	48.45	1894	51.26	1892	54.54	1890
67.49	1890	96.01	1890	183.89	1888	186.74	1886	189.54	1884
192.78	1882	201.4	1879.59	203.22	1880	493.14	1880	503.49	1880
622.96	1878.03	627.6	1878	641.69	1876	645.59	1874	657.9	1872
669.31	1870	706	1870	718.27	1870	722.23	1868	847.16	1868
890.02	1868	893.25	1868	926.69	1868	1003.9	1868	1024.94	1868
1050.1	1868	1053.37	1870	1074.5	1870	1256.28	1868	1265.44	1868
1348.69	1870	1349.92	1872	1353.44	1880	1363.04	1880.44	1499.17	1880.64
1637.4	1880	1641.8	1880	1663.86	1880	1789.74	1880	1813.02	1879.78
1827.06	1880	1834.72	1880.15	2041.02	1884	2047.24	1884.58	2065.9	1885.02
2070.5	1886	2073.79	1888	2076.94	1890	2096.88	1892	2137.73	1894
2181.15	1896	2185.3	1898	2186.83	1900	2188.68	1902	2198.04	1904
2202.73	1906	2203.42	1908	2209.34	1910	2216.5	1912.87	2232.27	1913.01
2257	1913.76	2261.18	1914	2266.13	1916	2269.6	1918	2273.02	1920
2275.73	1922	2277.3	1924	2278.19	1926	2279.11	1928	2279.97	1930
2280.68	1932	2281.17	1934	2283.68	1936	2286.31	1938	2289.29	1940
2292.46	1942	2295.54	1944	2298.69	1946	2301.81	1948	2304.96	1950
2308.06	1952	2311.21	1954	2314.21	1956	2317.37	1958		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	627.6	.03	1353.44	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
627.6	1353.44	431.03	464.84	465.88	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1873.24	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.53	Wt. n-Val.		0.030	
W.S. Elev (ft)	1871.70	Reach Len. (ft)	431.03	464.84	465.88
Crit W.S. (ft)	1871.70	Flow Area (sq ft)		2113.48	
E.G. Slope (ft/ft)	0.009088	Area (sq ft)		2113.48	
Q Total (cfs)	21000.00	Flow (cfs)		21000.00	
Top Width (ft)	690.15	Top Width (ft)		690.15	
Vel Total (ft/s)	9.94	Avg. Vel. (ft/s)		9.94	
Max Chl Dpth (ft)	3.70	Hydr. Depth (ft)		3.06	
Conv. Total (cfs)	220291.0	Conv. (cfs)		220291.0	
Length Wtd. (ft)	464.84	Wetted Per. (ft)		692.33	
Min Ch El (ft)	1868.00	Shear (lb/sq ft)		1.73	
Alpha	1.00	Stream Power (lb/ft s)		17.21	
Frctn Loss (ft)	3.05	Cum Volume (acre-ft)	30.32	368.66	37.37
C & E Loss (ft)	0.12	Cum SA (acres)	16.72	83.46	22.87

Warning: The energy equation could not be balanced within the specified number of iterations. The program selected the water surface that had the least amount of error between computed and assumed values.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1871.81	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.96	Wt. n-Val.		0.030	
W.S. Elev (ft)	1870.85	Reach Len. (ft)	431.03	464.84	465.88
Crit W.S. (ft)	1870.73	Flow Area (sq ft)		1526.90	
E.G. Slope (ft/ft)	0.008655	Area (sq ft)		1526.90	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	684.76	Top Width (ft)		684.76	
Vel Total (ft/s)	7.85	Avg. Vel. (ft/s)		7.85	
Max Chl Dpth (ft)	2.85	Hydr. Depth (ft)		2.23	
Conv. Total (cfs)	128877.7	Conv. (cfs)		128877.7	
Length Wtd. (ft)	464.84	Wetted Per. (ft)		686.38	
Min Ch El (ft)	1868.00	Shear (lb/sq ft)		1.20	
Alpha	1.00	Stream Power (lb/ft s)		9.44	
Frctn Loss (ft)	3.96	Cum Volume (acre-ft)	9.97	254.53	12.26
C & E Loss (ft)	0.00	Cum SA (acres)	8.47	80.86	13.76

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash   RS: 23

INPUT

Description:

Station Elevation Data   num=   80

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1894	2.42	1894	17.23	1893.91	78.42	1892	81.58	1890
84.73	1888	87.9	1886	91.03	1884	95.67	1882	105.02	1880
111.37	1878	113.57	1877.26	575.08	1876	591.68	1874	609	1872

631.02	1870	639.59	1869.52	761.39	1868	773.9	1866	789.88	1864
901.22	1864	937.75	1864	996.41	1864	1034.55	1864	1038.86	1864
1071.35	1864	1100.5	1864	1120.03	1864	1122.04	1864	1402.73	1866
1404.4	1868	1405.82	1870	1407.53	1872	1409.27	1874	1410.84	1876
1581.86	1877.39	1602.52	1877.29	1669.05	1876.76	1680.92	1877.13	1981.86	1878
1989.84	1880	1992.29	1880.7	2015.44	1881.92	2022.37	1884	2028.54	1886
2033.92	1887.87	2037.75	1888	2044.1	1888.79	2046.32	1890	2050.86	1892
2055.08	1894	2059.12	1896	2059.98	1896	2081.79	1896	2085.55	1898
2089.09	1900	2092.41	1902	2095.85	1904	2098.81	1906	2101.42	1908
2104.19	1910	2107.25	1912	2110.31	1914	2113.79	1916	2117.41	1918
2121.08	1920	2124.18	1922	2127.41	1924	2130.59	1926	2133.94	1928
2137.26	1930	2140.67	1932	2144.03	1934	2147.35	1936	2150.73	1938
2154.09	1940	2157.47	1942	2160.67	1944	2163.86	1946	2167.39	1948

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	761.39	.03	1410.84	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
761.39	1410.84	393.03	393.38	464.14	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1869.49	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.13	Wt. n-Val.	0.070	0.030	
W.S. Elev (ft)	1868.36	Reach Len. (ft)	393.03	393.38	464.14
Crit W.S. (ft)		Flow Area (sq ft)	5.09	2462.07	
E.G. Slope (ft/ft)	0.004966	Area (sq ft)	5.09	2462.07	
Q Total (cfs)	21000.00	Flow (cfs)	2.41	20997.59	
Top Width (ft)	671.83	Top Width (ft)	28.56	643.26	
Vel Total (ft/s)	8.51	Avg. Vel. (ft/s)	0.47	8.53	
Max Chl Dpth (ft)	4.36	Hydr. Depth (ft)	0.18	3.83	
Conv. Total (cfs)	297988.1	Conv. (cfs)	34.2	297953.8	

Length Wtd. (ft)	393.38	Wetted Per. (ft)	28.56	644.67	
Min Ch El (ft)	1864.00	Shear (lb/sq ft)	0.06	1.18	
Alpha	1.00	Stream Power (lb/ft s)	0.03	10.10	
Frctn Loss (ft)	1.43	Cum Volume (acre-ft)	30.29	344.24	37.37
C & E Loss (ft)	0.01	Cum SA (acres)	16.58	76.35	22.87

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #25 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1867.84	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.00	Wt. n-Val.		0.030	
W.S. Elev (ft)	1866.84	Reach Len. (ft)	393.03	393.38	464.14
Crit W.S. (ft)	1866.71	Flow Area (sq ft)		1494.32	
E.G. Slope (ft/ft)	0.008391	Area (sq ft)		1494.32	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	634.81	Top Width (ft)		634.81	
Vel Total (ft/s)	8.02	Avg. Vel. (ft/s)		8.02	
Max Chl Dpth (ft)	2.84	Hydr. Depth (ft)		2.35	
Conv. Total (cfs)	130891.6	Conv. (cfs)		130891.6	
Length Wtd. (ft)	393.38	Wetted Per. (ft)		635.41	
Min Ch El (ft)	1864.00	Shear (lb/sq ft)		1.23	
Alpha	1.00	Stream Power (lb/ft s)		9.88	
Frctn Loss (ft)	1.83	Cum Volume (acre-ft)	9.97	238.41	12.26
C & E Loss (ft)	0.08	Cum SA (acres)	8.47	73.82	13.76

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 22

INPUT

Description:

Station Elevation Data num= 83

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1900	9.94	1898	13.19	1896	16.33	1894	19.58	1892
22.66	1890	25.88	1888	29.5	1886	34.53	1884	39.41	1882
41.17	1880	43.2	1878	49.45	1876	69.47	1874.18	554.92	1874
587.36	1872	605.51	1870	629.3	1868	634.24	1866.77	658.22	1868
725.18	1868	731.16	1866	737.29	1864	744.49	1862	862.43	1860
887.4	1860	968.95	1860	989.67	1860	1060.81	1862	1085.23	1862
1110.08	1862	1164.2	1864	1166.63	1866	1169.43	1868	1172.93	1870
1174.65	1872	1237.08	1872	1253.37	1871.77	1260.86	1871.85	1267.21	1872
1457.13	1874	1585.26	1875.21	1609.1	1875.45	1629.52	1875.67	1637.24	1875.46
1735.38	1884.62	1750.14	1884.49	1775.16	1876	1776.04	1875.98	1795.28	1878
1801.7	1878.73	1805.04	1880	1811.05	1884	1813.99	1886	1817.11	1888
1820.5	1890	1848.83	1891.65	1866.17	1891.56	1877.63	1892	1889.09	1894
1892.39	1896	1895.69	1898	1899.19	1900	1902.86	1902	1906.62	1904
1910.54	1906	1914.41	1908	1915.65	1910	1916.95	1912	1918.63	1914
1923.84	1916	1929.01	1918	1933.67	1920	1936.96	1922	1941.19	1924
1944.17	1926	1947.26	1928	1950.12	1930	1953.03	1932	1956.09	1934
1959.12	1936	1961.63	1938	1964.04	1940				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	725.18	.03	1174.65	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
725.18	1174.65	388.99	396.75	377.61	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1868.04	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.08	Wt. n-Val.	0.070	0.030	
W.S. Elev (ft)	1866.96	Reach Len. (ft)	388.99	396.75	377.61
Crit W.S. (ft)		Flow Area (sq ft)	0.40	2516.51	
E.G. Slope (ft/ft)	0.002788	Area (sq ft)	0.40	2516.51	
Q Total (cfs)	21000.00	Flow (cfs)	0.09	20999.91	
Top Width (ft)	444.02	Top Width (ft)	4.36	439.66	
Vel Total (ft/s)	8.34	Avg. Vel. (ft/s)	0.23	8.34	
Max Chl Dpth (ft)	6.96	Hydr. Depth (ft)	0.09	5.72	
Conv. Total (cfs)	397718.9	Conv. (cfs)	1.8	397717.2	
Length Wtd. (ft)	396.75	Wetted Per. (ft)	4.39	441.52	
Min Ch El (ft)	1860.00	Shear (lb/sq ft)	0.02	0.99	
Alpha	1.00	Stream Power (lb/ft s)	0.00	8.28	
Frctn Loss (ft)	1.73	Cum Volume (acre-ft)	30.27	321.76	37.37
C & E Loss (ft)	0.12	Cum SA (acres)	16.43	71.46	22.87

Warning: Divided flow computed for this cross-section.

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1865.93	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.73	Wt. n-Val.		0.030	
W.S. Elev (ft)	1865.21	Reach Len. (ft)	388.99	396.75	377.61
Crit W.S. (ft)		Flow Area (sq ft)		1753.58	
E.G. Slope (ft/ft)	0.002952	Area (sq ft)		1753.58	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	432.07	Top Width (ft)		432.07	
Vel Total (ft/s)	6.84	Avg. Vel. (ft/s)		6.84	
Max Chl Dpth (ft)	5.20	Hydr. Depth (ft)		4.06	
Conv. Total (cfs)	220660.9	Conv. (cfs)		220660.9	
Length Wtd. (ft)	396.75	Wetted Per. (ft)		433.05	
Min Ch El (ft)	1860.00	Shear (lb/sq ft)		0.75	
Alpha	1.00	Stream Power (lb/ft s)		5.10	
Frctn Loss (ft)	1.84	Cum Volume (acre-ft)	9.97	223.74	12.26
C & E Loss (ft)	0.08	Cum SA (acres)	8.47	69.01	13.76

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for

additional cross sections.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than

0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 21

INPUT

Description:

Station Elevation Data num= 80

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1896	8.6	1894	12.22	1892	15.79	1890	24.67	1888
30.6	1886	36.19	1884	40.96	1882	45.89	1880	50.48	1878
54.72	1876	65.06	1874	73.83	1872.12	83.55	1872	334.26	1872
689.28	1872	708.78	1870	727.34	1868	743.79	1866	751.31	1865.16
786.93	1864	795.74	1862	801.41	1860	866.85	1858	1036.77	1858
1040.25	1860	1062.79	1860	1066.21	1860	1155.82	1862	1162.52	1864
1169.44	1866	1194.51	1868	1259.58	1870	1284.2	1872	1311.39	1872
1315.4	1871.9	1321.84	1871.91	1326.24	1872	1378.94	1872.07	1390.22	1872.18
1618.97	1874	1625.87	1874.9	1651.4	1875.27	1668.85	1876	1679.49	1882.07
1711.43	1882.22	1721.19	1885.02	1746.23	1883.92	1749.85	1884	1761.94	1886
1764.18	1888	1766.36	1890	1773.74	1890	1775.78	1890	1782.56	1892
1784.87	1894	1787.25	1896	1789.42	1898	1799.44	1900	1802.04	1902
1804.48	1904	1807.01	1906	1809.36	1908	1812.09	1910	1815.94	1912
1819.15	1914	1822.56	1916	1826.08	1918	1829.66	1920	1833.17	1922
1836.71	1924	1840.25	1926	1843.8	1928	1847.38	1930	1850.67	1932
1853.94	1934	1857.51	1936	1861	1938	1864.34	1940	1867.62	1942

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	786.93	.03	1169.44	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
786.93	1169.44	369.36	389.17	399.71	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1866.18	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.28	Wt. n-Val.		0.030	
W.S. Elev (ft)	1863.90	Reach Len. (ft)	369.36	389.17	399.71
Crit W.S. (ft)	1863.86	Flow Area (sq ft)		1733.40	
E.G. Slope (ft/ft)	0.007805	Area (sq ft)		1733.40	

Q Total (cfs)	21000.00	Flow (cfs)		21000.00	
Top Width (ft)	374.85	Top Width (ft)		374.85	
Vel Total (ft/s)	12.11	Avg. Vel. (ft/s)		12.11	
Max Chl Dpth (ft)	5.90	Hydr. Depth (ft)		4.62	
Conv. Total (cfs)	237706.0	Conv. (cfs)		237706.0	
Length Wtd. (ft)	389.17	Wetted Per. (ft)		376.27	
Min Ch El (ft)	1858.00	Shear (lb/sq ft)		2.24	
Alpha	1.00	Stream Power (lb/ft s)		27.19	
Frctn Loss (ft)	2.26	Cum Volume (acre-ft)	30.26	302.41	37.37
C & E Loss (ft)	0.17	Cum SA (acres)	16.42	67.75	22.87

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for

additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1864.01	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.55	Wt. n-Val.		0.030	
W.S. Elev (ft)	1862.46	Reach Len. (ft)	369.36	389.17	399.71
Crit W.S. (ft)	1862.39	Flow Area (sq ft)		1200.48	
E.G. Slope (ft/ft)	0.008304	Area (sq ft)		1200.48	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	363.66	Top Width (ft)		363.66	
Vel Total (ft/s)	9.99	Avg. Vel. (ft/s)		9.99	
Max Chl Dpth (ft)	4.46	Hydr. Depth (ft)		3.30	
Conv. Total (cfs)	131575.1	Conv. (cfs)		131575.1	
Length Wtd. (ft)	389.17	Wetted Per. (ft)		364.70	
Min Ch El (ft)	1858.00	Shear (lb/sq ft)		1.71	
Alpha	1.00	Stream Power (lb/ft s)		17.04	

Frctn Loss (ft)	2.50	Cum Volume (acre-ft)	9.97	210.29	12.26
C & E Loss (ft)	0.10	Cum SA (acres)	8.47	65.38	13.76

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 20

INPUT

Description:

Station Elevation Data num= 95

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1890	11	1888	16.97	1886	22.29	1884	25.93	1882
29.76	1880	33.96	1878	38.59	1876	44.5	1874	51.18	1872
58.79	1870.14	62.33	1870	191.84	1868	212.47	1866	236.96	1864
329.85	1864	355.72	1864	453.09	1864	696.84	1866	747.1	1867
748.12	1867.4	748.77	1867	750.44	1866	751.37	1866	753.01	1867
753.65	1867.4	789.17	1867	796.41	1866	813.52	1865	819.83	1864
824.58	1863	825.59	1862	826.58	1861	827.64	1860	828.64	1859
833.44	1858	834.8	1857	836.1	1856	942.93	1855	950.31	1855
975.21	1856	983.94	1856	985.4	1856	1022.32	1856	1037.63	1855
1070.72	1855	1083.81	1856	1086.65	1857	1131.49	1858	1154.72	1859
1169.28	1860	1174.53	1861	1178.77	1862	1184.4	1863	1190.16	1864
1198.92	1865	1199.59	1866	1200.37	1867	1201.23	1868	1202.19	1869
1203.21	1870	1218.75	1870.95	1225.78	1871.01	1641.53	1872	1651.32	1874
1657.31	1874.63	1683.12	1875.12	1692.73	1876	1695.53	1878	1697.5	1880
1699.49	1882	1701.48	1884	1703.49	1886	1705.42	1888	1707.42	1890
1707.46	1890	1731.4	1890.57	1745.65	1890.35	1751.96	1892	1752.55	1894

1752.9	1896	1753.59	1898	1753.85	1900	1754.35	1902	1754.83	1904
1755.25	1906	1755.77	1908	1761.27	1910	1767.82	1912	1772.27	1914
1775.59	1916	1778.91	1918	1782.22	1920	1785.62	1922	1788.93	1924

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	813.52	.03	1203.21	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
813.52	1203.21	250.91	250.89	254.9	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1863.75	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.71	Wt. n-Val.		0.030	
W.S. Elev (ft)	1862.04	Reach Len. (ft)	250.91	250.89	254.90
Crit W.S. (ft)		Flow Area (sq ft)		1999.75	
E.G. Slope (ft/ft)	0.004502	Area (sq ft)		1999.75	
Q Total (cfs)	21000.00	Flow (cfs)		21000.00	
Top Width (ft)	353.43	Top Width (ft)		353.43	
Vel Total (ft/s)	10.50	Avg. Vel. (ft/s)		10.50	
Max Chl Dpth (ft)	7.04	Hydr. Depth (ft)		5.66	
Conv. Total (cfs)	312996.9	Conv. (cfs)		312996.9	
Length Wtd. (ft)	250.89	Wetted Per. (ft)		355.99	
Min Ch El (ft)	1855.00	Shear (lb/sq ft)		1.58	
Alpha	1.00	Stream Power (lb/ft s)		16.58	
Frctn Loss (ft)	1.42	Cum Volume (acre-ft)	30.26	285.73	37.37
C & E Loss (ft)	0.09	Cum SA (acres)	16.42	64.49	22.87

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for
additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1861.40	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.22	Wt. n-Val.		0.030	
W.S. Elev (ft)	1860.19	Reach Len. (ft)	250.91	250.89	254.90
Crit W.S. (ft)		Flow Area (sq ft)		1355.36	
E.G. Slope (ft/ft)	0.005135	Area (sq ft)		1355.36	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	342.82	Top Width (ft)		342.82	
Vel Total (ft/s)	8.85	Avg. Vel. (ft/s)		8.85	
Max Chl Dpth (ft)	5.19	Hydr. Depth (ft)		3.95	
Conv. Total (cfs)	167324.7	Conv. (cfs)		167324.7	
Length Wtd. (ft)	250.89	Wetted Per. (ft)		344.43	
Min Ch El (ft)	1855.00	Shear (lb/sq ft)		1.26	
Alpha	1.00	Stream Power (lb/ft s)		11.16	
Frctn Loss (ft)	1.63	Cum Volume (acre-ft)	9.97	198.87	12.26
C & E Loss (ft)	0.07	Cum SA (acres)	8.47	62.23	13.76

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 19.5

INPUT

Description:

Station Elevation Data num= 91

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1886	8.75	1884	14.62	1882	20.5	1880	51.01	1878
56.44	1876	60.57	1874	64.63	1872	69.38	1870	73.31	1868
82.14	1866	89.52	1865.14	116.14	1864	472.56	1864	763.39	1866
765.97	1867	766.45	1867.18	766.71	1867	768.01	1866	770.15	1866
771.82	1866.99	774.73	1866	784.09	1866	830.48	1866	861.3	1865
880.71	1864	886.32	1863	889.08	1862	890.37	1861	891.68	1860
893.06	1859	894.29	1858	895.67	1857	897.13	1856	898.51	1855
912.11	1854	969.22	1854	1051.28	1854	1086.97	1854	1125.87	1854
1145.4	1853	1167.26	1853	1168.44	1854	1169.69	1855	1174.62	1856
1181.53	1857	1184.11	1858	1186.77	1859	1211.91	1859	1215.3	1859
1225.54	1860	1235.17	1861	1242.42	1862	1249.08	1863	1251.55	1864
1254.01	1865	1256.59	1866	1259.09	1867	1261.63	1868	1264.07	1869
1272.45	1870	1282.6	1870	1321.18	1869.79	1327.68	1869.69	1740.7	1870
1745.73	1872	1760.11	1873.21	1785.42	1872.75	1791.69	1874	1794.71	1876
1797.68	1878	1800.64	1880	1803.64	1882	1806.66	1884	1812.58	1884
1816.54	1883.88	1820.2	1884	1825.07	1884.16	1828.03	1886	1831	1888
1833.8	1890	1836.53	1892	1839.4	1894	1842.35	1896	1850.89	1896
1852.2	1895.69	1859.62	1896	1860.12	1895.89	1867.13	1898	1868.34	1900
1869.13	1902								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	880.71	.03	1186.77	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
880.71	1186.77	122.77	122.37	121.5	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1862.24	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.64	Wt. n-Val.		0.030	0.050
W.S. Elev (ft)	1859.59	Reach Len. (ft)	122.77	122.37	121.50
Crit W.S. (ft)	1859.59	Flow Area (sq ft)		1605.72	18.69
E.G. Slope (ft/ft)	0.007337	Area (sq ft)		1605.72	18.69
Q Total (cfs)	21000.00	Flow (cfs)		20968.47	31.53
Top Width (ft)	329.12	Top Width (ft)		294.53	34.59
Vel Total (ft/s)	12.93	Avg. Vel. (ft/s)		13.06	1.69
Max Chl Dpth (ft)	6.59	Hydr. Depth (ft)		5.45	0.54
Conv. Total (cfs)	245165.2	Conv. (cfs)		244797.1	368.1
Length Wtd. (ft)	122.37	Wetted Per. (ft)		297.35	34.62
Min Ch El (ft)	1853.00	Shear (lb/sq ft)		2.47	0.25
Alpha	1.02	Stream Power (lb/ft s)		32.30	0.42
Frctn Loss (ft)	0.92	Cum Volume (acre-ft)	30.26	275.35	37.32
C & E Loss (ft)	0.05	Cum SA (acres)	16.42	62.63	22.77

Warning: The energy equation could not be balanced within the specified number of iterations. The
program selected the water surface that had the least amount of error between computed and
assumed values.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical
depth, the calculated water surface came back below critical depth. This indicates that there
is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1859.71	Element	Left OB	Channel	Right OB

Vel Head (ft)	1.88	Wt. n-Val.		0.030	
W.S. Elev (ft)	1857.83	Reach Len. (ft)	122.77	122.37	121.50
Crit W.S. (ft)	1857.83	Flow Area (sq ft)		1090.24	
E.G. Slope (ft/ft)	0.008478	Area (sq ft)		1090.24	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	289.14	Top Width (ft)		289.14	
Vel Total (ft/s)	11.00	Avg. Vel. (ft/s)		11.00	
Max Chl Dpth (ft)	4.83	Hydr. Depth (ft)		3.77	
Conv. Total (cfs)	130216.5	Conv. (cfs)		130216.5	
Length Wtd. (ft)	122.37	Wetted Per. (ft)		291.15	
Min Ch El (ft)	1853.00	Shear (lb/sq ft)		1.98	
Alpha	1.00	Stream Power (lb/ft s)		21.80	
Frctn Loss (ft)	1.06	Cum Volume (acre-ft)	9.97	191.83	12.26
C & E Loss (ft)	0.04	Cum SA (acres)	8.47	60.41	13.76

Warning: The energy equation could not be balanced within the specified number of iterations. The

program selected the water surface that had the least amount of error between computed and

assumed values.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical

depth, the calculated water surface came back below critical depth. This indicates that there

is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash   RS: 19

INPUT

Description:

Station Elevation Data num= 114

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
2901.73	1892	2921.19	1890	2946.99	1888	2948.06	1887.83	2960.65	1887
2972.49	1886	2978.04	1884	2986.59	1882	2999.03	1880	3005.66	1880
3009.07	1880	3014.48	1878	3019.87	1876	3025.01	1874	3029.87	1872
3034.48	1870	3039.15	1868	3043.88	1866	3048.71	1864	3050.05	1863.69
3421.31	1863.91	3485.44	1863.94	3677.85	1863	3775.7	1862.54	3812.24	1863
3856.75	1863	3864.1	1862	3866.09	1861	3868.07	1860	3870.06	1859
3872.18	1858	3876.74	1857	3881.13	1856	3885.38	1855	3892.66	1855
3904.8	1855	3907.81	1854	4040.63	1853	4079.39	1853	4105.08	1853
4109.87	1852	4125.35	1852	4159.39	1853	4162.81	1853	4175.31	1853
4198.65	1854	4199.96	1855	4201.27	1856	4202.59	1857	4203.93	1858
4264.97	1859	4278.47	1860	4288.96	1861	4297.83	1862	4300.56	1863
4303.29	1864	4305.93	1865	4308.69	1866	4311.44	1867	4314.32	1868
4337.75	1869	4342.97	1869.07	4349.31	1869	4349.6	1868.98	4692.96	1868
4724.78	1868	4770.45	1870	4784.39	1871.47	4808.06	1871.45	4809.46	1872
4814.27	1874	4819.79	1875.05	4830.93	1876	4835.16	1876.31	4837.42	1878
4840.02	1880	4843.01	1882	4847.22	1884	4850.95	1886	4855.21	1888
4859.19	1890	4863.36	1892	4866.45	1894	4869.83	1896	4873.26	1898
4875.96	1900	4878.95	1902	4881.88	1904	4884.93	1906	4887.96	1908
4890.67	1910	4893.5	1912	4896.71	1914	4899.97	1916	4902.92	1918
4905.98	1920	4909.04	1922	4912.09	1924	4915.2	1926	4918.51	1928
4921.61	1930	4924.7	1932	4928.22	1934	4931.98	1936	4935.75	1938
4939.56	1940	4943.28	1942	4947.27	1944	4952.98	1946	4958.9	1948
4965.09	1950	4972.83	1952	4978.47	1954	4985.04	1956		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
2901.73	.07	3864.1	.03	4203.93	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
3864.1	4203.93	425.19	441.09	451.49	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1860.94	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.48	Wt. n-Val.		0.030	0.050
W.S. Elev (ft)	1858.45	Reach Len. (ft)	425.19	441.09	451.49
Crit W.S. (ft)	1858.45	Flow Area (sq ft)		1660.35	6.27
E.G. Slope (ft/ft)	0.007706	Area (sq ft)		1660.35	6.27
Q Total (cfs)	21000.00	Flow (cfs)		20993.93	6.07
Top Width (ft)	360.37	Top Width (ft)		332.71	27.66
Vel Total (ft/s)	12.60	Avg. Vel. (ft/s)		12.64	0.97
Max Chl Dpth (ft)	6.45	Hydr. Depth (ft)		4.99	0.23
Conv. Total (cfs)	239227.6	Conv. (cfs)		239158.4	69.2
Length Wtd. (ft)	441.09	Wetted Per. (ft)		334.80	27.66
Min Ch El (ft)	1852.00	Shear (lb/sq ft)		2.39	0.11
Alpha	1.01	Stream Power (lb/ft s)		30.17	0.11
Frctn Loss (ft)	3.38	Cum Volume (acre-ft)	30.26	270.76	37.28
C & E Loss (ft)	0.21	Cum SA (acres)	16.42	61.75	22.68

Warning: The energy equation could not be balanced within the specified number of iterations. The program selected the water surface that had the least amount of error between computed and assumed values.

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there

is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1858.59	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.76	Wt. n-Val.		0.030	
W.S. Elev (ft)	1856.83	Reach Len. (ft)	425.19	441.09	451.49
Crit W.S. (ft)	1856.83	Flow Area (sq ft)		1126.40	
E.G. Slope (ft/ft)	0.008855	Area (sq ft)		1126.40	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	324.89	Top Width (ft)		324.89	
Vel Total (ft/s)	10.64	Avg. Vel. (ft/s)		10.64	
Max Chl Dpth (ft)	4.83	Hydr. Depth (ft)		3.47	
Conv. Total (cfs)	127417.0	Conv. (cfs)		127417.0	
Length Wtd. (ft)	441.09	Wetted Per. (ft)		326.36	
Min Ch El (ft)	1852.00	Shear (lb/sq ft)		1.91	
Alpha	1.00	Stream Power (lb/ft s)		20.31	
Frctn Loss (ft)	3.60	Cum Volume (acre-ft)	9.97	188.71	12.26
C & E Loss (ft)	0.17	Cum SA (acres)	8.47	59.54	13.76

Warning: The energy equation could not be balanced within the specified number of iterations. The

program selected the water surface that had the least amount of error between computed and

assumed values.

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for

additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there

is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 18

INPUT

Description:

Station Elevation Data num= 101

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1886	3.2	1884	6.35	1882	9.41	1880	12.48	1878
15.65	1876	18.55	1874	21.96	1872	25.52	1870	29.05	1868
34.04	1866	39.9	1864	46.33	1862	394.14	1860	495.34	1860
595.13	1860	605.85	1860	617.17	1860	721.57	1860	773.04	1860
785.46	1859	797.47	1858	803.3	1857	808.69	1856	814.63	1855
821.43	1854	828.35	1853	841.92	1852	846.02	1851	850.12	1850
931.41	1850	1033.42	1850	1034.94	1849	1080.82	1849	1108.85	1849
1152.17	1849	1191.93	1850	1196.09	1850	1235.43	1850	1259.15	1851
1263.3	1852	1289.49	1853	1296.21	1854	1304.79	1854	1305.52	1853
1306.18	1852	1306.76	1851	1315.7	1851	1317.67	1852	1319.39	1853
1320.59	1854	1353.91	1855	1382.79	1855	1382.91	1855	1398.35	1856
1505.08	1858	1519.41	1860	1524.17	1862	1528.63	1864	1878.45	1868
1891.74	1868.26	1916.28	1868.41	1922.49	1870	1926.25	1872	1929.82	1874
1931.16	1876	1932.76	1878	1934.01	1880	1935.43	1882	1937.62	1884
1940.35	1886	1943.19	1888	1945.98	1890	1948.72	1892	1951.61	1894
1954.62	1896	1957.54	1898	1960.55	1900	1963.58	1902	1966.57	1904
1969.69	1906	1972.75	1908	1975.86	1910	1978.98	1912	1982.09	1914
1985.22	1916	1988.35	1918	1991.46	1920	1994.57	1922	1997.7	1924
2001.18	1926	2004.6	1928	2008.02	1930	2011.44	1932	2014.86	1934

```
 2018.29    1936 2021.72    1938 2025.15    1940 2028.65    1942 2032.24    1944
 2036.49    1946


Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .07  773.04     .03 1320.59     .05


Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        773.04 1320.59          368.22   402.4  428.15             .1       .3


CROSS SECTION OUTPUT  Profile #100 yr


  E.G. Elev (ft)          1855.90    Element                  Left OB    Channel   Right OB
  Vel Head (ft)              1.78    Wt. n-Val.                           0.030      0.050
  W.S. Elev (ft)          1854.12    Reach Len. (ft)          368.22     402.40     428.15
  Crit W.S. (ft)          1853.97    Flow Area (sq ft)                  1960.63       0.24
  E.G. Slope (ft/ft)     0.007630    Area (sq ft)                       1960.63       0.24
  Q Total (cfs)          21000.00    Flow (cfs)                        20999.91       0.09
  Top Width (ft)           503.93    Top Width (ft)                      499.97       3.96
  Vel Total (ft/s)          10.71    Avg. Vel. (ft/s)                     10.71       0.40
  Max Chl Dpth (ft)          5.12    Hydr. Depth (ft)                      3.92       0.06
  Conv. Total (cfs)      240407.3    Conv. (cfs)                       240406.2        1.1
  Length Wtd. (ft)         402.40    Wetted Per. (ft)                    503.36       3.96
  Min Ch El (ft)          1849.00    Shear (lb/sq ft)                      1.86       0.03
  Alpha                      1.00    Stream Power (lb/ft s)               19.87       0.01
  Frctn Loss (ft)            3.10    Cum Volume (acre-ft)      30.26     252.43      37.25
  C & E Loss (ft)            0.01    Cum SA (acres)            16.42      57.53      22.52


Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
         section.  This may indicate the need for additional cross sections.


CROSS SECTION OUTPUT  Profile #25 yr
```

E.G. Elev (ft)	1854.09	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.19	Wt. n-Val.		0.030	
W.S. Elev (ft)	1852.90	Reach Len. (ft)	368.22	402.40	428.15
Crit W.S. (ft)	1852.68	Flow Area (sq ft)		1371.68	
E.G. Slope (ft/ft)	0.007534	Area (sq ft)		1371.68	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	470.84	Top Width (ft)		470.84	
Vel Total (ft/s)	8.74	Avg. Vel. (ft/s)		8.74	
Max Chl Dpth (ft)	3.90	Hydr. Depth (ft)		2.91	
Conv. Total (cfs)	138137.8	Conv. (cfs)		138137.8	
Length Wtd. (ft)	402.40	Wetted Per. (ft)		473.12	
Min Ch El (ft)	1849.00	Shear (lb/sq ft)		1.36	
Alpha	1.00	Stream Power (lb/ft s)		11.92	
Frctn Loss (ft)	3.28	Cum Volume (acre-ft)	9.97	176.07	12.26
C & E Loss (ft)	0.03	Cum SA (acres)	8.47	55.51	13.76

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 17

INPUT

Description:

Station Elevation Data num= 118

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1878	6.83	1876	13.64	1874	22.59	1872	31.84	1870

37.82	1868	43.28	1866	48.62	1864	53.92	1862	55.35	1861.47
68.26	1860	179.86	1858	398.49	1858	456	1858	536.2	1856
567.71	1856	641.33	1856	647.39	1855	650.38	1854	653.33	1853
656.26	1852	692.75	1851	730.36	1850	732.26	1849	734.09	1848
747.82	1847	758.34	1846	760.24	1846	786.27	1846	787.22	1846
833.21	1846	889.82	1846	941.64	1846	969.44	1846	976.08	1847
979.71	1847	997.06	1846	1074.19	1846	1076.31	1847	1077.82	1848
1078.69	1849	1079.53	1850	1080.4	1851	1095.98	1851	1116.94	1850
1118.47	1849	1119.95	1848	1121.43	1847	1126.75	1846	1132.72	1846
1161.74	1847	1167.33	1848	1170.36	1849	1177.53	1850	1180.35	1851
1216.58	1851	1226.58	1851	1264.41	1851	1270.19	1851	1291.24	1852
1308.98	1853	1347.47	1854	1360.37	1855	1366.82	1856	1370.53	1857
1374.24	1858	1377.82	1859	1384.89	1860	1417.88	1860.61	1435.15	1861.39
1446.23	1862	1489.7	1861.34	1499.25	1861.16	1569.47	1861.4	1589.86	1861.24
1625.71	1862	1637.15	1862	1646.74	1861.2	1667.4	1861.44	1743.12	1861.28
1754.22	1861.4	1855.34	1862	1875.38	1862.39	1892.55	1862	1903.2	1861.83
1903.74	1862	1909.25	1864	1915.22	1866	1918.48	1868	1922.37	1870
1926.15	1872	1930.23	1874	1933.11	1876	1937.29	1878	1940.25	1880
1943.6	1882	1947.15	1884	1951.16	1886	1953.67	1888	1956.44	1890
1959.21	1892	1961.94	1894	1964.82	1896	1967.56	1898	1970.32	1900
1973.45	1902	1977.19	1904	1980.73	1906	1984.38	1908	1988.16	1910
1992.35	1912	1996.44	1914	2000.17	1916	2004.35	1918	2008.07	1920
2011.06	1922	2014.73	1924	2018.71	1926				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	641.33	.03	1180.35	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
641.33	1180.35	381.74	435.9	487.97	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1852.79	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.90	Wt. n-Val.		0.030	
W.S. Elev (ft)	1850.89	Reach Len. (ft)	381.74	435.90	487.97
Crit W.S. (ft)	1850.75	Flow Area (sq ft)		1897.01	
E.G. Slope (ft/ft)	0.007754	Area (sq ft)		1897.01	
Q Total (cfs)	21000.00	Flow (cfs)		21000.00	
Top Width (ft)	465.07	Top Width (ft)		465.07	
Vel Total (ft/s)	11.07	Avg. Vel. (ft/s)		11.07	
Max Chl Dpth (ft)	4.89	Hydr. Depth (ft)		4.08	
Conv. Total (cfs)	238481.2	Conv. (cfs)		238481.2	
Length Wtd. (ft)	435.90	Wetted Per. (ft)		469.14	
Min Ch El (ft)	1846.00	Shear (lb/sq ft)		1.96	
Alpha	1.00	Stream Power (lb/ft s)		21.67	
Frctn Loss (ft)	3.45	Cum Volume (acre-ft)	30.26	234.61	37.25
C & E Loss (ft)	0.03	Cum SA (acres)	16.42	53.07	22.50

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1850.79	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.48	Wt. n-Val.		0.030	
W.S. Elev (ft)	1849.31	Reach Len. (ft)	381.74	435.90	487.97
Crit W.S. (ft)	1849.27	Flow Area (sq ft)		1228.60	
E.G. Slope (ft/ft)	0.008829	Area (sq ft)		1228.60	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	401.87	Top Width (ft)		401.87	
Vel Total (ft/s)	9.76	Avg. Vel. (ft/s)		9.76	
Max Chl Dpth (ft)	3.31	Hydr. Depth (ft)		3.06	
Conv. Total (cfs)	127606.7	Conv. (cfs)		127606.7	

Length Wtd. (ft)	435.90	Wetted Per. (ft)		404.60	
Min Ch El (ft)	1846.00	Shear (lb/sq ft)		1.67	
Alpha	1.00	Stream Power (lb/ft s)		16.33	
Frctn Loss (ft)	3.45	Cum Volume (acre-ft)	9.97	164.06	12.26
C & E Loss (ft)	0.05	Cum SA (acres)	8.47	51.48	13.76

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 16

INPUT

Description:

Station Elevation Data num= 102

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1874	13.16	1872	17.23	1870	21.13	1868	25.25	1866
29.28	1864	33.55	1862	40.48	1860	56.86	1858	118.38	1856
129.2	1856	212.38	1856	294.21	1854	407.46	1852	548.23	1851
556.94	1851	592.14	1850	599.63	1850	630.09	1851	668.26	1851
674.88	1850	680.59	1849	686.79	1848	694.29	1847	702.92	1846
711.93	1845	719.88	1844	727.23	1843	741.13	1843	753.81	1843
773.42	1842	794.83	1842	864.2	1842	873.97	1842	882.16	1843
894.26	1843	901.41	1843	938.91	1843	1014.23	1842	1035.02	1842
1056.28	1843	1060.17	1843	1064.27	1843	1091.38	1844	1100.56	1845
1102.7	1846	1104.95	1847	1107.69	1848	1113.55	1849	1123.98	1850
1179.46	1851	1219.44	1852	1231.34	1852.8	1249.94	1852.67	1263.29	1853
1337.32	1854.87	1340.93	1855	1374.3	1856	1398.61	1857	1534.15	1857.55

1783.15	1856.96	1817.42	1857.28	1827.94	1861.08	1844.55	1858	1853.21	1860
1854.11	1862	1854.7	1864	1855.56	1866	1856.43	1868	1857.35	1870
1857.83	1872	1858.97	1874	1859.77	1876	1860.66	1878	1862.07	1880
1863.64	1882	1865.04	1884	1866.57	1886	1868.04	1888	1874.01	1890
1881.16	1892	1886.61	1894	1893.04	1896	1898.03	1898	1903.49	1900
1908	1902	1912.44	1904	1918.42	1906	1923.32	1908	1927.91	1910
1933.55	1912	1938.74	1914	1943.93	1916	1949.1	1918	1954.14	1920
1959.15	1922	1963.97	1924	1968.64	1926	1973.38	1928	1978.1	1930
1984.09	1932	1991.17	1934						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	668.26	.03	1123.98	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
668.26	1123.98	275	282.5	290	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1849.31	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.16	Wt. n-Val.		0.030	
W.S. Elev (ft)	1847.15	Reach Len. (ft)	275.00	282.50	290.00
Crit W.S. (ft)	1847.15	Flow Area (sq ft)		1780.22	
E.G. Slope (ft/ft)	0.008089	Area (sq ft)		1780.22	
Q Total (cfs)	21000.00	Flow (cfs)		21000.00	
Top Width (ft)	412.23	Top Width (ft)		412.23	
Vel Total (ft/s)	11.80	Avg. Vel. (ft/s)		11.80	
Max Chl Dpth (ft)	5.15	Hydr. Depth (ft)		4.32	
Conv. Total (cfs)	233492.4	Conv. (cfs)		233492.4	
Length Wtd. (ft)	282.50	Wetted Per. (ft)		413.13	
Min Ch El (ft)	1842.00	Shear (lb/sq ft)		2.18	
Alpha	1.00	Stream Power (lb/ft s)		25.67	
Frctn Loss (ft)	2.30	Cum Volume (acre-ft)	30.26	216.21	37.25

C & E Loss (ft)	0.04	Cum SA (acres)	16.42	48.68	22.50

Warning: The energy equation could not be balanced within the specified number of iterations. The program selected the water surface that had the least amount of error between computed and assumed values.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1847.29	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.31	Wt. n-Val.		0.030	
W.S. Elev (ft)	1845.98	Reach Len. (ft)	275.00	282.50	290.00
Crit W.S. (ft)	1845.74	Flow Area (sq ft)		1304.56	
E.G. Slope (ft/ft)	0.007123	Area (sq ft)		1304.56	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	399.57	Top Width (ft)		399.57	
Vel Total (ft/s)	9.19	Avg. Vel. (ft/s)		9.19	
Max Chl Dpth (ft)	3.98	Hydr. Depth (ft)		3.26	
Conv. Total (cfs)	142065.4	Conv. (cfs)		142065.4	
Length Wtd. (ft)	282.50	Wetted Per. (ft)		400.16	
Min Ch El (ft)	1842.00	Shear (lb/sq ft)		1.45	
Alpha	1.00	Stream Power (lb/ft s)		13.32	
Frctn Loss (ft)	2.28	Cum Volume (acre-ft)	9.97	151.38	12.26
C & E Loss (ft)	0.01	Cum SA (acres)	8.47	47.47	13.76

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 15

INPUT

Description:

Station Elevation Data num= 88

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1867.3	10.96	1877.68	12.82	1867.31	18.85	1866	25.4	1864
36.11	1862	40.33	1860	80.5	1858	166.29	1856	228.87	1854
315.46	1852	398.99	1850	485.51	1848	605.54	1848	743.21	1848
765.3	1847	773.43	1846	782.43	1845	796.58	1844	811.53	1843
828.87	1842	845.84	1841	876.26	1840	1014.74	1840	1021.97	1840
1027.58	1840	1060.18	1841	1077.41	1841	1094.54	1841	1116.79	1841
1182.66	1841	1220.13	1841	1225.91	1841	1361.46	1842	1363.32	1843
1364.05	1844	1364.85	1845	1365.64	1846	1367.93	1847	1373.68	1848
1378.63	1849	1382.49	1850	1384.08	1851	1385.68	1852	1387.23	1853
1389.17	1854	1748.03	1854.34	1769.99	1854.39	1801.16	1854.53	1815.86	1856
1816.82	1858	1817.66	1860	1818.53	1862	1819.47	1864	1820.38	1866
1821.12	1868	1822.17	1870	1824.22	1872	1826.9	1874	1829.45	1876
1832.17	1878	1834.78	1880	1837.35	1882	1839.92	1884	1842.56	1886
1845.16	1888	1847.76	1890	1850.37	1892	1853	1894	1855.6	1896
1858.73	1898	1861.81	1900	1865.18	1902	1868.02	1904	1871.36	1906
1874.72	1908	1877.7	1910	1881.03	1912	1885.14	1914	1888.43	1916
1891.58	1918	1895.56	1920	1900.96	1922	1906.41	1924	1911.6	1926
1918.14	1928	1923.63	1930	1929	1932				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	743.21	.03	1389.17	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
743.21	1389.17	305.8	329.92	377.91	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
1240	1929	1880	F

CROSS SECTION OUTPUT Profile #100 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1846.91				
Vel Head (ft)	2.01	Wt. n-Val.		0.030	
W.S. Elev (ft)	1844.90	Reach Len. (ft)	305.80	329.92	377.91
Crit W.S. (ft)	1844.90	Flow Area (sq ft)		1844.53	
E.G. Slope (ft/ft)	0.008205	Area (sq ft)		2256.78	
Q Total (cfs)	21000.00	Flow (cfs)		21000.00	
Top Width (ft)	580.90	Top Width (ft)		580.90	
Vel Total (ft/s)	11.39	Avg. Vel. (ft/s)		11.39	
Max Chl Dpth (ft)	4.90	Hydr. Depth (ft)		4.04	
Conv. Total (cfs)	231841.2	Conv. (cfs)		231841.2	
Length Wtd. (ft)	329.92	Wetted Per. (ft)		456.29	
Min Ch El (ft)	1840.00	Shear (lb/sq ft)		2.07	
Alpha	1.00	Stream Power (lb/ft s)		23.57	
Frctn Loss (ft)	2.36	Cum Volume (acre-ft)	30.26	203.12	37.25
C & E Loss (ft)	0.21	Cum SA (acres)	16.42	45.46	22.50

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for

additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical

depth, the calculated water surface came back below critical depth. This indicates that there

is not a valid subcritical answer. The program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

water surface was used.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1845.00	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.43	Wt. n-Val.		0.030	
W.S. Elev (ft)	1843.57	Reach Len. (ft)	305.80	329.92	377.91
Crit W.S. (ft)	1843.53	Flow Area (sq ft)		1249.20	
E.G. Slope (ft/ft)	0.009257	Area (sq ft)		1495.85	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	560.66	Top Width (ft)		560.66	
Vel Total (ft/s)	9.60	Avg. Vel. (ft/s)		9.60	
Max Chl Dpth (ft)	3.57	Hydr. Depth (ft)		2.86	
Conv. Total (cfs)	124619.4	Conv. (cfs)		124619.4	
Length Wtd. (ft)	329.92	Wetted Per. (ft)		437.03	
Min Ch El (ft)	1840.00	Shear (lb/sq ft)		1.65	
Alpha	1.00	Stream Power (lb/ft s)		15.85	
Frctn Loss (ft)	2.59	Cum Volume (acre-ft)	9.97	142.30	12.26
C & E Loss (ft)	0.16	Cum SA (acres)	8.47	44.36	13.76

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 14

INPUT

Description:

Station Elevation Data num= 82

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1872	3.4	1870	6.56	1868	9.63	1866	12.84	1864
16.08	1862	20.53	1860	31.06	1859.08	42.45	1858.16	58.6	1858
206.77	1856	217.94	1854	223	1852	227.34	1850	230.72	1848
244.31	1846	616.03	1844	664.26	1844	680.25	1844	693.09	1843
702.76	1842	713.5	1841	755.09	1840	780.57	1839	782.91	1838
803.55	1838	806.57	1838	849.76	1838	855.69	1838	863.62	1838.07
878.46	1838	894.57	1839	925.27	1839	944.02	1839	947.62	1839
951.73	1838	1136.87	1838	1142.02	1839	1280.6	1840	1323.58	1840
1454.51	1840	1455.42	1841	1456.31	1842	1457.22	1843	1458.12	1844
1459.03	1845	1460	1846	1460.92	1847	1461.83	1848	1462.8	1849
1463.7	1850	1464.68	1851	1750.53	1850.6	1784.03	1850.26	1787.72	1850
1802.95	1850	1809.35	1852	1814.1	1854	1818.12	1856	1821.96	1858
1828.79	1860	1835.15	1862	1840.6	1864	1844.6	1866	1849.41	1868
1854.67	1870	1859.26	1872	1863.65	1874	1867.45	1876	1871.73	1878
1875.32	1880	1878.84	1882	1882.53	1884	1886.62	1886	1890.53	1888
1893.64	1890	1897.34	1892	1901.43	1894	1905.47	1896	1910.09	1898

```
  1914.9    1900 1919.72    1902


Manning's n Values        num=       3

     Sta    n Val      Sta    n Val      Sta    n Val

       0      .07   680.25      .03 1464.68      .04


Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.

        680.25 1464.68           297.63  277.08  281.46             .3       .5

Ineffective Flow     num=       2

   Sta L    Sta R     Elev  Permanent

       0      738     1851        F

    1366 1919.72     1851        F


CROSS SECTION OUTPUT  Profile #100 yr


  E.G. Elev (ft)           1843.78    Element                  Left OB    Channel   Right OB

  Vel Head (ft)               1.33    Wt. n-Val.                            0.030

  W.S. Elev (ft)           1842.45    Reach Len. (ft)          297.63      277.08     281.46

  Crit W.S. (ft)           1842.11    Flow Area (sq ft)                   2272.82

  E.G. Slope (ft/ft)      0.006269    Area (sq ft)                        2546.41

  Q Total (cfs)           21000.00    Flow (cfs)                         21000.00

  Top Width (ft)            758.32    Top Width (ft)                       758.32

  Vel Total (ft/s)            9.24    Avg. Vel. (ft/s)                       9.24

  Max Chl Dpth (ft)           4.45    Hydr. Depth (ft)                       3.62

  Conv. Total (cfs)       265229.8    Conv. (cfs)                        265229.8

  Length Wtd. (ft)          277.09    Wetted Per. (ft)                     628.48

  Min Ch El (ft)           1838.00    Shear (lb/sq ft)                       1.42

  Alpha                       1.00    Stream Power (lb/ft s)                13.08

  Frctn Loss (ft)             1.39    Cum Volume (acre-ft)      30.26      184.93      37.25

  C & E Loss (ft)             0.06    Cum SA (acres)            16.42       40.39      22.50



Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
```

section. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

water surface was used.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1842.25	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.88	Wt. n-Val.		0.030	
W.S. Elev (ft)	1841.36	Reach Len. (ft)	297.63	277.08	281.46
Crit W.S. (ft)	1841.08	Flow Area (sq ft)		1588.40	
E.G. Slope (ft/ft)	0.006747	Area (sq ft)		1726.46	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	746.12	Top Width (ft)		746.12	
Vel Total (ft/s)	7.55	Avg. Vel. (ft/s)		7.55	
Max Chl Dpth (ft)	3.36	Hydr. Depth (ft)		2.53	
Conv. Total (cfs)	145975.5	Conv. (cfs)		145975.5	
Length Wtd. (ft)	277.08	Wetted Per. (ft)		628.48	
Min Ch El (ft)	1838.00	Shear (lb/sq ft)		1.06	
Alpha	1.00	Stream Power (lb/ft s)		8.04	
Frctn Loss (ft)	1.83	Cum Volume (acre-ft)	9.97	130.10	12.26
C & E Loss (ft)	0.04	Cum SA (acres)	8.47	39.41	13.76

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

water surface was used.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 13

INPUT

Description: Section @ Upstream End of Guide Banks

Station Elevation Data num= 92

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1870	1.18	1869	2.33	1868	3.49	1867	4.66	1866
5.82	1865	7.06	1864	8.32	1863	9.5	1862	10.67	1861
11.82	1860	12.98	1859	14.16	1858	15.31	1857	16.47	1856
17.61	1855	18.77	1854	20.33	1853	22.02	1852	23.71	1851
25.4	1850	27.1	1849	28.88	1848	30.97	1847	33.45	1846
38.21	1845	229.9	1844	282.4	1844	289.89	1844	352.59	1843.18
361.75	1843.12	420.1	1843	433.29	1842	439.71	1842	453.07	1843
464.68	1843	510.74	1842	547.9	1841	642.18	1840	650.71	1839
659.37	1838	675.7	1837	696.21	1836	720.74	1836	725.83	1837
754.57	1837	765.4	1837	777.25	1837	786.7	1836	814.07	1836
836.49	1836	860.8	1835	868.96	1835	926.74	1836	936.8	1836
952.94	1836	958.05	1837	974.41	1838	979.86	1839	993.26	1839
995.66	1838	998.9	1837	1003.65	1837	1005.58	1836	1026.45	1836
1057	1836	1103.65	1836	1160.55	1838	1210.89	1839	1218.61	1840
1224.33	1841	1229.21	1842	1241.24	1843	1245.58	1844	1247.49	1845
1248.31	1846	1249.06	1847	1249.8	1848	1271.71	1848.72	1399.16	1848.9
1419.11	1849	1450.03	1849	1462.79	1849	1490.65	1849.27	1551.25	1849
1551.29	1849.05	1564.34	1848.57	1594.53	1848.42	1651.26	1848.57	1680.94	1848.15
1681.68	1848	1728.05	1847						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	642.18	.03	1249.8	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
642.18	1249.8	205	205	205	.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	630	1851	F
1152	1728.05	1851	F

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1842.33	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.21	Wt. n-Val.	0.070	0.030	
W.S. Elev (ft)	1841.12	Reach Len. (ft)	205.00	205.00	205.00
Crit W.S. (ft)	1840.23	Flow Area (sq ft)	12.79	2373.16	
E.G. Slope (ft/ft)	0.004112	Area (sq ft)	58.18	2548.70	
Q Total (cfs)	21000.00	Flow (cfs)	17.98	20982.02	
Top Width (ft)	681.24	Top Width (ft)	98.53	582.71	
Vel Total (ft/s)	8.80	Avg. Vel. (ft/s)	1.41	8.84	
Max Chl Dpth (ft)	6.11	Hydr. Depth (ft)	1.05	4.65	
Conv. Total (cfs)	327467.6	Conv. (cfs)	280.4	327187.2	
Length Wtd. (ft)	205.00	Wetted Per. (ft)	12.18	511.01	
Min Ch El (ft)	1835.00	Shear (lb/sq ft)	0.27	1.19	
Alpha	1.01	Stream Power (lb/ft s)	0.38	10.54	
Frctn Loss (ft)	0.69	Cum Volume (acre-ft)	30.07	168.73	37.25
C & E Loss (ft)	0.00	Cum SA (acres)	16.08	36.13	22.50

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

water surface was used.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1840.38	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.03	Wt. n-Val.		0.030	
W.S. Elev (ft)	1839.35	Reach Len. (ft)	205.00	205.00	205.00
Crit W.S. (ft)	1839.02	Flow Area (sq ft)		1475.37	

E.G. Slope (ft/ft)	0.006453	Area (sq ft)		1531.46	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	565.87	Top Width (ft)		565.87	
Vel Total (ft/s)	8.13	Avg. Vel. (ft/s)		8.13	
Max Chl Dpth (ft)	4.35	Hydr. Depth (ft)		2.93	
Conv. Total (cfs)	149256.5	Conv. (cfs)		149256.5	
Length Wtd. (ft)	205.00	Wetted Per. (ft)		505.43	
Min Ch El (ft)	1835.00	Shear (lb/sq ft)		1.18	
Alpha	1.00	Stream Power (lb/ft s)		9.56	
Frctn Loss (ft)	0.83	Cum Volume (acre-ft)	9.97	119.74	12.26
C & E Loss (ft)	0.12	Cum SA (acres)	8.47	35.24	13.76

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than

0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

water surface was used.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 12

INPUT

Description:

Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1854.97	347.482	1851.52	402.791	1850.9	448.711	1835	465.538	1834.43
472.077	1833.34	475	1833.403	476.259	1833.43	535.654	1833.62	607.123	1833.86
670.111	1834.2	706.7	1834.32	714.128	1834.32	718.668	1834.37	736.055	1834.44
754.045	1834.51	756.426	1834.52	875	1835	881.045	1837	911.045	1848

```
 1009.05 1849.67 1091.05 1849.52 1114.05 1849.42 1163.05 1849.47    1177    1849
    1248    1849    1287    1849    1290    1859

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .07 402.791     .03 911.045     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       402.791 911.045           141.97   67.49  188.08             .3       .5
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
       0     485  1850.5       F
     865    1290  1850.5       F
Skew Angle = 15

CROSS SECTION OUTPUT  Profile #100 yr

  E.G. Elev (ft)           1841.63    Element                  Left OB    Channel   Right OB
  Vel Head (ft)               1.23    Wt. n-Val.                            0.030
  W.S. Elev (ft)           1840.40    Reach Len. (ft)            2.00       2.00       2.00
  Crit W.S. (ft)           1838.75    Flow Area (sq ft)                   2361.89
  E.G. Slope (ft/ft)      0.002820    Area (sq ft)                        2729.05
  Q Total (cfs)           21000.00    Flow (cfs)                         21000.00
  Top Width (ft)            457.21    Top Width (ft)                       457.21
  Vel Total (ft/s)            8.89    Avg. Vel. (ft/s)                       8.89
  Max Chl Dpth (ft)           7.06    Hydr. Depth (ft)                       6.22
  Conv. Total (cfs)       395472.0    Conv. (cfs)                        395472.0
  Length Wtd. (ft)            2.00    Wetted Per. (ft)                     380.00
  Min Ch El (ft)           1833.34    Shear (lb/sq ft)                       1.09
  Alpha                       1.00    Stream Power (lb/ft s)                 9.73
  Frctn Loss (ft)                     Cum Volume (acre-ft)      29.93     156.31      37.25
  C & E Loss (ft)                     Cum SA (acres)            15.85      33.68      22.50
```

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

energy was used.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1839.42	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.78	Wt. n-Val.		0.030	
W.S. Elev (ft)	1838.64	Reach Len. (ft)	2.00	2.00	2.00
Crit W.S. (ft)	1837.33	Flow Area (sq ft)		1692.90	
E.G. Slope (ft/ft)	0.002789	Area (sq ft)		1932.84	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	447.32	Top Width (ft)		447.32	
Vel Total (ft/s)	7.08	Avg. Vel. (ft/s)		7.08	
Max Chl Dpth (ft)	5.30	Hydr. Depth (ft)		4.46	
Conv. Total (cfs)	227022.5	Conv. (cfs)		227022.5	
Length Wtd. (ft)	2.00	Wetted Per. (ft)		380.00	
Min Ch El (ft)	1833.34	Shear (lb/sq ft)		0.78	
Alpha	1.00	Stream Power (lb/ft s)		5.49	
Frctn Loss (ft)		Cum Volume (acre-ft)	9.97	111.58	12.26
C & E Loss (ft)		Cum SA (acres)	8.47	32.85	13.76

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

energy was used.

BRIDGE

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 11.5

INPUT

Description:

Distance from Upstream XS = 2

Deck/Roadway Width = 37

Weir Coefficient = 2.6

Upstream Deck/Roadway Coordinates

num= 24

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
0	1854.56		40	1854.44		103	1854.25	
166	1854.06		238	1853.85		289	1853.69	
325	1853.58		380	1853.36		400	1852.96	
400	1855.63		475	1855.4	1837	475	1855.4	1848.04
875	1854.2	1846.84	875	1854.2	1844.25	950	1853.93	
950	1851.66		1082	1850.94		1102	1850.8	
1148	1850.44		1171	1850.04		1177	1849	
1248	1849		1287	1849		1290	1859	

Upstream Bridge Cross Section Data

Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1854.97	347.482	1851.52	402.791	1850.9	448.711	1835	465.538	1834.43
472.077	1833.34	475	1833.403	476.259	1833.43	535.654	1833.62	607.123	1833.86
670.111	1834.2	706.7	1834.32	714.128	1834.32	718.668	1834.37	736.055	1834.44
754.045	1834.51	756.426	1834.52	875	1835	881.045	1837	911.045	1848
1009.05	1849.67	1091.05	1849.52	1114.05	1849.42	1163.05	1849.47	1177	1849
1248	1849	1287	1849	1290	1859				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	402.791	.03	911.045	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
402.791	911.045	.3	.5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	485	1850.5	F
865	1290	1850.5	F

Skew Angle = 15

Downstream Deck/Roadway Coordinates

num= 24

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-53.9	1854.59		-3	1854.44		60	1854.25	
123	1854.06		195	1853.85		246	1853.69	
282	1853.58		337	1853.36		357	1852.96	
357	1855.63		432	1855.4	1834	432	1855.4	1848.04
832	1854.2	1846.84	832	1854.2	1834.9	907	1853.93	
907	1851.66		1039	1850.94		1059	1850.8	
1105	1850.44		1128	1850.04		1134	1849	
1205	1849		1244	1849		1247	1859	

Downstream Bridge Cross Section Data

Station Elevation Data num= 41

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-53.899	1843.56	0	1842.53	60.322	1842.26	127.889	1852.03	195.494	1841.12
241.993	1840.95	280.63	1838.34	299.775	1839.04	328.357	1837.99	347.926	1838.52
369.525	1837.98	413.474	1838.89	422.515	1832.71	432	1832.627	435.121	1832.6
444.413	1833.56	475.313	1833.41	510.038	1832.21	534.669	1833.19	565.501	1832.9
571.567	1832.09	611.441	1831.82	620.81	1832.9	637.482	1832.9	661.273	1832.9
693.854	1832.9	752.022	1832.9	809.697	1832.9	832	1832.9	862.697	1836.32
923.85	1844.92	955.648	1844.89	968.36	1844.74	1055.834	1845.87	1082.291	1849.47
1105	1850.44	1128	1850.04	1134	1849	1205	1849	1244	1849
1247	1859								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

```
 -53.899     .05 413.474     .03  923.85     .04


Bank Sta: Left   Right    Coeff Contr.   Expan.

       413.474  923.85             .3       .5

Ineffective Flow     num=       2

   Sta L   Sta R    Elev  Permanent

 -53.899     442 1847.01       F

     822    1247  1843.5       F

Left Levee      Station=   132.4      Elevation= 1852.03

Skew Angle = 15


Upstream Embankment side slope              =       4 horiz. to 1.0 vertical

Downstream Embankment side slope            =       4 horiz. to 1.0 vertical

Maximum allowable submergence for weir flow =     .95

Elevation at which weir flow begins         =

Energy head used in spillway design         =

Spillway height used in design              =

Weir crest shape                            = Broad Crested


Number of Abutments =  2


Abutment Data

Upstream     num=       2

     Sta    Elev     Sta    Elev

     475  1844.2     490  1834.2

Downstream     num=       2

     Sta    Elev     Sta    Elev

     432  1844.2     447  1834.2


Abutment Data

Upstream     num=       2

     Sta    Elev     Sta    Elev

     860  1833.2     875  1843.2
```

```
Downstream     num=       2
     Sta    Elev     Sta    Elev
     817  1833.2     832  1843.2


Number of Piers =  3


Pier Data
Pier Station     Upstream=     575    Downstream=     532
Upstream     num=       2
    Width   Elev    Width   Elev
       7    1830       7    1848
Downstream     num=       2
    Width   Elev    Width   Elev
       6    1830       6    1848


Pier Data
Pier Station     Upstream=     675    Downstream=     632
Upstream     num=       2
    Width   Elev    Width   Elev
       7    1830       7    1848
Downstream     num=       2
    Width   Elev    Width   Elev
       6    1830       6    1848


Pier Data
Pier Station     Upstream=     775    Downstream=     732
Upstream     num=       2
    Width   Elev    Width   Elev
       7    1830       7    1848
Downstream     num=       2
    Width   Elev    Width   Elev
       6    1830       6    1848
```

```
Number of Bridge Coefficient Sets =  1


Low Flow Methods and Data

       Energy

       Momentum               Cd   =     1.2

       Yarnell                KVal =    1.05

Selected Low Flow Methods = Highest Energy Answer


High Flow Method

       Pressure and Weir flow

           Submerged Inlet Cd          =

           Submerged Inlet + Outlet Cd =      .8

           Max Low Cord                =


Additional Bridge Parameters

       Add Friction component to Momentum

       Do not add Weight component to Momentum

       Class B flow critical depth computations use critical depth

           inside the bridge at the upstream end

       Criteria to check for pressure flow = Upstream energy grade line


BRIDGE OUTPUT  Profile #100 yr
```

E.G. US. (ft)	1841.63	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	1840.40	E.G. Elev (ft)	1841.55	1839.94
Q Total (cfs)	21000.00	W.S. Elev (ft)	1839.90	1837.60
Q Bridge (cfs)	21000.00	Crit W.S. (ft)	1838.98	1837.60
Q Weir (cfs)		Max Chl Dpth (ft)	6.50	5.78
Weir Sta Lft (ft)		Vel Total (ft/s)	10.30	12.28
Weir Sta Rgt (ft)		Flow Area (sq ft)	2038.01	1709.52
Weir Submerg		Froude # Chl	0.76	1.00
Weir Max Depth (ft)		Specif Force (cu ft)	12551.98	12113.33
Min El Weir Flow (ft)	1850.51	Hydr Depth (ft)	5.68	4.72

Min El Prs (ft)	1848.04	W.P. Total (ft)	395.50	392.96
Delta EG (ft)	1.95	Conv. Total (cfs)	301154.5	225646.4
Delta WS (ft)	2.83	Top Width (ft)	367.94	363.78
BR Open Area (sq ft)	4744.52	Frctn Loss (ft)		
BR Open Vel (ft/s)	12.28	C & E Loss (ft)		
Coef of Q		Shear Total (lb/sq ft)	1.56	2.35
Br Sel Method	Momentum	Power Total (lb/ft s)	16.12	28.90

Warning: The flow regime calculated by the momentum equation shows class B flow. For the best solution, this profile should be run as a mixed flow problem.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

BRIDGE OUTPUT Profile #25 yr

E.G. US. (ft)	1839.42	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	1838.64	E.G. Elev (ft)	1839.37	1837.80
Q Total (cfs)	11990.00	W.S. Elev (ft)	1838.35	1836.50
Q Bridge (cfs)	11990.00	Crit W.S. (ft)	1837.50	1836.10
Q Weir (cfs)		Max Chl Dpth (ft)	4.95	4.68
Weir Sta Lft (ft)		Vel Total (ft/s)	8.09	9.13
Weir Sta Rgt (ft)		Flow Area (sq ft)	1482.03	1313.41
Weir Submerg		Froude # Chl	0.70	0.84
Weir Max Depth (ft)		Specif Force (cu ft)	6118.62	5844.11
Min El Weir Flow (ft)	1850.51	Hydr Depth (ft)	4.13	3.64
Min El Prs (ft)	1848.04	W.P. Total (ft)	386.21	384.47
Delta EG (ft)	1.80	Conv. Total (cfs)	179923.9	147559.1
Delta WS (ft)	2.19	Top Width (ft)	363.29	360.49
BR Open Area (sq ft)	4744.52	Frctn Loss (ft)		

BR Open Vel (ft/s)	9.13	C & E Loss (ft)		
Coef of Q		Shear Total (lb/sq ft)	1.06	1.41
Br Sel Method	Momentum	Power Total (lb/ft s)	8.61	12.85

Warning: The water surface upstream of the bridge computed by the Yarnell method was below critical

depth. The Yarnell solution has been disregarded.

Note: Yarnell answer is not valid if the water surface is above the low chord or if there is weir flow.

The Yarnell answer has been disregarded.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

energy was used.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

energy was used.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 11

INPUT

Description:

Station Elevation Data num= 41

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-53.899	1843.56	0	1842.53	60.322	1842.26	127.889	1852.03	195.494	1841.12
241.993	1840.95	280.63	1838.34	299.775	1839.04	328.357	1837.99	347.926	1838.52
369.525	1837.98	413.474	1838.89	422.515	1832.71	432	1832.627	435.121	1832.6
444.413	1833.56	475.313	1833.41	510.038	1832.21	534.669	1833.19	565.501	1832.9
571.567	1832.09	611.441	1831.82	620.81	1832.9	637.482	1832.9	661.273	1832.9
693.854	1832.9	752.022	1832.9	809.697	1832.9	832	1832.9	862.697	1836.32

```
  923.85 1844.92 955.648 1844.89  968.36 1844.741055.834 1845.871082.291 1849.47
    1105 1850.44    1128 1850.04    1134    1849    1205    1849    1244    1849
    1247    1859

Manning's n Values        num=       3
     Sta    n Val     Sta    n Val     Sta    n Val
 -53.899     .05 413.474     .03  923.85     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       413.474  923.85           448.39  424.85  389.32             .3       .5
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
 -53.899     442 1847.01       F
     822    1247  1843.5       F
Left Levee      Station=   132.4      Elevation= 1852.03
Skew Angle = 15

CROSS SECTION OUTPUT  Profile #100 yr

  E.G. Elev (ft)           1839.67    Element                  Left OB    Channel   Right OB
  Vel Head (ft)               2.11    Wt. n-Val.                            0.030
  W.S. Elev (ft)           1837.57    Reach Len. (ft)          448.39     424.85     389.32
  Crit W.S. (ft)           1837.39    Flow Area (sq ft)                   1803.57
  E.G. Slope (ft/ft)      0.006932    Area (sq ft)                        2057.58
  Q Total (cfs)           21000.00    Flow (cfs)                         21000.00
  Top Width (ft)            456.17    Top Width (ft)                      456.17
  Vel Total (ft/s)           11.64    Avg. Vel. (ft/s)                     11.64
  Max Chl Dpth (ft)           5.75    Hydr. Depth (ft)                      4.75
  Conv. Total (cfs)       252217.5    Conv. (cfs)                        252217.5
  Length Wtd. (ft)          420.32    Wetted Per. (ft)                    380.17
  Min Ch El (ft)           1831.82    Shear (lb/sq ft)                      2.05
  Alpha                       1.00    Stream Power (lb/ft s)               23.91
  Frctn Loss (ft)             3.31    Cum Volume (acre-ft)      29.93     153.37      37.25
```

C & E Loss (ft)	0.12	Cum SA (acres)	15.85	33.08	22.50

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1837.62	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.18	Wt. n-Val.		0.030	
W.S. Elev (ft)	1836.45	Reach Len. (ft)	448.39	424.85	389.32
Crit W.S. (ft)	1835.97	Flow Area (sq ft)		1377.88	
E.G. Slope (ft/ft)	0.005544	Area (sq ft)		1551.94	
Q Total (cfs)	11990.00	Flow (cfs)		11990.00	
Top Width (ft)	446.57	Top Width (ft)		446.57	
Vel Total (ft/s)	8.70	Avg. Vel. (ft/s)		8.70	
Max Chl Dpth (ft)	4.63	Hydr. Depth (ft)		3.63	
Conv. Total (cfs)	161029.5	Conv. (cfs)		161029.5	
Length Wtd. (ft)	420.51	Wetted Per. (ft)		380.17	
Min Ch El (ft)	1831.82	Shear (lb/sq ft)		1.25	
Alpha	1.00	Stream Power (lb/ft s)		10.92	
Frctn Loss (ft)	3.13	Cum Volume (acre-ft)	9.97	109.38	12.26
C & E Loss (ft)	0.05	Cum SA (acres)	8.47	32.26	13.76

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash   RS: 10

INPUT

Description:

Station Elevation Data   num=   58

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-624.4	1870	-517.53	1865	-509.73	1860	-478.64	1850	-465.44	1845
-441.68	1840	-335.04	1840	-330.76	1842	-312.04	1842	-296.02	1838
-272.72	1835.2	-226.77	1834.84	-224.8	1835.6	-115.24	1836	-30.15	1836
1.8	1835.69	12.66	1835.63	15.32	1835	27.96	1834.99	40.86	1832.75
72.3	1830.99	75.46	1829.3	94.02	1830	115.3	1829.74	126.77	1830
150.84	1829.91	168.51	1830	186.53	1830	196.49	1828.86	212.07	1831.66
251.25	1831.64	253.65	1830.14	276.35	1830.95	307.97	1830.62	312.9	1830
313.66	1827.14	328.33	1826.87	332.45	1830	333.29	1828.83	353.61	1829.44
354.48	1830	360.3	1830	372.2	1830	399.14	1830	414.51	1830
451.96	1830	462	1830	528.31	1832.87	560.9	1834.35	589.09	1833.46
705.12	1834.38	758.84	1840	765.96	1841	831.17	1841	1077.83	1841
1113.54	1843	1226.17	1843	1291.78	1847				

Manning's n Values   num=   3

Sta	n Val	Sta	n Val	Sta	n Val
-624.4	.05	27.96	.03	360.3	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
27.96	360.3	464.82	392.17	304.28	.3	.5

Ineffective Flow   num=   2

Sta L	Sta R	Elev	Permanent
-624.4	-22	1860	F
552	1291.78	1839	F

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1836.25	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.87	Wt. n-Val.		0.030	0.040
W.S. Elev (ft)	1834.38	Reach Len. (ft)	464.82	392.17	304.28
Crit W.S. (ft)	1834.38	Flow Area (sq ft)		1326.37	663.92
E.G. Slope (ft/ft)	0.009022	Area (sq ft)		1326.37	732.89
Q Total (cfs)	21000.00	Flow (cfs)		15639.11	5360.89
Top Width (ft)	673.66	Top Width (ft)		328.83	344.83
Vel Total (ft/s)	10.55	Avg. Vel. (ft/s)		11.79	8.07
Max Chl Dpth (ft)	7.51	Hydr. Depth (ft)		4.03	3.46
Conv. Total (cfs)	221089.7	Conv. (cfs)		164649.8	56439.9
Length Wtd. (ft)	378.63	Wetted Per. (ft)		334.29	191.79
Min Ch El (ft)	1826.87	Shear (lb/sq ft)		2.23	1.95
Alpha	1.08	Stream Power (lb/ft s)		26.35	15.74
Frctn Loss (ft)	3.06	Cum Volume (acre-ft)	29.93	136.87	33.97
C & E Loss (ft)	0.08	Cum SA (acres)	15.85	29.25	20.95

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1834.44	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.36	Wt. n-Val.		0.030	0.040
W.S. Elev (ft)	1833.08	Reach Len. (ft)	464.82	392.17	304.28
Crit W.S. (ft)	1833.08	Flow Area (sq ft)		904.83	423.53
E.G. Slope (ft/ft)	0.010504	Area (sq ft)		904.83	423.53
Q Total (cfs)	11990.00	Flow (cfs)		9058.59	2931.41
Top Width (ft)	494.09	Top Width (ft)		321.36	172.73
Vel Total (ft/s)	9.03	Avg. Vel. (ft/s)		10.01	6.92
Max Chl Dpth (ft)	6.21	Hydr. Depth (ft)		2.82	2.45
Conv. Total (cfs)	116986.3	Conv. (cfs)		88384.6	28601.7
Length Wtd. (ft)	380.53	Wetted Per. (ft)		326.71	172.79
Min Ch El (ft)	1826.87	Shear (lb/sq ft)		1.82	1.61
Alpha	1.07	Stream Power (lb/ft s)		18.18	11.13
Frctn Loss (ft)	3.43	Cum Volume (acre-ft)	9.97	97.40	10.36
C & E Loss (ft)	0.08	Cum SA (acres)	8.47	28.52	12.99

Warning: The energy equation could not be balanced within the specified number of iterations. The

program used critical depth for the water surface and continued on with the calculations.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical

depth, the calculated water surface came back below critical depth. This indicates that there

is not a valid subcritical answer. The program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

water surface was used.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash   RS: 9

INPUT

Description:

Station Elevation Data   num=   114

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1862	5.78	1860	11.05	1858	16.57	1856	22.49	1854
46.53	1852	54.59	1851.11	71.08	1850.02	71.3	1850	101.38	1848
124.3	1846	137.33	1844	149.56	1842	161.98	1840	166.52	1838
176.48	1836	190.36	1834	199.22	1832	207.22	1830.83	227.54	1830.97
237.24	1830.98	255.84	1830.34	466.13	1832	496.66	1832	521.07	1831
526.07	1830	531.07	1829	541.63	1828	545.73	1827	592.89	1826
626.81	1826	627.92	1827	646.37	1827	651.2	1826	680.6	1826
692.2	1826	695.05	1825	710.78	1825	737.67	1826	743.07	1827
759.16	1827	770.29	1827	778.38	1827	792.68	1827	828.09	1827
861.67	1827	878.71	1827	905.36	1827	928.31	1827	937.47	1826
941.43	1825	946.91	1824	952.4	1824	969.08	1825	973.03	1826
976.35	1827	979.59	1828	982.46	1829	987.34	1829	1004.03	1828.54
1010.97	1828.78	1047.62	1828	1054.07	1828	1080.46	1829	1114.3	1830
1123.94	1830	1138.29	1829.73	1255.65	1830	1293.94	1831	1345.42	1832
1378.73	1832.62	1383.73	1833	1385.54	1833.12	1400.85	1834	1422.19	1835
1470.77	1836	1501.81	1838	1553.86	1838.72	1724.51	1838	1727.97	1838
1851.55	1838	1903.25	1838	1947.97	1839	1965.53	1840	1984.99	1841
1986.85	1841.25	1993.58	1842	2002.41	1843	2010.58	1844	2021.8	1845
2030.14	1845.75	2039.82	1845	2043.57	1844	2047.03	1843	2050.41	1842
2053.74	1841	2057.05	1840	2091.22	1840	2107.87	1841	2112.91	1841
2119.32	1840	2129.95	1839.69	2141.77	1840	2145.89	1840.03	2149.6	1840
2151.08	1840	2180.24	1841	2182.77	1842	2186.09	1843	2190.47	1844
2195	1845	2198.42	1846	2201.31	1847	2204.05	1848		

```
Manning's n Values        num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
       0      .04   521.07      .03   982.46      .04

Bank Sta: Left    Right    Lengths: Left Channel    Right     Coeff Contr.    Expan.
        521.07   982.46            454.9   368.46   304.53             .2       .4
Ineffective Flow     num=       2
   Sta L    Sta R    Elev   Permanent
       0      500    1840        F
    1142  2204.05    1833        F

CROSS SECTION OUTPUT  Profile #100 yr

  E.G. Elev (ft)           1832.26    Element                  Left OB    Channel   Right OB
  Vel Head (ft)               1.70    Wt. n-Val.                          0.030      0.040
  W.S. Elev (ft)           1830.56    Reach Len. (ft)          454.90     368.46     304.53
  Crit W.S. (ft)           1830.56    Flow Area (sq ft)                  1860.24     255.67
  E.G. Slope (ft/ft)      0.007259    Area (sq ft)               3.83    1860.24     340.41
  Q Total (cfs)           21000.00    Flow (cfs)                        19892.13    1107.87
  Top Width (ft)            788.44    Top Width (ft)            34.54     459.20     294.70
  Vel Total (ft/s)            9.92    Avg. Vel. (ft/s)                    10.69       4.33
  Max Chl Dpth (ft)           6.56    Hydr. Depth (ft)                     4.05       1.60
  Conv. Total (cfs)       246476.4    Conv. (cfs)                       233473.3    13003.0
  Length Wtd. (ft)          365.00    Wetted Per. (ft)                    461.19     159.60
  Min Ch El (ft)           1824.00    Shear (lb/sq ft)                     1.83       0.73
  Alpha                       1.11    Stream Power (lb/ft s)              19.55       3.15
  Frctn Loss (ft)             2.77    Cum Volume (acre-ft)      29.91     122.52      30.22
  C & E Loss (ft)             0.17    Cum SA (acres)            15.66      25.71      18.72


Warning: The energy equation could not be balanced within the specified number of iterations.
The
         program used critical depth for the water surface and continued on with the
calculations.
```

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1830.58	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.21	Wt. n-Val.		0.030	0.040
W.S. Elev (ft)	1829.38	Reach Len. (ft)	454.90	368.46	304.53
Crit W.S. (ft)	1829.30	Flow Area (sq ft)		1319.69	87.54
E.G. Slope (ft/ft)	0.007808	Area (sq ft)		1319.69	87.54
Q Total (cfs)	11990.00	Flow (cfs)		11744.40	245.60
Top Width (ft)	564.03	Top Width (ft)		453.27	110.76
Vel Total (ft/s)	8.52	Avg. Vel. (ft/s)		8.90	2.81
Max Chl Dpth (ft)	5.38	Hydr. Depth (ft)		2.91	0.79
Conv. Total (cfs)	135689.4	Conv. (cfs)		132909.9	2779.4
Length Wtd. (ft)	367.24	Wetted Per. (ft)		455.15	110.80
Min Ch El (ft)	1824.00	Shear (lb/sq ft)		1.41	0.39
Alpha	1.07	Stream Power (lb/ft s)		12.58	1.08
Frctn Loss (ft)	3.44	Cum Volume (acre-ft)	9.97	87.39	8.58
C & E Loss (ft)	0.04	Cum SA (acres)	8.47	25.03	12.00

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

water surface was used.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 8

INPUT

Description:

Station Elevation Data num= 149

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1886	8.92	1884	18.39	1882	29.39	1880	39.17	1878
50.2	1876	62.45	1874	67.54	1872	72.04	1870	73.17	1869.31
76.62	1868.97	88.46	1868	108.89	1866	123.34	1864	139.14	1862
154.87	1860	171.01	1858	183.63	1856	196.6	1854	209.64	1852
223.38	1850	239.77	1848	256.5	1846	269.32	1844	282.89	1842
303.07	1840	316.92	1838.17	318.49	1838	337.3	1836.29	337.53	1835.98
337.94	1836	346.26	1835.15	347.14	1835.41	352.95	1834	367.96	1832
401.38	1830	467.53	1829.34	471.57	1830	475.25	1830.72	488.9	1830
508.81	1829	515.12	1828	519.7	1827	528.77	1826	554.16	1825
640.53	1824	709.1	1824	711.64	1825	713.17	1825	736.45	1824
743.7	1824	749.17	1825	756.39	1825	758.92	1824	874.94	1823
878.64	1822	887.25	1822	916.55	1822	937.05	1822	949.64	1823
961.38	1824	963.16	1825	966.29	1826	975.04	1826	1002.38	1825
1020.76	1825	1052	1825	1058.08	1825	1066.32	1825	1074.97	1824
1083.07	1824	1083.21	1824	1086.78	1823	1091.84	1822	1109.73	1822
1130.88	1823	1146.24	1824	1153.85	1824	1156.96	1824	1171.38	1824
1174.66	1823	1179.95	1823	1182.19	1824	1183.19	1825	1212.21	1826
1221.65	1827	1226.64	1828	1230.47	1828	1242.08	1827	1264.18	1826.45
1271.24	1826.76	1324.34	1826	1325.29	1826	1458.23	1826	1463.53	1825

1514.84	1825	1520.17	1826	1523.8	1827	1527.15	1828	1542.33	1829
1554.8	1830	1566.55	1831	1582.8	1832	1601.66	1834	1617.2	1835.5
1623.02	1835.95	1633.97	1836	1641.66	1836	1728.61	1838	1816.61	1838.6
1836.89	1838.37	1845.29	1838.48	1871.85	1838	1876.75	1837.92	1887.51	1838
1957.47	1838.2	1971.58	1838	2004.22	1837.78	2095.77	1837.25	2116.18	1837
2150.66	1837	2200.56	1838	2218.58	1839	2246.76	1840	2248.21	1840.21
2251.32	1840.88	2252.8	1841	2261.88	1842	2271.04	1843	2281.67	1844
2289.43	1844.67	2292.12	1845	2296.66	1845	2300.66	1844	2303.47	1843
2306.25	1842	2309.01	1841	2311.8	1840	2318.1	1839	2362.75	1839
2372.57	1839.07	2386.33	1839.12	2409.66	1840	2434.54	1841	2437.26	1842
2441.82	1843	2444.28	1844	2446.52	1845	2448.78	1846		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	508.81	.03	1226.64	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
508.81	1226.64	378.01	321.27	255.23	.2	.4

CROSS SECTION OUTPUT Profile #100 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1828.37	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.27	Wt. n-Val.		0.030	0.040
W.S. Elev (ft)	1827.10	Reach Len. (ft)	378.01	321.27	255.23
Crit W.S. (ft)	1827.10	Flow Area (sq ft)		2140.45	322.78
E.G. Slope (ft/ft)	0.007965	Area (sq ft)		2140.45	322.78
Q Total (cfs)	21000.00	Flow (cfs)		19833.18	1166.82
Top Width (ft)	985.99	Top Width (ft)		702.86	283.14
Vel Total (ft/s)	8.53	Avg. Vel. (ft/s)		9.27	3.61
Max Chl Dpth (ft)	5.09	Hydr. Depth (ft)		3.05	1.14
Conv. Total (cfs)	235303.1	Conv. (cfs)		222229.0	13074.1
Length Wtd. (ft)	317.69	Wetted Per. (ft)		705.30	283.49
Min Ch El (ft)	1822.00	Shear (lb/sq ft)		1.51	0.57

Alpha	1.13	Stream Power (lb/ft s)		13.98	2.05
Frctn Loss (ft)	1.59	Cum Volume (acre-ft)	29.89	105.60	27.91
C & E Loss (ft)	0.19	Cum SA (acres)	15.48	20.79	16.70

Warning: The energy equation could not be balanced within the specified number of iterations. The
program used critical depth for the water surface and continued on with the calculations.

Warning: Divided flow computed for this cross-section.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than
0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical
depth, the calculated water surface came back below critical depth. This indicates that there
is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1827.11	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.11	Wt. n-Val.		0.030	0.040
W.S. Elev (ft)	1826.00	Reach Len. (ft)	378.01	321.27	255.23
Crit W.S. (ft)	1826.00	Flow Area (sq ft)		1380.65	56.56
E.G. Slope (ft/ft)	0.011470	Area (sq ft)		1380.65	56.56
Q Total (cfs)	11990.00	Flow (cfs)		11778.58	211.42
Top Width (ft)	736.54	Top Width (ft)		674.61	61.93
Vel Total (ft/s)	8.34	Avg. Vel. (ft/s)		8.53	3.74
Max Chl Dpth (ft)	4.00	Hydr. Depth (ft)		2.05	0.91
Conv. Total (cfs)	111955.4	Conv. (cfs)		109981.2	1974.1
Length Wtd. (ft)	320.43	Wetted Per. (ft)		676.92	62.12
Min Ch El (ft)	1822.00	Shear (lb/sq ft)		1.46	0.65

Alpha	1.03	Stream Power (lb/ft s)		12.46	2.44
Frctn Loss (ft)	2.37	Cum Volume (acre-ft)	9.97	75.96	8.07
C & E Loss (ft)	0.17	Cum SA (acres)	8.47	20.26	11.40

Warning: The energy equation could not be balanced within the specified number of iterations. The

program selected the water surface that had the least amount of error between computed and

assumed values.

Warning: Divided flow computed for this cross-section.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than

0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical

depth, the calculated water surface came back below critical depth. This indicates that there

is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 7

INPUT

Description:

Station Elevation Data num= 127

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
109.32	1896	139.34	1894	142.81	1892	146.26	1890	149.76	1888
152.6	1886	155.98	1884	159.33	1882	162.71	1880	165.88	1878
169.28	1876	170.79	1874	171.95	1872	172.76	1870	173.86	1868

174.87	1866	175.83	1864	176.69	1862	177.77	1860	178.6	1858
180.72	1856	183.94	1854	187.22	1852	190.55	1850	192.98	1848
194.27	1846	195.25	1844	196.22	1842	197.07	1840	198.17	1838
199.16	1836	200.12	1834	200.92	1832	201.97	1830	205.8	1828
212.35	1826	223.4	1824	426.14	1824	432.81	1825	438.6	1826
443.48	1827	448.22	1828	452.75	1829	456.27	1829.77	477.3	1829
522.4	1828.11	529.03	1828.04	530.53	1828	585.91	1828	586.59	1828
587.47	1827	588.38	1826	589.82	1825	593.63	1824	598.79	1823
616.44	1823	621.95	1823	629.78	1823	650.25	1823	669.55	1823
741.14	1823	744.89	1822	772.23	1821	823.88	1820	827.34	1820
837.33	1820	844.28	1820	860.37	1821	861.66	1821	864	1820
876.25	1820	878.9	1820	898.89	1820	901.69	1819	906.88	1819
910.25	1819	916.07	1819	921.06	1820	926.07	1820	943	1820
1014.64	1820	1035.7	1820	1048.42	1820	1089.95	1819	1122.79	1819
1143.95	1820	1146.69	1821	1190.88	1822	1242.23	1822	1248.57	1821
1265.49	1821	1272.67	1822	1275	1823	1279.38	1824	1310.14	1824
1330.72	1823	1396.45	1823	1532.3	1824	1597.89	1825	1620.17	1826
1663.62	1828	1673.29	1830	1682.84	1832	1699.54	1834	1705.65	1834.5
1729.2	1834.78	1738.38	1834	1742.28	1833.53	1747.97	1833.7	1755.8	1834
1912.78	1836	2093.68	1836.83	2130.37	1836	2236.52	1836	2297.07	1837
2305.85	1838	2314.16	1839	2321.63	1840	2324.03	1840	2348.75	1840
2357.68	1841	2360.13	1841.31	2365.48	1842	2373.23	1843	2374.28	1843.14
2382.49	1844	2388.17	1844.59						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
109.32	.04	585.91	.03	1279.38	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
585.91	1279.38	308.17	320.9	357.01	.2	.4

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
109.32	456.27	1829.77	F

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1825.76	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.78	Wt. n-Val.		0.030	0.040
W.S. Elev (ft)	1824.97	Reach Len. (ft)	308.17	320.90	357.01
Crit W.S. (ft)	1824.15	Flow Area (sq ft)		2734.32	421.25
E.G. Slope (ft/ft)	0.003446	Area (sq ft)	203.15	2734.32	421.25
Q Total (cfs)	21000.00	Flow (cfs)		19889.22	1110.78
Top Width (ft)	1220.84	Top Width (ft)	214.61	689.46	316.77
Vel Total (ft/s)	6.65	Avg. Vel. (ft/s)		7.27	2.64
Max Chl Dpth (ft)	5.97	Hydr. Depth (ft)		3.97	1.33
Conv. Total (cfs)	357730.1	Conv. (cfs)		338808.2	18921.9
Length Wtd. (ft)	323.43	Wetted Per. (ft)		691.04	316.81
Min Ch El (ft)	1819.00	Shear (lb/sq ft)		0.85	0.29
Alpha	1.14	Stream Power (lb/ft s)		6.19	0.75
Frctn Loss (ft)	1.41	Cum Volume (acre-ft)	29.01	87.62	25.73
C & E Loss (ft)	0.13	Cum SA (acres)	14.55	15.66	14.94

Warning: Divided flow computed for this cross-section.

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for

additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

water surface was used.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1824.27	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.69	Wt. n-Val.		0.030	0.040

W.S. Elev (ft)	1823.57	Reach Len. (ft)	308.17	320.90	357.01
Crit W.S. (ft)	1823.11	Flow Area (sq ft)		1772.23	63.17
E.G. Slope (ft/ft)	0.005152	Area (sq ft)		1772.23	63.17
Q Total (cfs)	11990.00	Flow (cfs)		11897.48	92.52
Top Width (ft)	836.86	Top Width (ft)		681.67	155.19
Vel Total (ft/s)	6.53	Avg. Vel. (ft/s)		6.71	1.46
Max Chl Dpth (ft)	4.57	Hydr. Depth (ft)		2.60	0.41
Conv. Total (cfs)	167036.5	Conv. (cfs)		165747.7	1288.9
Length Wtd. (ft)	321.78	Wetted Per. (ft)		683.03	155.21
Min Ch El (ft)	1819.00	Shear (lb/sq ft)		0.83	0.13
Alpha	1.05	Stream Power (lb/ft s)		5.60	0.19
Frctn Loss (ft)	1.52	Cum Volume (acre-ft)	9.97	64.34	7.72
C & E Loss (ft)	0.03	Cum SA (acres)	8.47	15.26	10.76

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 6

INPUT

Description:

Station Elevation Data num= 111

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
116.85	1890	123.25	1888	129.57	1886	133.11	1884	135.83	1882

```
  139.09    1880  142.84    1878  146.21    1876  151.62    1874  153.01    1872
  154.48    1870  155.85    1868  157.21    1866  158.49    1864  159.72    1862
  160.93    1860   162.1    1858  163.29    1856  164.43    1854  165.63    1852
  166.75    1850     168    1848  169.14    1846  170.34    1844  171.44    1842
  172.44    1840  173.55    1838  174.67    1836  175.79    1834  180.94    1832
  190.95    1830   200.6    1828  455.58 1826.87  529.91    1827  530.08 1827.09
  531.61    1827  537.02 1826.66  630.99    1827   690.1    1828  704.68    1829
  714.03    1830  721.77    1830  726.92    1829  733.87    1828  744.87 1826.94
  757.01 1827.23  846.69    1827  872.92    1826     874    1825  874.97    1824
  875.96    1823  876.95    1822  877.92    1821  885.05    1820  895.24    1819
  917.93    1818  984.67    1817 1066.87    1817 1080.53    1818 1089.38    1818
 1091.37    1817 1107.42    1817 1109.73    1818 1113.91    1819 1116.06    1820
 1121.64    1820 1122.51    1819  1197.3    1819 1208.33    1819 1217.04    1819
 1225.89    1819 1256.48    1819 1303.22    1820 1305.05    1821 1403.48    1821
 1415.88 1820.41 1428.35 1820.83 1458.36 1820.51 1494.72    1821 1587.78    1822
 1780.44 1824.82 1785.38    1824  1797.1    1826 1806.27    1828 1814.32    1830
 1820.65  1830.9  1883.1 1830.13 1915.75 1830.04 1977.39 1830.38 2042.71  1830.1
 2075.86 1830.04 2081.92 1830.77 2093.96    1831 2132.85    1832 2156.08    1833
 2160.54    1834 2163.12    1834 2190.61    1834 2200.22    1835 2208.04 1835.93
 2210.83    1836  2222.1 1836.28 2238.17  1836.3 2240.57    1836 2250.69    1835
 2261.65    1835 2272.74    1836 2342.83 1836.11  2363.4 1836.63 2370.99    1837
 2384.56    1838

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  116.85     .04  872.92     .03 1305.05     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        872.92 1305.05           270.26  292.58  317.61             .2       .4

CROSS SECTION OUTPUT  Profile #100 yr

  E.G. Elev (ft)           1824.22    Element                   Left OB    Channel   Right OB
```

Vel Head (ft)	1.45	Wt. n-Val.		0.030	0.040
W.S. Elev (ft)	1822.77	Reach Len. (ft)	270.26	292.58	317.61
Crit W.S. (ft)	1822.59	Flow Area (sq ft)		1908.18	501.00
E.G. Slope (ft/ft)	0.005664	Area (sq ft)		1908.18	501.00
Q Total (cfs)	21000.00	Flow (cfs)		19169.39	1830.61
Top Width (ft)	764.12	Top Width (ft)		428.86	335.26
Vel Total (ft/s)	8.72	Avg. Vel. (ft/s)		10.05	3.65
Max Chl Dpth (ft)	5.77	Hydr. Depth (ft)		4.45	1.49
Conv. Total (cfs)	279041.4	Conv. (cfs)		254716.8	24324.6
Length Wtd. (ft)	294.19	Wetted Per. (ft)		431.30	335.30
Min Ch El (ft)	1817.00	Shear (lb/sq ft)		1.56	0.53
Alpha	1.23	Stream Power (lb/ft s)		15.72	1.93
Frctn Loss (ft)	1.49	Cum Volume (acre-ft)	28.29	70.52	21.95
C & E Loss (ft)	0.08	Cum SA (acres)	13.79	11.54	12.27

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1822.72	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.85	Wt. n-Val.		0.030	0.040
W.S. Elev (ft)	1821.87	Reach Len. (ft)	270.26	292.58	317.61
Crit W.S. (ft)		Flow Area (sq ft)		1521.34	226.35
E.G. Slope (ft/ft)	0.004320	Area (sq ft)		1521.34	226.35
Q Total (cfs)	11990.00	Flow (cfs)		11499.00	491.00
Top Width (ft)	698.23	Top Width (ft)		427.97	270.26
Vel Total (ft/s)	6.86	Avg. Vel. (ft/s)		7.56	2.17
Max Chl Dpth (ft)	4.87	Hydr. Depth (ft)		3.55	0.84
Conv. Total (cfs)	182424.2	Conv. (cfs)		174953.7	7470.5
Length Wtd. (ft)	292.43	Wetted Per. (ft)		430.03	270.29
Min Ch El (ft)	1817.00	Shear (lb/sq ft)		0.95	0.23

Alpha	1.17	Stream Power (lb/ft s)		7.21	0.49
Frctn Loss (ft)	1.32	Cum Volume (acre-ft)	9.97	52.21	6.54
C & E Loss (ft)	0.06	Cum SA (acres)	8.47	11.17	9.02

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash   RS: 5

INPUT

Description:

Station Elevation Data   num=   94

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
214.45	1838	224.91	1836.61	228.1	1836	235.12	1834	239.71	1832
244.43	1830	249.35	1828	255.43	1826	302.4	1824	506.79	1823.69
514.52	1823.45	539.1	1824	684.49	1824	700.14	1823	710.2	1822
721.86	1821	733.24	1820	752.26	1819	770.96	1819	782.93	1820
799.25	1820.06	813.59	1820.33	819.82	1821	827.3	1822	835.03	1823
850.87	1823	856.7	1822	862.59	1821	868.45	1820	932.78	1819
934.38	1818	936.05	1817	961.96	1816	975.23	1816	996	1817
1008.14	1818	1028.23	1819	1030.05	1820	1033.24	1821	1055.42	1821
1057.52	1820	1057.67	1819	1057.81	1818	1058.03	1817	1058.22	1816
1068.03	1815	1081.14	1814	1127.04	1814	1130.77	1815	1137.98	1816
1140.37	1817	1142.45	1818	1148.57	1819	1153.67	1819	1160.09	1818
1179.27	1817	1183.11	1816	1194.48	1815	1246.72	1815	1273.06	1816
1274.58	1817	1276.19	1818	1303.49	1819	1308.89	1820	1327.41	1821
1346.27	1821	1364.27	1819.98	1398.89	1820	1417.77	1820	1427.98	1820.23
1450.7	1820.03	1451.11	1820	1465.7	1819	1876.22	1820	1892.64	1821

```
 1905.88 1821.88 1908.09    1822 1926.78    1823 1948.05    1824 1957.32 1824.28
 1962.94    1825  1970.5    1826 1978.96    1827 1989.16    1828 2025.65    1829
 2058.16    1829 2071.75    1829 2090.68  1829.9 2091.84    1830 2103.43 1830.89
 2115.29    1830 2116.21 1829.92 2149.95    1830 2160.06    1831
```

```
Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  214.45     .04 1055.42     .03 1276.19     .04
```

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
       1055.42 1276.19           430.91  414.45  462.38            .2       .4
```

CROSS SECTION OUTPUT Profile #100 yr

		Element	Left OB	Channel	Right OB
E.G. Elev (ft)	1822.65				
Vel Head (ft)	1.25	Wt. n-Val.	0.040	0.030	0.040
W.S. Elev (ft)	1821.40	Reach Len. (ft)	430.91	414.45	462.38
Crit W.S. (ft)	1821.40	Flow Area (sq ft)	720.04	1293.22	1071.44
E.G. Slope (ft/ft)	0.004538	Area (sq ft)	720.04	1293.22	1071.44
Q Total (cfs)	21000.00	Flow (cfs)	3346.62	13803.34	3850.03
Top Width (ft)	1144.04	Top Width (ft)	300.80	220.77	622.47
Vel Total (ft/s)	6.81	Avg. Vel. (ft/s)	4.65	10.67	3.59
Max Chl Dpth (ft)	7.40	Hydr. Depth (ft)	2.39	5.86	1.72
Conv. Total (cfs)	311728.7	Conv. (cfs)	49678.0	204899.9	57150.8
Length Wtd. (ft)	423.15	Wetted Per. (ft)	302.20	226.04	622.72
Min Ch El (ft)	1814.00	Shear (lb/sq ft)	0.68	1.62	0.49
Alpha	1.74	Stream Power (lb/ft s)	3.14	17.30	1.75
Frctn Loss (ft)	2.17	Cum Volume (acre-ft)	26.05	59.77	16.21
C & E Loss (ft)	0.01	Cum SA (acres)	12.86	9.36	8.78

Warning: The energy equation could not be balanced within the specified number of iterations.
The

program used critical depth for the water surface and continued on with the calculations.

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1821.34	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.14	Wt. n-Val.	0.040	0.030	0.040
W.S. Elev (ft)	1820.20	Reach Len. (ft)	430.91	414.45	462.38
Crit W.S. (ft)	1820.20	Flow Area (sq ft)	396.94	1029.17	362.99
E.G. Slope (ft/ft)	0.004718	Area (sq ft)	396.94	1029.17	362.99
Q Total (cfs)	11990.00	Flow (cfs)	1561.91	9671.73	756.37
Top Width (ft)	1009.24	Top Width (ft)	239.19	219.09	550.95
Vel Total (ft/s)	6.70	Avg. Vel. (ft/s)	3.93	9.40	2.08
Max Chl Dpth (ft)	6.20	Hydr. Depth (ft)	1.66	4.70	0.66
Conv. Total (cfs)	174556.7	Conv. (cfs)	22739.1	140806.0	11011.6
Length Wtd. (ft)	418.84	Wetted Per. (ft)	240.25	224.18	551.12
Min Ch El (ft)	1814.00	Shear (lb/sq ft)	0.49	1.35	0.19
Alpha	1.64	Stream Power (lb/ft s)	1.91	12.71	0.40
Frctn Loss (ft)	2.17	Cum Volume (acre-ft)	8.73	43.64	4.39
C & E Loss (ft)	0.03	Cum SA (acres)	7.73	9.00	6.02

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash   RS: 4

INPUT

Description:

Station Elevation Data   num=   91

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
135.29	1860	142.32	1850	149.22	1840	150.95	1838	153.5	1836
155.79	1834	158.79	1832	161.11	1830	165.34	1828	166.79	1826
168.17	1824	173.4	1822	181.04	1820.41	187.05	1820	187.8	1819.93
225.83	1818	292.92	1816	361.55	1814	383.14	1812	401.53	1812
415.21	1814	418.85	1816	422.89	1816	428.33	1814	454.2	1814
467.7	1814	472.48	1812	481.88	1810	508.81	1810	512.29	1812
518.51	1814	853.62	1814	867.59	1812	1014.18	1810	1040.25	1810
1045.54	1810	1058.32	1808	1086.48	1808	1092.43	1810	1098.95	1812
1116.71	1812	1124.06	1812	1146.46	1814	1161.22	1815.44	1167.47	1815.71
1263.59	1816	1286.46	1818	1300	1818	1316.05	1816	1320.39	1816
1343.19	1816	1353.76	1814	1363.27	1812.9	1405.54	1812.62	1408.27	1813.48
1420.48	1814	1429.78	1814.44	1442.96	1814.79	1465.39	1815.12	1504.6	1816
1518.32	1816.46	1540.11	1816.52	1553.9	1816.61	1575.11	1817.43	1588.04	1817.71
1610.81	1817.8	1615.66	1818	1623.96	1818.4	1645.47	1818.51	1658.7	1818.72
1680.67	1819.44	1690.75	1819.02	1728.92	1818.64	1807.34	1822	1828.54	1824
1833.5	1827.1	1835.55	1828	1839.28	1830	1842.13	1832	1845.93	1834

```
 1850.21    1836 1854.32    1838 1858.56    1840 1862.89    1842 1866.95    1844
 1871.22    1846 1875.53    1848 1879.69    1850 1883.93    1852 1888.32    1854
 1892.48    1856

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
  135.29     .04  853.62     .03 1167.47     .04

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        853.62 1167.47           291.64  429.09  457.75             .2       .4

CROSS SECTION OUTPUT  Profile #100 yr

  E.G. Elev (ft)          1817.00    Element                  Left OB    Channel   Right OB
  Vel Head (ft)              1.31    Wt. n-Val.                 0.040      0.030      0.040
  W.S. Elev (ft)          1815.70    Reach Len. (ft)           291.64     429.09     457.75
  Crit W.S. (ft)          1815.70    Flow Area (sq ft)        1097.75    1445.88     236.20
  E.G. Slope (ft/ft)     0.005835    Area (sq ft)             1097.75    1445.88     236.20
  Q Total (cfs)          21000.00    Flow (cfs)               4958.11   15120.99     920.90
  Top Width (ft)          1004.67    Top Width (ft)            544.86     313.53     146.27
  Vel Total (ft/s)           7.55    Avg. Vel. (ft/s)            4.52      10.46       3.90
  Max Chl Dpth (ft)          7.70    Hydr. Depth (ft)            2.01       4.61       1.61
  Conv. Total (cfs)      274912.6    Conv. (cfs)              64907.0   197950.1    12055.6
  Length Wtd. (ft)         405.36    Wetted Per. (ft)          547.32     314.64     146.66
  Min Ch El (ft)          1808.00    Shear (lb/sq ft)            0.73       1.67       0.59
  Alpha                      1.48    Stream Power (lb/ft s)      3.30      17.51       2.29
  Frctn Loss (ft)            1.27    Cum Volume (acre-ft)       17.06      46.74       9.27
  C & E Loss (ft)            0.17    Cum SA (acres)              8.68       6.82       4.70


Warning: The energy equation could not be balanced within the specified number of iterations.
The
         program used critical depth for the water surface and continued on with the
calculations.
```

Warning: Divided flow computed for this cross-section.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1815.70	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.08	Wt. n-Val.	0.040	0.030	0.040
W.S. Elev (ft)	1814.62	Reach Len. (ft)	291.64	429.09	457.75
Crit W.S. (ft)	1814.62	Flow Area (sq ft)	532.41	1116.66	109.88
E.G. Slope (ft/ft)	0.005732	Area (sq ft)	532.41	1116.66	109.88
Q Total (cfs)	11990.00	Flow (cfs)	1574.14	10052.61	363.25
Top Width (ft)	888.05	Top Width (ft)	502.93	299.17	85.95
Vel Total (ft/s)	6.82	Avg. Vel. (ft/s)	2.96	9.00	3.31
Max Chl Dpth (ft)	6.62	Hydr. Depth (ft)	1.06	3.73	1.28
Conv. Total (cfs)	158362.3	Conv. (cfs)	20791.0	132773.5	4797.8
Length Wtd. (ft)	417.18	Wetted Per. (ft)	504.91	300.22	86.23
Min Ch El (ft)	1808.00	Shear (lb/sq ft)	0.38	1.33	0.46
Alpha	1.49	Stream Power (lb/ft s)	1.12	11.98	1.51
Frctn Loss (ft)	1.30	Cum Volume (acre-ft)	4.14	33.43	1.88
C & E Loss (ft)	0.15	Cum SA (acres)	4.05	6.53	2.64

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning: Divided flow computed for this cross-section.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash RS: 3

INPUT

Description:

Station Elevation Data num= 99

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1870	5.96	1868	10.12	1866	14.35	1864	18.65	1862
23.01	1860	27.56	1858	31.82	1856	36.27	1854	40.6	1852
44.28	1850	46.35	1848	48.68	1846	50.83	1844	51.92	1842
52.37	1840	52.78	1838	53.21	1836	53.56	1834	54.02	1832
54.43	1830	54.84	1828	55.04	1826	55.57	1824	55.97	1822
56.41	1820	56.82	1818	57.25	1816	59.3	1814	62.52	1812
65.55	1810	72.42	1808.55	78.61	1808.33	126.47	1810	402.1	1812
524.89	1814	558.4	1814	603.02	1814	611.02	1814	649.08	1814
689.25	1814	694.08	1812	696.28	1810	698.42	1808	700.48	1806
702.55	1804	729.01	1804	740.85	1806	773.27	1806	776.34	1806
890.29	1806	922.52	1806	925.7	1806	947.55	1806	955.96	1806
969.4	1806	971.69	1808	973.98	1810	1006.92	1812	1011.32	1814
1039.15	1816	1045.1	1816	1062.19	1814	1072.41	1812	1090.24	1810.39

1191.26	1811.18	1248.88	1814	1404.14	1815.3	1444.63	1815.4	1445.11	1815.81
1477.02	1816	1565.15	1822.23	1569.99	1824	1574.54	1826	1579.02	1828
1583.46	1830	1587.89	1832	1591.88	1834	1595.17	1836	1598.37	1838
1601.56	1840	1604.75	1842	1607.92	1844	1611.04	1846	1614.14	1848
1617.2	1850	1620.23	1852	1623.25	1854	1626.25	1856	1629.26	1858
1632.26	1860	1635.25	1862	1638.24	1864	1641.23	1866	1644.29	1868
1647.57	1870	1650.72	1872	1653.9	1874	1664.5	1876		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	689.25	.03	973.98	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
689.25	973.98	294.24	375.19	433.01	.1	.3

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1814.20	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.87	Wt. n-Val.	0.040	0.030	0.040
W.S. Elev (ft)	1813.33	Reach Len. (ft)	294.24	375.19	433.01
Crit W.S. (ft)		Flow Area (sq ft)	961.67	2091.46	425.21
E.G. Slope (ft/ft)	0.001950	Area (sq ft)	961.67	2091.46	425.21
Q Total (cfs)	21000.00	Flow (cfs)	2721.59	17147.14	1131.27
Top Width (ft)	911.76	Top Width (ft)	423.26	283.11	205.39
Vel Total (ft/s)	6.04	Avg. Vel. (ft/s)	2.83	8.20	2.66
Max Chl Dpth (ft)	9.33	Hydr. Depth (ft)	2.27	7.39	2.07
Conv. Total (cfs)	475517.8	Conv. (cfs)	61626.9	388274.8	25616.1
Length Wtd. (ft)	367.59	Wetted Per. (ft)	424.44	288.22	206.00
Min Ch El (ft)	1804.00	Shear (lb/sq ft)	0.28	0.88	0.25
Alpha	1.54	Stream Power (lb/ft s)	0.78	7.24	0.67
Frctn Loss (ft)	0.90	Cum Volume (acre-ft)	10.17	29.32	5.80
C & E Loss (ft)	0.07	Cum SA (acres)	5.44	3.88	2.85

Warning: Divided flow computed for this cross-section.

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for

additional cross sections.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1812.33	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.71	Wt. n-Val.	0.040	0.030	0.040
W.S. Elev (ft)	1811.62	Reach Len. (ft)	294.24	375.19	433.01
Crit W.S. (ft)		Flow Area (sq ft)	336.47	1611.65	116.50
E.G. Slope (ft/ft)	0.001952	Area (sq ft)	336.47	1611.65	116.50
Q Total (cfs)	11990.00	Flow (cfs)	613.29	11215.47	161.24
Top Width (ft)	716.66	Top Width (ft)	286.80	279.48	150.37
Vel Total (ft/s)	5.81	Avg. Vel. (ft/s)	1.82	6.96	1.38
Max Chl Dpth (ft)	7.62	Hydr. Depth (ft)	1.17	5.77	0.77
Conv. Total (cfs)	271387.1	Conv. (cfs)	13881.5	253856.1	3649.5
Length Wtd. (ft)	373.49	Wetted Per. (ft)	287.48	284.19	150.49
Min Ch El (ft)	1804.00	Shear (lb/sq ft)	0.14	0.69	0.09
Alpha	1.35	Stream Power (lb/ft s)	0.26	4.81	0.13
Frctn Loss (ft)	1.23	Cum Volume (acre-ft)	1.23	19.99	0.69
C & E Loss (ft)	0.19	Cum SA (acres)	1.41	3.68	1.40

Warning: Divided flow computed for this cross-section.

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for

additional cross sections.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than

0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash   RS: 2

INPUT

Description:

Station Elevation Data   num=   39

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1842.19	22.27	1845.98	73.96	1814.29	95.19	1808.55	157.16	1807.92
215.78	1809.32	270.88	1809.52	365.22	1809.92	423.45	1810.36	491.08	1810.66
551.88	1811.01	616.41	1811.3	620.3	1810.43	651.73	1811.02	660.4	1812.57
727.89	1811.87	751.23	1811.66	798.33	1801.97	814.09	1800.73	818.08	1799.91
845.12	1799.88	853.09	1802.56	889.54	1803.13	925.01	1802.58	929.2	1810.59
988.11	1810.56	1022.02	1812.98	1047.65	1813.75	1055.5	1808.21	1063.93	1808.25
1116.32	1808.09	1159.02	1811.94	1205.84	1812.99	1250.4	1812.12	1285.91	1812.1
1332.62	1814.22	1382.18	1815.24	1538.8	1877.46	1577.75	1879.41		

Manning's n Values   num=   3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	751.23	.03	929.2	.04

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
751.23	929.2	306.5	408.93	457.37	.2	.4

Ineffective Flow   num=   1

Sta L	Sta R	Elev	Permanent
1205.84	1577.75	1815	F

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1813.23	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.59	Wt. n-Val.	0.040	0.030	0.040

W.S. Elev (ft)	1811.65	Reach Len. (ft)	306.50	408.93	457.37
Crit W.S. (ft)	1811.65	Flow Area (sq ft)	989.01	1489.53	360.62
E.G. Slope (ft/ft)	0.003160	Area (sq ft)	989.01	1489.53	360.62
Q Total (cfs)	21000.00	Flow (cfs)	2975.06	16702.61	1322.33
Top Width (ft)	928.62	Top Width (ft)	571.49	177.90	179.24
Vel Total (ft/s)	7.40	Avg. Vel. (ft/s)	3.01	11.21	3.67
Max Chl Dpth (ft)	11.77	Hydr. Depth (ft)	1.73	8.37	2.01
Conv. Total (cfs)	373553.4	Conv. (cfs)	52921.1	297110.3	23522.0
Length Wtd. (ft)	402.91	Wetted Per. (ft)	572.08	184.31	180.53
Min Ch El (ft)	1799.88	Shear (lb/sq ft)	0.34	1.59	0.39
Alpha	1.87	Stream Power (lb/ft s)	1.03	17.88	1.45
Frctn Loss (ft)	1.82	Cum Volume (acre-ft)	3.58	13.90	1.89
C & E Loss (ft)	0.31	Cum SA (acres)	2.08	1.89	0.94

Warning: The energy equation could not be balanced within the specified number of iterations. The

program used critical depth for the water surface and continued on with the calculations.

Warning: Divided flow computed for this cross-section.

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for

additional cross sections.

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than

0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross

section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical

depth, the calculated water surface came back below critical depth. This indicates that there

is not a valid subcritical answer. The program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,

water surface was used.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1810.91	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.56	Wt. n-Val.	0.040	0.030	0.040
W.S. Elev (ft)	1808.35	Reach Len. (ft)	306.50	408.93	457.37
Crit W.S. (ft)	1808.35	Flow Area (sq ft)	12.88	930.79	10.74
E.G. Slope (ft/ft)	0.006731	Area (sq ft)	12.88	930.79	10.74
Q Total (cfs)	11990.00	Flow (cfs)	14.06	11965.97	9.97
Top Width (ft)	284.69	Top Width (ft)	60.10	160.70	63.89
Vel Total (ft/s)	12.56	Avg. Vel. (ft/s)	1.09	12.86	0.93
Max Chl Dpth (ft)	8.47	Hydr. Depth (ft)	0.21	5.79	0.17
Conv. Total (cfs)	146138.4	Conv. (cfs)	171.3	145845.5	121.5
Length Wtd. (ft)	408.89	Wetted Per. (ft)	60.11	165.42	63.94
Min Ch El (ft)	1799.88	Shear (lb/sq ft)	0.09	2.36	0.07
Alpha	1.05	Stream Power (lb/ft s)	0.10	30.40	0.07
Frctn Loss (ft)	3.02	Cum Volume (acre-ft)	0.05	9.05	0.06
C & E Loss (ft)	0.13	Cum SA (acres)	0.24	1.79	0.34

Warning: The energy equation could not be balanced within the specified number of iterations. The
program used critical depth for the water surface and continued on with the calculations.

Warning: Divided flow computed for this cross-section.

Warning: The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section. This may indicate the need for additional cross sections.

Warning: During the standard step iterations, when the assumed water surface was set equal to critical
depth, the calculated water surface came back below critical depth. This indicates that there
is not a valid subcritical answer. The program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid,
water surface was used.

CROSS SECTION

RIVER: Reach #1

REACH: Beaver Dam Wash   RS: 1

INPUT

Description:

Station Elevation Data   num=   66

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	1845	11.88	1844	39.02	1842	64.03	1840	81.55	1838
102.84	1836	111.85	1834	128.39	1832	188.4	1830	197.04	1828
203.91	1826	209.89	1824	216.15	1822	225.78	1820	247.78	1818
273.76	1816	304.68	1816	305.77	1816.26	312.34	1816	342.01	1815.79
351.45	1814	359.62	1812	366.49	1810	373.63	1808	383.02	1806
387.31	1804	387.63	1803.73	394.99	1803.74	395.74	1804	401.49	1806
406.32	1808	408.98	1808	413.5	1806	453.56	1806	468.61	1806
489.84	1806	554.71	1808	584.39	1808	625.79	1808	707.89	1808
773.57	1808	831.09	1808	868.98	1806	871.68	1804	883.52	1802
944.45	1802	968.56	1802	971.61	1800	1000.69	1798	1019.12	1796
1074.39	1796	1090.17	1798	1091.14	1800	1095.9	1810	1100.65	1820
1105.58	1830	1110.28	1840	1115.01	1850	1115.95	1852	1116.89	1854
1117.73	1856	1118.7	1858	1125.47	1860	1131.65	1862	1137.4	1864
1146.65	1866								

Manning's n Values   num=   3

Sta	n Val	Sta	n Val	Sta	n Val
0	.04	868.98	.03	1095.9	.04

Bank Sta: Left	Right	Coeff Contr.	Expan.
868.98	1095.9	.2	.4

CROSS SECTION OUTPUT Profile #100 yr

E.G. Elev (ft)	1809.10	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.11	Wt. n-Val.	0.040	0.030	
W.S. Elev (ft)	1805.99	Reach Len. (ft)			
Crit W.S. (ft)	1805.99	Flow Area (sq ft)	28.85	1471.44	
E.G. Slope (ft/ft)	0.006984	Area (sq ft)	28.85	1471.44	
Q Total (cfs)	21000.00	Flow (cfs)	116.89	20883.11	
Top Width (ft)	243.43	Top Width (ft)	18.43	225.00	
Vel Total (ft/s)	14.00	Avg. Vel. (ft/s)	4.05	14.19	
Max Chl Dpth (ft)	9.99	Hydr. Depth (ft)	1.57	6.54	
Conv. Total (cfs)	251285.9	Conv. (cfs)	1398.7	249887.2	
Length Wtd. (ft)		Wetted Per. (ft)	19.35	231.77	
Min Ch El (ft)	1796.00	Shear (lb/sq ft)	0.65	2.77	
Alpha	1.02	Stream Power (lb/ft s)	2.63	39.29	
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

Warning: Divided flow computed for this cross-section.

Warning: Slope too steep for slope area to converge during supercritical flow calculations (normal depth

is below critical depth). Water surface set to critical depth.

CROSS SECTION OUTPUT Profile #25 yr

E.G. Elev (ft)	1806.11	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.25	Wt. n-Val.	0.040	0.030	
W.S. Elev (ft)	1803.86	Reach Len. (ft)			
Crit W.S. (ft)	1803.86	Flow Area (sq ft)	0.97	996.31	
E.G. Slope (ft/ft)	0.008129	Area (sq ft)	0.97	996.31	
Q Total (cfs)	11990.00	Flow (cfs)	0.80	11989.20	
Top Width (ft)	228.35	Top Width (ft)	7.87	220.48	

Vel Total (ft/s)	12.02	Avg. Vel. (ft/s)	0.82	12.03
Max Chl Dpth (ft)	7.86	Hydr. Depth (ft)	0.12	4.52
Conv. Total (cfs)	132987.0	Conv. (cfs)	8.8	132978.1
Length Wtd. (ft)		Wetted Per. (ft)	7.94	225.23
Min Ch El (ft)	1796.00	Shear (lb/sq ft)	0.06	2.24
Alpha	1.00	Stream Power (lb/ft s)	0.05	27.01
Frctn Loss (ft)		Cum Volume (acre-ft)		
C & E Loss (ft)		Cum SA (acres)		

Warning: Divided flow computed for this cross-section.

Warning: Slope too steep for slope area to converge during supercritical flow calculations (normal depth

is below critical depth). Water surface set to critical depth.

SUMMARY OF MANNING'S N VALUES

River:Reach #1

Reach	River Sta.	n1	n2	n3
Beaver Dam Wash	25	.07	.03	.05
Beaver Dam Wash	24	.07	.03	.05
Beaver Dam Wash	23	.07	.03	.05
Beaver Dam Wash	22	.07	.03	.05
Beaver Dam Wash	21	.07	.03	.05
Beaver Dam Wash	20	.07	.03	.05
Beaver Dam Wash	19.5	.07	.03	.05
Beaver Dam Wash	19	.07	.03	.05
Beaver Dam Wash	18	.07	.03	.05
Beaver Dam Wash	17	.07	.03	.05

Beaver Dam Wash	16		.07	.03	.05
Beaver Dam Wash	15		.07	.03	.05
Beaver Dam Wash	14		.07	.03	.04
Beaver Dam Wash	13		.07	.03	.04
Beaver Dam Wash	12		.07	.03	.04
Beaver Dam Wash	11.5	Bridge			
Beaver Dam Wash	11		.05	.03	.04
Beaver Dam Wash	10		.05	.03	.04
Beaver Dam Wash	9		.04	.03	.04
Beaver Dam Wash	8		.04	.03	.04
Beaver Dam Wash	7		.04	.03	.04
Beaver Dam Wash	6		.04	.03	.04
Beaver Dam Wash	5		.04	.03	.04
Beaver Dam Wash	4		.04	.03	.04
Beaver Dam Wash	3		.04	.03	.04
Beaver Dam Wash	2		.04	.03	.04
Beaver Dam Wash	1		.04	.03	.04

SUMMARY OF REACH LENGTHS

River: Reach #1

Reach	River Sta.	Left	Channel	Right
Beaver Dam Wash	25	481.74	506.65	552.44
Beaver Dam Wash	24	431.03	464.84	465.88
Beaver Dam Wash	23	393.03	393.38	464.14
Beaver Dam Wash	22	388.99	396.75	377.61
Beaver Dam Wash	21	369.36	389.17	399.71
Beaver Dam Wash	20	250.91	250.89	254.9

Beaver Dam Wash	19.5	122.77	122.37	121.5
Beaver Dam Wash	19	425.19	441.09	451.49
Beaver Dam Wash	18	368.22	402.4	428.15
Beaver Dam Wash	17	381.74	435.9	487.97
Beaver Dam Wash	16	275	282.5	290
Beaver Dam Wash	15	305.8	329.92	377.91
Beaver Dam Wash	14	297.63	277.08	281.46
Beaver Dam Wash	13	205	205	205
Beaver Dam Wash	12	141.97	67.49	188.08
Beaver Dam Wash	11.5	Bridge		
Beaver Dam Wash	11	448.39	424.85	389.32
Beaver Dam Wash	10	464.82	392.17	304.28
Beaver Dam Wash	9	454.9	368.46	304.53
Beaver Dam Wash	8	378.01	321.27	255.23
Beaver Dam Wash	7	308.17	320.9	357.01
Beaver Dam Wash	6	270.26	292.58	317.61
Beaver Dam Wash	5	430.91	414.45	462.38
Beaver Dam Wash	4	291.64	429.09	457.75
Beaver Dam Wash	3	294.24	375.19	433.01
Beaver Dam Wash	2	306.5	408.93	457.37
Beaver Dam Wash	1			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS

River: Reach #1

Reach	River Sta.	Contr.	Expan.
Beaver Dam Wash	25	.1	.3
Beaver Dam Wash	24	.1	.3

Beaver Dam Wash	23		.1	.3
Beaver Dam Wash	22		.1	.3
Beaver Dam Wash	21		.1	.3
Beaver Dam Wash	20		.1	.3
Beaver Dam Wash	19.5		.1	.3
Beaver Dam Wash	19		.1	.3
Beaver Dam Wash	18		.1	.3
Beaver Dam Wash	17		.1	.3
Beaver Dam Wash	16		.1	.3
Beaver Dam Wash	15		.1	.3
Beaver Dam Wash	14		.3	.5
Beaver Dam Wash	13		.3	.5
Beaver Dam Wash	12		.3	.5
Beaver Dam Wash	11.5	Bridge		
Beaver Dam Wash	11		.3	.5
Beaver Dam Wash	10		.3	.5
Beaver Dam Wash	9		.2	.4
Beaver Dam Wash	8		.2	.4
Beaver Dam Wash	7		.2	.4
Beaver Dam Wash	6		.2	.4
Beaver Dam Wash	5		.2	.4
Beaver Dam Wash	4		.2	.4
Beaver Dam Wash	3		.1	.3
Beaver Dam Wash	2		.2	.4
Beaver Dam Wash	1		.2	.4

ERRORS WARNINGS AND NOTES

Errors Warnings and Notes for Plan : 400-ft Brdg

River: Reach #1 Reach: Beaver Dam Wash   RS: 25   Profile: 100 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 25 Profile: 25 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 24 Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water

surface that had the least amount of error between computed and assumed values.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 24 Profile: 25 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 23 Profile: 100 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 23 Profile: 25 yr

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 22 Profile: 100 yr

Warning:Divided flow computed for this cross-section.

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 22 Profile: 25 yr

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 21 Profile: 100 yr

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 21 Profile: 25 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 20 Profile: 100 yr

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 20 Profile: 25 yr

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 19.5 Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water

surface that had the least amount of error between computed and assumed values.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 19.5 Profile: 25 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water

surface that had the least amount of error between computed and assumed values.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 19 Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water

surface that had the least amount of error between computed and assumed values.

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 19 Profile: 25 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water

surface that had the least amount of error between computed and assumed values.

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 18 Profile: 100 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 18 Profile: 25 yr

Warning:Divided flow computed for this cross-section.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 17 Profile: 100 yr

Warning:Divided flow computed for this cross-section.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 17 Profile: 25 yr

Warning:Divided flow computed for this cross-section.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash   RS: 16   Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water

surface that had the least amount of error between computed and assumed values.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash   RS: 16   Profile: 25 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash   RS: 15   Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 15   Profile: 25 yr

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 14 Profile: 100 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 14 Profile: 25 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 13 Profile: 100 yr

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 13 Profile: 25 yr

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 12 Profile: 100 yr

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 12   Profile: 25 yr

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 11.5   Profile: 100 yr

Warning:The flow regime calculated by the momentum equation shows class B flow. For the best solution, this profile should

be run as a mixed flow problem.

River: Reach #1 Reach: Beaver Dam Wash   RS: 11.5   Profile: 100 yr Upstream

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 11.5   Profile: 100 yr Downstream

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 11.5   Profile: 25 yr

Warning:The water surface upstream of the bridge computed by the Yarnell method was below critical depth. The Yarnell

solution has been disregarded.

Note: Yarnell answer is not valid if the water surface is above the low chord or if there is weir flow. The Yarnell answer

has been disregarded.

River: Reach #1 Reach: Beaver Dam Wash   RS: 11.5   Profile: 25 yr Upstream

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 11.5   Profile: 25 yr Downstream

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 11   Profile: 100 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 11   Profile: 25 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

River: Reach #1 Reach: Beaver Dam Wash RS: 10 Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 10 Profile: 25 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 9 Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 9   Profile: 25 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash   RS: 8   Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash   RS: 8   Profile: 25 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water surface that had the least amount of error between computed and assumed values.

Warning:Divided flow computed for this cross-section.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 7 Profile: 100 yr

Warning:Divided flow computed for this cross-section.

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 7 Profile: 25 yr

Warning:Divided flow computed for this cross-section.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 6 Profile: 100 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 6 Profile: 25 yr

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 5 Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 5 Profile: 25 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 4 Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 4 Profile: 25 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 3 Profile: 100 yr

Warning:Divided flow computed for this cross-section.

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 3 Profile: 25 yr

Warning:Divided flow computed for this cross-section.

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

River: Reach #1 Reach: Beaver Dam Wash RS: 2 Profile: 100 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 2 Profile: 25 yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The

program defaulted to critical depth.

Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was

used.

River: Reach #1 Reach: Beaver Dam Wash RS: 1 Profile: 100 yr

Warning:Divided flow computed for this cross-section.

Warning:Slope too steep for slope area to converge during supercritical flow calculations (normal depth is below critical

depth). Water surface set to critical depth.

River: Reach #1 Reach: Beaver Dam Wash RS: 1 Profile: 25 yr

Warning:Divided flow computed for this cross-section.

Warning:Slope too steep for slope area to converge during supercritical flow calculations (normal depth is below critical

depth). Water surface set to critical dep

Appendix E Digital Data on DVD

Appendix F Proposed Flood Warning System Instrumentation Location Map