Clark County Regional Flood Control District

2016 Flood Control Master Plan Update
Muddy River and Tributary Washes

REGIONAL FLOOD CONTROL DISTRICT

CLARK COUNTY NEVADA

ATKINS

2016
FLOOD CONTROL MASTER PLAN UPDATE
MUDDY RIVER AND TRIBUTARY WASHES

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Adopted by
Regional Flood Control District Board of Directors on
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REGIONAL FLOOD CONTROL DISTRICT

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Executive Summary

Introduction

The Clark County Regional Flood Control District (CCRFCD) is responsible for developing and implementing a comprehensive flood control master plan to alleviate flooding in Clark County. Nevada Revised Statute (NRS) 543.596 requires that flood control master plans be reviewed and updated at least every 5 years. The 2016 Flood Control Master Plan Update (2016 MPU) for the Muddy River and Tributary Washes is one of those updates. Previous MPUs for the Muddy River and Tributary Washes were prepared in 1988, 1994, 2001, 2005, and 2010. This 2016 MPU is a planning tool for use by public agencies, land planners, engineers, landowners, and other entities.

Purpose, Location, and Scope

The purpose of the MPU is to add any new relevant information to the Master Plan, to assess progress towards fulfillment of the Master Plan during the 5-year period, to identify obstacles to completing the Master Plan, and to recommend changes to the Master Plan resulting from growth and development. This document presents the results of field investigation, data collection, hydrologic/hydraulic analyses, facility planning, and cost estimate analyses that led to the development of the master plan.

The Muddy River and Tributary Washes MPU study area is situated approximately 50 miles northeast of Las Vegas along the Muddy River corridor in northeast Clark County, Nevada. The valley along the Muddy River generally runs northwest to southeast and is divided into two regions (referred to in this report as Moapa and Moapa Valley) by a narrow canyon south of Interstate 15 (I-15) known as the "Narrows". To facilitate the organization and presentation of the information collected and developed for the 2016 MPU, the study area has been subdivided into four areas that will be referred to as: (1) Western Washes, (2) Eastern Washes, (3) Lower Muddy River, and (4) Moapa.

The 2016 MPU is based on assumptions about future growth and development in the study area in order to represent the ultimate hydrologic condition and to aid in the planning and preliminary design of future flood control facilities. Soils information and land use data is used in conjunction with the 100-year frequency design rainfall event to develop hydrologic computer models that establish peak flow rates and flow volumes for drainage corridors. These peak flow rates and flow volumes are then used to analyze the existing/proposed flood control system and identify deficiencies or potential flooding vulnerabilities. The recommended flood control facility plan consisting of structural improvements is then developed (or updated) in order to mitigate identified deficiencies.

The 2016 MPU also includes general information and recommendations regarding floodplain management and non-structural solutions. Floodplain management and non-structural solutions may be relevant in this MPU because of the complex nature of the Muddy River floodplain that makes the structural solutions infeasible and/or difficult to implement along flat, riverine corridors in the study area that experience high flows and frequent flooding.

Watershed Analysis

A comprehensive review of the previous MPU hydrologic analysis was performed and significant updates were made to incorporate new data collected and ensure the analysis was based on best-available, current information. This involved updates to elevation data, inventories of existing facilities, hydrologic and hydraulic models, facility sizes, land use information, soils data, costs, geographic information system (GIS) databases, maps, and reports.

Major modifications made to the flood control plan during development of this MPU are based on the following:

- Updated topographic (LiDAR) data that was obtained specifically for the 2016 MPU
- Identification of flood control facilities constructed after the 2010 MPU
- Updated soils and land use data
- Updated subbasin delineations, hydrologic models, and analysis methodology
- Development of two-dimensional (2D) hydraulic models for the Eastern/Western Washes and Lower Muddy River to identify structural and non-structural alternatives
- Revisions to facility sizes and alignments due to changes in flow rates
- Addition of new facilities where deemed necessary to mitigate flood hazards

The 2016 MPU hydrologic modeling produced peak flow rates that were somewhat different than the peak flow estimates in the 2010 MPU. In some areas the flow rates increased while in other areas the flow rates decreased. The differences can be primarily attributed to the updated soils/land use data, revised curve numbers, updated hydrologic parameters, and revisions to the subbasin delineations based on better topography data.

Master Plan Progress since 2010 MPU

Progress has been made on the implementation of the flood control master plan since the 2010 MPU. This primarily consists of the following:

- Construction completed for the **Muddy River Cooper Street Bridge** (MRLV 0343-0388)
- Preliminary Design Report completed and final design initiated for the **Logandale Fairgrounds Detention Basin** (FGWS 0166) and outfall system (FGWS 0000-0164) in Whipple Avenue
- Final design completed for the **Muddy River Logandale Levee** (MRLL 0001-0038), advertising initiated, and start of construction anticipated in October 2016

Recommended Flood Control Plan

Changes to the 2010 MPU recommended in the 2016 MPU are described below. In addition, all existing and proposed regional flood control facilities in the 2016 MPU are summarized in the facility maps and inventory tables in **Figure F-1** and **Figure F-2** at the end of this report in the section titled **Facility Maps**.

Western Washes

For the majority of the Western Washes, the recommended flood control plan is similar to the plan outlined in the 2010 MPU with some modifications:

- **West Wash 1 Detention Basin (WWWA 0017) –** This detention basin from the previous MPU has been split into two proposed detention basins: the West Wash 1 Detention Basin (WWWA 0017) and the Ingram Avenue Detention Basin (WWIA 0016). This was necessary because there are distinct, separate washes and flow corridors in the area that could not be intercepted by one detention basin at a single location.

- **Western Washes Railroad Channel (WWRR 0000-0550)** – This proposed channel system and culvert/bridge crossings were reviewed and upsized as necessary using the updated hydrologic results. The 100-year peak discharge in the channel increased, due to the revised soils data and subbasin delineations that show certain areas downstream of the proposed detention basins draining directly to the channel. The channel was also extended at the upstream end to collect flow impacting the UPRR alignment south of the Gann Avenue Storm Drain.

- **Western Washes Detention Basins (WWWT 0004, WWDA 0009, WWCA 0050, WWWI 0027, WWWA 0017, WWIA 0016, WWPA 0018)** – All of the proposed Western Washes detention basins were reviewed and revised based on updated hydrologic analysis. Proposed detention basin volumes were also modified in order to account for sediment allowance and 1 foot of freeboard. The footprints and proposed locations of the detention basins were revised as necessary using the detailed 2015 LiDAR data to ensure they are situated in primary flow corridors and low-lying areas.

Eastern Washes

In addition to the Fairgrounds Detention Basin (currently in the predesign phase), two significant detention basin facilities have been added to the recommended flood control plan to mitigate flooding from the Eastern Washes:

- **Lyman Street Detention Basin and Outfall (FGLS 0000 – 0167)**. During the hydrologic/hydraulic analysis of the Eastern Washes, it became apparent that a large 23-square-mile watershed and significant peak 100-year discharge of approximately 5,000 cfs was draining toward a large, man-made, earthen berm located on the northeastern side of Logandale about 1 mile east of the

Bowman Reservoir. The berm diverts flow from the natural wash and directs it west in another wash that eventually discharges to the Bowman Reservoir. The man-made berm is not in good condition and is not an engineered structure that can be relied upon for flood protection of the downstream residential areas. Thus, a regional detention basin has been proposed in this area with a 72" RCP outfall system in Lyman Street that will connect to the proposed regional storm drain facility in Whipple Avenue.

- **Gubler Avenue Detention Basin and Outfall (EWGA 0000-0196)**. An additional detention basin has been added at the east end of Bunnell Avenue to intercept flow that drains to a natural wash at that location. The natural wash does not have capacity to convey the 100-year flow of 1,447 cfs safely through the residential areas, which results in flooding and sediment deposition on the local roadways. Thus, a regional detention basin system has been proposed in this area to intercept flow, reduce sediment, and safely convey flow to the Muddy River in a storm drain system in Gubler Avenue.

Lower Muddy River

The recommended flood control plan along the Lower Muddy River is based on previous MPUs. From Gubler Avenue to Cooper Street, the recommended flood control plan has been perpetuated from the 2010 MPU. Downstream of Cooper Street, the recommended flood control plan has been modified based on the 2D HEC-RAS model, updated MPU analysis, and the detailed LiDAR data obtained for the project. Updates to the recommended flood control plan for the Lower Muddy River are described below:

- **Muddy River, from Cooper Street to West Creek Confluence (MRLV 0268, 0276) –** The recommended regional facility for this reach is a stabilized earthen channel with rip-rap lined banks, 400-feet wide, 8-feet deep, and 3:1 side slopes. This facility was reviewed in detail and it was determined that a slightly steeper slope and a lower profile (i.e., below-grade channel) would allow the proposed West Creek Channel (MRWC 0000) to daylight into the Muddy River downstream, thereby eliminating the a parallel facility that was previously proposed. The recommended channel geometry is similar in size to the previous MPU but the profile is lower.

- **Muddy River, from West Creek Confluence to south of Lewis Avenue (MRLV 0184, 0198, 0240) –** The proposed regional facility in this reach is a stabilized earthen channel with rip-rap lined banks, 600-feet wide, 6.5-feet deep, and 3:1 side slopes. The proposed slope of the channel was adjusted from 0.4% to 0.2% based on updated topography, which also serves the purpose of keeping the velocity lower and the channel shallower for daylighting purposes near Lewis Avenue. Above-grade levees (4-5 feet high) on both sides of the channel are required since the channel is wide and flat and cannot be excavated further below grade without significant cost and daylighting issues.

- **Muddy River, from south of Lewis Avenue to Overton WMA (MRLV 0142) –** The proposed regional facility for this reach of the Muddy River is an earthen levee on the west side of the Muddy River corridor. This facility will begin downstream of the proposed confluence with Western Washes Railroad Channel, and will protect the private properties to the west and allow flow to spread out on the east and continue south to the Overton WMA.

- **Removal of Muddy River Facilities Downstream of Overton WMA –** The previous MPU proposed to extend a wide earthen channel with levees and a parallel facility 7,400 feet downstream of the Overton WMA diversion structure (MRLV 0000 and 0105). These facilities have been removed from the recommended control plan in the area, meaning the proposed Muddy River channel improvements stop at the diversion structure.

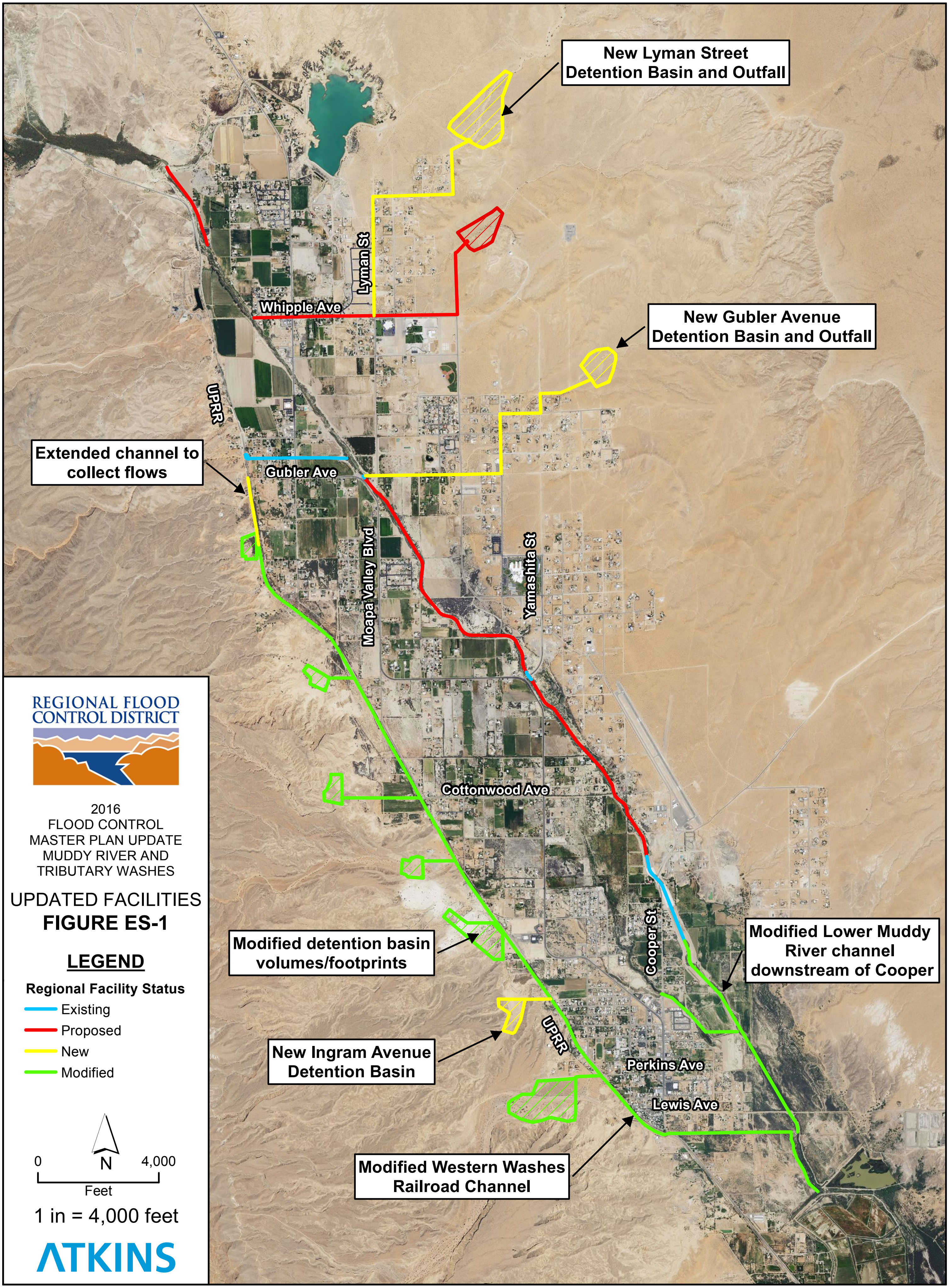
Moapa (Upper Muddy River Area)

The recommended flood control plan for Moapa is consistent with the previous MPU and essentially consists of a non-structural floodplain management plan, i.e., managing the floodplain according to FEMA standards and ensuring that new construction within the floodplain conforms to the National Flood Insurance Program (NFIP) and local floodplain ordinances. The flood control plan in the area should continue to evolve as more development plans occur in the future.

The locations of the facilities recommended in the 2016 MPU are shown on **Figure ES-1**. All facilities from the 2010 MPU that are not described above have not been modified and are perpetuated in the 2016 MPU recommended flood control plan.

In addition to the structural recommendations, the 2016 MPU also includes recommendations regarding non-structural solutions and floodplain management strategies that reduce the adverse impacts of flooding. Non-structural recommendations were first developed and included in the 2001 MPU and have been updated to include new information. Non-structural solutions are described in detail in **Section 8** and include alternatives such as acquiring/relocating property, floodplain mapping, public outreach and education, floodproofing structures, acquiring/relocating property, maintaining facilities, and taking advantage of state and federal flood hazard mitigation programs and grants.

Approximately 20.1 miles of conveyance facilities are included in the 2016 MPU. Approximately 1.6 miles of these facilities already exist or are under construction; the remaining 18.5 miles of proposed conveyance facilities remain to be constructed. A total of 10 detention basins are proposed in the 2016 MPU, ranging in size from 49 ac-ft to 1,247 ac-ft.


New Lyman Street Detention Basin and Outfall
Lyman St
Whipple Ave
New Gubler Avenue Detention Basin and Outfall
UPRR
Extended channel to collect flows
Gubler Ave
Moapa Valley Blvd
Yamashita St
Cottonwood Ave
Cooper St
Modified Lower Muddy River channel downstream of Cooper
Modified detention basin volumes/footprints
UPRR
New Ingram Avenue Detention Basin
Perkins Ave
Lewis Ave
Modified Western Washes Railroad Channel
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UPDATED FACILITIES
FIGURE ES-1
LEGEND
Regional Facility Status
Existing
Proposed
New
Modified
N
0
4,000
Feet
1 in = 4,000 feet
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Cost Estimates

Cost estimates for existing regional facilities in the 2016 MPU are based on actual cost data that has been compiled during previous MPUs and the past 5 years. Construction cost estimates for proposed regional facilities were determined using the CCRFCD Cost Estimation Tool that was developed as part of the 2008 Las Vegas Valley MPU. Based on input from CCRFCD, a cost factor of 0.815 was applied to all of the estimated costs in the 2016 MPU to be consistent with other cost estimates and the Ten Year Construction Program used at CCRFCD for planning purposes. The factor essentially accounts for an increase (inflation) in the costs of about 6.6% since the time the 2010 MPU was prepared (previous factor in 2010 MPU was 0.765).

The total estimated cost of existing flood control facilities in Moapa Valley is $25.3 million. The total estimated construction cost of proposed facilities in Moapa Valley is $118.7 million. The estimated costs of existing facilities are summarized in **Table ES-1** and total estimated costs of proposed facilities are summarized in **Table ES-2**. The estimated costs of proposed facilities from the 2010 MPU are also included in **Table ES-2** for comparison purposes.

Table ES-1 Estimated Cost of Existing Facilities

Existing Facilities			
ID / River Mile	**E/P**	**Facility Description**	**Total Cost ($ x 1000)**
GASD		**GANN AVENUE STORM DRAIN**	
0000	E2	20'X8' Transition Channel	$817
0005	E2	2- 10' RCP	$817
0030	E2	2- 10'X8' RCB	$817
0058	E2	Existing Debris Basin	$817
		Project Total:	**$3,268**
MRLV		**MUDDY RIVER LOWER VALLEY**	
0343	E2	Earthen Chnl w/ Riprap-Lined Bank 200'W 9.5'D 3:1 SS	$989
0350	E2	Earthen Chnl w/ Riprap-Lined Bank 200'W 11'D 3:1 SS	$1,234
0357	E2	Conc Chnl 200'W 11'D 2:1 SS	$3,849
0375	E2	Cooper Street Bridge	$4,197
0377	E2	Conc Chnl 180'W 13.6'D 2.5:1 SS	$1,988
0388	E2	Gabion Channel 200'W 11.5'D 3:1 SS	$1,440
0534	E2	Earthen Channel w/ Gabion Side Slopes	$686
0536	E2	Yamashita Street Bridge	$686
0537	E2	Earthen Channel w/ Gabion Side Slopes	$686
0725	E2	Gubler Avenue Bridge	$5,800
		Project Total:	**$21,555**
LWAW		**LOGAN WASH DIVERSION**	
0000	E2	Earthen Diversion Channel	$500
		Project Total:	**$500**
		Total Existing Facility Cost:	**$25,323**

Table ES-2 Estimated Construction Cost of Proposed Facilities

Proposed Facilities Cost Comparison			
	Facility Description	**2016 MPU Cost ($ x 1000)**	**2010 MPU Cost ($ X 1000)**
EASTERN WASHES			
EWGA	EASTERN WASHES - GUBLER	$10,345	-
FGLS	FAIRGROUNDS - LYMAN	$15,844	-
FGWS	FAIRGROUNDS - WHIPPLE	$9,540	$6,012
LOWER MUDDY RIVER			
MRLL	MUDDY RIVER LOGANDALE LEVEE	$3,332	$3,126
MRLV	MUDDY RIVER LOWER VALLEY	$41,225	$63,332
MRWC	MUDDY RIVER WEST CREEK	$2,083	$2,036
WESTERM WASHES			
WWCA	WESTERN WASHES CHANNEL SYSTEM - COTTONWOOD	$3,544	$3,368
WWDA	WESTERN WASHES CHANNEL SYSTEM - DUESING	$1,234	$933
WWIA	WESTERN WASHES CHANNEL SYSTEM - INGRAM	$1,926	-
WWPA	WESTERN WASHES CHANNEL SYSTEM - PERKINS	$8,566	$9,047
WWRR	WESTERN WASHES RAILROAD CHANNEL	$14,591	$9,576
WWWA	WESTERN WASHES CHANNEL SYSTEM - WEST WASH 1	$2,685	$3,334
WWWI	WESTERN WASHES CHANNEL SYSTEM - WIEBER	$2,520	$2,846
WWWT	WESTERN WASHES CHANNEL SYSTEM - WITTWER	$1,227	$990
	Total Proposed Facility Cost:	**$118,662**	**$104,600**

In the 2010 MPU, the total estimated cost of existing facilities was $11.8 million. The total estimated cost of existing facilities in the 2016 MPU has increased to $25.3 million due to the construction of the Muddy River Cooper Street Bridge and associated improvements to the Muddy River channel. Note that the $25.3 million estimated cost of existing facilities does not include right-of-way acquisition costs. The total right-of-way acquisition costs paid to date by Clark County to acquire property where flood control facilities are either built or proposed is approximately $10.7 million.

In the 2010 MPU, the total estimated cost of proposed facilities was $104.6 million. The total estimated costs for proposed facilities in the 2016 MPU have increased to $118.7 million because of inflation and the addition/modification of regional facilities in the flood control plan. The cost of proposed facilities includes estimated right-of-way acquisition costs where it is anticipated to be needed.

The 2016 MPU serves as a planning tool for the implementation of the flood control system in Moapa Valley and for the design of master plan facilities. The flood control system identified and described in this MPU may be subject to further amendments and revisions in the future as more detailed analyses are completed for facilities in the pre-design and design phases.

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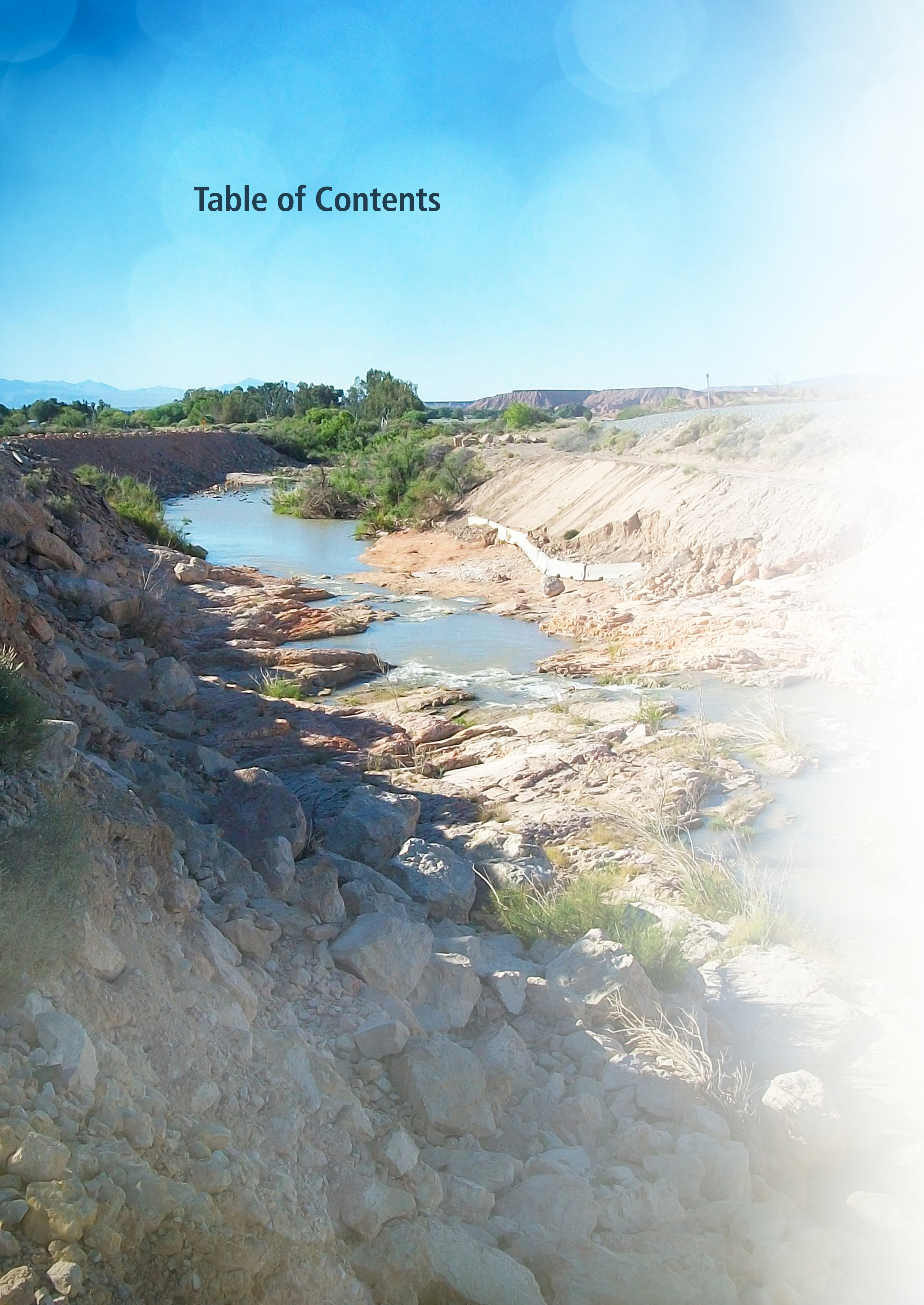

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*All appendices are included electronically on the CD provided with this document

Acronyms and Abbreviations

ac-ft	Acre-foot
AMC	Antecedent Moisture Condition
Ave	Avenue
BLM	Bureau of Land Management
CAA	Clean Air Act
CCMP	Clark County Master Plan
CCRFCD	Clark County Regional Flood Control District
CFR	Code of Federal Regulations
cfs	Cubic feet per second
Chnl	Channel
CN	Curve number
Conc	Concrete
CWA	Clean Water Act
DAQEM	Department of Air Quality & Environmental Management
DARF	Depth-area reduction factor
Design Manual	Hydrologic Criteria and Drainage Design Manual
DEM	Digital Elevation Model
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
ft	Foot
ft^3	Cubic foot
FTRS	Flood Threat Recognition System
GIS	Geographic Information System
HEC	Hydrologic Engineering Center of the USACE
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
I-15	Interstate 15
MVIC	Muddy Valley Irrigation Company
MVWD	Moapa Valley Water District
MPU	Master Plan Update

MSHCP	Multiple Species Habitat Conservation Plan
MUSYM	Map Unit Symbol
NAAQS	National Ambient Air Quality Standards
NAC	Nevada Administrative Code
NDEP	Nevada Division of Environmental Protection
NDOW	Nevada Department of Wildlife
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service
NRS	Nevada Revised Statute
PDM	Pre-Disaster Mitigation
PLU	Planned Land Use
PM	Particulate Matter
PMF	Probable maximum flood
RCB	Reinforced concrete box
RCP	Reinforced concrete pipe
ROW	Right-of-way
SDN	Storm Distribution Number
SFHA	Special Flood Hazard Area
SHPO	State Historic Preservation Office
SNWA	Southern Nevada Water Authority
SS	Side slopes
TAB	Town Advisory Board
TCP	Traditional Cultural Property
U.S.	United States
USACE	United State Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
UPRR	Union Pacific Railroad
USGS	United States of Geological Survey
WMA	Wildlife Management Area

SECTION 1
Introduction

1. Introduction

1.1. General

In 1985, in response to severe flooding problems in Clark County, the Nevada Legislature passed legislation that allowed the local entities the opportunity to create the Clark County Regional Flood Control District (CCRFCD). The CCRFCD is responsible for developing and implementing a comprehensive flood control master plan to alleviate flooding. In 1986, in accordance with Nevada state law, the original flood control master plan was developed that addressed flood control needs for the entire CCRFCD service area (i.e., Clark County).

Nevada Revised Statute (NRS) 543.596 requires that flood control master plans be reviewed and updated every 5 years. The 2016 Flood Control Master Plan Update for the Muddy River and Tributary Washes (hereafter referred to as the 2016 MPU) is one of those updates. Previous MPUs were prepared in 1988, 1994, 2001, 2005, and 2010 (note that the 2010 MPU was adopted by the CCRFCD Board of Directors on February 10, 2011 but is still referred to as the 2010 MPU in this report).

The 2016 MPU and previous MPUs are based in part on assumptions about future growth and development in Moapa Valley in order to represent the ultimate hydrologic condition and to aid in the planning and preliminary design of future flood control facilities. Soils information and land use data is used in conjunction with the 100-year frequency design rainfall event to develop hydrologic computer models that establish peak flow rates and flow volumes for drainage corridors. These peak flow rates and flow volumes are then used to analyze the existing and proposed flood control system and identify deficiencies or potential flooding vulnerabilities. The recommended flood control facility plan consisting of structural improvements is then developed (or updated) in order to mitigate identified deficiencies.

The 2016 MPU also includes general information and recommendations regarding floodplain management and non-structural solutions. Floodplain management and non-structural solutions are relevant because of the complex nature of the Muddy River floodplain that makes the structural solutions infeasible and/or difficult to implement along flat, riverine corridors that experience high flows and frequent flooding.

1.2. Purpose and Objectives

The purpose of the MPU is to add any new relevant information to the Master Plan, to assess progress towards fulfillment of the Master Plan during the 5-year period, to identify obstacles to completing the Master Plan, and to recommend changes to the Master Plan resulting from growth and development.

This document compiles all relevant information into a single source and serves as a planning tool for use by public agencies, land planners, developers, engineers, and other entities. It identifies necessary flood control projects and can be used to set priorities and allocate available funds for the design and construction of a regional flood control system. The technical information presented in this report is based on best available data as of February 2016. The flood control system identified and described in this MPU may be subject to further amendments and revisions in the future as more detailed analyses are completed for facilities in the pre-design and design phases.

The MPU does not include detailed facility design or in-depth information regarding local flooding problems, utility conflicts, existing/interim condition hydrology, maintenance problems, funding availability, or project timing; rather, the MPU is a planning document for the ultimate buildout condition that can be used in conjunction with other programs and floodplain management strategies to mitigate overall flooding concerns in the area.

1.3. Master Plan Process and Formulation

Preparation of the 2016 MPU included a thorough review of previous MPUs and updates to the following information: elevation data, inventories of existing facilities, hydrologic models, hydraulic models, facility sizes, land use information, soils data, costs, graphics, databases, GIS coverages, maps, and reports. The work completed for the 2016 MPU essentially consisted of four main tasks:

- **Data Collection**. This involved performing field investigations and collecting available reports, models, GIS data, and engineering plans relevant to the master plan. This information was reviewed in detail and relevant information was incorporated into the 2016 MPU. One of the most significant data collection efforts in 2016 MPU included obtaining updated aerial topographic data for the project, which extended from Wells Siding at the upstream end to the Overton WMA at the downstream end (approximately 7 miles) using light detection and ranging (LiDAR) technology. This is described further in **Section 3**.

- **Hydrologic Analysis**. Analysis was performed to update previous MPU hydrologic models and determine 100-year peak flows and volumes in the study area based on the CCRFCD Hydrologic Criteria and Drainage Design Manual (hereafter referred to as the Design Manual) dated August 1999, including subsequent revisions through 2014 (**Reference 1**).

- **Facility Analysis**. Using the results of the hydrologic analysis and a conceptual hydraulic analysis of the system, the proposed flood control facility plan was modified, revised, re-evaluated, and updated as necessary to incorporate all data collected and to verify that the proposed flood control system can adequately convey and/or detain flood flows.

- **Cost Analysis**. The CCRFCD Cost Tool that was developed for the 2008 Las Vegas Valley MPU was used to estimate the construction costs of proposed regional facilities. Cost estimates for existing regional facilities are based on actual cost data that has been compiled during previous MPUs and the past 5 years.

Modifications made to the flood control plan during development of this MPU are based on the following:

- Updated topographic (LiDAR) data that was obtained for the 2016 MPU
- Identification of flood control facilities constructed after the 2010 MPU
- Updated soils and land use data
- Updated subbasin delineations, hydrologic models, and analysis methodology
- Revisions to facility sizes and alignments due to changes in flow rates
- Development of two-dimensional (2D) hydraulic models for the Eastern/Western Washes and Lower Muddy River to identify structural and non-structural alternatives
- Addition of new facilities where deemed necessary to mitigate flood hazards

Approximately 20.1 miles of conveyance facilities are included in the 2016 MPU. Approximately 1.6 miles of these facilities already exist or are under construction; the remaining 18.5 miles of proposed conveyance facilities remain to be constructed. A total of 10 detention basins are proposed in the 2016 MPU, ranging in size from 49 ac-ft to 1,247 ac-ft. The 2016 MPU also includes relevant information about crossings, culverts, bridges, and detention/sediment basins in the study area.

1.4. Study Area Description and Location

The MPU study area is situated approximately 50 miles northeast of Las Vegas along the Muddy River corridor in northeast Clark County, Nevada. The valley along the Muddy River generally runs northwest to southeast and is divided into two regions by a narrow canyon south of Interstate 15 (I-15) through which the Muddy River flows, known as the "Narrows". The Narrows is also in the general location of the confluence of the Upper Muddy River, Meadow Valley Wash, California Wash, and Weiser Wash. This division is generally accepted as the boundary between the upper and lower portions of the Muddy River. In this report, the general area upstream of the Narrows is referred to as Moapa and the area south of the Narrows is referred to as Moapa Valley (see **Figure 1-1**).

Moapa is bounded on the west by the Meadow Valley Mountains and the Arrow Canyon Range. The Mormon Mountains lie east of Moapa. This valley is sparsely populated in the towns of Moapa and Glendale. Agriculture is the predominant land use in the area.

The Moapa Valley extends south to the Overton Arm of Lake Mead. This area is bounded on the east by the Mormon Mesa and on the west by the Muddy Mountains and Overton Ridge. The Moapa Valley contains the communities of Logandale and Overton. Agriculture is the predominant land use within the Moapa Valley, although the area is increasingly becoming more urbanized with residential and commercial areas. A vicinity map of the 2016 MPU study area is shown in **Figure 1-1**.

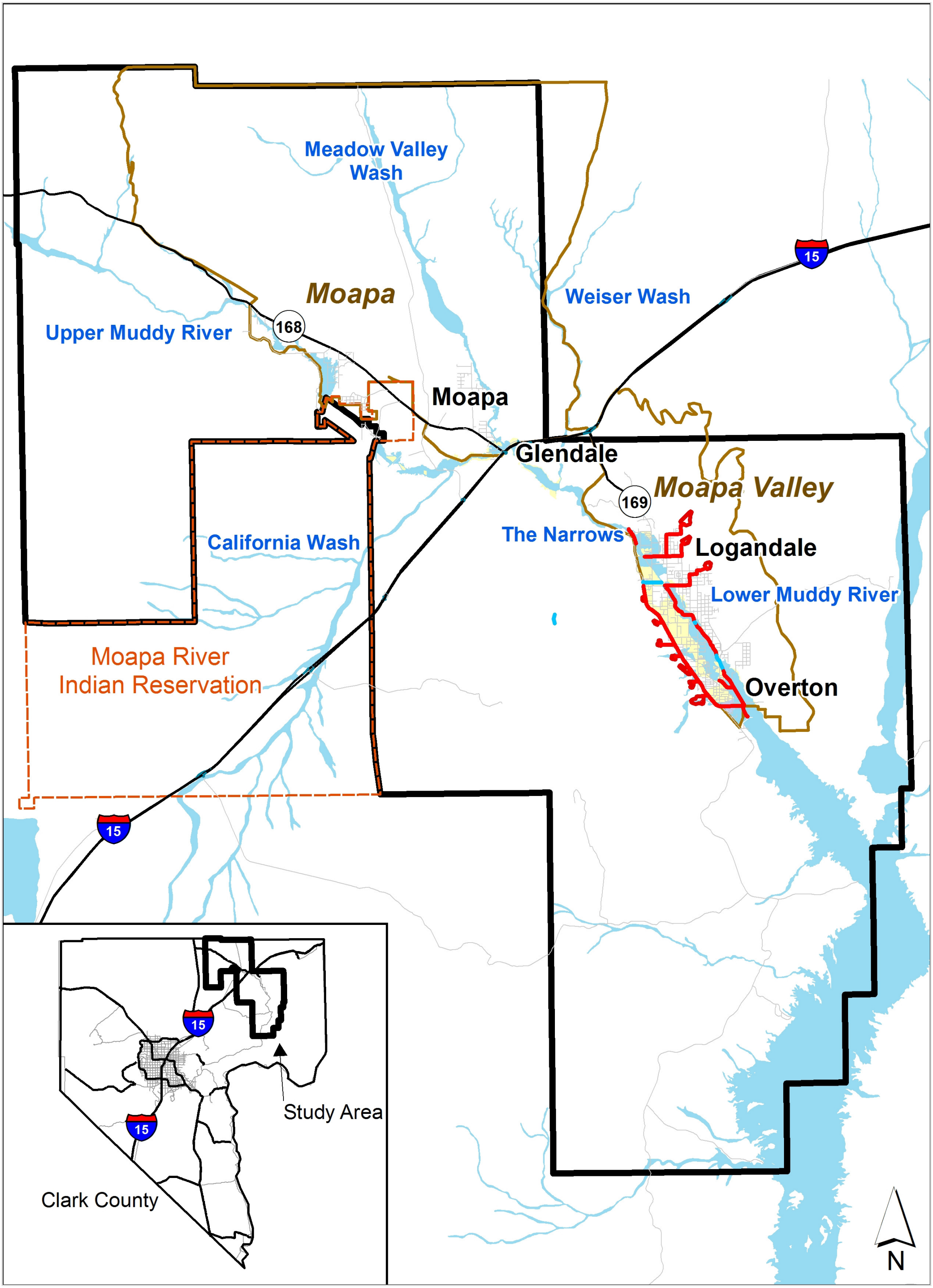


Figure 1-1 2016 Muddy River and Tributary Washes MPU Study Area

1.5. Climate

The climate in the study area is typical of the southern Nevada desert, with hot, dry summers and mild winters. The average annual precipitation is about 5 inches and generally occurs as the result of two storm types: (1) longer-duration, low-intensity winter events associated with cyclonic weather systems, or (2) shorter-duration, high-intensity summer thunderstorms. There are on average 27 days annually with measureable precipitation. The average July high is around 105 degrees while the average January low is around 31 degrees.

Winter storms in the area are regionally associated with broad low-pressure systems that develop over the Pacific Ocean and move easterly. Precipitation from these storms is generally widespread and is intense only on rare occasions.

Summer storms, on the other hand, occur as localized convective thunderstorms and can often be intense. Flooding of the dry washes in the area is generally associated with precipitation from the summer convective thunderstorms as surface runoff concentrates in a short period of time.

1.6. Recent Flood Events

An examination of past storm events provides valuable insight in planning for flood control facilities. Rainfall data, storm centerings, runoff volumes, peak flow rates in channels, property damage, and loss of life are all significant factors in determining the effectiveness of existing facilities and in evaluating the need for new and/or improved facilities. A few significant storm events occurred during the last 5 years that are briefly described below.

On **December 17-23, 2010**, significant rainfall occurred over large areas of Clark County. The National Weather Service recorded 1.77 inches of rainfall for December 2010, making it the third wettest December on record for Las Vegas. In the Moapa Valley area, flows in the Muddy River caused the closing of the Cooper Street crossing and unofficial reports of flooded properties in the vicinity of Lewis Avenue. The USGS estimate of the peak flow in the Muddy River was 4,800 cfs. For a more detailed report refer to the “Rainfall Event Report December 17-23, 2010” by Clark County Regional Flood Control District (**Reference 2**).

On **September 7-8, 2014**, intense rainfall occurred over large areas of Clark County. Rainfall occurred in the afternoon and evening of September 7. The same areas experienced significantly greater rainfall on the afternoon of September 8. The hardest hit area was Moapa and Moapa Valley, both north and south of I-15, including the towns of Moapa, Logandale, and Overton. CCRFCD rain gages in the large watershed area that drains to the Muddy River, Meadow Valley Wash, and Weiser Wash measured rainfall depths ranging from 2.5 to 4.6 inches, well above the 100-year design storm in this area.

The rainfall generated sizeable flows and exceeded the capacity of the I-15 drainage system and washed out large sections of I-15 near mile marker 92, which resulted in significant problems and the highway being closed to traffic for several days while repairs were made. Railroad tracks near Moapa were damaged and undermined as well. The Governor's office and Clark County Commission declared a state of emergency in the area.

Downstream of I-15, flood flows in the Muddy River severely eroded the Logandale Levee. The USGS estimated the flow in the Muddy River upstream of the Wells Siding Diversion to be 17,300 cfs. More than 100 homes were damaged in Moapa, the Moapa River Indian Reservation, Logandale, and Overton area. Damages to the County maintained roadways and I-15 were in excess of $6 million. For a more detailed report refer to the "Rainfall & Flood Event Report September 8, 2014" by Clark County Regional Flood Control District (**Reference 3**).

On **September 26-27, 2014**, intense rainfall moved across the Las Vegas Valley and parts of northeast Clark County. The hardest hit areas were the Muddy River drainage north of I-15. Rainfall gages in the Muddy River drainage area recorded rainfall depths of 1.5 to 1.75 inches of rain for the first few hours and then another 3 inches of rain across the northeast Clark County region. Flow in the Muddy River downstream of I-15 was largely contained within the river's banks and there were no reported flood damages in the Logandale or Overton areas. Flow in Overton Wash across SR-169 did necessitate a swift water rescue. For a more detailed report refer to the "Rainfall & Flood Event Report September 26-27, 2014" by Clark County Regional Flood Control District (**Reference 4**).

A detailed history of flooding and Town Advisory Board (TAB) meetings in the Moapa Valley is included in **Appendix D**. **Appendix D** also includes a summary of historical changes to the Muddy River MPU. The obstacles and challenges encountered in implementing the recommended flood control plan have been chronicled since the adoption of the 1986 Clark County Master Plan (CCMP) and are also summarized in **Appendix D.**

1.7. Coordination

Close coordination between Clark County and CCRFCD was necessary to ensure proper and efficient development of the 2016 MPU. Other stakeholders involved in the development of the 2016 MPU include the Moapa Valley Water District (MVWD), Muddy Valley Irrigation Company (MVIC), Clark County Commission, Clark County Liaison, Nevada Department of Wildlife (NDOW), National Park Service (NPS), and Moapa/Moapa Valley TABs.

Many field visits and progress meetings were held, and representatives from Clark County and other stakeholders were informed of project progress and given the opportunity to provide input. CCRFCD and Clark County representatives were also provided with the opportunity to review and comment on the information presented in the 2016 MPU report.

All of the meeting minutes from the MPU progress meetings and the town advisory board meetings are included in Appendix D on the electronic Data CD.

1.8. Report Organization

The 2016 MPU report has been organized into eight main sections: Section 1 serves as an overall introduction; Section 2 contains general information about master planning and watershed management; Section 3 contains detailed information about the overall approach and methodology for hydrologic/hydraulic analysis, computer modeling, facility analysis, cost estimates, and GIS data development; Sections 4-7 summarize the recommended flood control plan in each of the planning areas; Section 8 contains information regarding non-structural floodplain management solutions.

There is a **Facility Maps** section at the end of the report that contains facility maps and inventory tables showing the regional flood control facilities in the study area.

1.9. Technical Appendix and Data CD

A technical appendix is provided electronically on the Data CD included at the end of this report with all supporting documentation and analysis. The electronic Data CD also has other relevant electronic data and information used in the development of this MPU, such as a PDF version of the entire report, hydrologic/hydraulic model files, cost estimate software tools, GIS data, etc.

SECTION 2
Watershed Management

2. Watershed Management

2.1. General

This section discusses CCRFCD policies, management, phasing, and implementation considerations related to the 2016 MPU. The information contained in this section is for general reference only. The CCRFCD Design Manual and the CCRFCD Policies and Procedures Manual should be consulted for specific issues regarding stormwater drainage and flood control in Clark County.

2.2. Watershed Areas

To facilitate the organization and presentation of the information collected and developed for the 2016 MPU, the study area has been subdivided into four areas that will be referred to as: (1) Western Washes, (2) Eastern Washes, (3) Lower Muddy River, and (4) Moapa.

The Western Washes and Eastern Washes represent watershed areas on the west and east sides of Moapa Valley, respectively, that drain from mountainous regions and mesas toward the valley. These areas were analyzed using HEC-1 and FLO-2D as described in **Section 3**.

The Lower Muddy River area described in this report refers to the river corridor and floodplain area downstream of the "Narrows" and in between the Western and Eastern Washes. The towns of Logandale and Overton and the majority of the proposed regional facilities lie within this area. The peak flow in the Muddy River was not determined using HEC-1 computer modeling, because of the very large tributary watersheds that drain to the river. These watersheds include the California Wash, the Meadow Valley Wash, the Upper Muddy River, and the Weiser Wash, which encompass thousands of square miles. Because of the large tributary area, the peak 100-year flow in the Muddy River was referenced from the effective the Federal Emergency Management Agency's (FEMA) Flood Insurance Study (FIS) for Clark County, Nevada and Incorporated Areas (**Reference 5**) and was confirmed by performing flood frequency statistical analysis using historical stream gage data in the area (refer to **Section 6** for more information). The Lower Muddy River hydraulics and floodplain characteristics were analyzed using the HEC-RAS computer program.

Moapa refers to the area upstream of the Lower Muddy River and the "Narrows". Similar to the Lower Muddy River, the peak flows in the large washes and watersheds in this area were not determined using HEC-1 models; rather, peak flows were referenced from the FIS and verified with gage analysis. No updated hydraulic analysis was needed or performed in this area.

These study areas are shown in **Figure 2-1** and are described in detail in **Section 4**, **5**, **6**, and **7**.

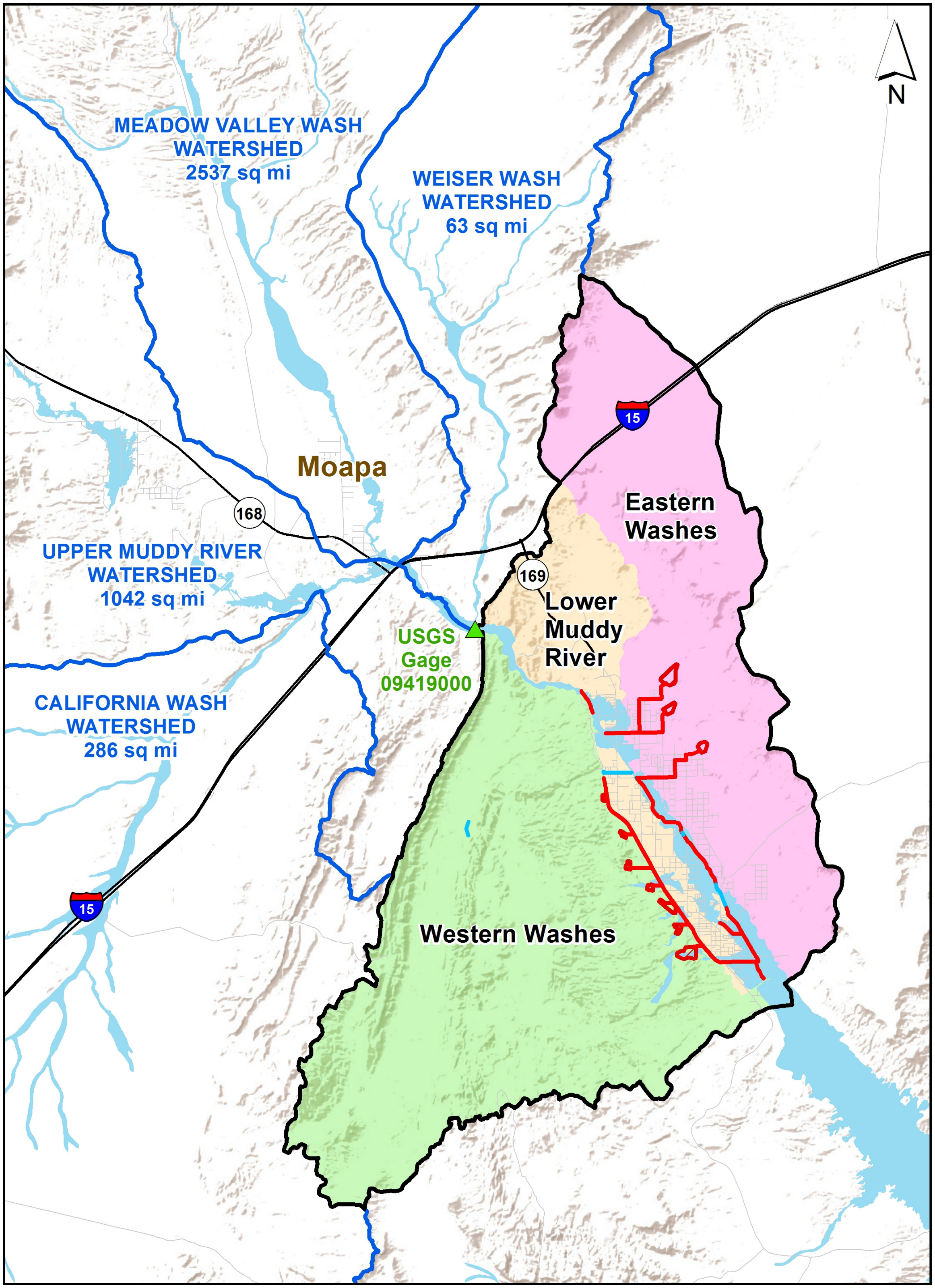


Figure 2-1 2016 Muddy River MPU Watershed Areas

2.3. Key Flooding Locations

Since the settlement of Moapa and Moapa Valley in the late 1800's, flooding has been a recurring and costly problem. Flooding in the study area is generally of two types: (1) major storms in the upstream watershed of the Muddy River and Meadow Valley Wash and (2) intense, convective storms on the local side washes. The natural topography in the valley is very flat, especially near the southern portions of Overton. The flooding and sediment potential from washes on the east and west combined with the high flows in the Muddy River makes it very difficult to develop cost-effective and feasible structural flood control solutions. For this reason, the effort to prepare the 2016 MPU encompassed various analysis techniques, computer models, and a combination of structural and non-structural flood mitigation strategies in order to identify effective solutions and focus on improvements that would be the most beneficial.

Priorities for the 2016 MPU were established based on a review of the flood history, previous MPUs, and coordination with Clark County, CCRFCD, local residents, and other project stakeholders. Some of the key locations where the recommended flood control plan has been updated include:

- The Western Washes area along the western side of Logandale/Overton
- The Eastern Washes in the vicinity of the Clark County Fairgrounds
- The Lower Muddy River, especially the reach downstream of Cooper Street to Lewis Avenue
- Overton Wildlife Management Area at the southern end of the study area

2.4. FEMA Special Flood Hazard Areas

FEMA publishes Flood Insurance Rate Maps (FIRMs) that identify special flood hazard areas (SFHA) or flood zones in the study area. The SFHA is the area where the National Flood Insurance Program's (NFIP) floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies. SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year (also referred to as the base flood or 100-year flood). The majority of the developed areas in the Muddy River MPU are within the SFHA. The following SFHAs are found within the study area:

- **Zone AE** - Areas subject to inundation by the base flood determined by detailed methods. Base Flood Elevations (BFEs) are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.
- **Zone A** - Areas subject to inundation by base flood generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no BFEs or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

- **Zone AO** - Areas subject to inundation by the base flood, usually in the form of shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply. Zone AO have been designated in areas with high flood velocities such as alluvial fans and washes.

- **Zone X (Shaded)** – Area of moderate flood hazard, usually between the limits of the 100-year and 500-year floods. Flood insurance is encouraged in these areas but not mandatory.

The flood zones in Moapa Valley are shown on **Figures F-1 and F-2** in the **Facility Maps** section at the end of this report. The flood zones in Moapa are shown in **Figure 7-3** in **Section 7**. Floodplain management is a key component of the flood control plan in the area and is discussed in more detail in **Section 8**.

2.5. Implementation

The CCRFCD is responsible for the overall development and management of the Master Plan and the associated facilities. The implementation of the Master Plan, including pre-design, design, construction, and maintenance of facilities, is primarily the responsibility of Clark County in coordination with the CCRFCD. Clark County is responsible for the prioritization of proposed flood control design and construction projects. This prioritization is based on established criteria described in the CCRFCD Policies and Procedures Manual.

2.6. Regional versus Local Facilities

Regional flood control facilities in the MPU are generally described as existing (already constructed and in place) or proposed (planned for the future). Regional facilities are flood control facilities required to safely convey and detain major flood flows with typically a minimum 100-year frequency flood event flow of 500 cfs or a minimum contributing drainage area of 1 square mile.

Funding for regional facilities is provided through an interlocal contract between the CCRFCD and the lead local governmental entity for the project (in this case Clark County). Funding for regional facilities may include costs associated with design, right-of-way acquisition, environmental mitigation, construction, construction management, operation and maintenance, and FEMA flood map revisions.

Local drainage facilities, in conjunction with regional facilities, help to decrease the volume of water on surface streets; this lessens the impact of surface flow on adjacent properties and allows for the safe passage of vehicular traffic during a storm event. These facilities are generally smaller, convey less flow than regional facilities, and help to alleviate local flooding problems and ponding. Local drainage projects and associated studies typically include analysis of the existing condition. Analyzing this condition helps determine what areas may be prone to flooding before the construction of proposed flood control facilities, mitigates the existing or interim flooding issues, and establishes priorities for future facility construction.

Local drainage facilities have not been evaluated or studied in detail in the 2016 MPU or previous MPUs.

2.7. Detention and Debris Basins

Detention basins are primary master plan components and provide temporary storage of floodwaters during flood events. These facilities accept high inflow rates that are of relatively short duration (usually 1 to 12 hours) and discharge flow at a much lower rate than the inflow (usually 5 to 15 percent of the inflow for a 100-year event) for a long period of time (usually 24 hours to several days). The reduction in flow rate between the inflow and outflow requires that a significant volume of water be stored for a certain period of time. Storage volume is obtained by constructing above-grade embankments/dams, excavating below-grade, or a combination of both.

Detention basins provide several benefits to the overall flood control system and the downstream areas that they protect. Detention basins can capture sediment from upstream areas, combine flood flows from several different drainage corridors into one downstream discharge point, and control the release of flood flows, resulting in a major reduction in the required conveyance capacity of downstream facilities. The reduction in required downstream conveyance capacity allows for smaller, less expensive downstream facilities and is the primary purpose of detention basins.

Detention basins are relatively inexpensive facilities but often require the acquisition of a significant amount of land to provide enough area to store large volumes of water. In addition, many detention basins have been used for parks or other recreational purposes. Detention basins are easy to maintain, considering that heavy precipitation and major flood events in arid, desert regions are infrequent.

Debris basins are used to capture sediment and other debris from upstream areas. Debris basins are generally used where the upstream watershed is expected to produce large volumes of sediment and other debris. Sediment and debris can cause severe problems in flood control structures by clogging culvert and bridge openings, by producing general accumulations of sediment in channel bottoms, or by creating sediment bulking, all of which reduce facility conveyance capacity and cause damage to roadways and other property. Debris basins do not reduce the peak flood flows conveyed by downstream facilities. These facilities capture debris and sediment during storm events and require regular maintenance, especially following significant storm events.

2.8. Multi-Use Facilities

The primary purpose of all flood control facilities is the safe detainment and conveyance of flood flows. Public safety and the proper functioning of flood control facilities are paramount and cannot be compromised by other uses; however, multi-use opportunities exist with many master plan facilities. Therefore, CCRFCD policy is to encourage early planning to identify and take advantage of multi-use opportunities afforded by flood control facilities included in the Master Plan.

Recreation is the principal multi-use opportunity. Recreational uses of flood control facilities include parks, trail systems, and environmental preserves. Recreational improvements are usually implemented near the end of a flood control construction project, and some existing flood control facilities have been modified to accommodate recreational amenities.

Available flood control facility construction monies are in high demand to implement Master Plan flood control facilities, which improve the protection of life and property. It is therefore CCRFCD policy that recreational or other multi-use components be incorporated into the construction of flood control facilities when other funding sources can be obtained to facilitate the construction of these multi-use amenities.

Many of the recommended facilities in the 2016 MPU are underground or concrete-lined facilities, which do not lend themselves well to recreational use. However, the use of the Lower Muddy River channel facility as a trail or other recreational amenity is a possibility that could be investigated in the future.

The CCRFCD has developed policy statements and criteria to regulate the use of Master Plan facilities for recreation or other multi-use opportunities. These policy statements and criteria are available in the CCRFCD Design Manual.

2.9. Storm Drain versus Open Channels

Using storm drains or open channels to convey flood flows is normally governed by whether the required right-of-way is available for an open channel, the cost of the right-of-way, and the location of the right-of-way relative to any existing or future roadways. Construction costs for open channels are generally less expensive than construction costs for storm drains; for this reason, open channels are usually preferred to storm drains. In some areas, however, right-of-way is not available or is too expensive, especially if the flood control facility is being constructed in a developed area. During the pre-design phase of a project, analysis should be completed to determine which type of facility best suits the location where it is being proposed.

2.10. Channel Lining

The primary purpose of flood control channels is the safe conveyance of flood flows; therefore, channel linings should be selected that will fulfill this purpose. The CCRFCD Design Manual specifies maximum allowable flow velocities for channel lining types.

It is desirable, where possible, to use natural washes or "soft linings" to convey flood flows provided it can be done in a manner that ensures a proper level of protection. However, due to steep slopes and high flow velocities (greater than 10 to 15 feet per second) and the inability of the natural system to safely convey flood flows, concrete-lined channels are recommended in several areas in the MPU. Concrete channels convey flood flows effectively and efficiently and, when designed properly, eliminate the potential for erosional hazards. Concrete-lined channels also require little maintenance when compared to other channel types such as riprap, grass, or natural washes. The aesthetic value and environmental benefits of concrete channels are minimal.

When flow velocity in existing washes and unlined channels exceed 5 ft/sec, there is a potential for significant erosion and scour. All undeveloped areas will produce flows that have a high concentration of sediment that are deposited wherever flow velocities decrease sufficiently, such as entrances to culverts, grate inlets, and channel bends. Scour and deposition can cause significant damage to flood control facilities and in some cases can make the facility completely ineffective. This can cause flows to take drainage paths that are damaging to both public facilities and private property. Therefore, it is critical that scour and sedimentation be taken into account when designing flood control facilities. This includes, but is not limited to, the construction of sediment basins, over-sizing culverts to account for sediment clogging, freeboard in detention basins and channels to account for sedimentation, and smooth transitions from channels to culverts to eliminate sedimentation and hydraulic jumps. Additionally, due to high velocities in concrete channels, particular attention should be paid to super-elevation at channel bends, culvert transitions, hydraulic jumps, culvert entrances, and scour at channel outlets.

2.11. Project Specific Analysis

A Project Specific Analysis is required for all new CCRFCD flood control facilities. The Record of Decision for the Final Supplemental Programmatic Environmental Impact Statement, Clark County Regional Flood Control District, 2002 Master Plan Update (SEIS) (September 2004) requires the preparation of an environmental analysis using the methods described in Chapter 8 Project Specific Procedures of the SEIS for all new CCRFCD facilities within the SEIS project area (Las Vegas Valley and Boulder City). Since the proposed facilities in this MPU are outside of the SEIS project area, the Chapter 8 Analysis is not directly applicable. However, a similar site-specific impact analysis that incorporates all elements of the Chapter 8 Analysis is still required by the U.S. Army Corps of Engineers (USACE) Regional General Permit 7 for new construction of flood control facilities within Clark County, but outside of the SEIS project area. If a proposed project exceeds the amount of impacts to wetlands and/or waters of the United States allowed under RGP7, or if the USACE Regulatory Branch determines that another permitting mechanism (e.g., individual permit, nationwide permit, etc.) is more applicable, other environmental documentation may be required.

The facility-specific process is designed to allow for an explicit screening of facilities to determine the appropriate level of environmental documentation (i.e., categorical exclusion/ memorandum to file, environmental assessment (EA), or facility-specific Environmental Impact Statement (EIS)).

2.12. Environmental Considerations

The CCRFCD is required to follow all federal, state, and local environmental compliance regulations relating to construction and maintenance of flood control facilities within their service area.

This sub-section is not intended to serve as comprehensive environmental analysis; rather, it provides a general overview of existing sensitive resources and the agencies (federal, state, and/or local) responsible for the management of those resources. During early phase of any master plan design/construction project, contact should be established with the various/appropriate resources and land management agencies to identify current policies and/or resources that might be present and adversely impacted as well as mitigation measures that might be required.

Figure 2-2 at the end of this section shows broad land ownership within the Moapa Valley area and includes the locations of proposed flood control infrastructure facilities. **Figure 2-3** shows "Environmentally Sensitive Areas" (ESAs) within the Moapa Valley area as well as the locations of proposed flood control infrastructure facilities. These ESA's include various types of wetlands and water features as well as proposed critical habitat for the federally threatened yellow-billed cuckoo (*Coccyzus americanus*) as designated by the U.S. Fish and Wildlife Service (USFWS). Specific environmental issues will vary for each facility due to variations in design and location.

Site-specific investigations and species-specific surveys must be conducted for each project to determine the environmental impacts associated with a specific project area. Environmental resources that may need to be addressed for proposed projects include: geology and soils, groundwater resources, terrestrial and aquatic biological resources, paleontological resources, cultural resources, visual resources, air quality, noise, hazardous materials, land use and recreation, and socioeconomics. Some of these key topics are highlighted briefly below.

2.12.1. Geology and Soils

Where possible, facilities should be located so as to avoid localized area of slope instability or subsidence. Although the potential for movement along local faults is considered to be low, facilities should be located away from surface fault zones whenever possible. When geologic constraints cannot be avoided, costs should be increased to reflect the increased design effort and cost of a more substantial facility to withstand the estimated impacts.

2.12.2. Surface Water

Higher flow velocities in improved channels represent an increased safety hazard. Therefore, excessive channel depths should be avoided, and channel costs should include fencing. Consideration should be given to changes in the historical patterns of erosion and deposition caused by construction of detention/debris basins and concrete-lined channels. Detention may improve downstream surface-water quality in urban areas. Limiting detention basin drain times to a maximum of 24 hours whenever possible should minimize reductions in flow volume to Lake Mead, but provides minimal development of local groundwater aquifers.

Section 2.13 provides additional information pertaining to regulatory requirements for deposition of fill materials (e.g., soil, riprap, concrete, etc.) into waters of the U.S.

2.12.3. Biological Resources

Biological resources considered during planning phases of a project generally include vegetation communities (or habitat) and wildlife within and immediately surrounding the area of impact. Field survey is required to delineate habitat and assess the potential for occurrence of wildlife species at a particular project site.

Vegetation Communities

The study area consists of five primary ecosystems: Mojave Desert scrub, mesquite/catclaw, desert aquatic, spring, and other (Recon 2000). These ecosystems are described in more detail below:

- **Mojave Desert Scrub –** The primary vegetation type within this ecological zone in the Moapa Valley is creosote-bursage, which is dominated by creosote bush (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*). The creosote-white bursage desert scrub typically occurs on well-drained sandy flats and bajadas throughout most of the Mojave Desert from 150 to 1,500 meters elevation in Nevada. Many heat-tolerant reptile species are dependent on this habitat, including the desert tortoise (*Gopherus agassizii*) that burrows directly under creosote bushes to take advantage of the substrate stability created by the plant roots (Wildlife Action Plan Team 2012).

  About 80% of this type of habitat in Nevada occurs in Clark County and is in relatively good condition. However, increased development, invasive weeds, wildfire, and dispersed recreational activities threaten the quality of the habitat. The largest challenge to maintaining this community is conversion to urban and suburban development, including installation of solar energy facilities and off-highway vehicle recreation. The creosote bush-white bursage habitat is expected to expand northward with climate change, but increased fire with the continued presence of non-native grasses threatens the persistence of the shrubs. The shrub overstory is extremely important to the continued survival of reptiles and mammals that utilize this habitat for burrows and thermal cover (Wildlife Action Team 2012).

- **Mesquite/Catclaw –** This ecological zone is dominated by either mesquite (*Prosopis glandulosa*) or catclaw (*Arcacia greggii*) and generally occurs in association with desert waterways. Mesquite-dominated communities typically occur along the edges of larger watercourses, such as the Muddy River, but also near desert springs. Catclaw-dominated communities generally occur along intermittent streams and sandy washes. These habitats tend to be managed for conservation and a broad spectrum of recreational uses. Water development in riparian and spring areas can be a potential threat to these areas.

- **Desert Aquatic –** The desert aquatic ecological zone within the study area includes desert riparian/wetland areas associated with the Muddy River, desert washes flowing to the Muddy River, the actual river, and the Overton Arm of Lake Mead.

  Vegetation in the wash areas tends to overlap with the mesquite/catclaw and spring ecosystems. Dominant riparian vegetation includes Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), velvet ash (*Fraxinus velutina*), honey mesquite (*Prosopis glandulosa*), and screwbeam mesquite (*Prosopis pubescens*). Desert riparian areas are important areas for cover and forage by many species of wildlife, including some sensitive species, so are considered conservation priorities by regulatory agencies.

  The Muddy River is a relatively stable flow system dependent upon spring discharge. The river is considered to be a unique wetland habitat within the Mojave Desert. Therefore, projects that would potentially impact the river, tributaries, or adjacent hydrophitic vegetation require approvals from regulatory agencies (see the Regulatory Compliance section below).

- **Spring** – The Moapa Valley includes one of the greatest densities of perennial springs in southern Nevada. Springs in Clark County are typically cold-water and range from isolated pools to the larger spring-fed Muddy River. Associated vegetation varies greatly depending on the structure of the spring. Common associations include various sedges (*Carex* sp.) and grasses as well as willows (*Salix* sp.). Springs can be considered a conservation priority to regulatory agencies depending upon the habitat supported and hydrology of the landscape.

- **Other** – Other lands generally include those areas that have been permanently altered due to anthropogenic activities such as the construction of aboveground developments (e.g., buildings, roads, parking lots, golf courses, and urban parks) and/or agriculture. Developed land is characterized by a high percentage of non-vegetated bare earth or paved surfaces (e.g., asphalt, concrete, and other permanent cover), or predominantly vegetated with non-native plants (including ornamental or turf plant species).

Wildlife

The Endangered Species Act of 1973 (ESA; 16 USC 1531 et seq.) requires all Federal departments and agencies provide for the conservation of threatened and endangered species and their ecosystems. The Secretary of the Interior maintains a list of species likely to become endangered within the foreseeable future throughout all or a significant portion of its range (threatened) and that are currently in danger of extinction throughout all or a significant portion of its range (endangered).

According to the U.S. Fish and Wildlife Service (USFWS), six sensitive wildlife species could be impacted by projects within the study area (USFWS 2016). Additional species may need to be considered on a project specific basis. The six species include the following:

- Amphibians: relict leopard frog (*Lithobates onca*)
- Birds: southwestern willow flycatcher (*Empidonax traillii extimus*); yellow-billed cuckoo (*Coccyzus americanus*); Yuma clapper rail (*Rallus longirostris yumanensis*)
- Fishes: razorback sucker (*Xyrauchen texanus*)
- Reptiles: desert tortoise.

The USFWS has also proposed critical habitat for the yellow-billed cuckoo along portions of the Muddy River proceeding up the Moapa Valley and designated critical habitat for the razorback sucker where the Muddy River meets the Overton Arm of Lake Mead.

2.12.4. Air Quality

The Moapa Valley area is located within Clark County, Nevada. The State of Nevada and Clark County Department of Air Quality and Environmental Management (DAQEM) use hydrographic basins to delineate air quality management areas for planning purposes.

Pursuant to the federal Clean Air Act (CAA) of 1970, 42 USC 7401 et seq. as amended in 1990, the U.S. Environmental Protection Agency (EPA) has established primary and secondary National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants: ozone (O3), nitrogen dioxide (NO2), lead (Pb), carbon monoxide (CO), particulate matter less than 10 microns (PM10), and particulate matter less than 2.5 microns (PM2.5).

The Nevada Division of Environmental Protection (NDEP), Bureau of Air Quality is charged with maintaining and improving the air quality for citizens of the state of Nevada. The state of Nevada's air pollution statutes (Chapter 445B of Nevada Administrative Code) seek to achieve and maintain levels of air quality that will protect human health and safety, prevent injury to plant and animal life, prevent damage to property, and preserve visibility and scenic, aesthetic, and historic values. The statutes require the use of reasonably available methods to prevent, reduce, or control air pollution throughout Nevada.

The Clark County DAQEM is responsible for monitoring air, developing proper control measures, enforcing those measures, and educating the citizens of Clark County on how they can choose clean air. DAQEM regulates all stationary and non-vehicular sources, including construction sources, of fugitive dust. According to Section 17 of Clark County's Air Quality Regulations, a plan-specific permit is required for construction activities involving surface disturbances greater than 0.25 acre, such as grading and trenching. This permit would include conditions requiring control of fugitive dust emissions, as defined in Section 41 of the regulations.

2.13. Regulatory Compliance

2.13.1. Biological Resources and Wetlands/Waters

Several regulatory agencies are stakeholders within and surrounding the Moapa Valley. Private lands within the valley are surrounded by Bureau of Land Management (BLM) areas. The Valley of Fire State Park, managed by Nevada State Parks, is located directly west of the valley. The Overton Wildlife Management Area, managed by NDOW, occurs in the lower extremes of the Moapa river valley at the north end of the Overton Arm of Lake Mead. The Lake Mead National Recreation Area, managed by the U.S. National Park Service, also includes areas surrounding the Overton Arm of the lake. Any actions planned within the jurisdiction of a public lands stakeholder would require approval from the managing Federal/State agency prior to commencement of the project.

The study area is also included in the Clark County Multiple Species Habitat Conservation Plan (MSHCP) area. The MSHCP allows for the incidental take of Covered Species in connection with the development of non-Federal lands within Clark County until 2030. A participating agency must comply with the terms of the Implementation Agreement for an activity to be covered under the MSHCP. If an activity is not covered under the MSHCP, coordination with the USFWS, NDOW, and the Nevada Natural Heritage Program is required to ensure compliance with Federal and State laws related to species impacts.

Lastly, the study area includes desert aquatic resources that are likely considered jurisdictional resources under Section 404 of the Clean Water Act (CWA). The CWA (1977, as amended) establishes the basic structure for regulating discharges of pollutants into waters of the U.S. It gives the EPA the authority to implement pollution control programs, including setting wastewater standards for industry and water quality standards for contaminants in surface waters. The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters, without a permit under its provisions.

Discharge of fill material into "waters of the US," including wetlands, is regulated by the USACE under Section 404 of the CWA (33 USC 1251-1376). USACE regulations implementing Section 404 define "waters of the U.S." to include intrastate waters (such as, lakes, rivers, streams, wetlands, and natural ponds) that the use, degradation, or destruction of could affect interstate or foreign commerce. Wetlands are defined for regulatory purposes as "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3; 40 CFR 230.3). The placement of structures in "navigable waters of the U.S." is also regulated by the USACE under Section 10 of the Federal Rivers and Harbors Act (33 USC 401 et seq.). Projects are approved by USACE under standard (i.e., individual) or general (i.e., nationwide, programmatic, or regional) permits. The type of permit is determined by the USACE and based on project parameters.

The Fish and Wildlife Coordination Act requires consultation with the USFWS, the National Oceanic and Atmospheric Administration (NOAA) Fisheries, and responsible State wildlife agency for any federally authorized action to control or modify surface waters. Therefore, any project proposed or permitted by the USACE under the CWA Section 404 must also be reviewed by the Federal wildlife agencies and NDOW.

Section 401 of the CWA requires any applicant for a Federal license or permit, which involves an activity that may result in a discharge of a pollutant into waters of the U.S., obtain a certification that the discharge will comply with applicable effluent limitations and water quality standards. CWA 401 certifications are issued by the Nevada Division of Environmental Protection.

2.13.2. Cultural Resources

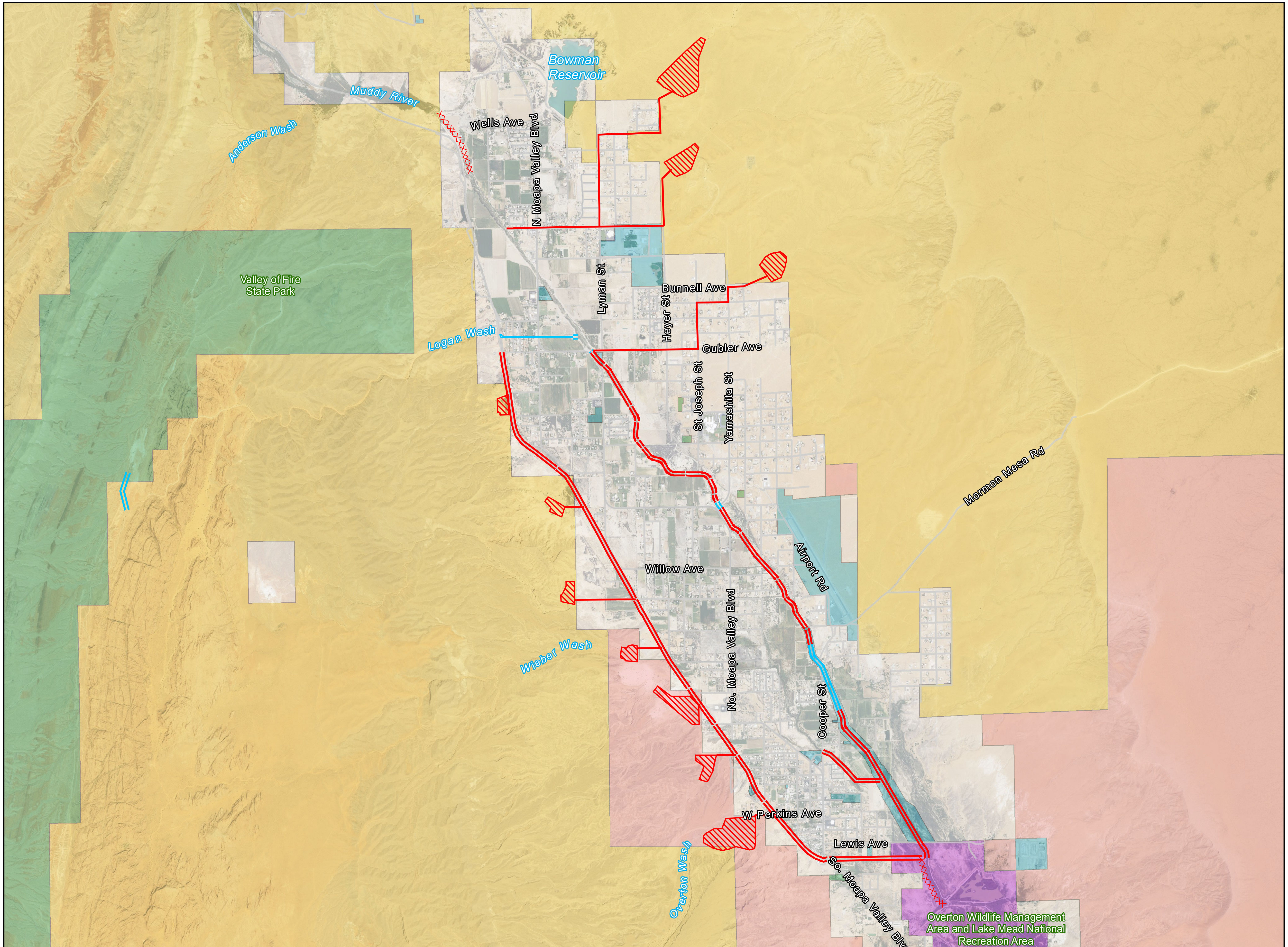
Legislative mandates, including the National Historic Preservation Act of 1966, as amended (NHPA) (36 CFR 800) and the Archaeological Resources Protection Act of 1979, as amended (16 USC 470aa-mm) require federal agencies to assess potential effects federal actions may have on districts, sites, buildings, structures, or objects included, or eligible to be included, in the National Register of Historic Places. Federal actions are defined as projects planned, constructed, or assisted by federal agencies through funding, technical support, or administrative authorizations such as licenses, permits, and ROW grants.

It is federal policy to avoid or minimize adverse effects to cultural resources when planning, constructing, and/or assisting a federal project. In some cases, it is impossible to avoid disturbance or destruction of cultural resources in order to implement an approved project. In such instances, it is federal policy to recover the information embodied in those resources through historical and archaeological study before the project begins.

The procedure for addressing cultural resources involves the consultation with other agencies, such as the State Historic Preservation Office (SHPO), Tribal Historic Preservation Officer, and Advisory Council on Historic Preservation, before proceeding with projects that may adversely affect cultural resources. Section 106 of the NHPA legally mandates this process. The consultation process may be completed on a project-by-project basis or through the preparation of a Programmatic Agreement.

The 1992 changes to the NHPA placed major emphasis on the role of Native American involvement when actions involve tribal property or properties to which tribes attach religious and/or cultural significance as discussed in 36 CFR Part 800.14. These Traditional Cultural Properties (TCPs) are described in the *Guidelines for Evaluating and Documenting Traditional Cultural Properties*, National Register Bulletin No. 38. A TCP is a property where significance is derived from the role the property plays in a community's historically rooted beliefs, customs, and practices. A TCP can be a location associated with traditional ceremonial, medicinal, or religious activities of a Native American group; a rural community whose buildings or patterns of land use reflect cultural traditions valued by its long-term residents; or an urban neighborhood that is the traditional home of a particular group. These types of sites may be difficult to identify without contact with the tribal groups because a TCP can be a mountaintop, a lake, a neighborhood, a field, or a stretch of river. A TCP is eligible for inclusion in the National Register as a "historic property" because of its association with cultural practices or beliefs of a living community that (1) are rooted in that community's history, and (2) are important in maintaining the continuing cultural identity of the community.

Project–specific analysis for cultural resources may be required and would include a site record search and consultation with Native Americans to develop an inventory of potentially affected cultural resources including TCPs. Where sensitive cultural resources are known or have a high potential to occur, this information will be submitted to the SHPO/Tribal Historic Preservation Officer to initiate Section 106 consultation with the Advisory Council on Historic Preservation (SHPO 1998). Depending upon the types of resources identified and potential eligibility for inclusion to the National Register of Historic Places, preparation of site-specific treatment plans may be required. If the site is important primarily for its information content, adverse impacts may be reduced to acceptable levels by implementing archaeological excavation and analysis plans, or completing detailed architectural recording according to standards developed by the Department of Interior. If the site is significant for values other than its information content, a memorandum of agreement must be prepared for Advisory Council on Historic Preservation review.

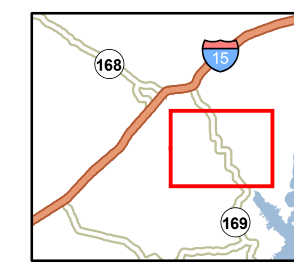


REGIONAL FLOOD CONTROL DISTRICT

2016
FLOOD CONTROL MASTER PLAN UPDATE
MUDDY RIVER AND TRIBUTARY WASHES

LEGEND

- Existing Storm Drain
- Existing Lined Channel
- Existing Dike
- Existing Erosion Control Structure
- Existing Culvert or Bridge Crossing
- Existing Detention Basin
- Proposed Storm Drain
- Proposed Lined Channel
- Proposed Dike
- Proposed Erosion Control Structure
- Proposed Culvert or Bridge Crossing
- Proposed Detention Basin
- Bureau of Land Management
- Bureau of Reclamation
- Clark County
- National Park Service
- Nevada State
- Private



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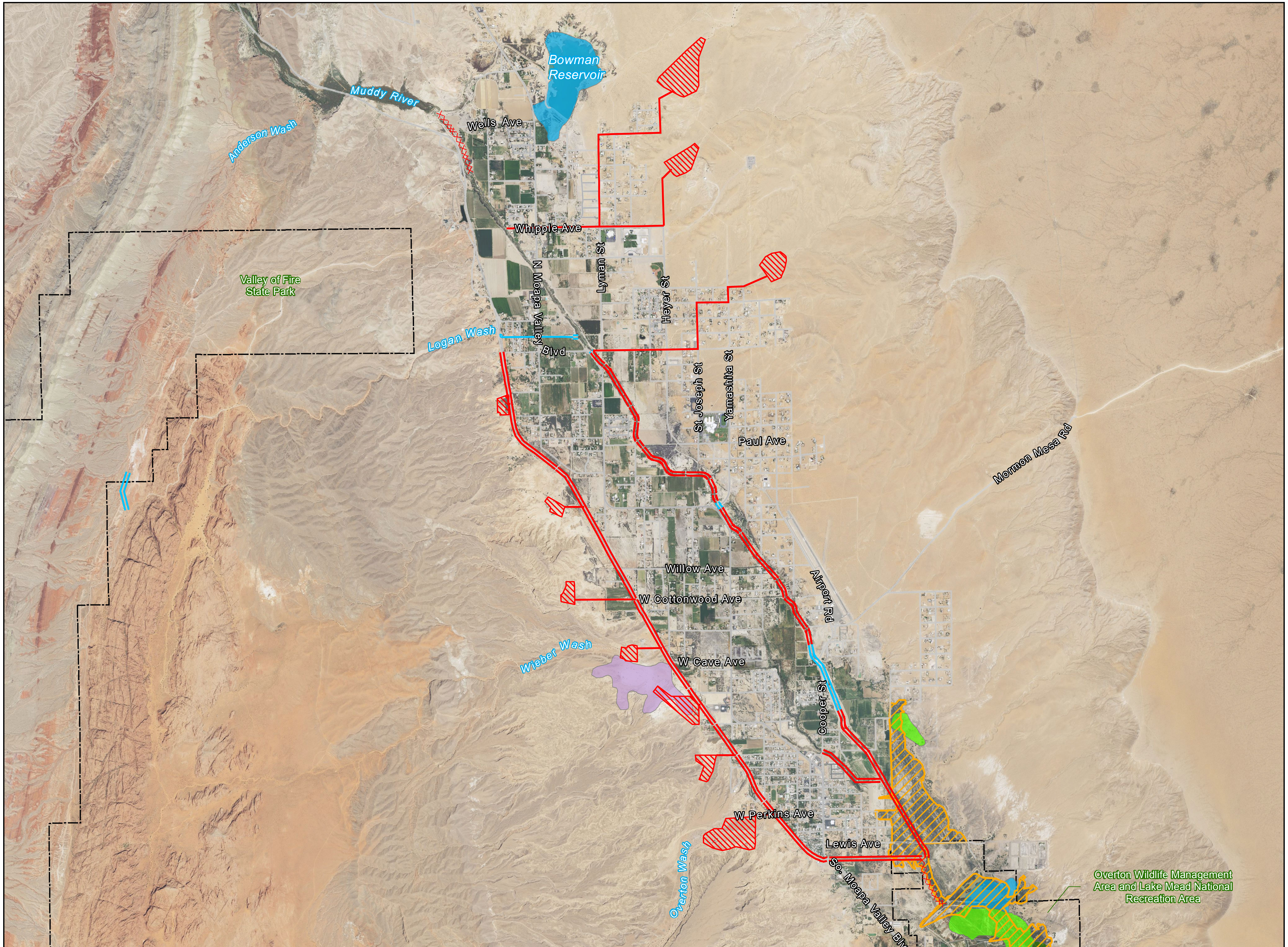
Feet

SCALE: 1 inch = 4000 feet

LAND OWNERSHIP
FIGURE 2-2

ATKINS



REGIONAL FLOOD CONTROL DISTRICT

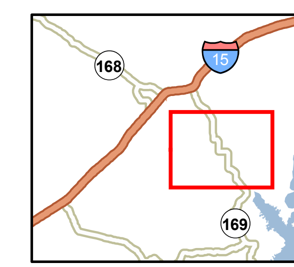
2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

LEGEND

- Existing Storm Drain
- Existing Lined Channel
- Existing Dike
- Existing Erosion Control Structure
- Existing Culvert or Bridge Crossing
- Existing Detention Basin
- Proposed Storm Drain
- Proposed Lined Channel
- Proposed Dike
- Proposed Erosion Control Structure
- Proposed Culvert or Bridge Crossing
- Proposed Detention Basin
- Critical Habitat of Yellow-Billed Cuckoo

USFWS Wetlands Inventory

- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Lake
- Other



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Feet

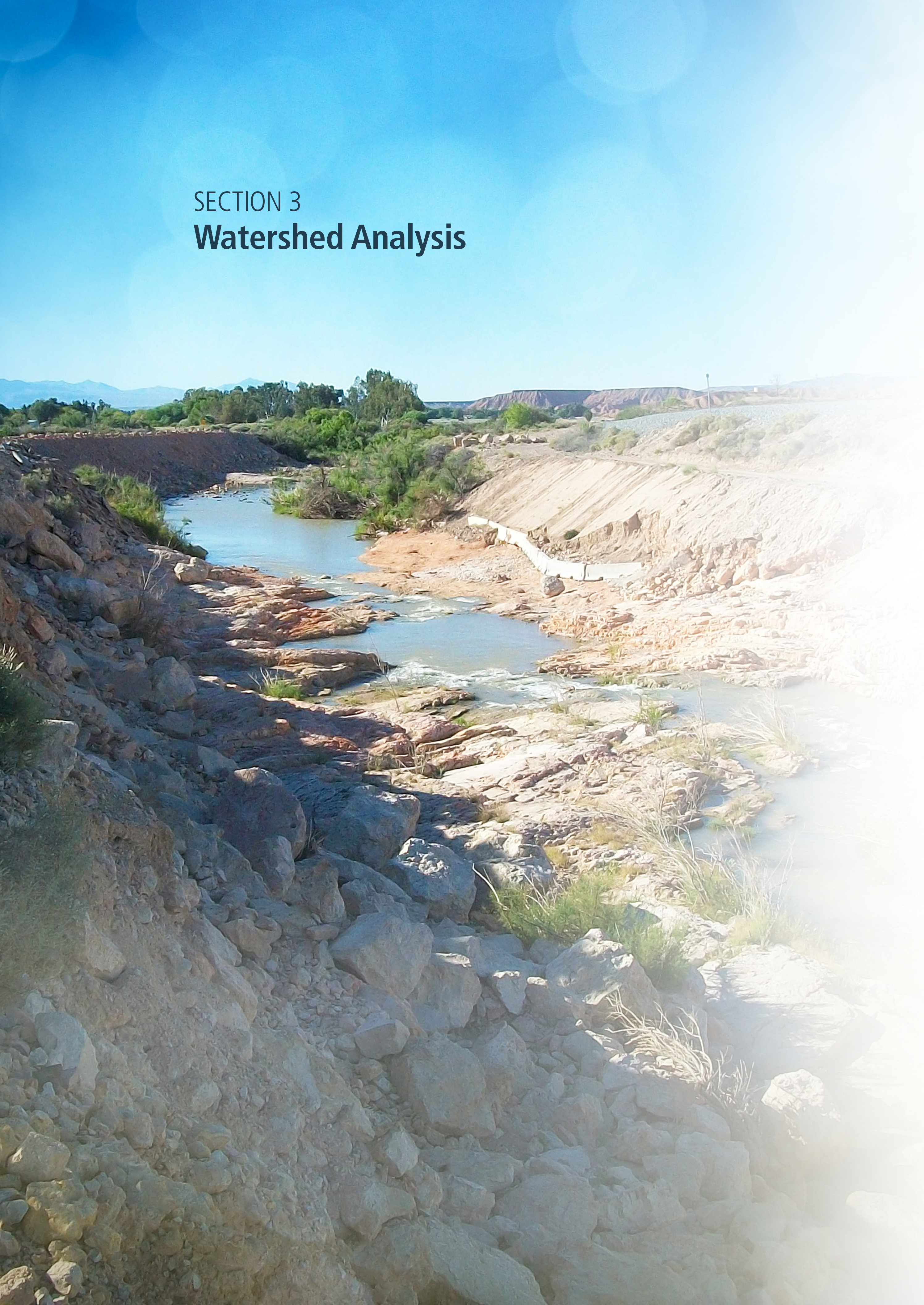
SCALE: 1 inch = 4000 feet

ENVIRONMENTALLY
SENSITIVE AREAS
FIGURE 2-3

ATKINS

SECTION 3

Watershed Analysis



3. Watershed Analysis

3.1. General

This section includes information regarding the criteria, methodology, and analyses performed for the 2016 MPU watershed analysis. These criteria, methodology, and analyses are consistent with the CCRFCD Design Manual and the CCRFCD Policies and Procedures Manual. Any deviations from these standard CCRFCD documents resulted from either a lack of available information for specific areas or an effort to simplify the analyses when appropriate for master planning purposes. Required deviations are discussed in detail for each specific area or watershed in Sections 4 through 7. This section provides an overview of the criteria, methodology, and analyses used for the following MPU tasks:

- Data collection
- Topography acquisition
- Hydrologic/Hydraulic analysis
- Facility analysis
- Facility construction cost estimates
- GIS data development

3.2. Data Collection

Planning studies, drainage reports, and construction plans completed since the 2010 MPU were collected and reviewed in conjunction with the development of the 2016 MPU. Documents were then reviewed based on their relevancy to the MPU and input from the CCRFCD and affected stakeholders. The documents were reviewed with respect to the following:

- Verification of the 2010 MPU data
- Verification of the GIS facility inventory
- Impacts on regional drainage patterns and facilities
- Continuity of drainage basin boundaries, flow patterns, and hydrologic parameters
- Accuracy of the study information and validity of assumptions/approximations
- Local and secondary drainage facilities

Information considered appropriate for master planning was extracted from the documents and incorporated into the MPU to the fullest extent possible without exceeding the level of detail established by the CCRFCD.

In addition, field investigations and field survey were necessary to confirm some of the data collected. This effort included verifying land use, confirming subbasin boundaries, and examining existing facilities to check for any discrepancies in existing facility type or size, drainage patterns in the study area, and location/alignment of regional facilities.

3.3. Topography Acquisition

Several sources of topography and elevation data were used in the development of the 2016 MPU. These include:

- **Detailed 2015 LiDAR Data**. At part of the 2016 MPU project, detailed LiDAR was flown in Moapa Valley by Keystone Aerial Surveys on September 27, 2015 using an Optech Gemini LiDAR system in a single engine Cessna aircraft. The LiDAR coverage area is approximately 18 square miles and encompassed the floodplain and the majority of the developed areas in the towns of Logandale and Overton. Hydrographic break lines were created to enforce monotonicity for water features. The LiDAR data was used to create a bare-earth digital elevation model (DEM) at a 3.125- foot cell resolution for the entire project area. One foot contours were also created for reference purposes in the study area. The electronic LiDAR data and all supporting information is provided on the **Data CD**. This detailed elevation data was a valuable tool in the development of the 2016 MPU hydrology and facility recommendations and provided enhanced information compared with previous MPU studies.

- **SNWA LiDAR.** SNWA provided preliminary LiDAR data that they obtained in the study area in the summer of 2008 using the vendor DMI of Huntington Beach, California. This consisted of 10-ft resolution grid files (in .asc format). Based on discussion and coordination, this data was not considered “engineering” grade and was not fully post-processed or validated. The data was also outdated and did not represent all elevation features in the study area. This elevation data was used for general reference and for some hydraulic analysis in Eastern Washes areas not covered by the detailed 2015 LiDAR data described above.

- **USGS DEMs.** USGS DEMs (1/3 arc second or 10 meter resolution) were also used in the upstream portions of the watershed for hydrologic analysis and subbasin delineation.

- **Detailed Field Survey**. Two field surveys were performed by Atkins survey crew on August 18, 2015 and August 25, 2015. A total of 22 channel cross sections were surveyed along the Muddy River including bridges. Other features relevant to the MPU were also surveyed, such as roadways and Overton WMA berms. The field survey data is also provided on the **Data CD**.

3.4. Hydrologic Analysis

A thorough review of the previous MPU hydrologic analysis (last updated in 2005) was performed and significant revisions and updates were made to incorporate new data collected and to ensure the analysis was based on best-available, current information. In addition, the organization of the hydrologic analysis was simplified, fully documented with supporting calculations in the appendix, and streamlined to be consistent with other MPUs in Clark County.

The hydrologic analysis for the 2016 MPU is consistent with the CCRFCD Design Manual dated August 1999. The sections below discuss the criteria, methodology, and assumptions applied to the 2016 MPU hydrologic analysis.

3.4.1. Subbasin Delineations

The HEC-1 model area was subdivided into homogeneous subbasins that drain to single combination points. Subbasin boundaries generally follow delineations made in previous MPU hydrologic models; however, revisions or updates were made to subbasin delineations when new information from design projects/studies, aerial photos, topography, or field investigation indicated that old delineations were either obsolete or inaccurate. Further subdivision or adjustments to basin boundaries were based on effects of existing and proposed flood control facilities and ultimate development.

The topography data used for the subbasin delineation included the 10-meter USGS DEM data as well as the detailed 2015 LiDAR obtained for the 2016 MPU. USGS's watershed boundary dataset (HUC-12) was also used as a reference for delineating subbasins in the study area. The 2016 MPU subbasins are shown on a large hydrology map (**Figure 3-2**) at the end of this Section.

3.4.2. Computer Modeling

HEC-1 Version 4.1 (dated June 1998) was used for the 2016 MPU hydrologic modeling to simulate the rainfall-runoff process.

Previous MPUs for the Muddy River and Tributary Washes used many different HEC-1 models (more than 10+), each covering different portions or subsets of the watershed. This made it difficult to organize or evaluate peak flow results. The 2016 MPU abandoned the sub-divided models and incorporated all parameters and subbasins into a single HEC-1 model covering the entire study area. This helps to avoid potential errors, reduces duplication of models, and makes it easier to use the models and results in future MPU studies.

In addition to the HEC-1 models, FLO-2D computer models were also used for hydrologic/hydraulic modeling purposes in the Eastern and Western Washes. The FLO-2D models are described in more detail in **Section 4** and **Section 5**.

3.4.3. Design Storm

The design storm for the 2016 MPU is the 6-hour, 100-year frequency rainfall event. The rainfall used for hydrologic modeling of MPU facilities is intended to produce runoff discharges with an expected 100-year recurrence interval. A 100-year recurrence interval is defined as having a 1.0 percent chance of being equaled or exceeded in any given year.

3.4.4. Precipitation

Rainfall data published by the National Oceanic and Atmospheric Administration (NOAA) in *NOAA Atlas 2, Precipitation–Frequency Atlas of the Western United States*, Volume VII – Nevada (*NOAA 1973*) were used for the 2016 MPU. The rainfall depths were obtained from the NOAA Atlas map (Figure 506 in CCRFCD Design Manual) and multiplied by an adjustment factor of 1.43 (see Table 501 in CCRFCD Design Manual) in accordance with established CCRFCD methodologies. The adjusted 100-year, 6-hour rainfall depths range from approximately 2.86 inches to 3.02 inches in the MPU watershed. These rainfall depths are essentially the same as those used in the 2010 MPU. Rainfall maps are included in **Appendix A**.

3.4.5. Storm Distribution

The rainfall depths discussed in the previous section were distributed over the 6-hour design storm period using three different storm distributions: SDN 3, SDN 4, and SDN 5. For drainage areas less than 8 square miles in size, SDN 3 was used. For drainage areas greater than or equal to 8 and less than 12 square miles in size, SDN 4 was used. SDN 5 was used for drainage areas greater than or equal to 12 square miles in size. The storm distributions are found in Table 503 of the CCRFCD Design Manual.

3.4.6. Depth-Area Reduction Factors

The precipitation depths obtained from NOAA Atlas 2 represent rainfall frequency at isolated points. Storms, however, cause rainfall to occur over widespread areas simultaneously, with the most intense rainfall typically occurring near the center of the storm. To account for the rainfall variation, standard precipitation analysis methods require adjusting point precipitation depths downward in order to better represent the average depth of rainfall over the entire storm area. This is done using depth-area reduction curves that relate point precipitation reduction factors to storm area and duration. The reduction factors cause the rainfall depth to decrease as the tributary area increases.

Depth-area reduction factors (DARFs) were applied to the rainfall depths in the hydrologic models at each concentration point based on upstream tributary area. Table 1 summarizes the DARF values used for each SDN in the hydrologic models. DARF ratios were established using Table 502 in the CCRFCD Design Manual. The DARF ratios are shown in **Table 3-1**.

Table 3-1 2016 MPU Depth-Area Reduction Factors

Area (Square Miles)	SDN 3	SDN 4	SDN 5
0≤Area<0.5	0.99	—	—
0.5≤Area<1	0.975	—	—
1≤Area<2	0.95	—	—
2≤Area<3	0.925	—	—
3≤Area<4	0.915	—	—
4≤Area<5	0.908	—	—
5≤Area<6	0.903	—	—
6≤Area<7	0.895	—	—
7≤Area<8	0.885	—	—
8≤Area<9	—	0.875	—
9≤Area<10	—	0.865	—
10≤Area<11	—	0.857	—
11≤Area<12	—	0.85	—
12≤Area<16	—	—	0.832
16≤Area<20	—	—	0.804
20≤Area<30	—	—	0.765
30≤Area<40	—	—	0.725
40≤Area<50	—	—	0.695
50≤Area<100	—	—	0.64
100≤Area<150	—	—	0.58
150≤Area<200	—	—	0.53

Note that in some locations in the 2016 MPU HEC-1 models, the area at certain combination points along the Muddy River is greater than 200 square miles. However, these points are included in the model for reference purposes only because peak flows along the Muddy River are referenced from the effective FIS study and gage data analysis and are not computed using HEC-1.

3.4.7. Land Use

Land use data used for the 2016 MPU is a crucial component of the overall plan. Land use densities and the associated impervious areas directly affect the amount of runoff that will occur for a given area. Impervious area increases as land use densities increase, which, in turn, increases both the volume and rate of runoff.

Based on input from Clark County Comprehensive Planning, the Clark County Planned Land Use (PLU, 2012) GIS dataset is the best available land use data in the study area. This information was used to develop the ultimate condition land use map for the 2016 MPU. The 2012 Clark County GIS data was re-categorized to correspond with matching MPU land use categories for hydrologic purposes.

In order to be consistent with other MPUs in Clark County, the land use categories from the Las Vegas Valley and other MPUs were used as a starting point, and three new categories were added as appropriate for the study area: Agriculture, Right-of-Way and Residential Countryside (0.5 unit/acre). Each land use is defined by a specified percentage of impervious ground, landscaped area in good condition, and amount of desert shrub in poor hydrologic condition.

The data was also reviewed in detail by Atkins and validated and modified based on parcel data, aerial photos, field investigations, and feedback/comments from Clark County, CCRFCD, and other stakeholders. Revisions to the land use data were the result of development in the study area, more accurate land use data, revised residential density calculations, and more reasonable assumptions made when converting entity zoning categories to MPU land use categories. Some of the land use revisions resulted in higher residential densities and higher runoff volumes in certain areas of the watershed.

Table 3-2 summarizes the land use categories included in the 2016 MPU. Detailed land use data and maps are included in **Appendix A.**

Table 3-2 2016 MPU Land Use Categories

Land Use ID	Description - Typical Land Uses	Impervious (%)	Open Landscaped Good Condition (%)	Open Desert Shrub Poor Condition ***Natural Desert Landscaping*** (%)
1	Undeveloped Land, Open Desert	0	0	100
2	Parks, Golf Courses	5	85	10
3	Rural, 1 unit/acre	20	20	60
4	Low-Density Residential, 2 units/acre	25	40	35
5	Medium-Density Residential, 3 units/acre	29	71	0
6	High-Density Residential, 6 units/acre	62	38	0
7	Public Facility, Residential Apartments/Condos	72	28	0
8	Very High-Density Residential, 12 units/acre or more	85	15	0
9	Commercial, Retail, Casino, High Rise Condominiums	90	10	0
10	Light Industrial	70	15	15
11	Heavy Industrial	85	8	7
12	Schools / Church	50	50	0
13	Lakes	0	0	0
14	Agriculture	0	60	40
15	Right-of-Way	75	25	0
16	Residential Countryside, 0.5 unit/acre	12	10	78

3.4.8. Soils

The soil data used in the 2016 MPU is a conglomeration of the following soil survey data sources:

- **Source 1:** U.S. Department of Agriculture, NRCS, Soil Survey of Virgin River Area, Nevada and Arizona, dated August 2014 (Soil Survey Symbol: NV608)
- **Source 2:** U.S. Department of Agriculture, NRCS, Soil Survey of Lincoln County, Nevada, South Part, dated August 2014 (Soil Survey Symbol: NV754)
- **Source 3:** U.S. Department of Agriculture, NRCS, Soil Survey of Clark County Area, Nevada, dated August 2014 (Soil Survey Symbol: NV755).

NRCS methodology divides soils into four hydrologic soil groups as defined below:

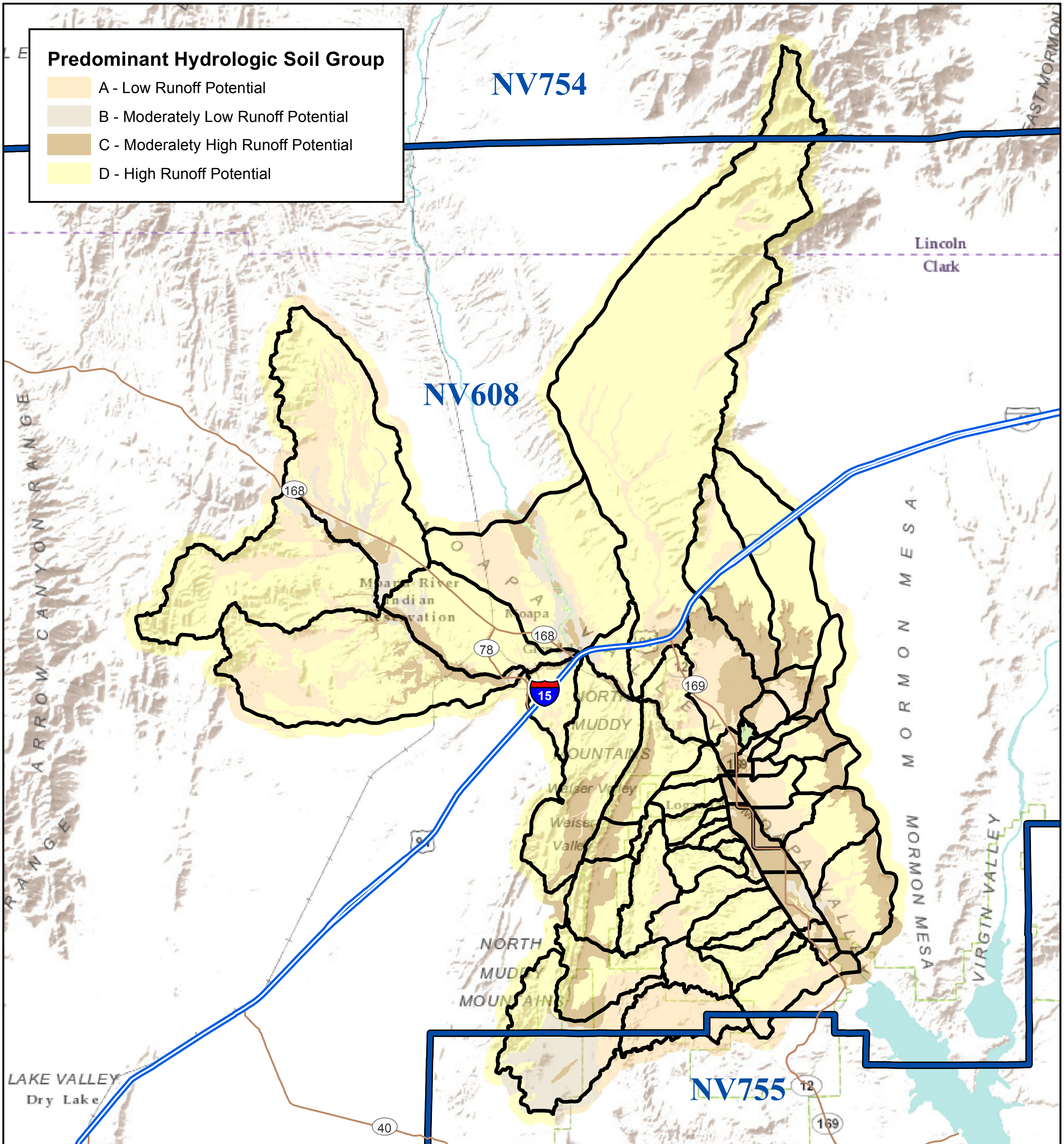
A High infiltration rate, low runoff potential
B Moderate infiltration rate, moderately low runoff potential
C Low infiltration rate, moderately high runoff potential
D Very low infiltration rate, high runoff potential

The soil survey data described above was downloaded from the NRCS website in a GIS layer. Each soil type (map unit number) in the study area is shown as a polygon and is made up of a certain percentage of hydrologic soil group (HSG) A, B, C, and D. In some cases, the soil type also comprises rock outcrop in addition to the four hydrologic soil groups. Most soil types do not include all four hydrologic soil groups or rock outcrop, and very few soil types consist entirely of a single hydrologic soil group or rock outcrop.

In 2016 MPU, the individual breakdown of each soil type into percentages of the minor HSGS or rock outcrop was used to determine weighted curve numbers for each subbasin, rather than solely relying on the predominant HSG like was done in the previous MPU. This approach is recommended because it uses best available data, is based on the physical properties of the soil, and accounts for rock outcrop areas which are prevalent in the study area.

An overview map with the soil survey boundaries in the study area and the predominant hydrologic soil groups is shown in **Figure 3-1**.

Detailed information about the soils data and a larger version of the soil map with detailed polygon boundaries for each map unit is included **Appendix A.**



N
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Miles
1 in = 5 miles

2016
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MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

SOIL MAP
FIGURE 3-1

LEGEND

Soil Survey Area
Subbasins

REGIONAL FLOOD CONTROL DISTRICT

ATKINS

3.4.9. Curve Numbers

Rainfall losses due to soil infiltration, depression storage, and other factors were calculated using the NRCS curve number method, which is a function of soil type, land cover, and antecedent moisture condition. Based on the CCRFCD Design Manual, the average antecedent moisture condition (AMC II) is used for computing losses. A curve number of 90 is assumed for rock outcrop areas.

In order to calculate composite curve numbers, each subbasin is divided into polygons that have a single land use and soil map unit. A curve number matrix is then generated that calculates a weighted curve number for a given soil map unit and land use type combination. Impervious areas are aggregated into the composite curve number; in other words, directly connected imperviousness is not entered separately for each subbasin in the HEC-1 model. This is appropriate in the Muddy River MPU study area where there are large subbasins, many undeveloped and rural areas, and limited, connected impervious areas.

GIS polygon processing was used to calculate a weighted curve number for each subbasin using the curve number matrix, subbasin delineations, soil map unit delineations, and the GIS land use layer. A weighted curve number is calculated for the whole subbasin based on the areas of the subdivided polygons and their associated curve numbers. The curve number and total area of each subbasin is then used in the hydrologic models input files.

Detailed curve number tables and calculations are included in **Appendix A**.

3.4.10. Lag Times

Lag times were calculated for subbasins over 1 square mile using the U.S. Bureau of Reclamation Method in the CCRFCD Design Manual. For subbasins less than 1 square mile, the time of concentration (velocity method) was used to compute lag time. Each method is further explained below.

U.S. Bureau of Reclamation Method

The lag time for basins over 1 square mile is calculated as follows:

$$T_{lag} = 20\ Kn\ (L\ L_c/S^{1/2})^{1/3}$$

Where:

T_{lag} = Lag time (hours)
L = Length of longest watercourse (miles)
L_c = Length along longest watercourse measured upstream to a point opposite the centroid of the basin (miles)
S = Average slope of the longest watercourse (feet/mile)
K_n = Manning's roughness for the basin channels.

Time of Concentration Method

For drainage basins less than 1 square mile, the lag time is related to the time of concentration by the following empirical relationship:

$$T_{lag} = 0.6T_c$$

Where:

T_{lag} = Lag time
T_c = Time of concentration

The time of concentration is calculated as follows:

$$T_c = T_i + T_t$$

Where:

T_c = Time of concentration
T_i = Initial, inlet, or overland flow time
T_t = Travel time in the ditch, gutter, etc.

Initial flow time is calculated as follows:

$$T_i = 1.8(1.1 - K)L_o^{1/2}/S^{1/3}$$

Where:

T_i = Initial overland flow time (minutes)
K = 0.0132 * CN - 0.39
CN = Curve number
L_o = Length of overland flow (ft, maximum 500 feet)
S = Average basin slope (percent)

Travel time is calculated as follows:

$$T_t = 500/(60\ V_1) + (L_t - 500)/(60\ V_2)$$

Where:

T_t = Travel time in the ditch, gutter, etc. (minutes)
L_t = Travel length (feet)
V_1 = Average velocity of flow for the first 500 feet of travel distance (feet/second)
V_2 = Average velocity of flow for the remaining travel distance (feet/second)

V_1 and V_2 are calculated as follows:

$$V_1 = C_1 * (S/100)^{1/2}$$

$$V_2 = C_2 * (S/100)^{1/2}$$

Where:

C_1 = 20.2 for developed areas and 14.8 for undeveloped areas
C_2 = 30.6 for developed areas and 29.4 for undeveloped areas
S = Average slope for the flow path (percent)

In urbanized areas, the time of concentration calculated above should not exceed the time of concentration calculated by the following equation:

$$T_c = (L / 180) + 10$$

Where:

T_c = Time of concentration at the first design point in an urban watershed (minutes)
L = Watershed length (feet)

The smaller of the two calculations for time of concentration controls minimum T_c for any watershed and should not be less than 5 minutes. Detailed lag time calculations for the 2016 MPU are included in **Appendix A**.

3.4.11. Routing

Muskingum and Muskingum-Cunge flood routing methods are used in the 2016 MPU HEC-1 model, similar to what was done in previous MPUs. Channel routing in natural channels, floodways, alluvial fans, and undeveloped sheet flow areas is performed using Muskingum method. Whereas routing in developed areas, improved channels, and storm drains is performed using the Muskingum-Cunge method. These methods are described below.

Muskingum Routing

Muskingum routing requires three input parameters: X, K, and NSTPS. The weighting factor X in the Muskingum routing method accounts for the peak flow reduction caused by channel routing. A value of 0.15 was used in undeveloped areas for the 2016 MPU. This value is representative of a poorly-defined channel with some storage in overbank areas.

The K parameter is essentially the travel time through the routing reach. To estimate the travel time, an average channel velocity is estimated using Manning's Equation as follows:

$$V = 1.49 * R^{2/3} * S^{1/2} / n$$

Where:

V = Velocity in feet/second
R = Hydraulic radius in feet (For the 2016 MPU, a value of 1.5 is assumed for poorly defined natural channels and 2.5 is assumed for flows primarily confined within a major wash)
S = Slope in feet/feet
n = Roughness coefficient

The K parameter is essentially equal to the travel time in hours given by:

$$K = L / 3600 * V_{WAVE}$$

Where:

L = Length of the routing reach in feet
V_{WAVE} = Wave velocity, which is assumed to be equal to 8/5 of average channel velocity for a wide rectangular channel

The NSTPS parameter is the number of time steps required. Attenuation of the peak flow is affected by the number of subreaches; the more subreaches the lower the attenuation and vice versa. It is determined by using the closest integer given by the following equation:

$$NSTPS = 60\ K/\Delta t$$

Where:

Δt = Simulation time step

Muskingum-Cunge Routing

Muskingum-Cunge routing requires the following physical input parameters: roughness coefficient, base width, side slope, slope, and reach length. Muskingum-Cunge routings were used for routing flows in improved channels, streets, and storm drains.

Details about the routing parameters that were calculated during the 2016 MPU are included in **Appendix A**. Hydrograph routing was generally performed for all subbasins and combination points to route flows to the next downstream combination point. In general, two or more hydrographs were not routed down a channel reach independently (i.e., hydrographs were combined and routed using one routing card). Additional combination points were necessary in some areas to prevent routing overlap.

3.4.12. Concentration Points

Concentration points and routing parameters were inserted into the 2016 MPU HEC-1 models to obtain peak flow rates for each MPU facility to the fullest extent possible. Detailed information about the peak 100-year flows and concentration points used to size facilities is included in Sections 4-7.

3.5. HEC-1 Model Input and Output Summary

After calculating and compiling the hydrologic parameters described above, the HEC-1 models were successfully run for SDN 3, 4, and 5 distributions in order to determine peak 100-year discharges and volumes in the study area. A summary of the input parameters at each of the subbasins in the 2016 MPU HEC-1 model is provided below in **Table 3-3**.

Table 3-3 2016 MPU Subbasins Hydrologic Parameter Summary

Subbasin	Area (sq. mi.)	Rainfall (in)	Weighted CN	Lag Time (hr)
AWASH1	4.57	2.88	86.4	0.789
AWASH2	1.63	2.86	87.2	0.510
AWASH3	5.03	2.86	87.9	1.000
BMN1	3.72	2.86	82.6	0.564
BMN2	4.08	2.86	87.3	0.717
BMN3	5.12	2.86	85.3	1.196
BMN4	6.98	2.86	86.5	1.345
BMN5	1.48	2.86	75.3	0.640
BMN6	2.06	2.86	85.0	1.053
BMN7	0.45	2.86	81.2	0.357
BMN8	1.27	2.86	67.6	0.516
BOWMAN	0.30	2.86	33.4	0.990
EWASH1	6.33	2.86	80.9	1.204
EWASH2	4.80	2.86	82.9	0.939
EWASH3	1.77	2.86	74.4	0.813
EWASH4	2.03	2.86	77.3	0.612
EWASH5	0.58	2.86	72.7	0.727
EWASH6	0.78	2.86	80.5	0.666
EWASH7	6.39	2.86	76.6	0.615
EWASH8	3.47	2.86	80.7	1.241
EWDB	1.89	2.86	86.2	0.429
FGDB	1.92	2.86	83.6	0.422
FGDB1	0.39	2.86	76.8	0.345
FGDB2	0.46	2.86	73.2	0.320
LOG1	0.41	2.86	81.6	0.507
LOG2	1.62	2.86	84.8	0.670

Table 3-3 2016 MPU Subbasins Hydrologic Parameter Summary (continued)

Subbasin	Area (sq. mi.)	Rainfall (in)	Weighted CN	Lag Time (hr)
LOG3	0.51	2.86	84.6	0.756
LWASH1	4.03	2.86	78.4	0.706
LWASH2	0.70	2.86	82.7	0.499
LWASH3	1.17	2.86	89.0	0.441
MAGW1	5.52	2.86	76.0	1.263
MAGW2	4.81	2.86	81.8	1.059
MDW	19.44	2.86	83.0	1.080
MRIV1	22.91	2.86	82.8	2.120
MRIV2	18.37	2.92	85.0	1.687
MRIV3	21.99	2.86	82.5	2.017
MRIV4	10.45	2.86	87.8	1.755
MRIV5	3.26	2.86	86.2	0.786
MRIV6	2.17	2.86	86.3	1.332
MRIV7	12.41	2.86	87.3	1.215
OVR1	1.88	2.86	85.0	0.613
OVR2	0.47	2.86	81.4	0.458
OVR3	0.45	2.86	77.1	0.440
OWASH1	2.44	2.86	76.8	0.786
OWASH2	2.43	2.86	84.3	0.611
OWASH3	0.32	2.86	88.6	0.278
OWASHN	5.95	2.90	84.0	0.894
OWASHS	11.43	3.02	80.9	0.801
WIWASH	3.50	2.86	80.9	0.913
WSWASH	61.31	2.86	86.4	1.759
WWASH1A	1.25	2.86	88.1	0.341
WWASH1B	2.63	2.86	88.4	0.433
WWASH2	1.90	2.86	88.4	0.542
WWASH2A	0.39	2.86	85.7	0.366
WWASH3	0.45	2.86	89.8	0.152
WWASH3A	0.49	2.86	89.6	0.322
WWASH4	0.58	2.86	89.4	0.377
WWASH4A	0.31	2.86	89.8	0.229
WWASH5	1.61	2.86	89.4	0.395
WWASH6	1.20	2.86	88.9	0.391

The results of the hydrologic analysis are shown on the Hydrologic Summary Map (**Figure 3-2**) at the end of this section, which includes subbasins, flow arrows, peak flows, and other data and information relevant to the hydrologic analysis. The full HEC-1 models are included in **Appendix A** and provided electronically on the Data CD.

3.6. Hydraulic Analysis and Computer Modeling

Standard MPU methodology for hydraulic analysis and facility sizing generally involves simple normal depth calculations to determine conveyance capacity. However, because of the complex nature of the Muddy River corridor and the braided, natural washes and sheet flow characteristics in the Eastern and Western Washes, 2D hydraulic models were also developed and used during the 2016 MPU analysis. These models are briefly described below.

<u>HEC-RAS</u>

A 2D hydraulic riverine model was developed as part of the 2016 MPU using HEC-RAS 2D (Beta Version 5.0). The primary purpose of the 2D model was to evaluate the complex flow patterns and characteristics of the existing floodplain, which includes flow breakouts, overbank flooding, and 2D flow patterns in relatively flat areas.

The model was run for the existing condition to determine the maximum flood depths and inundation limits in the Muddy River floodplain. The model was based on the detailed LiDAR data obtained for the project and extended from Wells Siding at the upstream end to the Overton WMA at the downstream end (approximately 7 miles). Proposed condition modeling scenarios were also run in order to refine the regional facility recommendations proposed along the Lower Muddy River. The model was used to understand the impacts of phasing the construction along the river and building separate reaches of improvements at different times. These modeling scenarios were compared to the existing condition scenario to understand and identify any adverse impacts to the floodplain or nearby properties that could result from construction.

The HEC-RAS model was a valuable tool in the MPU facility planning process and provided insight and understanding regarding structural and non-structural alternatives, especially in the breakout areas downstream of Cooper Street near Lewis Avenue. The model should be considered preliminary and was only developed to a level of detail considered appropriate for master planning purposes. The model can be used as a foundation for future FEMA floodplain studies or other projects, but it should be reviewed and refined in more detail beyond what was done for the 2016 MPU.

<u>FLO-2D</u>

FLO-2D performs 2D overland unconfined flood routing in 8 directions. 2D modeling is appropriate in flat areas or where the flow corridors are braided or not well defined, as is the case in the Western and Eastern Washes. FLO-2D was used in these areas, in conjunction with the HEC-1 models, to perform rainfall-runoff simulations and flood routing in order to delineate subbasins, identify primary flow corridors, map the flood depths and extents, evaluate potential flood hazard locations, and refine the footprints of proposed detention basins.

More detailed information regarding the HEC-RAS and FLO-2D models for each planning area in the 2016 MPU is included later in **Sections 4**, **5**, and **6**.

3.7. Facility Analysis

3.7.1. Existing Facilities

Existing MPU facilities in Moapa Valley were analyzed to determine whether they can adequately detain and/or convey the 2016 MPU 100-year peak flow rates from the HEC-1 hydrologic models. In general, the capacity of the existing facilities was determined based on normal depth calculations.

3.7.2. Proposed Facilities

Proposed 2016 MPU facilities in Moapa Valley were analyzed to determine whether they can adequately detain and/or convey the 100-year peak flow rates generated from the 2016 MPU hydrologic analyses. Previously proposed facilities from the 2010 MPU or earlier were also re-evaluated to determine whether any modifications to facility type or geometry were required. Capacity of the proposed facilities was determined based on normal depth calculations with applicable freeboard. The proposed facility alignments were also evaluated based on the best available development and infrastructure information to determine whether other locations and alignments of facilities could more efficiently facilitate the implementation of the flood control plan.

It should be noted that the hydraulic analysis is broad in nature for planning purposes and assumes all flow is contained within the proposed facility. During detailed design, it is fully expected that all features in an urban setting (i.e., street flow) will be used to minimize project costs.

3.7.3. Hydraulic Analysis

The following criteria, in general, were used for hydraulic calculations to size proposed facilities:

Channels

- Depth and velocity were determined using normal depth calculations and Manning's equation.
- Freeboard was based on Subcritical Equation 741 and Supercritical Equation 747 from the CCRFCD Design Manual.
- Design slope based on the ground slope

Channel Type	Manning's "n"
Concrete	0.015
Grass	0.030
Riprap	0.040
Earth (Unlined)	0.030

RCP Storm Drains

- Reinforced concrete pipe (RCP) capacity based on Manning's equation, non-pressure full flow
- Pipe sized to convey entire 100-year discharge
- Standard pipe size increased by 6 inches to account for minor losses
- Manning's n = 0.013
- Design Slope based on the ground slope

RCB Storm Drains

- Reinforced concrete box (RCB) capacity based on Manning's equation, non-pressure full flow
- Conduit sized to convey the entire 100-year discharge
- Total RCB cross-sectional area increased by 15% to account for minor hydraulic losses
- Manning's n = 0.015
- Design slope based on ground slope

RCB Culverts

- Proposed RCB culverts were sized using the bridge criteria outlined in the CCRFCD Design Manual, which states that there is to be a minimum of 2 feet of freeboard between the 100-year water surface and the low chord above the culvert
- Capacity = Inlet control per HDS No. 5 Federal Highways Administration (FHWA)
- Maximum Headwater Depth = height of the box – 2 ft

Bridges

- Depth and Velocity determined using normal depth and Manning's Equation
- Freeboard based on CCRFCD Design Manual minimum of 2 feet of freeboard between 100-water surface and the low chord of the bridge
- Design slope based on ground slope

Levees

Levees were sized using the following procedure:

Develop a channel cross section adjacent to the levee using a normal depth calculation that keeps the water depth at 3 feet or less and size the levee based on the following relationship: assume the channel is unlined unless the channel is also a master planned facility for which channel lining would be used. Choose a lining for the levee that is consistent with the normal depth velocity of the channel. The relationship for the height of the dike is as follows:

$$Ht = Df + Dd + Fb + Vh$$

Where: Ht = Height of dike (feet)
Df = Depth of flow (feet)
Dd = 1.3 x Df = Depth of sediment deposition (feet)
Fb = 3 (ft) = FEMA freeboard criteria
Vh = Velocity head (feet)

Detention Basins

1. Choose detention basin site and approximate limits.

2. Calculate approximate stage/area/discharge curve based on outlet size and impoundment area.

3. Run HEC-1 model to determine clear-water storage volume required (Modified Puls Method)

4. Calculate total storage volume by adding 10% volume for sediment allowance and an additional 1 foot of freeboard.

Other considerations:

- Maximum discharge = 5 to 15 percent of peak inflow depending on existing downstream facility capacity

- Outlet capacity – Equation 1202 (CCRFCD Design Manual)

- Spillway elevation = 1 foot above peak 100-year stage (including sediment allowance)

- Spillway Design storm = PMF (10 x 100-year discharge)

Details about the detention basins and hydraulic analysis of existing and proposed facilities are included in **Appendix B**.

3.8. Cost Estimation

Cost estimates for existing regional facilities in the MPU were based on actual cost data that has been compiled during previous MPUs and updated as part of the 2016 MPU.

Construction cost estimates for proposed regional facilities were determined using the CCRFCD Cost Estimation Tool that was developed as part of the 2008 Las Vegas Valley MPU. For more background information about the development of the Cost Tool, please refer to Section 4.5 of the 2008 Las Vegas Valley MPU.

In the 2010 MPU, the cost estimates for the proposed regional facilities were determined using the 2008 Las Vegas Valley Cost Tool, but an adjustment factor of 0.765 was applied to all of the estimated costs to account for a decrease in overall construction costs at the time the 2010 MPU was prepared. Based on input from CCRFCD, an updated cost factor of 0.815 was applied to all of the estimated costs in the 2016 MPU. This was done to be consistent with other cost estimates and the Ten Year Construction Program used at CCRFCD for planning purposes. The factor essentially accounts for an increase (inflation) in the costs of about 6.6% since the time the 2010 MPU was prepared (0.765 * 1.066 = 0.815).

3.9. GIS Data Development

ArcGIS 10.1 software was used in this MPU to update the flood control facility inventory for Moapa Valley. The base layer of facilities was downloaded from the CCRFCD website at the onset of the project and then updated and modified based on information developed throughout the 2016 MPU process.

Some of the significant GIS layers used in the 2016 MPU include:

- Topography data, DEMs, survey data
- Subbasins, flow paths, and flow direction arrows
- Proposed facility linework and detention basin footprints (regional facilities)
- Soils and land use data
- Aerial photos
- Land ownership and parcel boundaries
- FEMA flood zones
- Environmentally sensitive areas

All of the relevant GIS data is provided electronically on the Data CD included with this report.

Combination Points ID	100-year Flow (cfs)	Tributary Area (sq. mi.)
CAWASH2	2831	6.2
CAWASH3	3896	11.23
CBMN3	2948	8.84
CBMN34	5027	19.9
CBMN4	3646	11.06
CBMN56	5196	23.44
CBMN7	5274	23.89
CBOWMAN	267	1.57
CCOWASH2	4492	22.25
CEWASH4	802	3.92
CEWASH5	378	27.24
CEWASH6	2097	7.17
CFGDB1	270	24.28
CFGDB2	317	26.66
CLWASH1	1718	4.73
CLWASH3	2108	5.9
CMAGW2	1893	10.33
CMRIV1	5671	41.28
CMRIV3	7001	63.27
CMRIV5	9965	96.42
CMRIV7	13080	172.31
COVR2	916	34.54
COWASH1	4701	19.82
COWASH2	826	33.75
COWASH3	855	34.07
COWASHS	4429	17.38
CRDBFGWS	221	2.38
CWIWASH	863	7.62
CWWASH1A	870	11.5
CWWASH1B	814	10.25
CWWASH2	873	4.12
CWWASH2A	821	2.22
CWWASH3	536	1.83
CWWASH3A	516	1.38
CWWASH4	909	0.89

N

0 4,000 Feet

1 in = 4,000 feet

2016 FLOOD CONTROL MASTER PLAN UPDATE
MUDDY RIVER AND TRIBUTARY WASHES

HYDROLOGY SUMMARY MAP
FIGURE 3-2

LEGEND

- USGS Gage 09419000
- HEC-1 Combination Point
- Flow Arrows
- Hydrologic Subbasin
- Existing Regional Facility
- Proposed Regional Facility
- Existing Detention Basin
- Proposed Detention Basin
- Lower Muddy River
- Eastern Washes
- Western Washes

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SECTION 4
Western Washes

4. Western Washes

4.1. Introduction

This section describes the drainage characteristics and the flood control master plan for the area referred to in this report as the Western Washes, which encompasses a watershed area of approximately 58 square miles west of Logandale and Overton. This area is largely undeveloped and consists of badland formations and dry, natural washes with relatively steep slopes running from west to east that have historically been a common source of flooding in the towns of Logandale and Overton.

4.2. Drainage Characteristics

The Western Washes are bordered on the west by mountainous areas and the Weiser Ridge that runs from north to south along the western boundary of the Valley of Fire State Park. Runoff in this area results from moderate to heavy rainfall which occurs on a sporadic basis and rapidly fills the natural washes draining toward Logandale and Overton. Desert soils in the area are typically low in permeability due to badland formations and rock outcrop areas.

These areas discharge to four major washes known as the Anderson Wash, Overton Wash, Wieber Wash, and Logan Wash (aka, Benson Wash), as well as many smaller unnamed washes. Presently, runoff is conveyed in the washes through bridges and culverts under the Union Pacific Railroad (UPRR) and flow east through Overton to the Muddy River. The relatively flat topography in Logandale/Overton, the uncertainty of the flow patterns, and the lack of flood control facilities makes this area prone to flash flooding and sediment deposition.

4.3. Hydrologic and Hydraulic Analysis

The hydrologic and hydraulic analysis completed for the Western Washes is consistent with the methodology described in **Section 3**. The peak 100-year discharges in the Western Washes were determined using HEC-1. A thorough review of the hydrologic analysis and parameters was performed using best available data and information. This effort included an update of land use information, subbasin delineations, soils information, lag time calculations, and routing information.

In addition to the lumped parameter HEC-1 model, a 2D rainfall-runoff model of the Western Washes was also developed using the FLO-2D program. FLO-2D performs 2D overland unconfined flood routing in 8 directions. 2D modeling is appropriate in flat areas or where the flow corridors are braided or not well defined, as is the case in the Western Washes.

The FLO-2D model was based on 10-meter USGS DEM data obtained from the USGS National Map website (http://viewer.nationalmap.gov/viewer). This elevation data was imported onto the FLO-2D computational grid with a cell size of 60 feet by 60 feet. Then the CN values in the area and the 100-year, 6-hour rainfall depth and distribution were assigned to the grid and the model was run to simulate the rainfall-runoff process and subsequent flood routing in the washes.

The unsteady FLO-2D model accounted for the effects of floodwave attenuation and was effective in determining the limits of inundation and refining subbasin delineations. Thus, the HEC-1 model was used to determine peak flows and volumes, while the FLO-2D model was used to delineate subbasins, identify primary flow corridors, evaluate potential flood hazard locations, and refine the footprints of proposed detention basins.

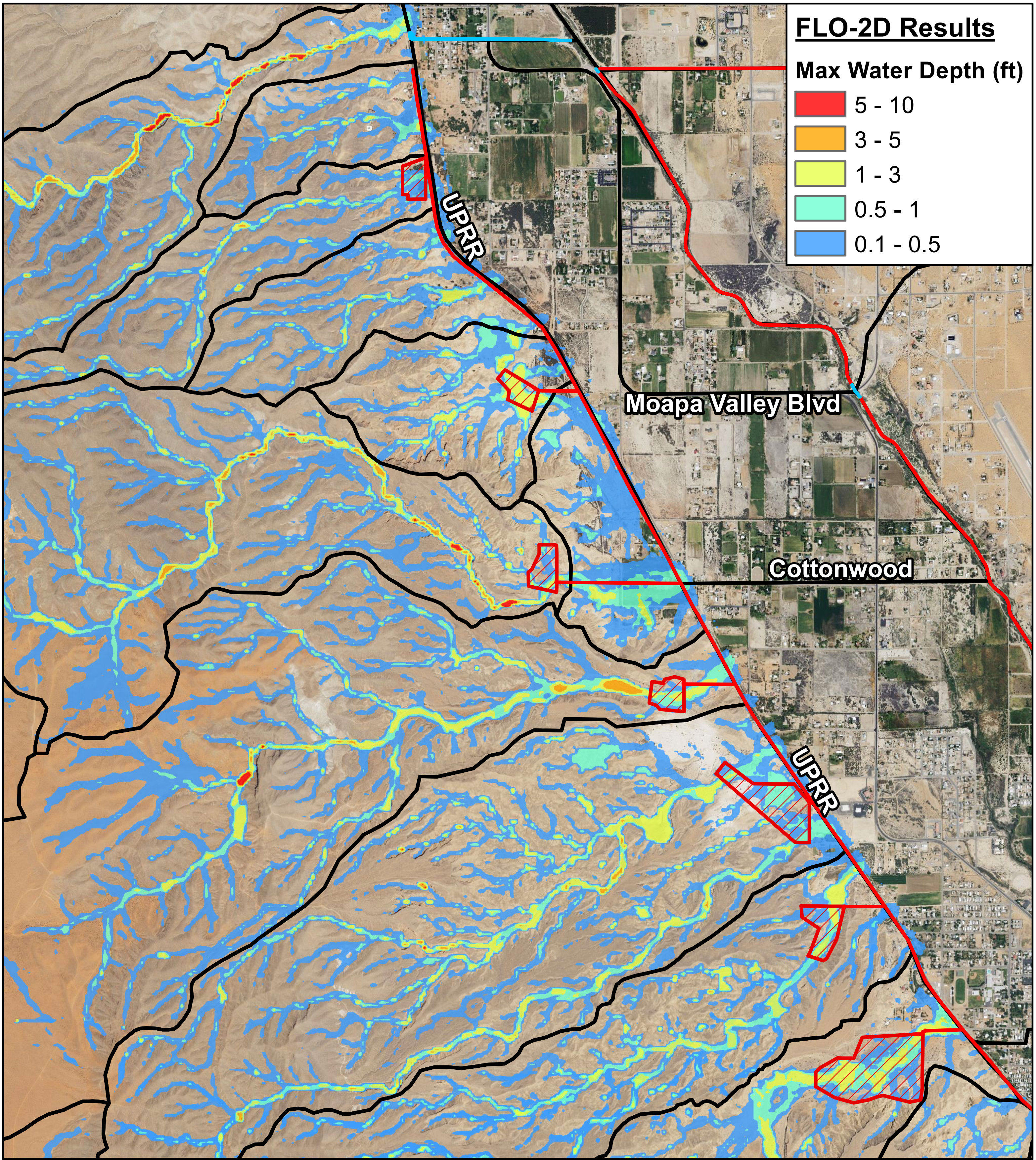
Previous MPU models used generalized subbasins and assumed that all areas in the Western Washes drained directly to proposed detention basins in the area; however, after reviewing the topography and the FLO-2D model, it became apparent that several subbasins in lower portions of the watershed near UPRR would drain directly to the proposed regional channel and bypass proposed detention basins. The models and proposed flood control facility plan was revised accordingly to account for flows in this area that will drain directly to the channel.

An exhibit showing the FLO-2D results, subbasins, and proposed detention basin locations in the Western Washes is included in **Figure 4-1**.

The hydrologic modeling resulted in peak flow rates that were somewhat different than the previous MPU. In some areas the flow rates increased while in other areas the flow rates decreased. The differences can be primarily attributed to the updated soils data and revisions to the subbasin delineations described above.

It should be noted that the HEC-1 combination point labeled CWWASH2 (located at Cottonwood Avenue and UPRR) was the controlling concentration point for the proposed Western Washes Railroad Channel (WWRR) facilities located downstream. Even though this concentration point is located upstream of other concentration points, the peak flow at this location governs because of the decreasing peak flow that occurs downstream due to increasing tributary area, depth area reduction factors, and attenuation of flow from routing. Other storm centering scenarios were evaluated (such as removing the detention basin flows and only applying the storm downstream to reduce tributary area), but the flow at CWWASH2 with the entire tributary included still produced the highest or "governing" design flow that was used for sizing regional facilities.

Proposed detention basins were sized for the Western Washes using the HEC-1 model according to the methodology described in **Section 3**. Proposed flood control conveyance facilities were sized and analyzed using normal depth calculations in the facility sizing tool. For more information on the analysis of the facilities included in the recommended flood control plan for the Western Washes, refer to **Appendix B**.



N
0 0.6
Miles
1 in = 0.6 miles

2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

WESTERN WASHES
FLO-2D RESULTS
FIGURE 4-1

Legend

- Subbasin Boundary
- Existing Regional Facility
- Proposed Regional Facility
- Existing Detention Basin
- Proposed Detention Basin

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4.4. Master Plan Progress and Existing Regional Facilities

No progress has been made on the implementation of the flood control master plan in the Western Washes since the 2010 MPU.

There is one existing regional facility in the upstream portion of the watershed in the Western Washes area, known as the Logan Wash Diversion (LWAW 0000). This facility consists of a 45-foot wide earthen channel and a large adjacent berm with some rip-rap lining that redirects flows from the Logan Wash to the Anderson Wash. The Gann Avenue storm drain and debris basin is also located at the downstream end of the Logan Wash on the west side of UPRR, but this facility is discussed in Section 6 since it connects to the Lower Muddy River.

The UPRR embankment provides some limited flood protection in the existing condition in some locations. In addition, there are some man-made earthen berms/remnants, small local drainage facilities, and bridges and culverts along the UPRR that have capacity to direct or convey some of the flow from the Western Washes toward the Muddy River during smaller storm events.

4.5. Recommended Flood Control Plan

For the majority of the Western Washes, the recommended flood control plan is similar to the plan outlined in the 2010 MPU with some modifications. Areas of the recommended plan that have been modified since the 2010 MPU are described below:

- **West Wash 1 Detention Basin (WWWA 0017)** – This detention basin from the previous MPU has been split into two proposed detention basins: the West Wash 1 Detention Basin (WWWA 0017) and the Ingram Avenue Detention Basin (WWIA 0016). This was necessary because there are distinct, separate washes and flow corridors in the area that could not be intercepted by one detention basin at a single location. Therefore, the Ingram Avenue Detention Basin is proposed south of the West Wash 1 Detention Basin to intercept flow from the wash in that area. The upstream subbasins were also split to identify the peak flows and volumes impacting each detention basin. During the design phase, these detention basins can be reviewed in more detail to determine if a single basin could be constructed with a combination of diversion berms or collector channels to direct flow to a single basin. For master planning purposes, it was determined that two separate detention basins were the most cost effective and feasible to design and construct.

- **Western Washes Railroad Channel (WWRR 0000-0550)** – This proposed channel system and culvert/bridge crossings were reviewed and upsized as necessary using the updated hydrologic results. The 100-year peak discharge in the channel increased, due to the revised subbasin delineations which show certain areas downstream of the proposed detention basins draining directly to the channel. The previous MPU calculated a peak 100-year discharge in the channel ranging from 38 cfs at the upstream end to 603 cfs at the downstream end. The updated analysis shows the peak

100-year discharge in the channel ranges from 395 cfs at the upstream end to 916 cfs at the downstream end.

Atkins reviewed the possibility of splitting the Western Washes Railroad Channel into separate segments and building cross-valley channels from UPRR to Muddy River to convey the flows. The MVIC indicated that some local irrigation facilities and corridors could potentially be used to convey flows from the Western Washes detention basins to the Muddy River.

After reviewing this option, it was concluded that the proposed regional system would remain as is (i.e., a single channel along the western side of UPRR extending all the way to the Muddy River). The option of splitting the channel into various segments can be reviewed in more detail during the design phase, but for master planning and cost programming purposes, showing a single channel along west side of UPRR is still representative of the total facilities and funding needed for the project. Even if cross-valley channels cut off some of the flow and connected sooner to the Muddy River, there would still be a need for a channel along the western side of the UPRR. Further, previous MPUs have reviewed this alternative and determined that it was most cost effective to use a single channel along the UPRR. If this "segmented" option is explored during design phase, Cottonwood Avenue is recommended as the most logical location to split the channel because right-of-way is available and because downstream of that location, all of the Western Washes subbasins drain to proposed detention basins that have relatively low outflow rates. This would allow for the remaining segment of the proposed channel to be significantly reduced in size.

- **WWRR 0550** – This proposed channel was added at the upstream end of the Western Washes Railroad Channel to collect flow impacting the UPRR alignment in that area and convey it to the Wittwer Ave Detention Basin (WWWT 0004).

- **WWRR 0000 –** One minor change in the hydrologic analysis was incorporated at the downstream end of the Western Washes Railroad Channel. In the previous MPU, the subbasin in this area (OVR2) connected to a proposed parallel channel along the west side of the Muddy River. Because of revisions to the proposed regional facilities in that area (see **Section 6**), the parallel facility has been eliminated. This means runoff from subbasin OVR2 is assumed to be conveyed south to the proposed Western Washes Railroad Channel (WWRR 0000) in the ultimate condition.

  This could be facilitated by installing a local storm drain and/or culvert crossing at Lewis Avenue (approximately 650 east of Spur Street) to drain flow south to the proposed regional facility. The runoff in this area is less than 500 cfs so a local storm drain facility is recommended in lieu of a regional facility. However, this local storm drain would be considered a collection facility within a quarter-mile of the proposed regional facility, and therefore it may be eligible for funding according to CCRFCD policies and procedures for local drainage participation.

- **Western Washes Detention Basins (WWWT 0004, WWDA 0009, WWCA 0050, WWWI 0027, WWWA 0017, WWIA 0016, WWPA 0018)** – All of the proposed Western Washes detention basins were reviewed and revised based on updated hydrologic analysis. Proposed detention basin volumes were also modified in order to account for sediment allowance and 1 foot of freeboard according to the methodology described in **Section 3**. The footprints of the detention basins were reviewed and revised as necessary using the FLO-2D results and the LiDAR data to ensure they are sized appropriately and situated in primary flow corridors and low-lying areas. Finally, the stage-area-discharge curves in the HEC-1 model were revised to be consistent with detention basin footprints, impoundment areas, invert elevations, and outlet sizes. Supporting information for development of the stage-area-discharge curves is provided in **Appendix B**. A summary of the proposed detention basins sizes, volumes, and flow rates is provided in **Table 4-1**.

Table 4-1 Western Washes Proposed Detention Basins

ID MILE	Name of Detention Basin	Peak Inflow (cfs)	Peak Outflow (cfs)	2016 MPU Storage Volume (ac-ft)	2010 MPU Storage Volume (ac-ft)
WWCA 0050	Cottonwood Avenue Detention Basin	1417	118	156	146
WWDA 0009	Duesing Avenue Detention Basin	674	24	49	46
WWIA 0016	Ingram Avenue Detention Basin	1184	85	108	N/A
WWPA 0018	Perkins Avenue Detention Basin	4492	273	992	1179
WWWA 0017	West Wash 1 Detention Basin	2140	117	235	229
WWWI 0027	Wieber Wash Detention Basin	1196	129	182	244
WWWT 0004	Wittwer Avenue Detention Basin	909	31	91	76

The remaining regional flood control facilities from the 2010 MPU that are not described above have been perpetuated in the 2016 MPU recommended flood control plan for the Western Washes.

The existing and proposed regional flood control facilities for the Western Washes are summarized in the inventory table shown in **Table 4-2**.

In addition, detailed facility maps and inventory tables showing all regional facilities in the Western Washes and other areas in Moapa Valley are shown in **Figure F-1** and **Figure F-2** at the end of this report in the section titled **Facility Maps**.

Table 4-2 Western Washes Regional Flood Control Facilities

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	Channel Slope (%)
WWCA		**WESTERN WASHES CHANNEL SYSTEM - COTTONWOOD**			
0000	P1	60" RCP	2550	118	0.500
0048	P1	30" RCP Outlet Pipe	70	118	0.500
0049	P1	14,170 cfs Spillway	--	14170	--
0050	P1	156 acre-ft Cottonwood Avenue Detention Basin	--	1417	--
WWDA		**WESTERN WASHES CHANNEL SYSTEM - DUESING**			
0000	P1	36" RCP	750	24	0.500
0007	P1	18" RCP Outlet Pipe	70	24	0.500
0008	P1	6,740 cfs Spillway	--	6740	--
0009	P1	49 acre-ft Duesing Avenue Detention Basin	--	674	--
WWIA		**WESTERN WASHES CHANNEL SYSTEM - INGRAM**			
0000	P1	48" RCP	760	85	1.000
0014	P1	30" RCP Outlet Pipe	70	85	0.500
0015	P1	11,840 cfs Spillway	--	11840	--
0016	P1	108 acre-ft Ingram Avenue Detention Basin	--	1184	--
WWPA		**WESTERN WASHES CHANNEL SYSTEM - PERKINS**			
0000	P1	6' x 6' RCB	840	273	0.500
0016	P1	42" RCP Outlet Pipe	70	273	0.500
0017	P1	44,920 cfs Spillway	--	44920	--
0018	P1	992 acre-ft Perkins Avenue Detention Basin	--	4492	--
WWRR		**WESTERN WASHES RAILROAD CHANNEL**			
0000	P1	Conc Chnl 12'W 5.5'D 2:1 SS	4030	916	0.400
0077	P1	14' X 7' RCBC @ State Route 169	100	873	0.500
0079	P1	Conc Chnl 12'W 5.5D 2:1 SS	515	873	0.500
0083	P1	Conc Chnl 12'W 5.5'D 2:1 SS	2500	873	0.400
0139	P1	14' X 7' RCBC @ Access Road	60	873	0.400
0141	P1	Conc Chnl 12'W 5.5'D 2:1 SS	725	873	0.400
0157	P1	14' X 7' RCBC @ Access Road	60	873	0.400
0159	P1	Conc Chnl 12'W 5.5'D 2:1 SS	2310	873	0.400
0204	P1	14' X 7' RCBC @ Access Road	60	873	0.400
0206	P1	Conc Chnl 12'W 5.5'D 2:1 SS	1620	873	0.400
0236	P1	14' X 7' RCBC @ Access Road	60	873	0.400
0238	P1	Conc Chnl 12'W 5.5'D 2:1 SS	1900	873	0.400
0274	P1	14' X 7' RCBC @ Access Road	60	873	0.400
0276	P1	Conc Chnl 12'W 5.5'D 2:1 SS	2035	873	0.400
0305	P1	Conc Chnl 12'W 5.5'D 2:1 SS	2350	873	0.400
0359	P1	14' X 7' RCBC @ Access Road	60	873	0.400
0361	P1	Conc Chnl 12'W 5.5'D 2:1 SS	4525	821	0.400
0441	P1	Conc Chnl 12'W 4.5'D 2:1 SS	2050	539	0.500
0480	P1	12' X 6' RCBC @ Access Road	60	539	0.500
0482	P1	Conc Chnl 12'W 4.5'D 2:1 SS	3565	539	0.500
0550	P1	Conc Chnl 12'W 4'D 2:1 SS	2250	395	0.500

Table 4-2 Western Washes Regional Flood Control Facilities (Continued)

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	Channel Slope (%)
WWWA		**WESTERN WASHES CHANNEL SYSTEM - WEST WASH 1**			
0000	P1	36" RCP Outlet Pipe	70	117	0.500
0016	P1	21,400 cfs Spillway	--	21400	--
0017	P1	235 acre-ft West Wash 1 Detention Basin	--	2140	--
WWWI		**WESTERN WASHES CHANNEL SYSTEM - WIEBER**			
0000	P1	60" RCP	1010	129	0.500
0025	P1	30" RCP Outlet Pipe	70	129	0.500
0026	P1	11,960 cfs Spillway	--	11960	--
0027	P1	182 acre-ft Wieber Wash Detention Basin	--	1196	--
WWWT		**WESTERN WASHES CHANNEL SYSTEM - WITTWER**			
0000	P1	18" RCP Outlet Pipe	70	31	0.500
0003	P1	9,090 cfs Spillway	--	9090	--
0004	P1	91 acre-ft Wittwer Avenue Detention Basin	--	909	--
LWAW		**LOGAN WASH DIVERSION**			
0000	E	Earthen Diversion Channel	1675	2303	0.500

4.6. Facility Cost Estimates

Cost estimates for all facilities in the Western Washes area have been derived using the Cost Estimation Tool described in **Section 3**. The total estimated current value of existing facilities and total estimated construction cost of proposed facilities in the Western Washes are as follows:

Estimated Value of Existing Facilities = $500,000

Estimated Construction Cost of Proposed Facilities = $36,293,000

Table 4-3 shows the current estimated value of existing facilities in the Western Washes, and **Table 4-4** shows the construction cost estimates for proposed facilities in the Western Washes area.

Table 4-3 Western Washes Cost of Existing Facilities

ID / River Mile	E/P	Facility Description	Total Cost ($ x 1000)
LWAW		**LOGAN WASH DIVERSION**	
0000	E2	Earthen Diversion Channel	$500
		Project Total:	**$500**
		WESTERN WASHES EXISTING TOTAL:	**$500**

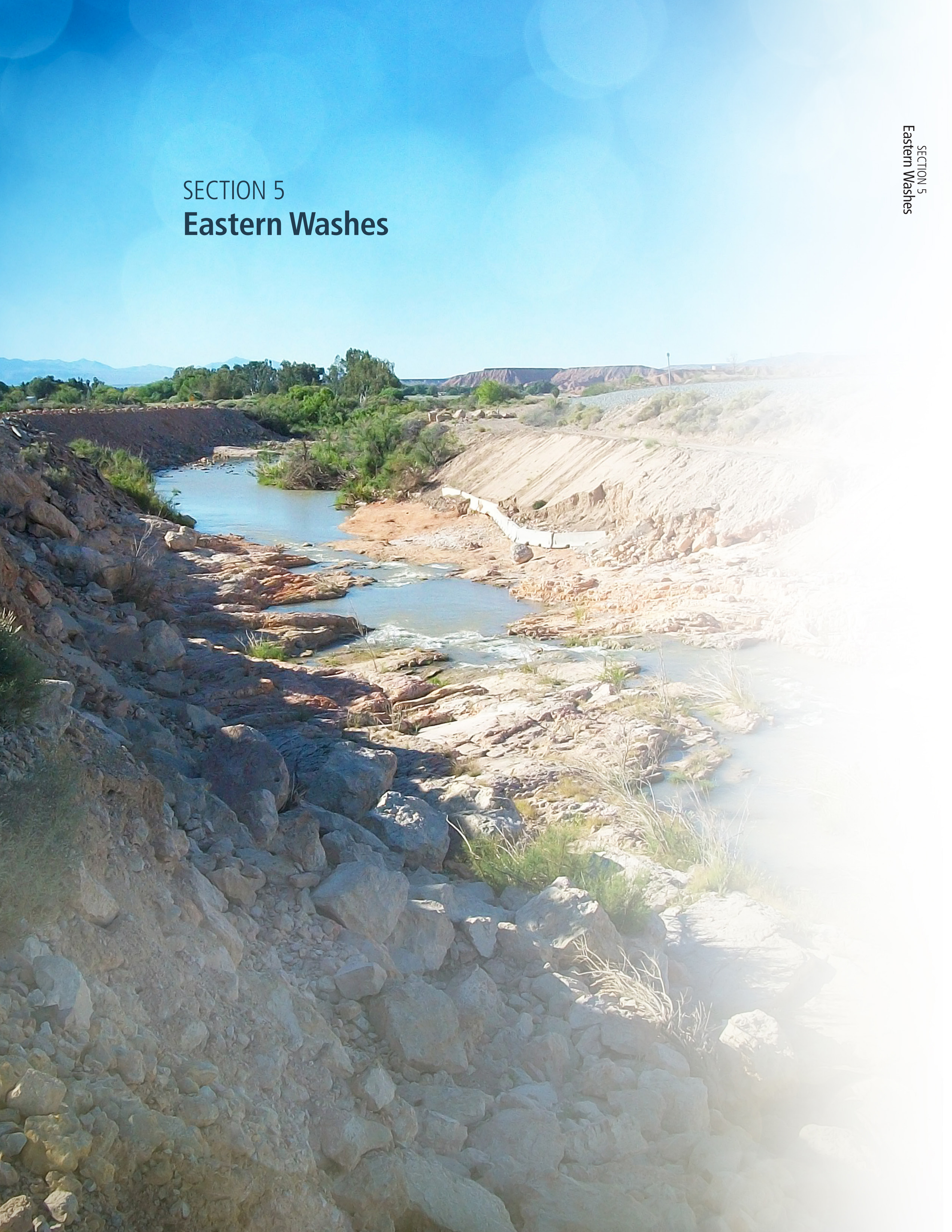
Table 4-4 Western Washes Cost Estimate for Proposed Facilities

ID / River Mile	E/P	Facility Description	Design & Admin ($ X 1000)	Right of Way Cost ($ X 1000)	Const. Cost ($ X 1000)	Total Cost ($ X 1000)
WWCA		**WESTERN WASHES CHANNEL SYSTEM - COTTONWOOD**				
0000	P1	60" RCP	$205	$0	$1,467	$1,672
0048	P1	30" RCP Outlet Pipe	$4	$0	$27	$31
0049	P1	14170 cfs Spillway	$150	$0	$943	$1,094
0050	P1	156 acre-feet Cottonwood Avenue Detention Basin	$103	$0	$644	$747
		Project Total:	**$462**	**$0**	**$3,081**	**$3,544**
WWDA		**WESTERN WASHES CHANNEL SYSTEM - DUESING**				
0000	P1	36" RCP	$46	$0	$327	$373
0007	P1	18" RCP Outlet Pipe	$3	$0	$25	$28
0008	P1	6,740 cfs Spillway	$82	$0	$517	$599
0009	P1	49 acre-foot Duesing Avenue Detention Basin	$32	$0	$202	$234
		Project Total:	**$163**	**$0**	**$1,071**	**$1,234**
WWIA		**WESTERN WASHES CHANNEL SYSTEM - INGRAM**				
0000	P1	48" RCP	$53	$0	$379	$432
0014	P1	30" RCP Outlet Pipe	$4	$0	$27	$31
0015	P1	11,840 CFS Spillway	$130	$0	$816	$946
0016	P1	108 ac-ft Ingram Avenue Detention Basin	$71	$0	$446	$517
		Project Total:	**$258**	**$0**	**$1,668**	**$1,926**
WWPA		**WESTERN WASHES CHANNEL SYSTEM - PERKINS**				
0000	P1	6'x6' RCB	$123	$0	$876	$999
0016	P1	42" RCP Outlet Pipe	$4	$0	$31	$35
0017	P1	44,920 cfs Spillway	$383	$0	$2,402	$2,785
0018	P1	992 acre-feet Perkins Avenue Detention Basin	$653	$0	$4,095	$4,747
		Project Total:	**$1,163**	**$0**	**$7,404**	**$8,566**
WWRR		**WESTERN WASHES RAILROAD CHANNEL**				
0000	P1	Conc Chnl 12'W 5.5'D 2:1 SS	$248	$0	$1,772	$2,019
0077	P1	14'X7' RCBC @ State Route 169	$22	$0	$156	$178
0079	P1	Conc Chnl 12'W 5.5D 2:1 SS	$32	$0	$226	$258
0083	P1	Conc Chnl 12'W 5.5'D 2:1 SS	$154	$0	$1,099	$1,253
0139	P1	14'X7' RCBC @ Access Road	$13	$0	$94	$107
0141	P1	Conc Chnl 12'W 5.5'D 2:1 SS	$45	$0	$319	$363
0157	P1	14'X7' RCBC @ Access Road	$13	$0	$94	$107
0159	P1	Conc Chnl 12'W 5.5'D 2:1 SS	$142	$0	$1,015	$1,157
0204	P1	14'X7' RCBC @ Access Road	$13	$0	$94	$107
0206	P1	Conc Chnl 12'W 5.5'D 2:1 SS	$100	$0	$712	$812
0236	P1	14'X7' RCBC @ Access Road	$13	$0	$94	$107
0238	P1	Conc Chnl 12'W5.5'D 2:1 SS	$117	$0	$835	$952
0274	P1	14'X7' RCBC @ Access Road	$13	$0	$94	$107
0276	P1	Conc Chnl 12'W 5.5'D 2:1 SS	$125	$0	$895	$1,020
0305	P1	Conc Chnl 12'W 5.5'D 2:1 SS	$144	$0	$1,033	$1,178
0359	P1	14'X7' RCBC @ Access Road	$13	$0	$94	$107
0361	P1	Conc Chnl 12'W 5.5'D 2:1 SS	$278	$0	$1,989	$2,267

Table 4-4 Western Washes Cost Estimate for Proposed Facilities (Continued)

ID / River Mile	E/P	Facility Description	Design & Admin ($ X 1000)	Right of Way Cost ($ X 1000)	Const. Cost ($ X 1000)	Total Cost ($ X 1000)
WWRR		**WESTERN WASHES RAILROAD CHANNEL (CONTINUED)**				
0441	P1	Conc Chnl 12'W 4.5'D 2:1 SS	$108	$0	$770	$877
0480	P1	12'X6' RCBC @ Access Road	$11	$0	$78	$89
0482	P1	Conc Chnl 12'W 4.5'D 2:1 SS	$187	$0	$1,339	$1,526
0550	P1	Conc Chnl 12'W 4'D 2:1 SS	$108	$0	$773	$881
		Project Total:	**$1,791**	**$0**	**$12,802**	**$14,591**
WWWA		**WESTERN WASHES CHANNEL SYSTEM – WEST WASH 1**				
0000	P1	36" RCP Outlet Pipe	$4	$0	$29	$33
0016	P1	21,400 cfs Spillway	$210	$0	$1,318	$1,527
0017	P1	235 acre-feet West Wash 1 Detention Basin	$155	$0	$970	$1,125
		Project Total:	**$369**	**$0**	**$2,317**	**$2,685**
WWWI		**WESTERN WASHES CHANNEL SYSTEM - WIEBER**				
0000	P1	60" RCP	$82	$0	$586	$668
0025	P1	18" RCP Outlet Pipe	$3	$0	$25	$28
0026	P1	11,960 cfs Spillway	$131	$0	$822	$953
0027	P1	182 acre-feet Wieber Wash Detention Basin	$120	$0	$751	$871
		Project Total:	**$336**	**$0**	**$2,184**	**$2,520**
WWWT		**WESTERN WASHES CHANNEL SYSTEM - WITTWER**				
0000	P1	18" RCP Outlet Pipe	$3	$0	$25	$28
0003	P1	9,090 CFS Spillway	$105	$0	$659	$763
0004	P1	91 ac-ft Wittwer Detention Basin	$60	$0	$376	$436
		Project Total:	**$168**	**$0**	**$1,060**	**$1,227**
		WESTERN WASHES PROPOSED TOTAL:	**$4,710**	**$0**	**$31,587**	**$36,293**

SECTION 5
Eastern Washes



5. Eastern Washes

5.1. Introduction

This section describes the drainage characteristics and the flood control master plan for the area referred to in this report as the Eastern Washes, which encompasses a watershed area of approximately 46.4 square miles located east and northeast of the Muddy River. The downstream portions of this area near the Muddy River floodplain are somewhat developed and consist of residential areas, commercial developments, schools, and agricultural areas.

5.2. Drainage Characteristics

Drainage patterns in the Eastern Washes are generally from east to west, draining from mountainous areas and mesas in the east towards the Muddy River at an approximate slope of 2 percent. The area is bounded on the east by the Mormon Mesa, on the north by the Mormon Mountains, and on the west by the Muddy River. Runoff in this area results from moderate to heavy rainfall which occurs on a sporadic basis and rapidly fills the natural washes draining toward Logandale and Overton.

There are currently no regional flood control facilities in the Eastern Washes area, meaning that runoff tends to spread out and is conveyed on streets and through natural, unlined washes and small culverts that cut through neighborhoods and developed areas until eventually discharging to the Muddy River corridor. Sandy soils in the area provide high potential for sediment transport and deposition. The lack of flood control facilities in the area and the potential for sediment deposition makes this area prone to frequent flash flooding and damage during storm events.

5.3. Hydrologic and Hydraulic Analysis

The hydrologic and hydraulic analysis completed for the Eastern Washes is consistent with the methodology described in **Section 3**. The peak 100-year discharges in the Eastern Washes were determined using HEC-1. A thorough review of the hydrologic analysis and parameters was performed using best available data and information. This effort included an update of land use information, subbasin delineations, soils information, lag time calculations, and routing information.

In addition to the lumped parameter HEC-1 model, four different 2D flood routing models of the Eastern Washes were developed in FLO-2D to analyze the major washes. The purpose of these models was to perform flood routing and inundation mapping to determine the flooding extents of the natural washes draining through the residential areas. In other words, the 100-year peak discharges and hydrographs from the HEC-1 models were loaded into the 2D models to route the flows and determine maximum depths, velocities, and flooding extents in the residential areas. These results were then reviewed and regional facilities were proposed as needed to mitigate problem areas.

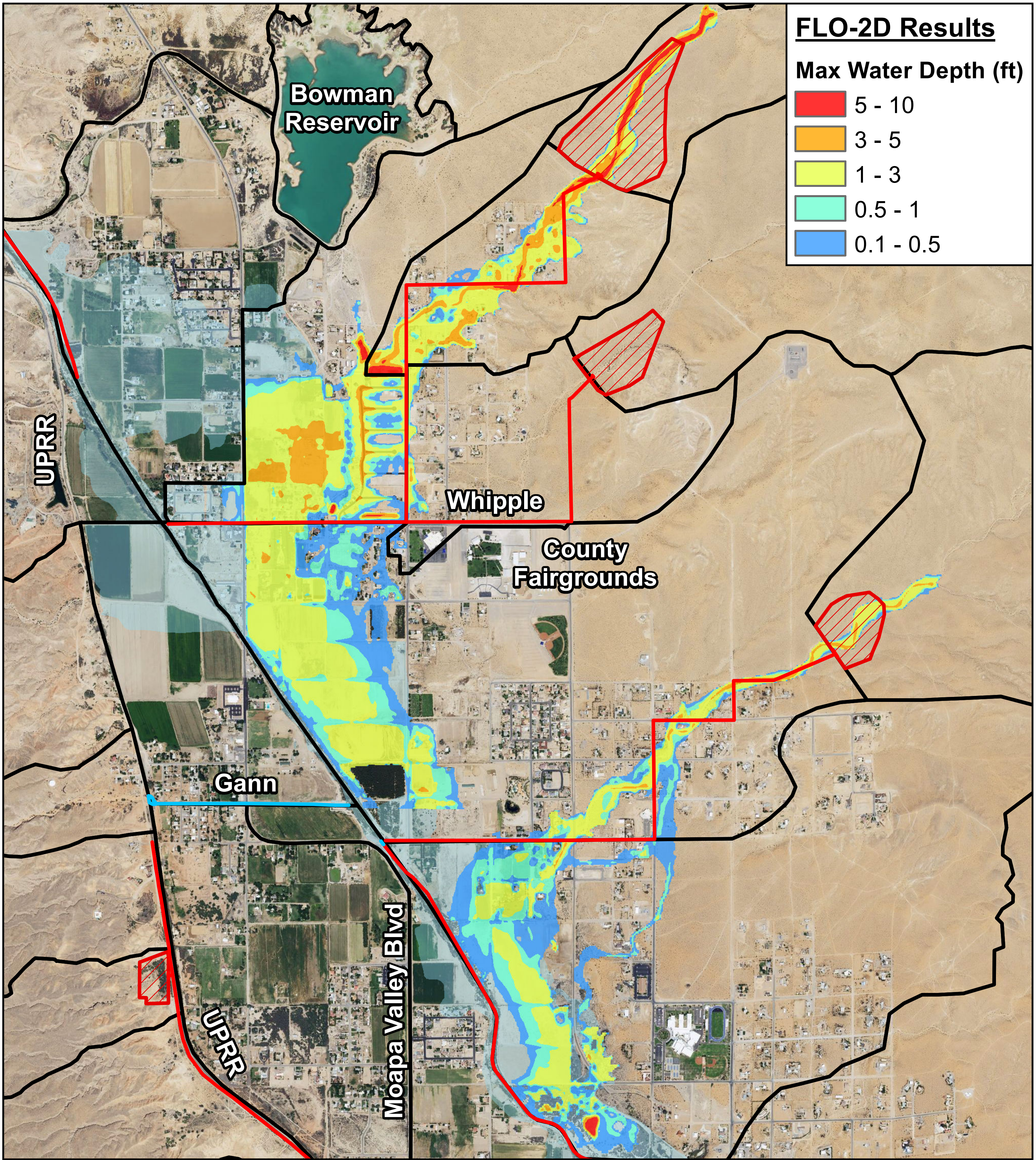
The FLO-2D models were based on the SNWA ASCII grids described in **Section 3**, since the detailed 2015 LiDAR data did not cover all of the Eastern Washes areas. This elevation data was imported onto the FLO-2D computational grids, which varied in size for each model from 20-30 feet. The HEC-1 hydrographs were loaded onto the grid in FLO-2D and the model was run to simulate the flood routing in the washes. Two exhibits showing the FLO-2D results (one in the northern portion of the watershed the other in the southern portion) are included in **Figure 5-1** and **Figure 5-2**.

There was no need to develop a FLO-2D model upstream of the Fairgrounds Detention Basin since a regional facility is already proposed along that wash and the flood hazard was previously identified in the MPU.

The unsteady FLO-2D model was helpful in identifying the flood hazard areas, maximum flood depths, and limits of inundation. The results from the FLO-2D models were reviewed in order to make recommendations and update the proposed flood control facility plan as needed. Refer to **Section 5.5** for more information regarding the recommended facilities recommended to address flooding from the Eastern Washes.

The hydrologic modeling resulted in peak flow rates that were different than the previous MPU. For the majority of the watershed, the flow rates decreased. In a small, southern portion of the watershed, the flow rates increased. The differences can be primarily attributed to the updated land use data and soils data. The 2014 detailed soil survey data used in the 2016 MPU represents a significant improvement in quality over the previous soils data that was used from 1980. The flow rates are based on best available data and information.

Proposed detention basins were sized for the Eastern Washes using the HEC-1 model according to the methodology described in **Section 3**. Proposed flood control conveyance facilities were sized and analyzed using normal depth calculations in the facility sizing tool. For more information on the analysis of the facilities included in the recommended flood control plan for the Eastern Washes, refer to **Appendix B**.



2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

EASTERN WASHES - NORTH
FLO-2D RESULTS
FIGURE 5-1

Legend

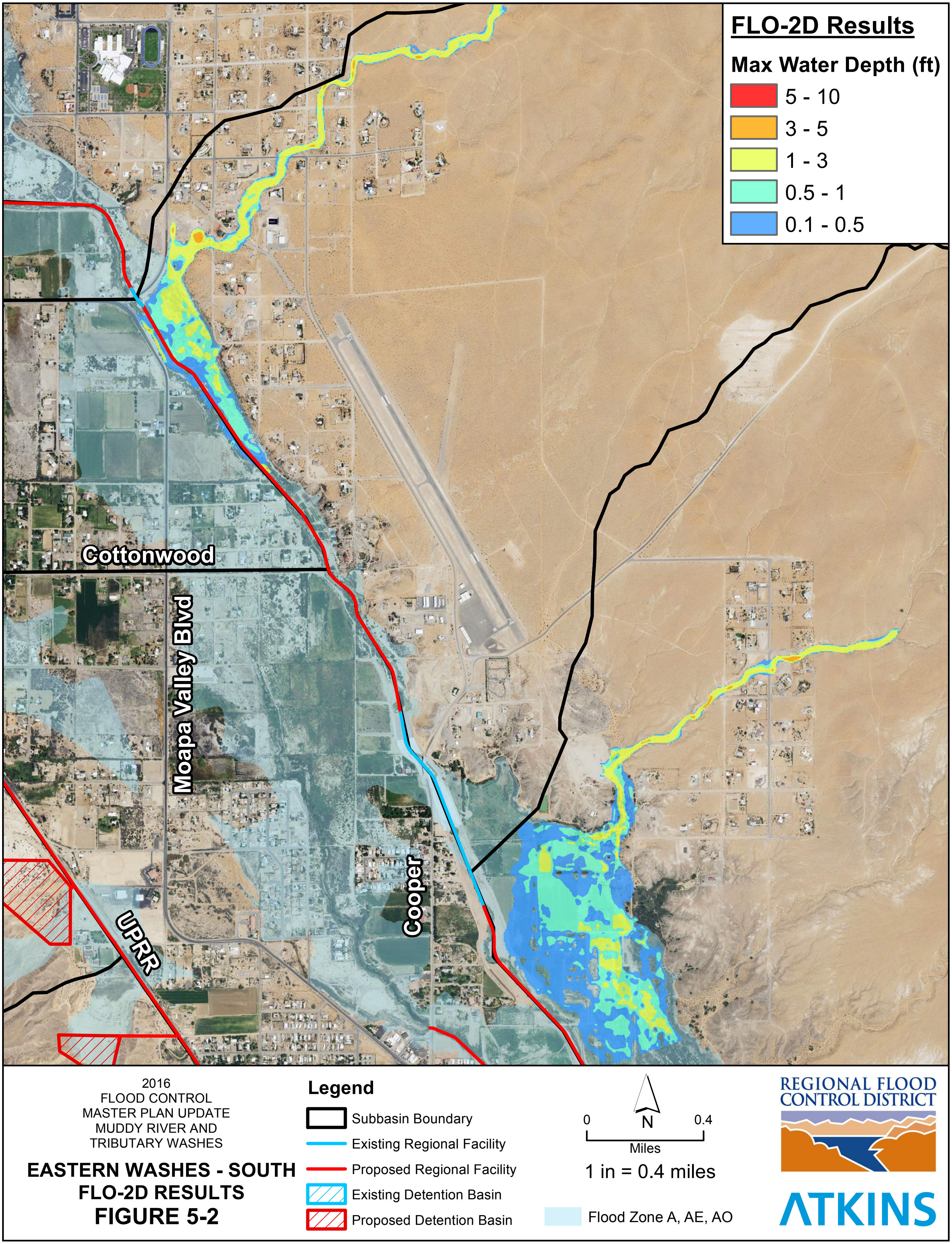
- Subbasin Boundary
- Existing Regional Facility
- Proposed Regional Facility
- Existing Detention Basin
- Proposed Detention Basin
- Flood Zone A, AE, AO

N

0 0.5
Miles
1 in = 0.5 miles

REGIONAL FLOOD CONTROL DISTRICT

ATKINS



FLO-2D Results
Max Water Depth (ft)
5 - 10
3 - 5
1 - 3
0.5 - 1
0.1 - 0.5
Cottonwood
Moapa Valley Blvd
Cooper
UPRR
2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES
EASTERN WASHES - SOUTH
FLO-2D RESULTS
FIGURE 5-2
Legend
Subbasin Boundary
Existing Regional Facility
Proposed Regional Facility
Existing Detention Basin
Proposed Detention Basin
0
0.4
N
Miles
1 in = 0.4 miles
Flood Zone A, AE, AO
REGIONAL FLOOD CONTROL DISTRICT
ATKINS

5.4. Master Plan Progress and Existing Regional Facilities

Some progress has been made on the implementation of the flood control master plan in the Eastern Washes since the 2010 MPU. This primarily consists of the preliminary design report (**Reference 6**) and work that has been completed by Clark County and their consultant, Louis Berger, on the Fairgrounds Detention Basin (FGWS 0166) and outfall system (FGWS 0000-0164) in Whipple Avenue. Coordination with Clark County and Louis Berger occurred throughout the MPU process to ensure the latest design information was incorporated into the 2016 MPU.

No existing regional facilities exist in the Eastern Washes. There are some man-made earthen berms/remnants, small local drainage facilities, and culverts along some of the primary washes and in residential areas that provide limited flood protection and have capacity to direct or convey some of the flow from the Eastern Washes toward the Muddy River during smaller storm events. There is also a local detention basin at the intersection of Jensen Street and Lyman Street and a retention basin on the west side of Lyman Street, just north of Whipple Avenue. These basins were constructed as part of the Valley Heights Subdivision. The local detention basin provides limited flood protection and inflow culverts and adjacent roadways and culverts are prone to sediment deposition and are frequently clogged and/or damaged during storm events.

5.5. Recommended Flood Control Plan

The recommended flood control plan in the Eastern Washes has been updated based on field investigations and hydrologic/hydraulic analysis described above. Two significant detention basin facilities have been added to the recommended flood control plan to mitigate flooding from the Eastern Washes, as described below.

- **Lyman Street Detention Basin and Outfall (FGLS 0000 – 0167)**. During the hydrologic/hydraulic analysis of the Eastern Washes, it became apparent that a large watershed area (over 23 square miles, see combination point CBMN56 on **Figure 3-2** in Section 3) and significant peak 100-year discharge (greater than 5,000 cfs) was draining toward a large, man-made, earthen berm located on the northeastern side of Logandale about 1 mile east of the Bowman Reservoir.

  Based on field investigations and discussions at the MPU progress meetings, this berm was made by local residents for flood relief purposes and has been in the area for some time. The berm diverts flow from the natural wash and directs it west in another wash that eventually discharges to the Bowman Reservoir, thereby alleviating some of the flow that would otherwise continue south toward the residential areas.

  Figure 5-3 shows a map of the area and Figure 5-4 shows a recent photo of the man-made berm.

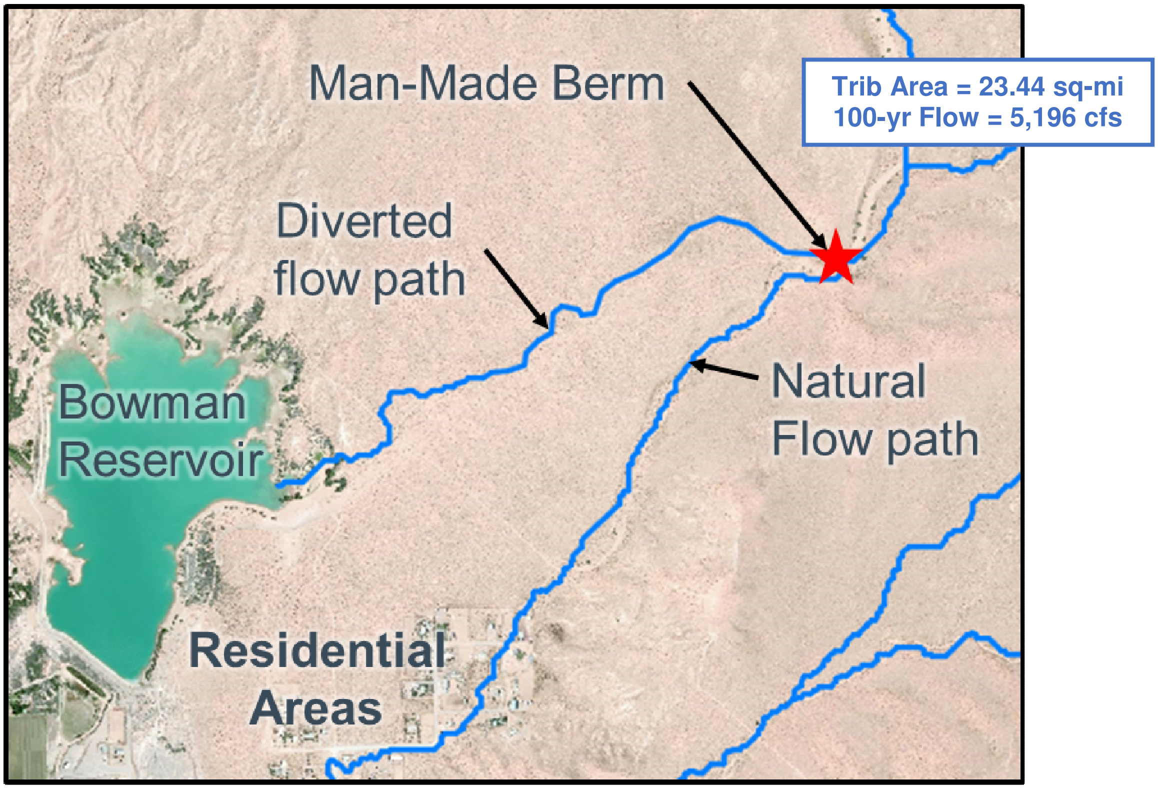


Figure 5-3 Man-Made Berm and Flow Paths in Northeast Logandale

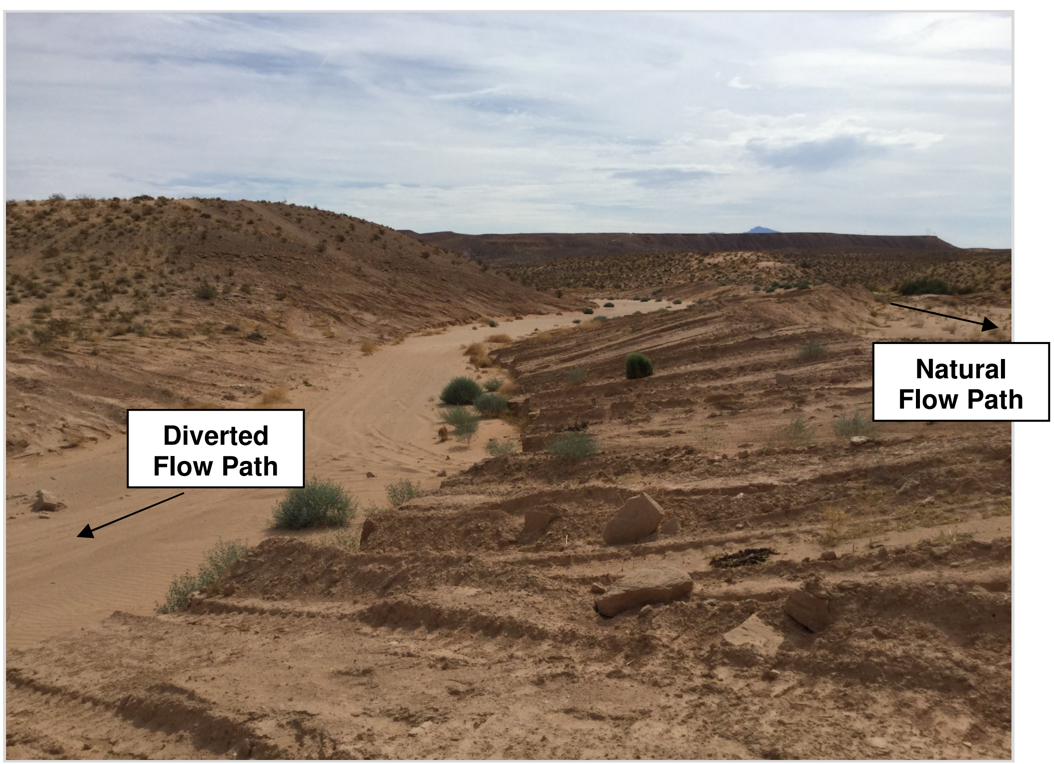


Figure 5-4 Man-Made Berm Photo (Looking east)

The man-made berm is not in good condition and has several portions that are starting to wash out and/or overtop. The berm is not an engineered structure and should not be relied upon for flood protection of the downstream residential areas. Recent storm events in September 2014 resulted in high flows that overtopped the man-made berm and flooded downstream properties and washes with flood depths ranging from 1-5 feet, which is very similar to what is shown in the FLO-2D inundation map in **Figure 5-1**.

Thus, a regional detention basin has been proposed in this area with a 72” RCP outfall system in Lyman Street that will connect to the regional storm drain facility being designed by Louis Berger at Whipple Avenue. This 72” RCP can also accommodate flows from the local detention basin outfall (in Lyman Street, south of Jensen St) in the future.

In the interim condition before the proposed regional facility is built, possible flood mitigation in the area would include flood hazard mapping in the area, updating FEMA FIRMs, encouraging residents to purchase flood insurance, maintenance of the berm, etc.

- **Gubler Avenue Detention Basin and Outfall (EWGA 0000-0196)**. An additional detention basin has been added to the recommended flood control plan to intercept flow from the Eastern Washes that drains to a natural wash at the east end of Bunnell Avenue. The natural wash in this area does not have capacity to convey the 100-year flow of 1,447 cfs safely through the residential areas, which results in flooding and sediment deposition on the local roadways, especially at the intersection of Gubler Avenue and Heyer Street. Thus, a regional detention basin and outfall system has been proposed in this are to intercept flow, reduce sediment, and safely convey flow to the Muddy River in a storm drain system in Gubler Avenue.

- **Fairgrounds Detention Basin Facilities (FGWS)** – The proposed Fairground Detention Basin, outfall, and storm drain facilities were modified to reflect the latest design plans based on the Preliminary Design Report (**Reference 6**) and coordination with Clark County and Louis Berger.

The proposed detention basins in the Eastern Washes are summarized in **Table 5-1**.

Table 5-1 Eastern Washes Proposed Detention Basins

ID MILE	Name of Detention Basin	Peak Inflow (cfs)	Peak Outflow (cfs)	2016 MPU Storage Volume (ac-ft)	2010 MPU Storage Volume (ac-ft)
EWGA 0196	Gubler Avenue Detention Basin	1447	88	157	N/A
FGLS 0167	Lyman Street Detention Basin	5274	254	1247	N/A
FGWS 0166	Fairgrounds Detention Basin	1318	44	139	130

The proposed regional flood control facilities for the Eastern Washes are summarized in the inventory table shown in **Table 4-2**.

In addition, detailed facility maps and inventory tables showing all regional facilities in the Eastern Washes and other areas in Moapa Valley are shown in **Figure F-1** and **Figure F-2** at the end of this report in the section titled **Facility Maps**.

Table 5-2 Eastern Washes Regional Flood Control Facilities

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	Channel Slope (%)
EWGA		**EASTERN WASHES - GUBLER**			
0000	P1	10' x 5' RCB	3155	802	1.200
0060	P1	48" RCP	7035	88	1.200
0194	P1	30" RCP Outlet Pipe	70	88	0.500
0195	P1	14,470 cfs Spillway	--	14470	--
0196	P1	157 acre-ft Gubler Avenue Detention Basin	--	1447	--
FGLS		**FAIRGROUNDS - LYMAN**			
0000	P1	72" RCP	2625	270	0.900
0050	P1	72" RCP	6070	254	0.700
0165	P1	42" RCP Outlet Pipe	70	254	0.500
0166	P1	52,740 cfs Spillway	--	52740	--
0167	P1	1,247 acre-ft Lyman Street Detention Basin	--	5274	--
FGWS		**FAIRGROUNDS - WHIPPLE**			
0000	P2	7' x 5' RCB	3975	378	1.000
0075	P2	54" RCP	1580	221	1.400
0105	P2	48" RCP	1200	44	1.800
0128	P2	36" RCP	2645	44	1.000
0164	P2	18" RCP Outlet Pipe	70	44	0.500
0165	P2	16,000 cfs Spillway	--	16000	--
0166	P2	139 acre-ft Fairgrounds Detention Basin	--	1318	--

5.6. Facility Cost Estimates

Cost estimates for the proposed facilities in the Eastern Washes have been derived using the Cost Estimation Tool described in **Section 3**. The total estimated construction cost of proposed facilities in the Eastern Washes are:

Estimated Construction Cost of Proposed Facilities = $35,729,000

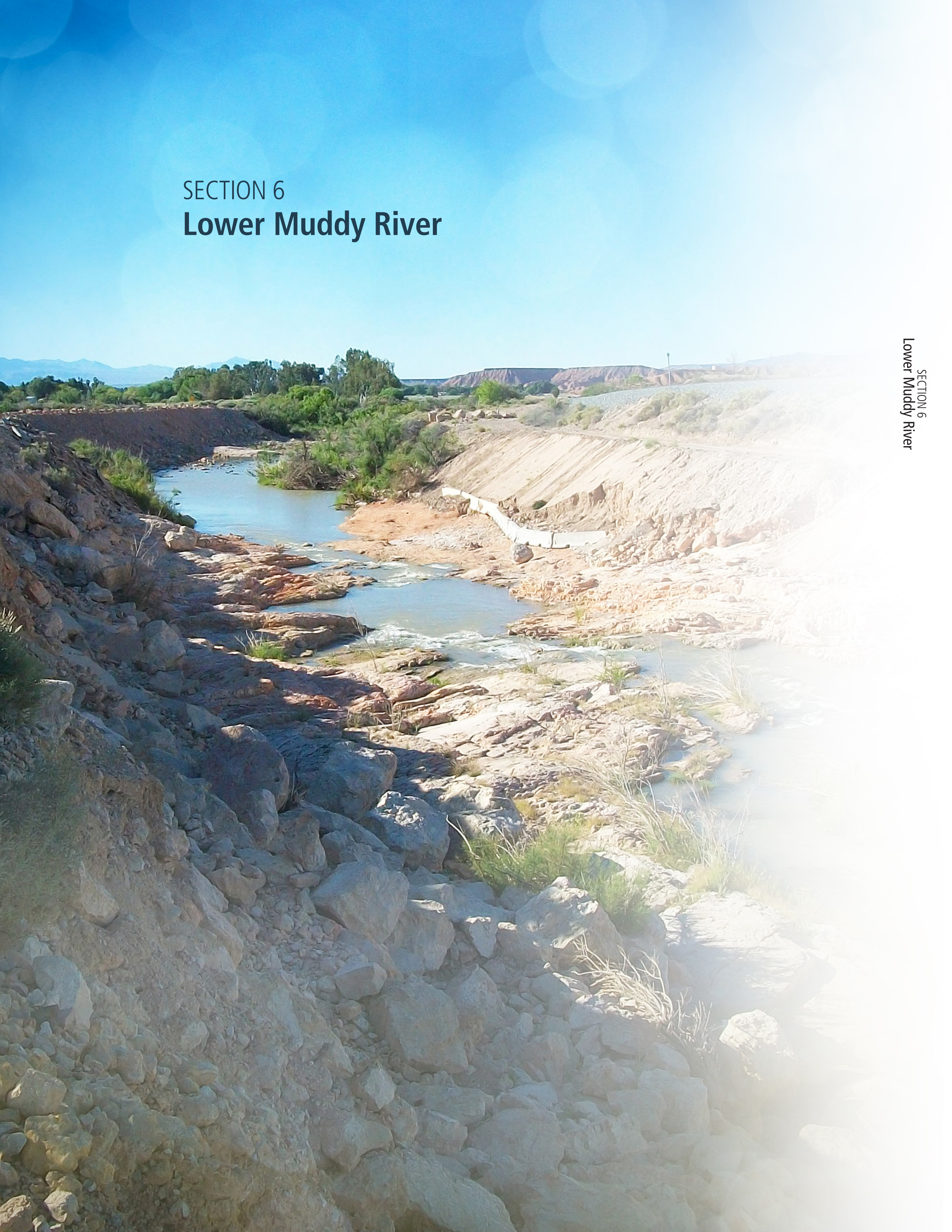
Table 5-3 shows the construction cost estimates for proposed facilities in the Eastern Washes area.

Table 5-3 Eastern Washes Cost Estimate for Proposed Facilities

ID / River Mile	E/P	Facility Description	Design & Admin ($ X 1000)	Right of Way Cost ($ X 1000)	Const. Cost ($ X 1000)	Total Cost ($ X 1000)
FGLS		**FAIRGROUNDS - LYMAN**				
0000	P1	72" RCP	$247	$0	$1,769	**$2,016**
0050	P1	72" RCP	$571	$0	$4,082	**$4,653**
0165	P1	42" RCP Outlet Pipe	$4	$0	$31	**$35**
0166	P1	52,740 CFS Spillway	$436	$0	$2,736	**$3,172**
0167	P1	1247 ac-ft Lyman Street Detention Basin	$820	$0	$5,147	**$5,968**
		Project Total:	**$2,078**	**$0**	**$13,765**	**$15,844**
FGWS		**FAIRGROUNDS - WHIPPLE**				
0000	P2	7' X 5' RCB	$575	$0	$4,109	**$4,683**
0075	P2	54" RCP	$118	$0	$845	**$963**
0105	P2	48" RCP	$83	$0	$597	**$680**
0128	P2	36" RCP	$161	$0	$1,153	**$1,314**
0164	P2	18" RCP Outlet Pipe	$3	$0	$25	**$28**
0165	P2	16000 cfs Spillway	$166	$0	$1,041	**$1,207**
0166	P2	139 acre-feet Whipple Street Detention Basin	$91	$0	$574	**$665**
		Project Total:	**$1,197**	**$0**	**$8,344**	**$9,540**
EWGA		**EASTERN WASHES - GUBLER**				
0000	P1	10' X 5' RCB	$547	$0	$3,912	**$4,459**
0060	P1	48" RCP	$490	$0	$3,502	**$3,991**
0194	P1	30" RCP Outlet Pipe	$4	$0	$27	**$31**
0195	P1	14,470 CFS Spillway	$153	$0	$960	**$1,113**
0196	P1	157 acre-feet Gubler Avenue Detention Basin	$103	$0	$648	**$751**
		Project Total:	**$1,297**	**$0**	**$9,049**	**$10,345**
EASTERN WASHES PROPOSED TOTAL:			**$4,572**	**$0**	**$31,158**	**$35,729**

SECTION 6

Lower Muddy River



6. Lower Muddy River

6.1. Introduction

This section describes the drainage characteristics and the flood control master plan for the Lower Muddy River, which is defined as the area downstream of the "Narrows" and in between the Western and Eastern Washes. The towns of Logandale and Overton and the majority of the proposed regional facilities lie within this area. The Lower Muddy River receives tributary flows from very large upstream watersheds and washes, including the Upper Muddy River, California Wash, Meadow Valley Wash, and Weiser Wash, which encompass thousands of square miles (see **Figure 6-1**).

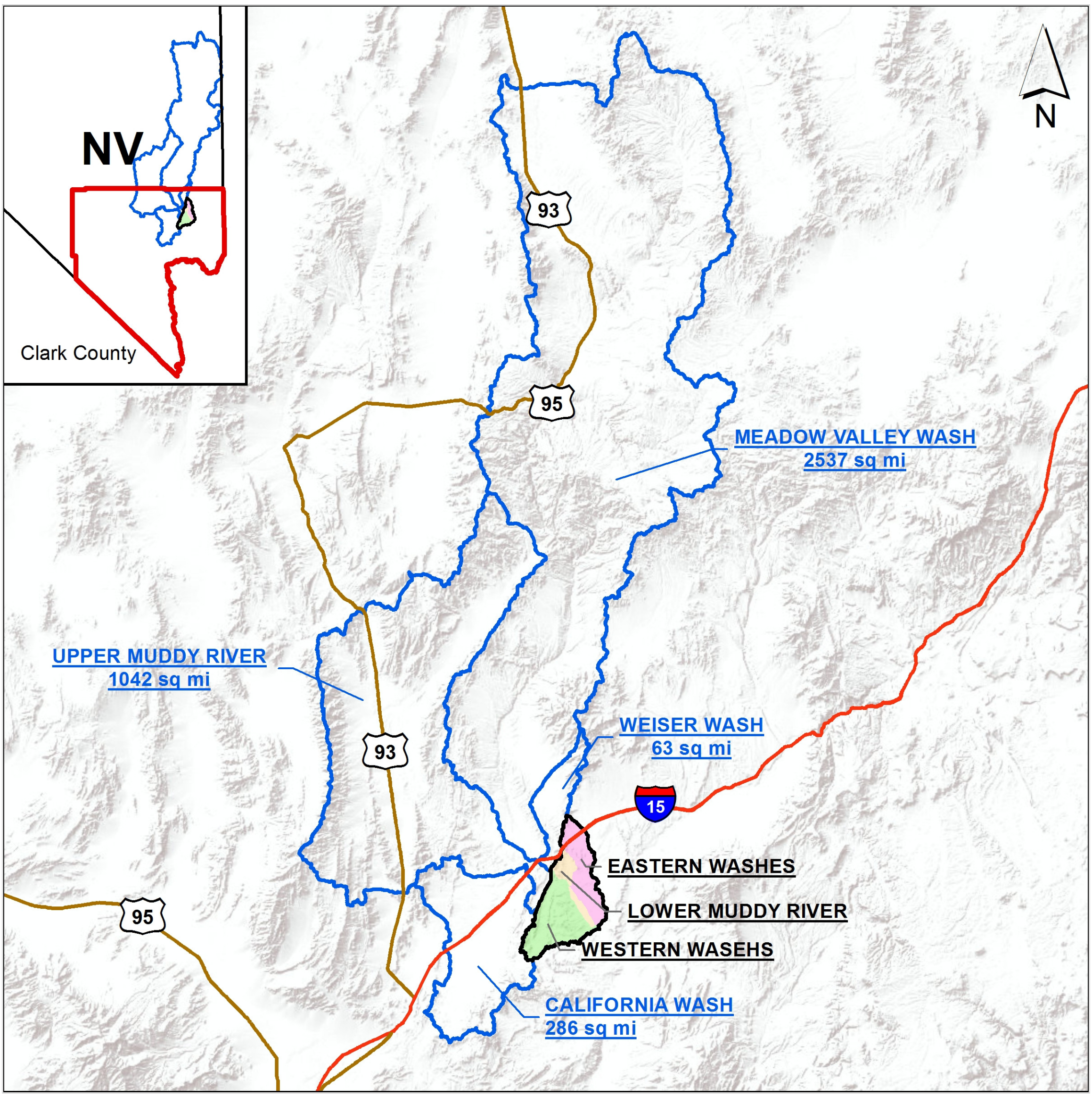


Figure 6-1 Lower Muddy River and Upstream Watersheds

6.2. Drainage Characteristics

The Muddy River, formerly known as the Moapa River, is relatively short (approximately 32 miles long) and originates in the Warm Springs Natural Area in Moapa and flows in a southeasterly direction traversing Moapa Valley and eventually draining to Lake Mead.

From the Wells Siding Diversion structure to Gubler Avenue, the Muddy River channel geometry is a relatively large (~20-30'wide, 25-30' deep, 2:1 SS) and conveys the majority of the 100-year flow within the river banks, which are unlined and consist of fine grained sediments and desert plants and vegetation. From Gubler Avenue downstream to Lewis Avenue and the Overton WMA, the channel loses definition and gets progressively shallower and wider with less conveyance capacity, especially downstream of Cooper Street where there is minimal conveyance capacity within the banks and the thalweg is perched above a wide, adjacent floodplain.

For illustrative purposes, a cross section of the Muddy River near the upstream end (near Whipple Avenue) is compared with a cross section of the Muddy River at the downstream end (near Lewis Avenue) in **Figure 6-2**. As evident in the plot, the difference between the channel geometry and conveyance capacity at the upstream end compared to the downstream end is drastic, causing flow to break out of the channel and be conveyed in the overbanks, which consist of sparse to thick desert plant vegetation, agricultural pastures, and sparse, rural development.

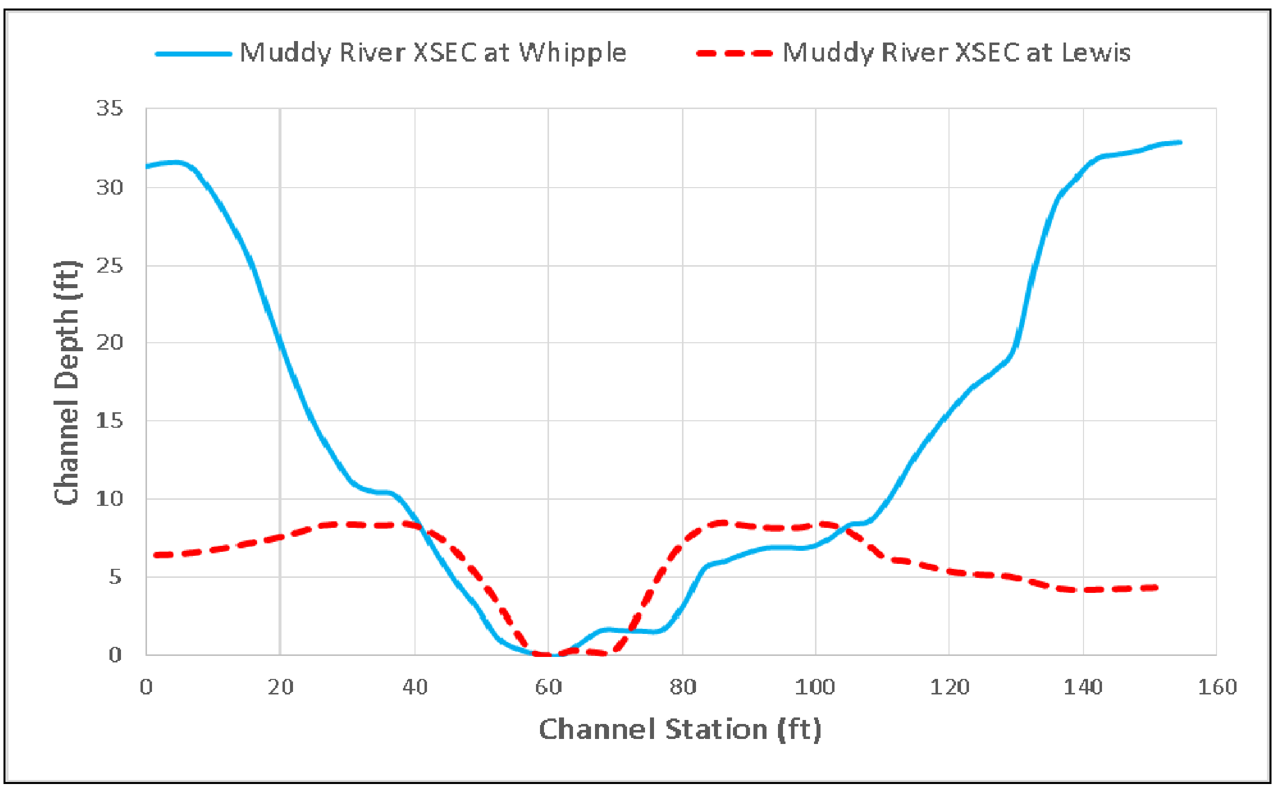


Figure 6-2 Lower Muddy River Cross Section Comparison

The Lower Muddy River has been subject to intermittent flooding events recorded from the early 1900s to the present. When the capacity of the low flow river channel is exceeded, there are numerous residences, businesses, public and private facilities that are impacted by the floodwaters. Development within the Lower Moapa Valley along the Muddy River has further increased the potential for damage due to flooding.

6.3. Hydrologic and Hydraulic Analysis

Hydrologic Analysis

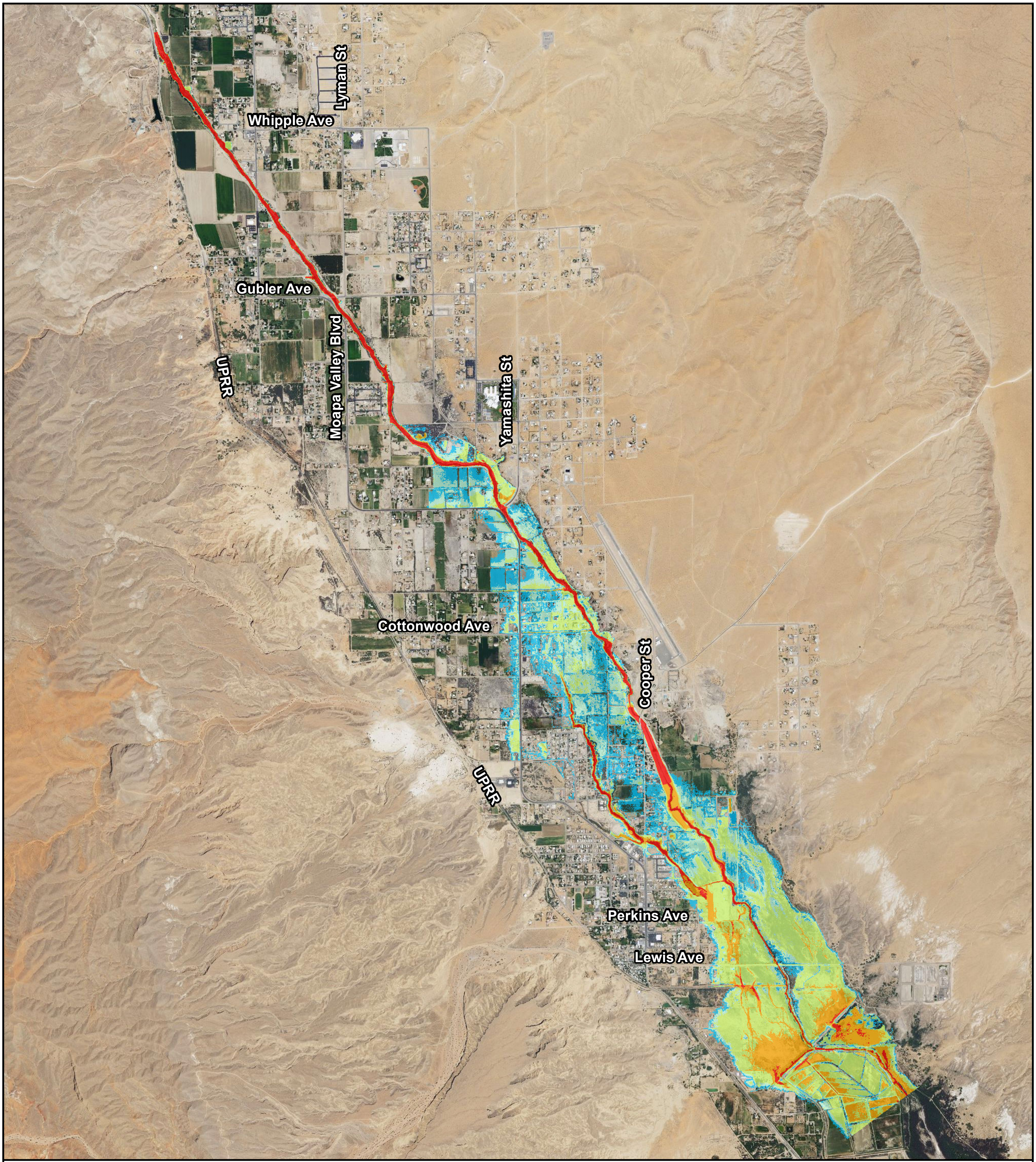
The Lower Muddy River 100-year flow is 21,400 cfs, which was referenced from previous MPUs and the effective FIS. The regulatory flow rate in the FIS was determined based on statistical analysis of the annual peak discharge rates that have been measured at USGS stream gage (ID 09419000) located in the "Narrows" between the Upper and Lower Muddy River. The original FIS analysis made use of the 33-year period of record at the gage up to the 1983 water year to determine peak flows based on Log-Pearson Type III method recommended by Water Resources Council Bulletin 17B (**Reference 7**).

As part of the 2016 MPU, the gage analysis previously performed in the FIS was reviewed and updated to incorporate an additional 31 years of peak flow measurements that have been recorded at the gage since 1983. The updated years of record (period) available at the gage is now 65 with measurements recorded from 1950 to 2014. The available gaged data was obtained and the Bulletin 17B statistical analysis was performed. The resulting 100-year flow from the updated analysis was 21,970 cfs, which is very similar to the effective flow of 21,400 cfs and well within the 68% confidence interval. Therefore, no change was necessary to the 100-year flow for MPU purposes. Refer to **Appendix C** for additional information regarding the updated gage analysis.

Hydraulic Analysis

Standard MPU methodology for hydraulic analysis and facility sizing generally involves normal depth calculations to determine conveyance capacity. However, because of the complex nature of the Muddy River, a 2D hydraulic riverine model was developed as part of the 2016 MPU using HEC-RAS 2D (Beta Version 5.0). The primary purpose of the 2D model was to evaluate complex flow patterns of the existing floodplain, which includes flow breakouts, overbank flooding, and 2D flow patterns in relatively flat areas.

The model was run for the existing condition to determine the maximum flood depths and inundation limits in the Muddy River floodplain. The model was based on the detailed LiDAR data obtained for the project and extended from Wells Siding at the upstream end to the Overton WMA at the downstream end (approximately 7 miles). The inflow hydrograph in the model was based on the 100-year flow of 21,400 cfs that was scaled to fit the hydrograph shape of the September 2014 flood event as measured at the USGS gage mentioned above. The existing condition results from the HEC-RAS model are shown in **Figure 6-3**. In addition, a video animation of the HEC-RAS flooding results in Moapa Valley is included on the Data CD, which illustrates the timing and nature of the flooding in the area.



N

0 4,000

Feet

1 in = 4,000 feet

2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

PRELIMINARY
LOWER MUDDY RIVER
HEC-RAS 2D RESULTS
FIGURE 6-3

HEC-RAS 2D Results

100-yr Flow = 21,400 cfs

Max Water Depth (ft)

- 5 +
- 3 - 5
- 1 - 3
- 0.5 - 1
- 0.1 - 0.5

REGIONAL FLOOD CONTROL DISTRICT

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Proposed condition modeling scenarios were also run in order to refine the regional facility recommendations proposed along the Lower Muddy River. The model was used to understand the impacts of phasing the construction along the river and building separate reaches of improvements at different times. These modeling scenarios were compared to the existing condition scenario to understand and identify any adverse impacts to the floodplain or nearby properties that could result from construction.

The HEC-RAS 2D model was a valuable tool in the MPU facility planning process and provided insight and understanding regarding structural and non-structural alternatives, especially in the breakout areas downstream of Cooper Street near Lewis Avenue. The model should be considered preliminary and was only developed to a level of detail considered appropriate for master planning purposes. The model can be used as a foundation for future FEMA floodplain studies or other projects, but it should be reviewed and refined in more detail beyond what was done for the 2016 MPU.

6.4. Master Plan Progress and Existing Regional Facilities

Significant progress has been made on the implementation of the flood control master plan in the Lower Muddy River since the 2010 MPU, including construction of the Cooper Street Bridge and adjacent channel sections (MRLV 0343-0388), right-of-way acquisition from Lewis Avenue to Ramos Ranch Road, and design of the Logandale Levee (MRLL 0001-0038) on the east bank of the Muddy River downstream of the Wells Siding Diversion Structure.

The existing regional flood control facilities along the Lower Muddy River were inventoried based on the 2010 MPU, data collection, design plans, and field investigations. The objective of the field investigations was to verify the information presented in the 2010 MPU and to identify new regional facilities constructed after the 2010 MPU. Many updates were made to the existing facility descriptions, types, slopes, and lengths in the 2016 MPU facility maps and tables and GIS data.

There are several existing regional facilities in the Lower Muddy River area:

- The **Gann Avenue Storm Drain (GASD 0000 – 0058)** consists of an existing debris basin, a transition structure, a double RCP storm drain, and a double RCB storm drain. Normal depth calculations were performed to confirm that the facility has the capacity to convey the 100-year flow of 2,108 cfs from the Logan Wash to the Muddy River.
- The **Gubler Avenue Bridge (MRLV 0725)** and the **Yamashita Street Bridge** (MRLV 0534-0537) are existing regional facilities that have been constructed in the Lower Muddy River area and have capacity to convey the 100-year flow.
- As mentioned above, the **Cooper Street Bridge** and adjacent channel sections (**MRLV 0343-0388**) are existing regional facilities along the Lower Muddy River. These facilities were recently completed and consists of trapezoidal and rectangular channel sections, transition structures, a roadway bridge, and gabion, concrete,

earthen, and rip-rap linings in different reaches. This facility has the capacity to convey the 100-year flow of 21,400 cfs.

- The existing **Logandale Levee** was also shown in previous MPUs as an existing regional facility (MRLL 0000). This is an earthen embankment along the east bank of the Muddy River downstream of the Wells Siding Diversion Structure. The existing Logandale Levee is not an engineered structure or certifiable by FEMA for levee accreditation or flood mapping purposes. Since plans are being finalized to construct a concrete levee to replace it, the earthen embankment previously identified as ID-Mile MRLL 0000 is no longer shown as an existing regional flood control facility in the MPU. Only the proposed facilities (MRLL 0001-0038) are shown.

The Wells Siding Diversion Structure is also located on the Muddy River at the upstream end of Logandale (west of Wells Avenue). This structure is privately owned and operated by MVIC and can be used to divert flows to an irrigation channel that runs west/east and conveys flows to/from the Bowman Reservoir. Although it has been used in the past to divert some flow out of the Muddy River during flood events (approximately 500 cfs), it is not considered a regional facility nor a viable flood control option in the master plan.

The existing regional facilities in the Lower Muddy River were analyzed using normal depth calculations and the facility sizing tool described in Section 3. All of the existing regional flood control facilities within the Lower Muddy River area have adequate capacity to convey the 2016 MPU 100-year flows.

6.5. Recommended Flood Control Plan

The recommended flood control plan along the Lower Muddy River is based on previous MPUs and the Final Predesign Memorandum for the Muddy River Riverine Enhancement project (**Reference 8**). From Gubler Avenue to Cooper Street, the recommended flood control plan has been perpetuated from the 2010 MPU. Downstream of Cooper Street, the recommended flood control plan has been modified based on updated MPU analysis and the detailed LiDAR data obtained for the project. The recommended flood control plan for the Lower Muddy River is described below:

- **Muddy River, from Gubler Avenue to Cooper Street (MRLV 0395-0710)** – No changes were made to the facility recommendations and grade control structures previously shown in the 2010 MPU for this reach. The proposed facility is an earthen channel with rip-rap lined banks (200-feet wide, 13-feet deep, 3:1 side slopes). The lengths and costs were reviewed and updated and the sizing tool was used to confirm that the proposed channel sections have adequate capacity to convey the 100-year flow. The proposed facility will require additional right-of-way acquisition from Ramos Ranch Road to Gubler Avenue.

- **Muddy River, from Cooper Street to West Creek Confluence (MRLV 0268, 0276)** – The recommended regional facility for this reach is a stabilized earthen channel with rip-rap lined banks, 400-feet wide, 8-feet deep, and 3:1 side slopes. This facility was reviewed in detail to determine if a below-grade channel (maintaining the thalweg) could be extended from the end of the Cooper Street improvements to the West Creek confluence area, which is beneficial because it allows the West Creek Channel to daylight into the Muddy River and eliminates the previously proposed parallel facility. The available right-of-way and topography were reviewed and it was determined that a slightly steeper slope of 0.3% would be feasible and would allow the West Creek to daylight into the Muddy River. The channel velocities in this proposed reach are relatively high (greater than 9-10 ft/sec) which will require protective lining or stabilization. Thus, the recommended channel geometry is similar in size to the previous MPU but the profile is lower below grade.

Another option for this reach that was discussed in MPU progress meetings and could be considered during the design phase is a concrete-lined section, which would essentially extend the existing concrete channel section from Cooper Street to the West Creek confluence. This would be a suitable lining because of the high velocity and would also allow for a below-grade channel. This option would require detailed environmental review and permitting in order to excavate the thalweg and concrete line the channel, but it provides significant hydraulic benefit and would be much easier to maintain. A combination of the concrete-lined section and earthen section described above may also be appropriate, using the concrete-lined section in the upstream reach where the right-of-way width is narrower and the earthen section downstream as the right-of-way width gets wider.

- **Muddy River, from West Creek Confluence to south of Lewis Avenue (MRLV 0184, 0198, 0240)** – The proposed regional facility in this reach is very similar to the previous MPU and consists of a stabilized earthen channel with rip-rap lined banks, 600-feet wide, 6.5-feet deep, and 3:1 side slopes. The proposed slope of the channel was adjusted from the previous MPU from 0.4% to 0.2%. The revised slope is based on updated topography data and also serves the purpose of keeping the velocity lower and the channel shallower for daylighting purposes downstream of Lewis Avenue. This section will require above-grade levees (4-5 feet high) on both sides of the channel since the channel in this area is wide and very flat and cannot be excavated further below grade without significant cost and daylighting issues. A low-flow crossing or culvert structure will be required during the design phase at Lewis Avenue to maintain access over the channel and adjacent levees during low flow.

- **Muddy River, from south of Lewis Avenue to Overton WMA (MRLV 0142)** – The proposed regional facility for this reach of the Muddy River is an earthen levee on the west side of the Muddy River corridor. This facility will begin downstream of the proposed confluence with Western Washes Railroad Channel, and will protect the private properties on the west and allow flow to spread out on the east on public land and continue south to the Overton WMA.

- **Removal of Muddy River Facilities Downstream of Overton WMA** – The previous MPU proposed to extend a wide earthen channel with levees and a parallel facility 7,400 feet downstream of the Overton WMA diversion structure (MRLV 0000 and 0105). These facilities would not be practical to construct and would not provide significant benefit. In addition, the cost of the facilities was over $12.5

million. These facilities have been removed from the recommended control plan in the area, meaning the proposed Muddy River channel improvements stop at the diversion structure. The channel improvements in this area reviewed in more detail in the design phase to determine the logical endpoint.

- **West Creek Channel (MRWC 0000, 0065)** – The West Creek Channel is proposed as a concrete channel, 10-feet wide, 6-feet deep, and 3:1 side slopes that extends from the low point at Cooper Street (1000 feet north of Moapa Valley Boulevard) and connects to the Muddy River near Overton Avenue. The proposed system also includes a dual 12' x 9' RCBC culvert at Cooper Street to collect runoff that currently collects and ponds in the low lying area west of Cooper Street. Additional collection and conveyance facilities may be required a short distance upstream of the culvert in order to collect flow, which should be reviewed during the design phase.

Based on MPU analysis and coordination with CCRFCD and Clark County, high priority facilities that could be built in early phases include the West Creek Channel and the Muddy River improvements from Cooper Street to the West Creek Channel confluence. These facilities will provide downstream flood protection by redirecting the West Creek to the Muddy River, which is consistent with historical flow paths. These facilities can likely be constructed without causing adverse impact to downstream properties. The recommended facilities downstream of Cooper Street may require modification to the existing USACE 404 permit. During the design phase of these facilities, the 404 permit will have to be further reviewed and revised if necessary.

It is important to note that the recommended facilities downstream of Cooper Street can be difficult to design, construct, and maintain because of the existing topography. Further, there are relatively few structures and private parcels in the area that would be protected from flooding by the proposed structural improvements, which would yield a non-favorable benefit-cost ratio. As such, this area is also discussed in the non-structural section of this report, since the non-structural alternative may be the best strategy for the area. See **Section 8** for additional information. Any channel improvements or non-structural solutions along the Muddy River corridor should be coordinated with the local community, town advisory boards, CCRFCD, and Clark County

The topography and drainage characteristics in the Overton WMA were also investigated during the 2016 MPU. Detailed survey was obtained and field investigations were performed with NDOW representatives to understand the impacts of the berms and structures at the upstream end of the Overton WMA. NDOW is in the process of lowering several berms to be level with adjacent grade. In addition, preliminary work is being done to determine if the gates at the diversion structure can be automated. Additional improvements in this area may provide benefit to the overall flood control plan in the area and should continue to be coordinated with NDOW and Clark County.

The existing and proposed regional flood control facilities for the Lower Muddy River are summarized in the inventory table shown in **Table 6-1**. In addition, detailed facility maps and inventory tables for the entire study area are shown in **Figure F-1** and **Figure F-2** at the end of this report in the section titled **Facility Maps**.

Table 6-1 Lower Muddy River Regional Flood Control Facilities

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	Channel Slope (%)
GASD		**GANN AVENUE STORM DRAIN**			
0000	E	20' x 8' Transition Channel	220	2108	0.500
0005	E	2: 10' RCP	1400	2108	0.500
0030	E	2: 10' x 8' RCB	1600	2108	1.100
0058	E	Gann Avenue Debris Basin	--	2108	--
MRLL		**MUDDY RIVER LOGANDALE LEVEE**			
0001	P3	Concrete Levee	675	21400	0.900
0013	P3	Concrete Levee	1325	21400	1.200
0038	P3	Concrete Levee	925	21400	1.700
MRLV		**MUDDY RIVER LOWER VALLEY**			
0142	P1	Earthen Levee	2230	21400	0.300
0184	P1	Stabilized Earthen Chnl w/ Riprap-Lined Bank 600'W 6.5'D 3:1 SS	750	21400	0.200
0198	P2	Stabilized Earthen Chnl w/ Riprap-Lined Bank 600'W 6.5'D 3:1 SS	2872	21400	0.200
0240	P2	Stabilized Earthen Chnl w/ Riprap-Lined Bank 600'W 6.5'D 3:1 SS	376	21400	0.200
0268	P2	Stabilized Earthen Chnl w/ Riprap-Lined Bank 400'W 8'D 3:1 SS	450	21400	0.300
0276	P2	Stabilized Earthen Chnl w/ Riprap-Lined Bank 400'W 8'D 3:1 SS	3005	21400	0.300
0343	E	Earthen Chnl w/ Riprap-Lined Bank 200'W 9.5'D 3:1 SS	600	21400	0.300
0350	E	Earthen Chnl w/ Riprap-Lined Bank 200'W 11'D 3:1 SS	630	21400	0.400
0357	E	Conc Chnl 200'W 11'D 2:1 SS	818	21400	0.400
0375	E	Cooper Street Bridge	290	21400	0.400
0377	E	Conc Chnl 180'W 13.6'D 2.5:1 SS	375	21400	0.400
0388	E	Gabion Chnl 200'W 11.5'D 3:1 SS	386	21400	0.200
0395	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 11.5'D 3:1 SS	673	21400	0.200
0423	P2	Grade Control Structure	--	--	--
0424	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	1720	21400	0.100
0442	P2	Grade Control Structure	--	--	--
0443	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	723	21400	0.100
0458	P2	Grade Control Structure	--	--	--
0459	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	2549	21400	0.100
0507	P2	Grade Control Structure	--	--	--
0508	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	1395	21400	0.100
0534	E	Earthen Channel w/ Gabion Side Slopes	135	21400	--
0536	E	Yamashita Street Bridge	36	21400	--
0537	E	Earthen Channel w/ Gabion Side Slopes	100	21400	--
0539	P2	Grade Control Structure	--	--	--
0540	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	345	21400	0.100
0547	P2	Grade Control Structure	--	--	--
0548	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	698	21400	0.100
0561	P2	Grade Control Structure	--	--	--
0562	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	1016	21400	0.100
0583	P2	Grade Control Structure	--	--	--
0584	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	2297	21400	0.100

Table 6-1 Lower Muddy River Regional Flood Control Facilities (continued)

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	Channel Slope (%)
0629	P2	Grade Control Structure	--	--	--
0630	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	464	21400	0.100
0637	P2	Grade Control Structure	--	--	--
0638	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	885	21400	0.100
0654	P2	Grade Control Structure	--	--	--
0655	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	744	21400	0.100
0669	P2	Grade Control Structure	--	--	--
0670	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	2115	21400	0.100
0709	P2	Grade Control Structure	--	--	--
0710	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	625	21400	0.100
0725	E	Gubler Avenue Bridge	50	21400	0.400
MRWC		**MUDDY RIVER WEST CREEK**			
0000	P1	Conc Chnl 10'W 6'D 3:1 SS	2964	1115	0.300
0065	P1	Cooper Street Culvert 2:12' x 9' RCBC	60	1115	0.100

6.6. Facility Cost Estimates

Cost estimates for all facilities along the Lower Muddy River have been derived using the Cost Estimation Tool described in **Section 3**. The total estimated current value of existing facilities and total estimated construction cost of proposed facilities in the Lower Muddy River are as follows:

Estimated Value of Existing Facilities = $24,823,000

Estimated Construction Cost of Proposed Facilities = $46,640,000

In addition, the total right-of-way acquisition costs paid to property owners by Clark County along the Lower Muddy River (from Lewis Avenue to Ramos Ranch Road, and in the vicinity of the Logandale Levee (pending)) is approximately $10,730,000.

Table 6-2 shows the current estimated value of existing facilities in the Lower Muddy River. **Table 6-3** shows the construction cost estimates for proposed facilities in the Lower Muddy River.

Table 6-2 Lower Muddy River Cost of Existing Facilities

ID / River Mile	E/P	Facility Description	Total Cost ($ x 1000)
GASD		**GANN AVENUE STORM DRAIN**	
0000	E2	20'X8' Transition Channel	$817
0005	E2	2- 10' RCP	$817
0030	E2	2- 10'X8' RCB	$817
0058	E2	Existing Debris Basin	$817
		Project Total:	**$3,268**
MRLV		**MUDDY RIVER LOWER VALLEY**	
0343	E2	Earthen Chnl w/ Riprap-Lined Bank 200'W 9.5'D 3:1 SS	$989
0350	E2	Earthen Chnl w/ Riprap-Lined Bank 200'W 11'D 3:1 SS	$1,234
0357	E2	Conc Chnl 200'W 11'D 2:1 SS	$3,849
0375	E2	Cooper Street Bridge	$4,197
0377	E2	Conc Chnl 180'W 13.6'D 2.5:1 SS	$1,988
0388	E2	Gabion Channel 200'W 11.5'D 3:1 SS	$1,440
0534	E2	Earthen Channel w/ Gabion Side Slopes	$686
0536	E2	Yamashita Street Bridge	$686
0537	E2	Earthen Channel w/ Gabion Side Slopes	$686
0725	E2	Gubler Avenue Bridge	$5,800
		Project Total:	**$21,555**
		LOWER MUDDY RIVER EXISTING TOTAL:	**$24,823**

Table 6-3 Lower Muddy River Cost Estimate for Proposed Facilities

ID / River Mile	E/P	Facility Description	Design & Admin ($ X 1000)	Right of Way Cost ($ X 1000)	Const. Cost ($ X 1000)	Total Cost ($ X 1000)
MRLL		**MUDDY RIVER LOGANDALE LEVEE**				
0001	P1	Concrete Levee	$117	$0	$691	**$807**
0013	P1	Concrete Levee	$217	$0	$1,286	**$1,503**
0038	P1	Concrete Levee	$148	$0	$874	**$1,022**
		Project Total:	**$482**	**$0**	**$2,851**	**$3,332**
MRLV		**MUDDY RIVER LOWER VALLEY**				
0142	P1	Earthen Levee	$161	$0	$951	**$1,112**
0184	P2	Stabilized Earth Chnl w/ Riprap Bank 600'W 6.5'D 3:1 SS	$170	$0	$1,218	**$1,388**
0198	P2	Stabilized Earth Chnl w/ Riprap Bank 600'W 6.5'D 3:1 SS	$650	$0	$4,647	**$5,297**
0240	P2	Stabilized Earth Chnl w/ Riprap Bank 600'W 6.5'D 3:1 SS	$86	$0	$616	**$702**
0268	P2	Stabilized Earth Chnl w/ Riprap Bank 400'W 8'D 3:1 SS	$86	$0	$615	**$701**
0276	P2	Stabilized Earth Chnl w/ Riprap Bank 400'W 8'D 3:1 SS	$573	$0	$4,100	**$4,674**
0395	P1	Earthen Chnl w/ Riprap-Lined Bank 200'W 11.5'D 3:1 SS	$103	$0	$736	**$839**
0423	P2	Grade Control Structure	$0	$0	$51	**$51**
0424	P1	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$305	$244	$2,181	**$2,730**
0442	P2	Grade Control Structure	$0	$0	$51	**$51**
0443	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$138	$110	$985	**$1,233**
0458	P2	Grade Control Structure	$0	$0	$51	**$51**
0459	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$462	$370	$3,305	**$4,138**
0507	P2	Grade Control Structure	$0	$0	$51	**$51**
0508	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$259	$207	$1,850	**$2,315**
0539	P2	Grade Control Structure	$0	$0	$51	**$51**
0540	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$68	$54	$487	**$609**
0547	P2	Grade Control Structure	$0	$0	$51	**$51**
0548	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$133	$107	$952	**$1,192**
0561	P2	Grade Control Structure	$0	$0	$51	**$51**
0562	P2	Earthen Chnl w' Riprap-Lined Bank 200'W 13'D 3:1 SS	$191	$153	$1,364	**$1,708**
0583	P2	Grade Control Structure	$0	$0	$51	**$51**
0584	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$418	$334	$2,990	**$3,742**
0629	P2	Grade Control Structure	$0	$0	$51	**$51**
0630	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$90	$72	$645	**$808**
0637	P2	Grade Control Structure	$0	$0	$51	**$51**
0638	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$167	$134	$1,195	**$1,496**
0654	P2	Grade Control Structure	$0	$0	$51	**$51**
0655	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$142	$113	$1,012	**$1,267**
0669	P2	Grade Control Structure	$0	$0	$51	**$51**
0670	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$386	$309	$2,761	**$3,456**
0709	P2	Grade Control Structure	$0	$0	$51	**$51**
0710	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	$129	$103	$922	**$1,155**
		Project Total:	**$4,717**	**$2,310**	**$34,195**	**$41,225**
MRWC		**MUDDY RIVER WEST CREEK**				
0000	P1	Conc Chnl 10'W 6'D 3:1 SS	$213	$171	$1,524	**$1,908**
0065	P1	Cooper Street Culvert (2-12'x9' RCBC)	$22	$0	$154	**$175**
		Project Total:	**$235**	**$171**	**$1,678**	**$2,083**
LOWER MUDDY RIVER PROPOSED TOTAL:			**$5,434**	**$2,481**	**$38,724**	**$46,640**

SECTION 7
Moapa

7. Moapa

7.1. Introduction

As described previously, Moapa refers to the valley area upstream of the "narrows". Moapa is bounded on the west by the Meadow Valley Mountains and the Arrow Canyon Range. The Mormon Mountains lie east of Moapa. This valley is sparsely populated with the population concentrated in the towns of Moapa and Glendale. Agriculture is the predominant land use in the area.

7.2. Drainage Characteristics

Three major watersheds drain to Moapa via the Meadow Valley Wash, the Upper Muddy River, and the California Wash. These three washes have a common confluence located immediately upstream of the town of Glendale. A smaller wash known as the Weiser Wash also drains to the Muddy River slightly farther downstream near the "Narrows". The history of flooding within the area indicates that storm flows sufficient to cause flooding in Moapa/Moapa Valley can originate from any of these watersheds.

Although the Upper Muddy River Watershed is the largest of the three contributing watersheds, several factors unique to this watershed result in a substantially lower 100-year peak flow from this drainage compared to either the California Wash or the Meadow Valley Wash. The Pahranagat National Wildlife Refuge occupies a 10-square-mile area within the Upper Muddy River Watershed. This area contains a series of ponds, lakes, and dams that reduce storm flows. Based on previous MPU reports, the refuge has sufficient capacity to retain the storm runoff generated by the 3,240 square mile upstream watershed. This was established in a study prepared by the by the USACE (**Reference 9**). The Pahranagat Wildlife Refuge effectively reduces the size of the Upper Muddy River drainage area from approximately 4,230 square miles to 1,042 square miles.

Upstream from the confluence with the Muddy River, the California Wash and the Meadow Valley Wash have drainage areas of 286 square miles and 2,537 square miles, respectively. Devastating flood events have been caused by intense summer thunderstorms that occur in the watersheds draining to these washes. A number of debris basins and small detention basins were constructed in both the Meadow Valley Wash and in the California Wash in the early 1930s as part of the Civil Conservation Corps. However, these basins have either been removed or silted in over the years. These basins are not regarded as providing any flood control functionality at this time.

7.3. Hydrologic and Hydraulic Analysis

Similar to the Lower Muddy River, the peak flows in the large washes were not determined using HEC-1 models; rather, peak flows were referenced from previous MPUs and the FIS and verified with updated gage analysis that was performed as part of the 2016 MPU analysis.

The 100-year peak discharges in the major washes in Moapa were established in previous MPUs and FIS studies using a number of different techniques and criteria, including Log-Pearson III statistical analysis, S-Graph methods, and storm centering in rainfall-runoff models. There are several USGS gages in the study area as shown in **Figure 7-1**. The available data at each gage was obtained and statistical analysis was performed using Bulletin 17B methods to determine the 100-year flow. The 100-year discharge at each gage is summarized in **Table 7-1**.

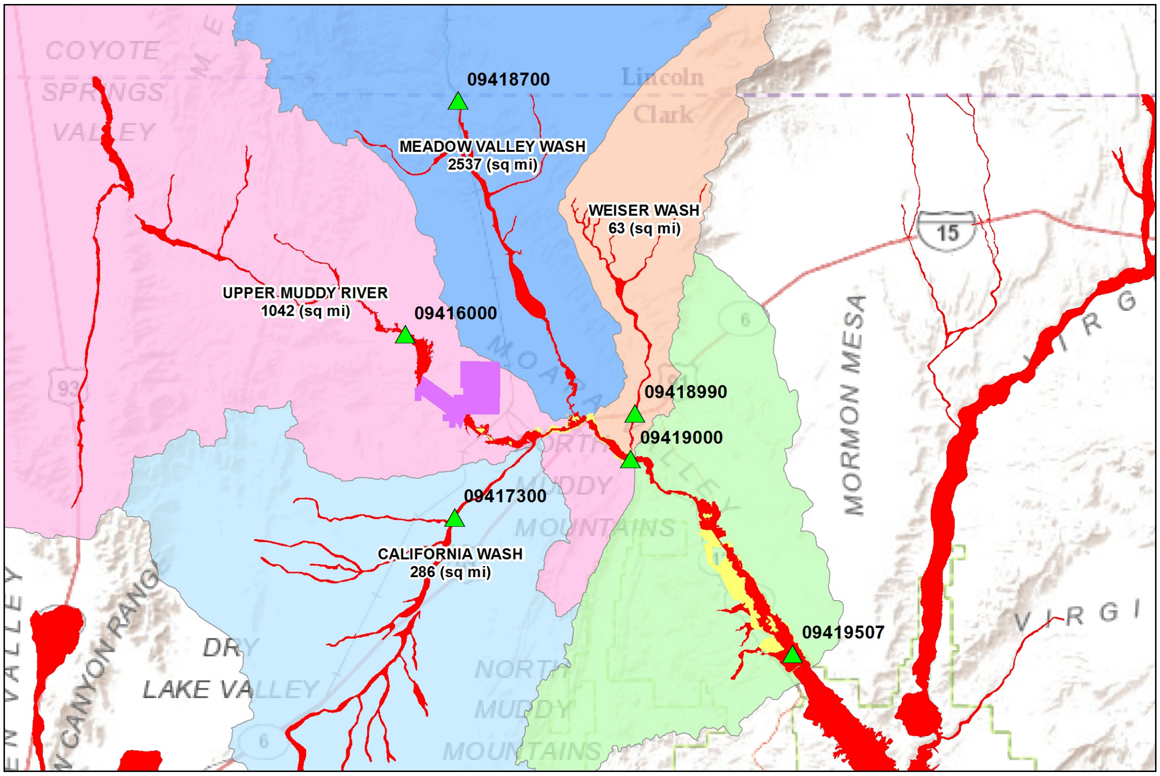


Figure 7-1 Major Washes and USGS Gages in Moapa

Table 7-1 100-yr Flows at USGS Gages in Moapa

Gage ID	Name	Years of Record (Period)	100-yr Flow (cfs) (68% confidence intervals)
9416000	Muddy River Near Moapa	76 (1913-2014)	6,980 (9,872-5,172)
9417300	California Wash Near Moapa	29 (1981-2014)	13,110 (27,830-7,221)
9418990	Weiser Wash Near Glendale	35 (1966-2014)	14,340 (46,290-5,513)
9419000	Muddy River Near Glendale	65 (1950-2014)	21,970 (32,570-15,670)
9418700	Meadow Valley Wash NR Rox	10 (1987-2003)	15,470 (118,500-4,025)

Comparing flow rates from the updated statistical analysis (in **Table 7-1**) with the flow rates established in previous MPUs, the flow rates from the previous MPUs appear reasonable and fall within the 68% confidence interval of the statistical analysis results. Thus, previously established flow rates appear to be reasonable for master planning purposes and were not adjusted. The 100-year flow rates used in the MPU for each of the washes is shown on **Figure 7-3**.

It should also be noted that the 2016 MPU HEC-1 models included local subbasins in Moapa in order to determine runoff in the smaller side washes draining through the towns to the major washes. These model results are included in the model for reference, but the peak flows from HEC-1 were not directly used for any facility sizing purposes. The local subbasins and peak flow rates in the Moapa are shown for reference in **Figure 7-2**.

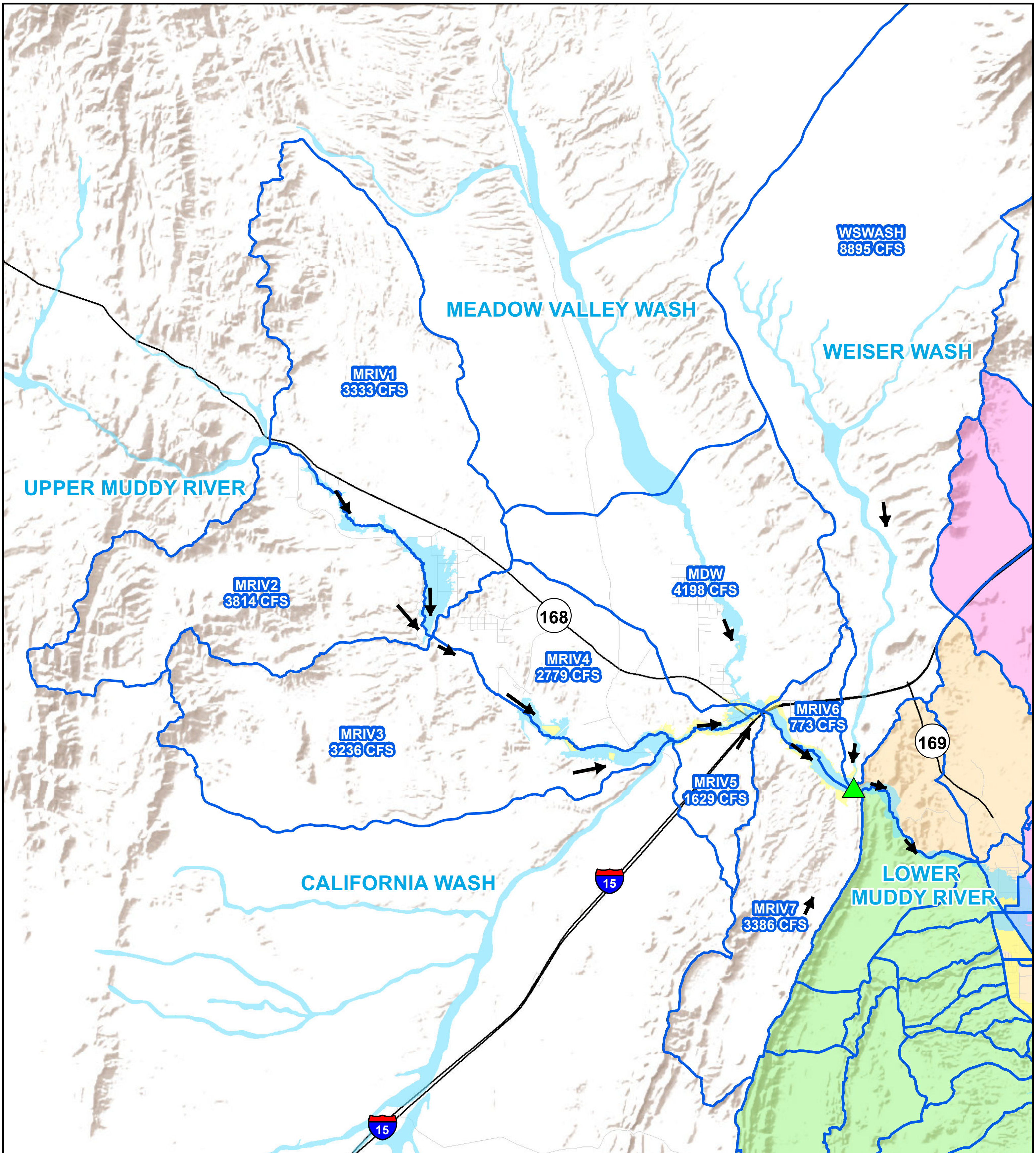
No updated hydraulic analysis was needed or performed in this area.

7.4. Recommended Flood Control Plan

The recommended flood control plan for Moapa consists of a Non-Structural Floodplain Management Plan. The recommended floodplain management approach is consistent with the recommendations in previous MPUs and has not been changed. An FIS restudy was completed in the area to define the flood zone boundaries in the area. Under the Non-Structural Floodplain Management Plan, new construction within the floodplain would be required to conform to the National Flood Insurance Program (NFIP) and local floodplain ordinances. In addition, consideration could be given to the development of flood proofing mitigation and assistance programs for existing structures within the floodplain. Additional information regarding non-structural solutions is included in **Section 8**.

The flood control plan in the area should continue to evolve as more development plans occur in the future. Updating the topography data and revising the floodplain mapping may be beneficial in the future to ensure that flood zone boundaries are current and accurately representing the flood hazard in the area.

The recommended flood control plan in Moapa is shown on **Figure 7-3**.



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2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

MOAPA
HYDROLOGY MAP
FIGURE 7-2

LEGEND

USGS Gage 09419000	Lower Muddy River
Flow Arrows selection	Eastern Washes
Basin ID / 100-yr Flow — Hydrologic Subbasin	Western Washes
Flood Zone A,AE,AO	
Flood Zone Shaded X	

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FLOOD CONTROL
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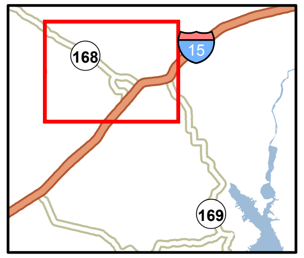
MUDDY RIVER AND
TRIBUTARY WASHES

LEGEND

- Flood Zone A, AE, AO
- Flood Zone X (Shaded)
- Stream Gages



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SCALE: 1 inch = 1 mile

MOAPA
NON-STRUCTURAL FLOODPLAIN
MANAGEMENT PLAN

FIGURE 7-3

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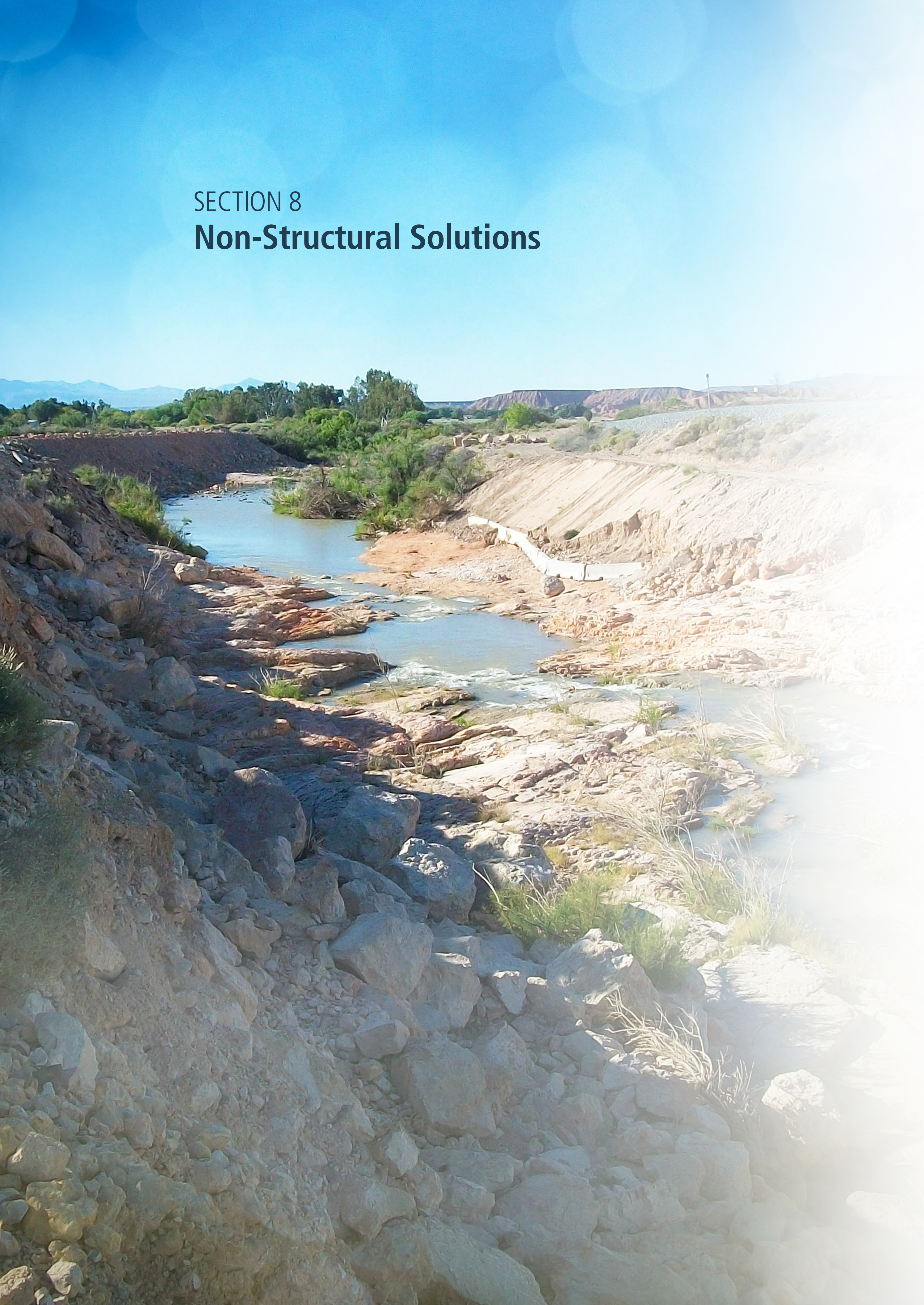
SECTION 8

Non-Structural Solutions



8. Non-Structural Floodplain Management

8.1. Introduction

This section includes a framework and general recommendations regarding non-structural solutions and floodplain management strategies. For the purpose of this report, non-structural solutions refers to any proactive mitigation action and activity that seeks to reduce the adverse impacts of flooding, separate from designing/constructing the regional flood control facilities described in this MPU. This may include activities such as floodplain mapping, public outreach and education, floodproofing structures, acquiring/relocating property, applying for FEMA grants and funding, etc.

Non-structural solutions may be relevant in the Muddy River MPU study area because of complex nature of the floodplain and complicated structural solutions that are difficult to implement along flat, riverine corridors that experience high flows and frequent flooding, particularly in light of the sparse development in the area. Non-structural recommendations were first developed and included in the 2001 MPU and have been updated to include new information.

Used in conjunction with the MPU, developing a non-structural floodplain management plan could be an effective tool to reduce flood losses in Moapa and Moapa Valley. The main goals of this plan would be to:

1. Protect existing homes and buildings in floodplain areas
2. Provide sustainable flood mitigation
3. Provide comprehensive floodplain management
4. Reduce storm water runoff damage to public/private property

The information in this Section is not intended to be a final action plan or comprehensive discussion of all possible non-structural measures and alternatives; rather, the information in this Section provides an overview of possible options and ideas that could be beneficial in terms of reducing overall flood risk before, during, or after the ultimate condition buildout of the facilities described in the 2016 MPU are complete. Ongoing coordination with CCRFCD, Clark County, and the local residents should continue in order determine final solutions for the area.

8.2. Voluntary Acquisition/Relocation of Property

Non-structural measures involve removal of structures from at-risk locations or the modification of existing buildings and structures to help them better withstand and recover from the forces of a hazard. Property acquisition of structures that lie in flood-prone areas is a very effective non-structural solution because it is permanent, it protects people and property from the devastating effects of flooding, and it reduces emotional and financial costs associated with disaster response, recovery, and repair.

Property acquisition is defined as the **voluntary** acquisition (i.e., willing seller/willing buyer) of an existing flood-prone structure and, typically, the underlying land, and conversion of the land to open space through the demolition of the structure. The property should be deed-restricted in perpetuity to open space uses to restore and/or conserve the natural floodplain functions.

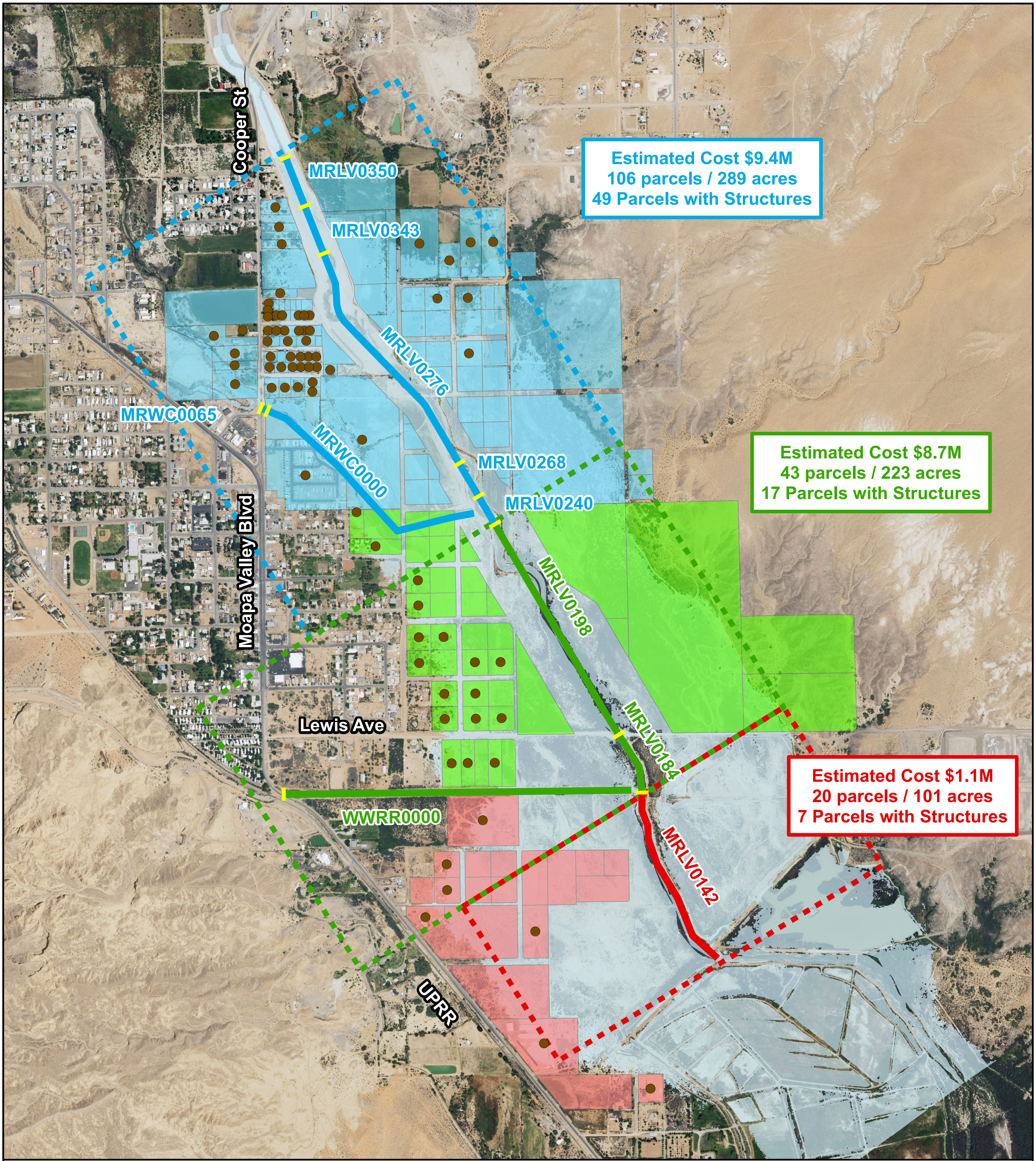
As mentioned previously in this report, many homes in the study area have experienced flooding and lie within the FEMA SFHA. The recommended facilities in this MPU provide a long-term structural solution to flooding; however, some of these facilities may not be built for many years and are difficult to design and construct because of the existing topography. For these reasons, property acquisition could be reviewed in more detail by CCRFCD/Clark County to determine if it is warranted in certain locations.

One possible location where property acquisition may be more appropriate than the structural solution is downstream of Cooper Street Bridge in the vicinity of Lewis Avenue where structures have experienced repetitive flooding within the wide floodplain areas. There are relatively few parcels in this area and acquisition of property may be very beneficial compared to the costs and challenges associated with the proposed structural solution.

In order to identify structures that could be considered for acquisition in this area, the 2D HEC-RAS model previously described was run with the assumption that the proposed regional channel improvements were constructed and in place upstream of Cooper Street to Gubler Avenue. Downstream of the existing Cooper Street Bridge improvements, it was assumed that no structural improvements were made to the existing channel or floodplain. This model was run and the resulting inundation limits and floodplain extent was determined in order to identify private properties that would be within the flood extents downstream of Cooper Street Bridge improvements. These properties are shown in **Figure 8-1** and could be considered candidates for acquisition. As shown on the figure, many of these properties are vacant or do not contain structures (as indicated by dots on the figure).

For the purpose of comparing the structural and non-structural alternative, the structural solution was grouped into three sections and color coded in order to identify potential project phases. The first section (Section 1) of the structural solution protects the most properties and still provides significant benefit, including the proposed West Creek Channel which will protect many downstream properties. The second and third sections of the structural solution (Section 2 and 3) provide less benefit and are more challenging to design and construct.

Thus, it is recommended that the structural solution be implemented through Section 1, downstream of the Cooper Street Bridge improvements to the confluence with the West Creek Channel. Downstream of the confluence in Sections 2 and 3, the non-structural solution is recommended as a viable alternative. Further coordination will be required to finalize the structural/non-structural plan and extents in the area.



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2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

LOWER MUDDY RIVER
NON-STRUCTURAL SOLUTION IMPACTS

FIGURE 8-1

LEGEND

- Parcels with Structures
- Floodplain Extent if MRLV is Built U/S of Cooper
- SECTION 1
- SECTION 2
- SECTION 3
- SECTION 1 Impacted Parcels (106)
- SECTION 2 Impacted Parcels (43)
- SECTION 3 Impacted Parcels (20)

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8.3. Mitigation Programs and Sources of Assistance

Several state and federal agencies have flood hazard mitigation programs and offer technical assistance. These programs may be funded at different levels over time or may be activated under special circumstances such as after a presidential disaster declaration.

FEMA offers several programs that provide technical assistance and grant funding to sponsor mitigation efforts across the United States. Numerous mitigation grants are awarded each year to states and communities to undertake mitigation projects to prevent future loss of life and property resulting from hazard impacts, including flooding.

FEMA's Hazard Mitigation Assistance (HMA) program specifically targets mitigation, with grant assistance through the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), and Pre-Disaster Mitigation (PDM) programs.

The **PDM** program provides funds on an annual basis for hazard mitigation planning and the implementation of mitigation projects for the purpose of reducing overall risk to the population and structures, while at the same time, also reducing reliance on federal funding from actual disaster declarations. PDM projects are funded 75% federal share and 25% non-federal (local) share. FEMA is making $90 million available for FY 2016 PDM grants, which are nationally competitive and cannot exceed $3 million in federal share for each subapplication.

The **FMA** grant program provides funds on an annual basis so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program (NFIP). FMA projects are funded 75% federal share and 25% non-federal (local) share. FEMA is making $199 million available for FY 2016 FMA grants.

Funding under HMA programs is subject to availability of annual appropriations and under HMGP to the amount of FEMA disaster recovery assistance under a presidential major disaster declaration. FEMA's HMA grants are provided to eligible States, Tribes, and Territories that, in turn, provide subgrants to local governments and communities. The State selects and prioritizes subapplications developed and submitted to them by subapplicants (e.g., local governments, government agencies, certain non-profit organizations). These subapplications are submitted to FEMA for consideration of funding.

See the attached Nevada brochure at the end of this Section for state contact information as well as state grant application deadlines. FEMA's Guidance documents are also available for download: https://www.fema.gov/media-library/assets/documents/103279.

Based on extensive analysis, pre-calculated benefits have been determined by FEMA for acquisition and elevation projects located in SFHAs. This analysis demonstrates a national average for benefits of $276,000 for acquisition projects and of $175,000 for elevation projects. Therefore, FEMA has determined that the acquisition or elevation of a structure located in the 100-year floodplain for which costs are equal to or less than the amount of benefits noted above is cost effective.

8.4. Protection of Buildings/Structures

Other non-structural measures involve the modification of existing buildings and structures to help them better withstand and recover from the forces of a hazard. There are many ways to protect residential and non-residential structures from flood damage, some of which may include:

- Elevate structures so that the lowest floor, including the basement, is raised above the base flood elevation. Utilities or other mechanical devices should also be raised above expected flood levels.
- Manufactured homes should be elevated above the base flood elevation and anchored or, more preferably, kept out of the floodplain.
- Relocate utilities and water heaters above BFE and consider the use of tankless water heaters if there are space limitations.
- In a basement, wet-floodproofing may be preferable to attempting to keep water out completely because it allows for controlled flooding to balance exterior and interior wall forces and discourages structural collapse. Water resistant paints or other materials should be used to allow for easy cleanup after floodwater exposure in accessory structures or in a garage area below an elevated residential structure.
- Encourage wet floodproofing of areas above BFE.
- Dry floodproof non-residential structures by strengthening walls, sealing openings, or using waterproof compounds or plastic sheeting on walls to keep water out.
- Obtain flood insurance for building and contents to aid recovery after a flood event occurs.

8.5. General Information Assistance

Education of public officials and the general populace is key to implementing non-structural solutions and/or an effective floodplain management plan. The dissemination of public information regarding flood mechanics, floodplain and floodway boundaries, possible mitigation measures, national and local regulations, and assistance programs will be helpful in educating residents and developing and implementing a successful floodplain management plan.

8.5.1. Flood Protection Information

The CCRFCD's website (**www.regionalflood.org**) provides up to date information about flood events, flood protection projects, historical flooding (historical information about rain and flooding) and rainfall/weather (up-to-the-minute readings from weather gauges). Available web services and programs can be used to see if your property is in a 100-year flood zone or to view drainage studies, current and proposed flood control facilities, and parcel information.

8.5.2. Flood Protection Library

A collection of the current local hydrology studies (i.e., the FIS, Master Plan Update) is available for use at the Moapa Valley Library in Overton and through Clark County. More information on retrofitting measures could be added to the library as a reference for local businesses and residence owners.

8.5.3. Outreach Programs

Typically, Public Service Announcements over radio and television are a good way to reach a large number of people. Presently, the network television stations from Las Vegas provide notification of flash flood watch and warnings. Additionally, the "Flood Channel" offers general information and education on local flooding and facilities. Mailers are a method of public notification, which allow a message to reach a wide audience. An effective measure of reaching a large local audience is the use of public information billboards.

8.5.4. Handbook/Video

Handbooks/videos for flood protection measures are currently available from FEMA, however, these are for general purposes and designed for a broad audience. A handbook and/or video with information specific to the Moapa Valley could be developed for use by the area residents.

8.5.5. Public Meetings/Open House

The Moapa Valley and Moapa Town Advisory Boards hold regular meetings open to the public. An "Open House" meeting that features experts and professionals advertising their wares or services (i.e., insurance agents, contractors) to the public is another way to inform the public of flood control measures that can be undertaken by property owners.

8.6. Emergency Services

Flood Warning - The Clark County Regional Flood Control District continually expands their Flood Threat Recognition System (FTRS). Through the use of the FTRS, the ALERT-type data collection system provides real-time rainfall data. This information is available on the CCRFCD's website (www.regionalflood.org) and allows for reasonable warning time in the event of a storm in the upper watershed. Currently, CCRFCD sends advisories to pertinent agencies that provide emergency management services and to individuals who request to be added to CCRFCD's advisory email distribution list.

Critical Facilities - Critical facilities are defined as buildings or locations that are vital to the flood response effort. Buildings or areas in the floodplain that have the potential for creating a secondary disaster if flooded are also classified as critical facilities. Critical facilities should have their own emergency plans in case of disaster. An effective floodplain management plan identifies the critical facilities within the area.

8.7. Regional Facility Maintenance

The hydraulic modeling performed as part of the 2016 MPU included various runs with different ranges of Manning's n values (based on assumptions regarding vegetation in the channel and overbank areas). These preliminary models indicate Manning's n value is a sensitive parameter and has an impact on the water surface elevation in the channel as well as the overall depth and flood extents on the floodplains if flows break out of the channel. In other words, regular maintenance is an important activity and has the potential to provide benefit in terms of reducing overall flooding in the study area.

The CCRFCD provides funds to Clark County to maintain the regional flood control facilities within their jurisdiction. CCRFCD works with Clark County every year to develop the fiscal year maintenance work plan and budget. Continued maintenance of the Muddy River (clearing vegetation, etc.) provides additional flood carrying capacity and will serve to protect private property and public infrastructure.

Vegetation in channels of the Muddy River and other washes can obstruct flood flows. In many areas, trees and shrubs grow on the channel banks and bottom and thereby increase roughness and decrease the effective flow area of the channel. There are also several culverts and bridge crossings along the Muddy River that are often overtopped by floodwaters, thereby causing erosion, scour, sediment deposition, and damage. Regular maintenance can help alleviate or reduce the impacts of these problems.

8.8. Summary of Non-Structural Recommendations

1. Many of the properties in the MPU study area are already mapped in the FEMA SFHA, which in and of itself is an effective non-structural solution. The floodplain and floodway should continue be managed according to standard FEMA regulations, including mandatory flood insurance purchase requirements, to protect residents in the area.

2. Acquisition of property, especially in the areas downstream of Cooper Street, is an effective and permanent non-structural solution that should be reviewed in more detail by CCRFCD and Clark County.

3. State and federal agencies, especially FEMA, have flood hazard mitigation programs and funds available to sponsor flood mitigation efforts. These programs should be investigated in more detail in order to identify applicable programs and grants that could be used in Moapa and Moapa Valley.

4. Existing buildings and structures in the study area that experience frequent flooding can be modified or floodproofed to better protect them from damage during flood events.

5. Public outreach and the dissemination of flood data and information is helpful in educating residents, realizing mutual understanding, and developing/implementing a successful floodplain management plan.

6. Best-available methods and technology should continue to be used to ensure that early warnings, advisories, and flood information is sent ahead of time to pertinent agencies and individuals responsible for emergency management services in the area.

7. Maintenance of existing flood control facilities and the Muddy River channel is beneficial and should be performed on a regular basis and on an as-need basis after significant storm events. Field visits, inspections, and additional coordination with Clark County should occur to review current maintenance activities, identify obstacles, and improve the overall maintenance procedures in the area.

8. New buildings constructed in the floodplain should meet current County, CCRFCD, State, Local, and FEMA Regulations.

Eligible Activities	HMGP	PDM	FMA
1. Mitigation Projects	✔	✔	✔
Property Acquisition and Structure Demolition	✔	✔	✔
Property Acquisition and Structure Relocation	✔	✔	✔
Structure Elevation	✔	✔	✔
Mitigation Reconstruction	✔	✔	✔
Dry Floodproofing of Historic Residential Structures	✔	✔	✔
Dry Floodproofing of Non-Residential Structures	✔	✔	✔
Generators	✔	✔	
Localized Flood Risk Reduction Projects	✔	✔	✔
Non-Localized Flood Risk Reduction Projects	✔	✔	
Structural Retrofitting of Existing Buildings	✔	✔	✔
Non-Structural Retrofitting of Existing Buildings and Facilities	✔	✔	✔
Safe Room Construction	✔	✔	
Wind Retrofit for One- and Two-Family Residences	✔	✔	
Infrastructure Retrofit	✔	✔	✔
Soil Stabilization	✔	✔	✔
Wildfire Mitigation	✔	✔	
Post-Disaster Code Enforcement	✔		
Advance Assistance	✔		
5 Percent Initiative Projects	✔		
Miscellaneous/Other	✔	✔	✔
2. Hazard Mitigation Planning	✔	✔	✔
Planning-Related Activities	✔		
3. Technical Assistance			✔
4. Management Costs	✔	✔	✔

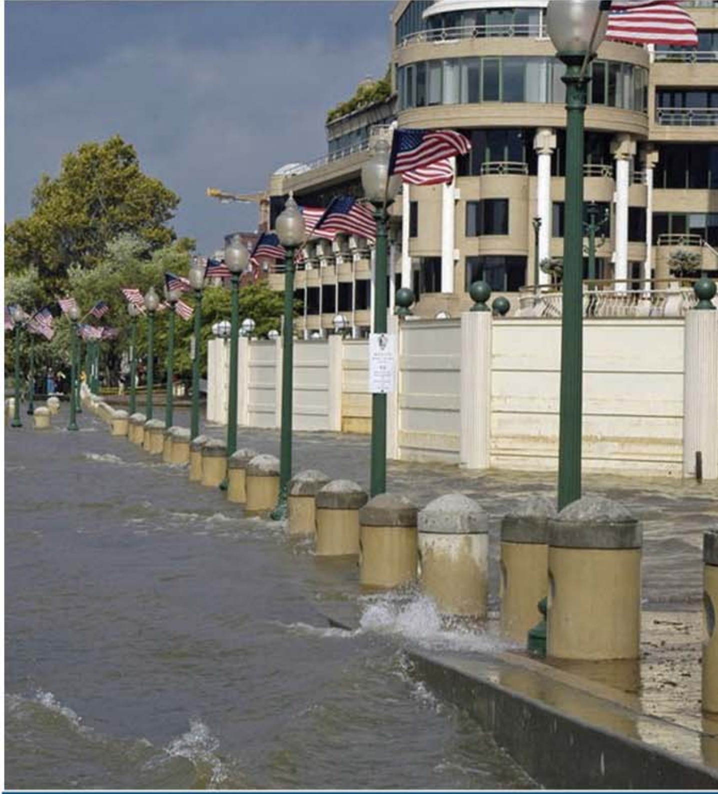
Nevada Contact: PDM, HMGP, FMA
Karen Johnson
Nevada Division of Emergency Management
(775) 687.0373 - Kijohnson@dps.state.nv.us

Dates & Deadlines HMA 2016 TBD

February 2016	FEMA publication of HMA Guidelines (all future dates dependent on publication date)
February 2016	FEMA application period opens
March 1, 2016	Notice of Interest forms due to NDEM
March 1, 2016	Establish eGrants access
March 15, 2016	Complete SOW & BCA
TBD	NHMPC meeting - Presentation to NHMPC & Ranking
June 1, 2016	Full Application Package with backup documentation in eGrants
June 14, 2016	State submits application in eGrants to FEMA, application period closes

NDEM Mitigation: http://dem.nv.gov/About/RandM/
HMA Helpline: 1-866-222-3580
FEMA eGrants Helpdesk: 1-855-228-3362
Benefit-Cost Analysis Helpline: BCHelpline@fema.dhs.gov

www.NevadaFloods.org



Hazard Mitigation Assistance Program in Nevada

HMGP HAZARD MITIGATION GRANT PROGRAM
PDM PRE-DISASTER MITIGATION
FMA FLOOD MITIGATION ASSISTANCE

FEMA

Hazard Mitigation Assistance (HMA)

The Federal Emergency Management Agency's (FEMA) HMA programs provide funds for projects that reduce the risk to individuals and property from natural hazards. These programs enable mitigation measures to be implemented before, during, and after disaster recovery.

Hazard Mitigation Grant Program (HMGP)

The HMGP provides funding for long-term hazard mitigation measures following major disaster declarations.
Funding is available to implement projects in accordance with State, territorial, federally-recognized tribal, and local priorities.

Pre-Disaster Mitigation (PDM) The PDM program provides funds on an annual basis for hazard mitigation planning and the implementation of mitigation projects. FEMA provides funding for measures to reduce or eliminate overall risk from natural hazards.

Flood Mitigation Assistance (FMA) The FMA program provides funds on an annual basis so that measures can be taken to reduce or eliminate the risk of flood damage to buildings insured under the National Flood Insurance Program (NFIP). The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities.

What are the roles of local communities, federally-recognized tribes, territories, States, and FEMA?

Local jurisdictions develop projects that could reduce property damage from future disasters, and submit applications to the State, territory, or federally-recognized tribes.

The States, territories, and federally-recognized tribes (acting as Applicants) establish their mitigation priorities, facilitate the development of applications, and submit applications to FEMA based on State, territorial, or federally-recognized tribal criteria and available funding.

FEMA conducts a final eligibility review to ensure compliance with Federal regulations. Projects must comply with Federal environmental laws and regulations, be
cost-effective, technically feasible, and meet additional program criteria.

What are the roles of home and business owners?

Individuals, property and business owners may not apply directly to the State, territory, or FEMA, but eligible local governments may apply on their behalf.

FEMA encourages property and business owners interested in implementing mitigation activities to contact their local community planning, emergency management, or hazard mitigation office for more information.

www.fema.gov/government/grant/pdm/index.shtm

Who is eligible to apply?

Local governments, State entities, and Federally Recognized Tribal Entities

Certain private nonprofit organizations

Cost Sharing

HMA program funds are cost-shared. The total cost to implement approved mitigation activities is generally funded by a combination of Federal and non-Federal sources.

Program Cost Share Requirements	Mitigation Activity Award (Percent of Federal/ Non-Federal Share)
HMGP	75 / 25
PDM	75 / 25
PDM (sub recipient is small impoverished community)	90 / 10
PDM (federally-recognized tribal Recipient is small impoverished community)	90 / 10
FMA (Insured properties and planning grants)	75 / 25
FMA (repetitive loss property with repetitive loss strategy)	90 / 10
FMA (severe repetitive loss property with repetitive loss strategy)	100 / 0

University of Nevada Cooperative Extension

Living With Fire

www.NevadaFloods.org

9. References

1. Clark County Regional Flood Control District, *Hydrologic Criteria and Drainage Design Manual*, Adopted August 12, 1999.

2. Clark County Regional Flood Control District, *Rainfall & Flood Event Report December 17-23, 2010*. http://gustfront.ccrfcd.org/pdf_arch1/flood%20event%20reports/2010-12-17.pdf

3. Clark County Regional Flood Control District, *Rainfall & Flood Event Report September 8, 2014*. http://gustfront.ccrfcd.org/pdf_arch1/flood%20event%20reports/2014-09-08%20Rainfall%20and%20Flood%20Event%20Report.pdf

4. Clark County Regional Flood Control District, *Rainfall & Flood Event Report September 26-27, 2014*. http://gustfront.ccrfcd.org/pdf_arch1/flood%20event%20reports/2014-09-26%20Rainfall%20and%20Flood%20Event%20Report.pdf

5. FEMA, *Flood Insurance Study, Clark County, Nevada, and Incorporated Areas,* 32003CV002C, Revised November 16, 2011.

6. Louis Berger, *Preliminary Design Report Fairgrounds Detention Basin*, August 2014.

7. U.S. Water Resources Council, Guidelines for Determining Flood Flow Frequency, Bulletin #17B, September 1981.

8. Clark County Department of Public Works, *Final Predesign Memorandum for the Muddy River Riverine Enhancement*, G.C. Wallace, Inc., April 1998.

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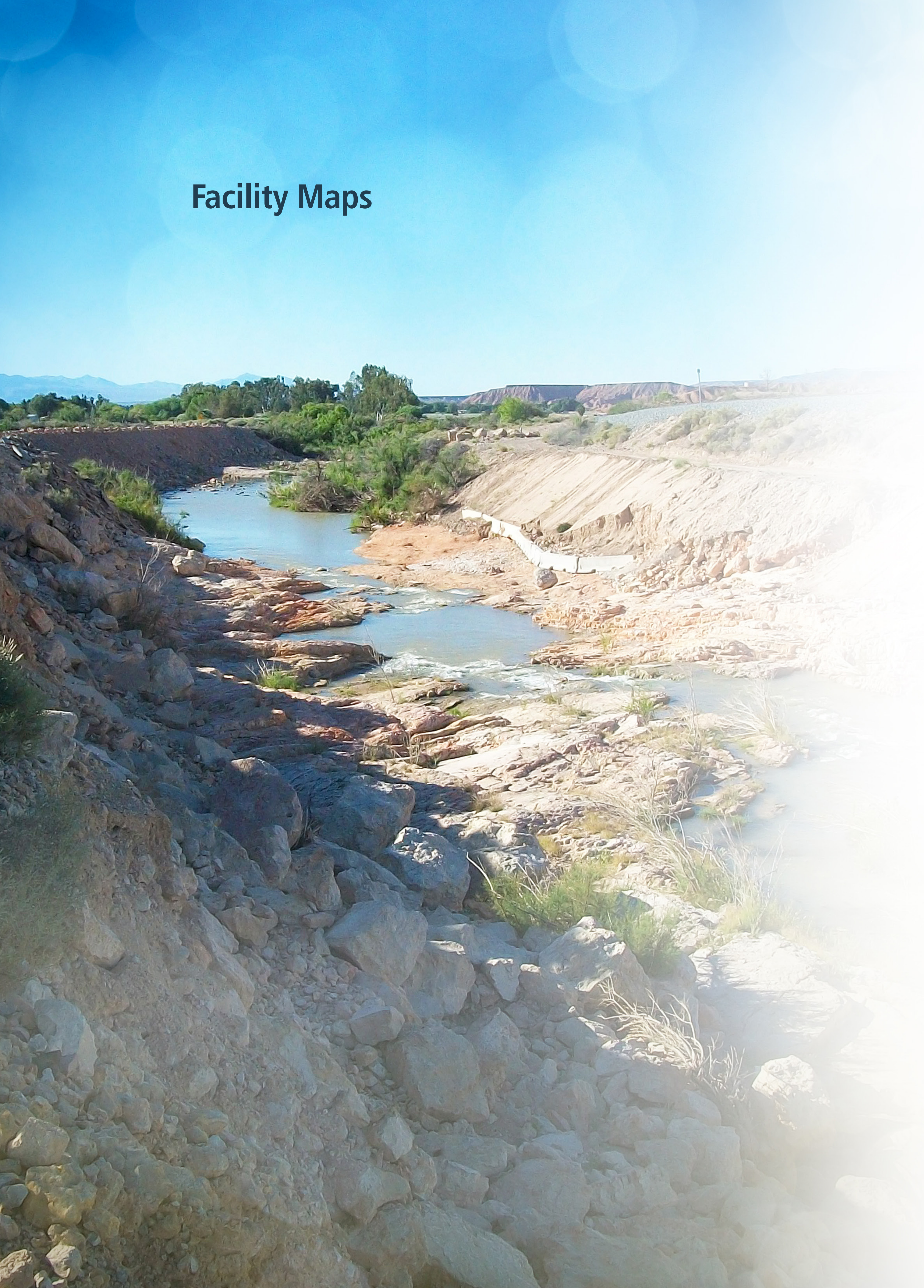
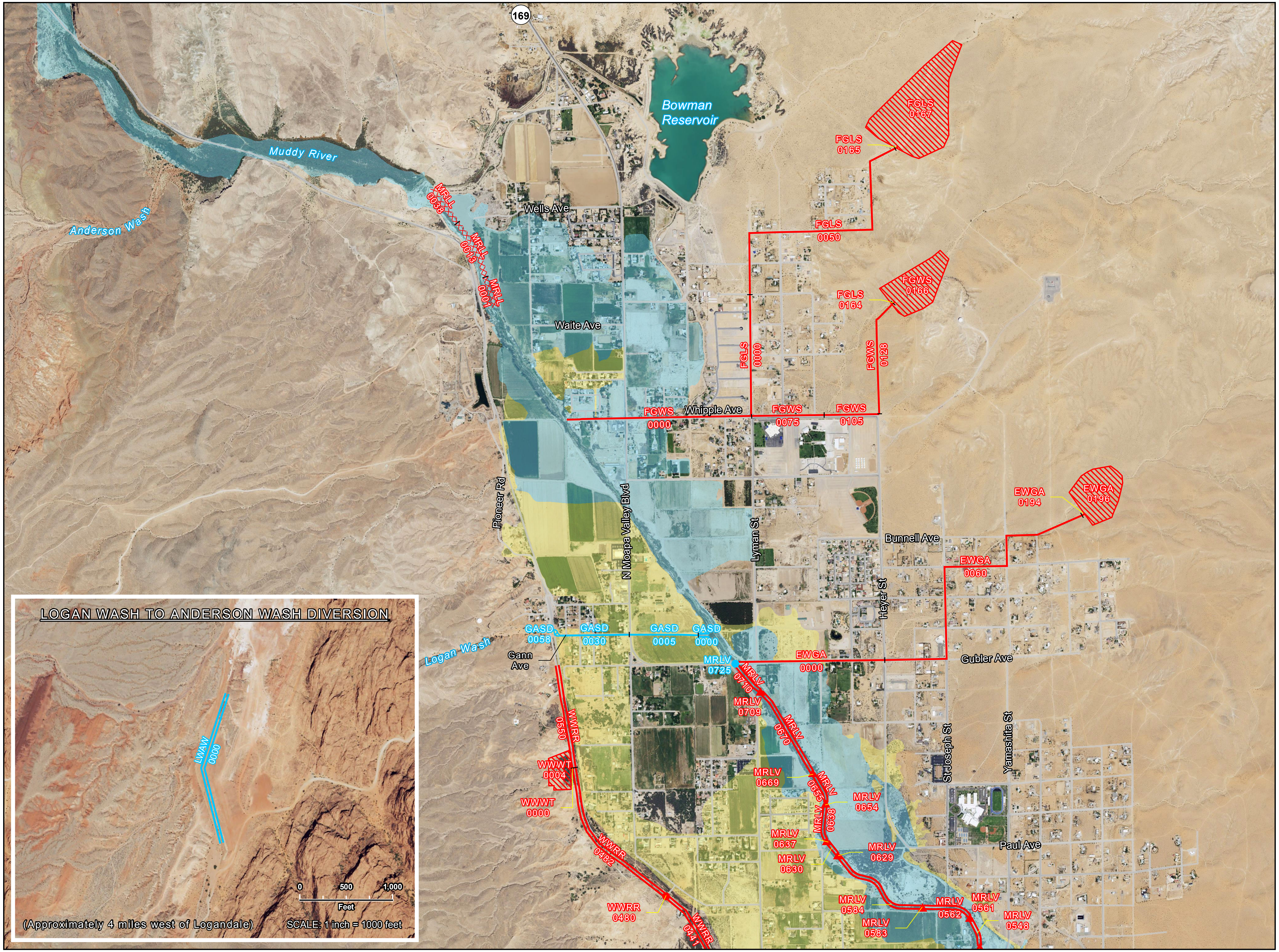
Facility Maps





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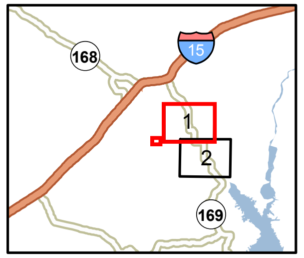
LEGEND

- Existing Storm Drain
- Existing Lined Channel
- Existing Dike
- Existing Erosion Control Structure
- Existing Culvert or Bridge Crossing
- Existing Detention Basin
- Proposed Storm Drain
- Proposed Lined Channel
- Proposed Dike
- Proposed Erosion Control Structure
- Proposed Culvert or Bridge Crossing
- Proposed Detention Basin
- Flood Zone A, AE, AO
- Flood Zone X (Shaded)



N

0 2,000
Feet

SCALE: 1 inch = 2000 feet

FLOOD CONTROL FACILITIES
FIGURE F-1

ATKINS

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **
EWGA		**EASTERN WASHES - GUBLER**						
0000	P1	10' x 5' RCB	3155	802	CEWASH4	MRMPU3	3.92	1.200
0060	P1	48" RCP	7035	88	DBEWGA	MRMPU3	1.89	1.200
0194	P1	30" RCP Outlet Pipe	70	88	DBEWGA	MRMPU3	1.89	0.500
0195	P1	14,470 cfs Spillway		14470	EWDB	MRMPU3	1.89	
0196	P1	157 acre-ft Gubler Avenue Detention Basin		1447	EWDB	MRMPU3	1.89	
FGLS		**FAIRGROUNDS - LYMAN**						
0000	P1	72" RCP	2625	270	CFGDB1	MRMPU5	24.28	0.900
0050	P1	72" RCP	6070	254	DBFGLS	MRMPU5	23.89	0.700
0165	P1	42" RCP Outlet Pipe	70	254	DBFGLS	MRMPU5	23.89	0.500
0166	P1	52,740 cfs Spillway		52740	CBMN7	MRMPU5	23.89	
0167	P1	1,247 acre-ft Lyman Street Detention Basin		5274	CBMN7	MRMPU5	23.89	
FGWS		**FAIRGROUNDS - WHIPPLE**						
0000	P2	7' x 5' RCB	3975	378	CEWASH5	MRMPU5	27.24	1.000
0075	P2	54" RCP	1580	221	CRDBFGWS	MRMPU3	2.38	1.400
0105	P2	48" RCP	1200	44	DBFGWS	MRMPU3	1.92	1.800
0128	P2	36" RCP	2645	44	DBFGWS	MRMPU3	1.92	1.000
0164	P2	18" RCP Outlet Pipe	70	44	DBFGWS	MRMPU3	1.92	0.500
0165	P2	16,000 cfs Spillway		16000	FGDB	MRMPU3	1.92	
0166	P2	139 acre-ft Fairgrounds Detention Basin		1318	FGDB	MRMPU3	1.92	
GASD		**GANN AVENUE STORM DRAIN**						
0000	E	20' x 8' Transition Channel	220	2108	CLWASH3	MRMPU3	5.90	0.500
0005	E	2: 10' RCP	1400	2108	CLWASH3	MRMPU3	5.90	0.500
0030	E	2: 10' x 8' RCB	1600	2108	CLWASH3	MRMPU3	5.90	1.100
0058	E	Gann Avenue Debris Basin		2108	CLWASH3	MRMPU3	5.90	
LWAW		**LOGAN WASH DIVERSION**						
0000	E	Earthern Diversion Channel	1675	2303	AWASH1	MRMPU3	4.57	0.500
MRLL		**MUDDY RIVER LOGANDALE LEVEE**						
0001	P3	Concrete Levee	675	21400				0.900
0013	P3	Concrete Levee	1325	21400				1.200
0038	P3	Concrete Levee	925	21400				1.700
MRLV		**MUDDY RIVER LOWER VALLEY**						
0548	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	698	21400				0.100
0561	P2	Grade Control Structure						
0562	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	1016	21400				0.100
0583	P2	Grade Control Structure						
0584	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	2297	21400				0.100
0629	P2	Grade Control Structure						
0630	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	464	21400				0.100
0637	P2	Grade Control Structure						
0638	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	885	21400				0.100
0654	P2	Grade Control Structure						
0655	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	744	21400				0.100
0669	P2	Grade Control Structure						
0670	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	2115	21400				0.100
0709	P2	Grade Control Structure						
0710	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	625	21400				0.100
0725	E	Gubler Avenue Bridge	50	21400				0.400
WWRR		**WESTERN WASHES RAILROAD CHANNEL**						
0441	P1	Conc Chnl 12'W 4.5'D 2:1 SS	2050	539	WWASH3A	MRMPU3	1.38	0.500
0480	P1	12' X 6' RCBC @ Access Road	60	539	WWASH3A	MRMPU3	1.38	0.500
0482	P1	Conc Chnl 12'W 4.5'D 2:1 SS	3565	539	WWASH3A	MRMPU3	1.38	0.500
0550	P1	Conc Chnl 12'W 4'D 2:1 SS	2250	395	WWASH4A	MRMPU3	0.31	0.500
WWWT		**WESTERN WASHES CHANNEL SYSTEM - WITTWER**						
0000	P1	18" RCP Outlet Pipe	70	31	DBWWWT	MRMPU3	0.89	0.500
0003	P1	9,090 cfs Spillway		9090	CWWASH4	MRMPU3	0.89	
0004	P1	91 acre-ft Wittwer Avenue Detention Basin		909	CWWASH4	MRMPU3	0.89	

**The HEC-1 node shown identifies the controlling concentration point for the associated facility and is located upstream of this facility due to decreasing peak flow with increasing tributary area caused by storm distribution transitions, depth area reduction factors, or attenuation of flow from routing.*
***As-built or design slopes were used when available. All other slopes are based on existing topography. The user should verify the facility slope listed prior to performing any facility specific analysis.*

REGIONAL FLOOD CONTROL DISTRICT

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FACILITY INVENTORY
FIGURE F-1

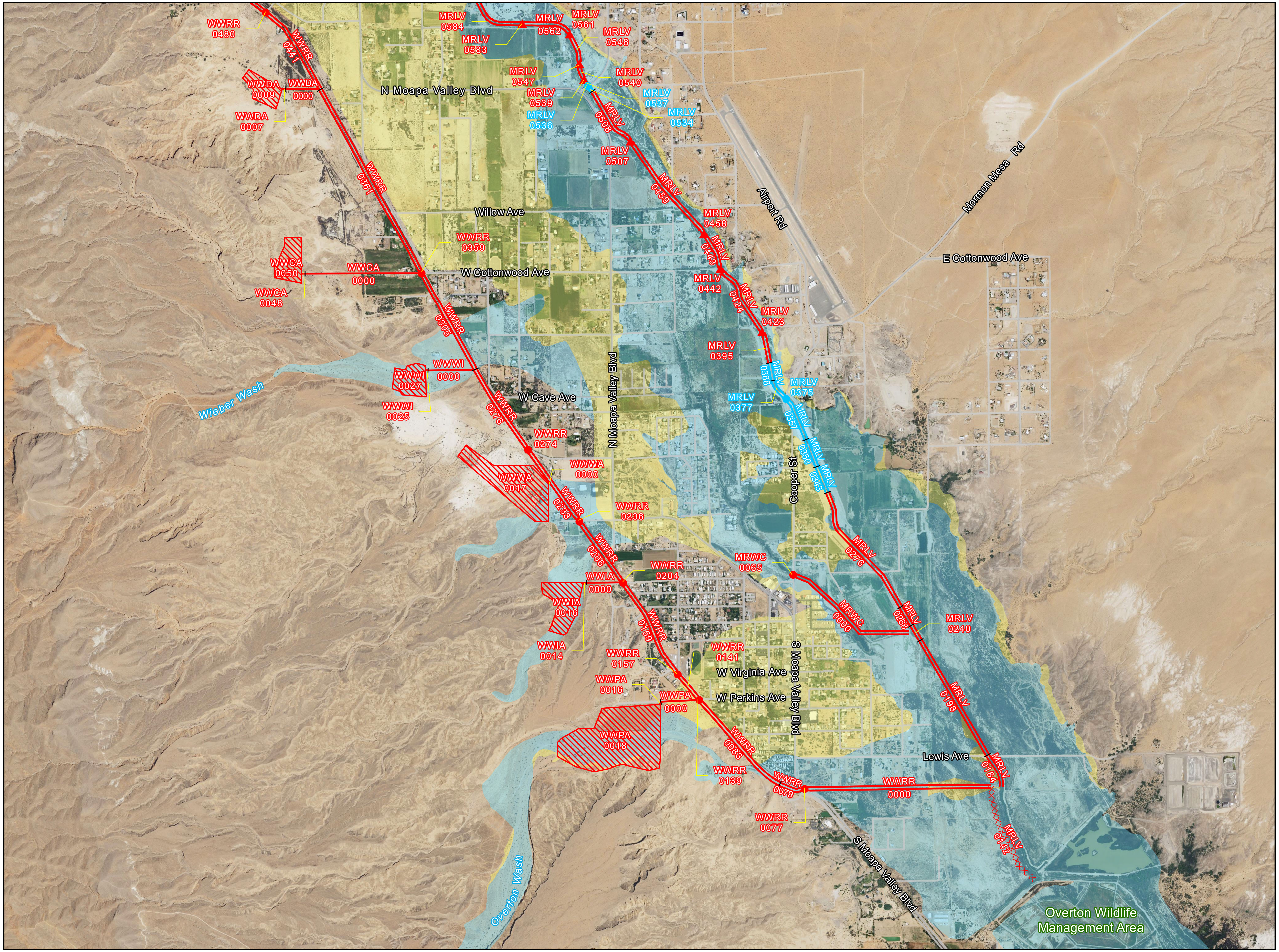
LEGEND

ID (Facility Identifier) AABB
Parent Stream Name
Stream Name
River Mile 0000
Distance Above Confluence with Parent Stream (Miles)
Miles in Hundredths

Existing Facility.......... E
Proposed or Modified Facility........ P
Contingency Level
Category B.......... P0
Master Plan.......... P1
Preliminary Design.......... P2
Design.......... P3

Bottom Width........ W
Depth.......... D
Side Slope, H:V..... SS

Construction Features
Cast in Place Concrete Pipe.......... CIPCP
Corrugated Metal Arch Pipe Culvert.......... CMAP
Corrugated Metal Pipe Culvert.......... CMPC
High Density Polyethylene.......... HDPE
Horizontal Elliptical Reinforced Concrete Pipe....... HERCP
Reinforced Concrete Arch Pipe.......... RCAP
Reinforced Concrete Arch Culvert..... RCAC
Reinforced Concrete Box.......... RCB
Reinforced Concrete Box Culvert...... RCBC
Reinforced Concrete Pipe.......... RCP
Reinforced Concrete Pipe Culvert..... RCPC
Storm Sewer Pipe.......... SSP



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LEGEND

- Existing Storm Drain
- Existing Lined Channel
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- Existing Culvert or Bridge Crossing
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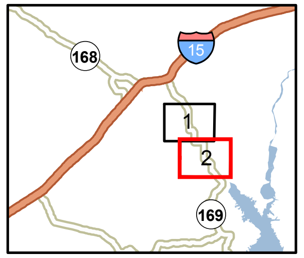
- Flood Zone A, AE, AO
- Flood Zone X (Shaded)



N

0 2,000
Feet

SCALE: 1 inch = 2000 feet

FLOOD CONTROL FACILITIES
FIGURE F-2

ATKINS

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **
MRLV		**MUDDDY RIVER LOWER VALLEY**						
0142	P1	Earthen Levee	2230	21400				0.300
0184	P1	Stabilized Earthen Chnl w/ Riprap-Lined Bank 600'W 6.5'D 3:1 SS	750	21400				0.200
0198	P2	Stabilized Earthen Chnl w/ Riprap-Lined Bank 600'W 6.5'D 3:1 SS	2872	21400				0.200
0240	P2	Stabilized Earthen Chnl w/ Riprap-Lined Bank 600'W 6.5'D 3:1 SS	376	21400				0.200
0268	P2	Stabilized Earthen Chnl w/ Riprap-Lined Bank 400'W 8'D 3:1 SS	450	21400				0.300
0276	P2	Stabilized Earthen Chnl w/ Riprap-Lined Bank 400'W 8'D 3:1 SS	3005	21400				0.300
0343	E	Earthen Chnl w/ Riprap-Lined Bank 200'W 9.5'D 3:1 SS	600	21400				0.300
0350	E	Earthen Chnl w/ Riprap-Lined Bank 200'W 11'D 3:1 SS	630	21400				0.400
0357	E	Conc Chnl 200'W 11'D 2:1 SS	818	21400				0.400
0375	E	Cooper Street Bridge	290	21400				0.400
0377	E	Conc Chnl 180'W 13.6'D 2.5:1 SS	375	21400				0.400
0388	E	Gabion Chnl 200'W 11.5'D 3:1 SS	386	21400				0.200
0395	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 11.5'D 3:1 SS	673	21400				0.200
0423	P2	Grade Control Structure						
0424	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	1720	21400				0.100
0442	P2	Grade Control Structure						
0443	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	723	21400				0.100
0458	P2	Grade Control Structure						
0459	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	2549	21400				0.100
0507	P2	Grade Control Structure						
0508	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	1395	21400				0.100
0534	E	Earthen Channel w/ Gabion Side Slopes	135	21400				
0536	E	Yamashita Street Bridge	36	21400				
0537	E	Earthen Channel w/ Gabion Side Slopes	100	21400				
0539	P2	Grade Control Structure						
0540	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	345	21400				0.100
0547	P2	Grade Control Structure						
0548	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	698	21400				0.100
0561	P2	Grade Control Structure						
0562	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	1016	21400				0.100
0583	P2	Grade Control Structure						
0584	P2	Earthen Chnl w/ Riprap-Lined Bank 200'W 13'D 3:1 SS	2297	21400				0.100
MRWC		**MUDDY RIVER WEST CREEK**						
0000	P1	Conc Chnl 10'W 6'D 3:1 SS	2964	1115	OVR1	MRMPU3	1.88	0.300
0065	P1	Cooper Street Culvert 2:12' x 9' RCBC	60	1115	OVR1	MRMPU3	1.88	0.100
WWCA		**WESTERN WASHES CHANNEL SYSTEM - COTTONWOOD**						
0000	P1	60" RCP	2550	118	DBWWCA	MRMPU3	1.90	0.500
0048	P1	30" RCP Outlet Pipe	70	118	DBWWCA	MRMPU3	1.90	0.500
0049	P1	14,170 cfs Spillway		14170	WWASH2	MRMPU3	1.90	
0050	P1	156 acre-ft Cottonwood Avenue Detention Basin		1417	WWASH2	MRMPU3	1.90	
WWDA		**WESTERN WASHES CHANNEL SYSTEM - DUESING**						
0000	P1	36" RCP	750	24	DBWWDA	MRMPU3	0.45	0.500
0007	P1	18" RCP Outlet Pipe	70	24	DBWWDA	MRMPU3	0.45	0.500
0008	P1	6,740 cfs Spillway		6740	WWASH3	MRMPU3	0.45	
0009	P1	49 acre-ft Duesing Avenue Detention Basin		674	WWASH3	MRMPU3	0.45	

ID / River Mile	Status	Facility Description	Length (ft.)	Flow (cfs)	HEC-1 Node	HEC-1 Model	Tributary Area (sq.mi.)	Channel Slope (%) **
WWIA		**WESTERN WASHES CHANNEL SYSTEM - INGRAM**						
0000	P1	48" RCP	760	85	DBWWIA	MRMPU3	1.25	1.000
0014	P1	30" RCP Outlet Pipe	70	85	DBWWIA	MRMPU3	1.25	0.500
0015	P1	11,840 cfs Spillway		11840	WWASH1A	MRMPU3	1.25	
0016	P1	108 acre-ft Ingram Avenue Detention Basin		1184	WWASH1A	MRMPU3	1.25	
WWPA		**WESTERN WASHES CHANNEL SYSTEM - PERKINS**						
0000	P1	6' x 6' RCB	840	273	DBWWPA	MRMPU5	22.25	0.500
0016	P1	42" RCP Outlet Pipe	70	273	DBWWPA	MRMPU5	22.25	0.500
0017	P1	44,920 cfs Spillway		44920	CCOWASH2	MRMPU5	22.25	
0018	P1	992 acre-ft Perkins Avenue Detention Basin		4492	CCOWASH2	MRMPU5	22.25	
WWRR		**WESTERN WASHES RAILROAD CHANNEL**						
0000	P1	Conc Chnl 12'W 5.5'D 2:1 SS	4030	916	COVR2	MRMPU5	34.54	0.400
0077	P1	14' X 7' RCBC @ State Route 169	100	873	CWWASH2*	MRMPU3	4.12	0.500
0079	P1	Conc Chnl 12'W 5.5'D 2:1 SS	515	873	CWWASH2*	MRMPU3	4.12	0.500
0083	P1	Conc Chnl 12'W 5.5'D 2:1 SS	2500	873	CWWASH2*	MRMPU3	4.12	0.400
0139	P1	14' X 7' RCBC @ Access Road	60	873	CWWASH2*	MRMPU3	4.12	0.400
0141	P1	Conc Chnl 12'W 5.5'D 2:1 SS	725	873	CWWASH2*	MRMPU3	4.12	0.400
0157	P1	14' X 7' RCBC @ Access Road	60	873	CWWASH2*	MRMPU3	4.12	0.400
0159	P1	Conc Chnl 12'W 5.5'D 2:1 SS	2310	873	CWWASH2*	MRMPU3	4.12	0.400
0204	P1	14' X 7' RCBC @ Access Road	60	873	CWWASH2*	MRMPU3	4.12	0.400
0206	P1	Conc Chnl 12'W 5.5'D 2:1 SS	1620	873	CWWASH2*	MRMPU3	4.12	0.400
0236	P1	14' X 7' RCBC @ Access Road	60	873	CWWASH2*	MRMPU3	4.12	0.400
0238	P1	Conc Chnl 12'W 5.5'D 2:1 SS	1900	873	CWWASH2*	MRMPU3	4.12	0.400
0274	P1	14' X 7' RCBC @ Access Road	60	873	CWWASH2*	MRMPU3	4.12	0.400
0276	P1	Conc Chnl 12'W 5.5'D 2:1 SS	2035	873	CWWASH2*	MRMPU3	4.12	0.400
0305	P1	Conc Chnl 12'W 5.5'D 2:1 SS	2350	873	CWWASH2	MRMPU3	4.12	0.400
0359	P1	14' X 7' RCBC @ Access Road	60	873	CWWASH2	MRMPU3	4.12	0.400
0361	P1	Conc Chnl 12'W 5.5'D 2:1 SS	4525	821	CWWASH2A	MRMPU3	2.22	0.400
0441	P1	Conc Chnl 12'W 4.5'D 2:1 SS	2050	539	WWASH3A	MRMPU3	1.38	0.500
0480	P1	12' X 6' RCBC @ Access Road	60	539	WWASH3A	MRMPU3	1.38	0.500
WWWA		**WESTERN WASHES CHANNEL SYSTEM - WEST WASH 1**						
0000	P1	36" RCP Outlet Pipe	70	117	DBWWWA	MRMPU3	2.63	0.500
0016	P1	21,400 cfs Spillway		21400	WWASH1B	MRMPU3	2.63	
0017	P1	235 acre-ft West Wash 1 Detention Basin		2140	WWASH1B	MRMPU3	2.63	
WWWI		**WESTERN WASHES CHANNEL SYSTEM - WIEBER**						
0000	P1	60" RCP	1010	129	DBWWWI	MRMPU3	3.50	0.500
0025	P1	30" RCP Outlet Pipe	70	129	DBWWWI	MRMPU3	3.50	0.500
0026	P1	11,960 cfs Spillway		11960	WIWASH	MRMPU3	3.50	
0027	P1	182 acre-ft Wieber Wash Detention Basin		1196	WIWASH	MRMPU3	3.50	

**The HEC-1 node shown identifies the controlling concentration point for the associated facility and is located upstream of this facility due to decreasing peak flow with increasing tributary area caused by storm distribution transitions, depth area reduction factors, or attenuation of flow from routing.*
***As-built or design slopes were used when available. All other slopes are based on existing topography. The user should verify the facility slope listed prior to performing any facility specific analysis.*

REGIONAL FLOOD CONTROL DISTRICT

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FACILITY INVENTORY
FIGURE F-2

LEGEND

ID (Faclity Identifier) AABB
Parent Stream Name
Stream Name
River Mile 0000
Distance Above Confluence with Parent Stream (Miles)
Miles in Hundredths

Existing Facility.......................... E
Proposed or Modified Facility........ P
Contingency Level
Category B......................... P0
Master Plan........................ P1
Preliminary Design............... P2
Design.............................. P3

Bottom Width........W
Depth..................D
Side Slope, H:V.....SS

Construction Features

Cast in Place Concrete Pipe..........................CIPCP
Corrugated Metal Arch Pipe Culvert................ CMAP
Corrugated Metal Pipe Culvert.........................CMPC
High Density Polyethylene..............................HDPE
Horizontal Elliptical Reinforced Concrete Pipe.......HERCP
Reinforced Concrete Arch Pipe....................... RCAP
Reinforced Concrete Arch Culvert..... RCAC
Reinforced Concrete Box.................RCB
Reinforced Concrete Box Culvert...... RCBC
Reinforced Concrete Pipe................RCP
Reinforced Concrete Pipe Culvert..... RCPC
Storm Sewer Pipe..........................SSP

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Henderson, Nevada 89074
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Appendix A

Hydrologic Analysis

- Appendix A-1: Land Use Maps
- Appendix A-2: Soil Maps
- Appendix A-3: Hydrologic Parameters
- Appendix A-4: HEC-1 Models
- Appendix A-5: HEC-1 Results

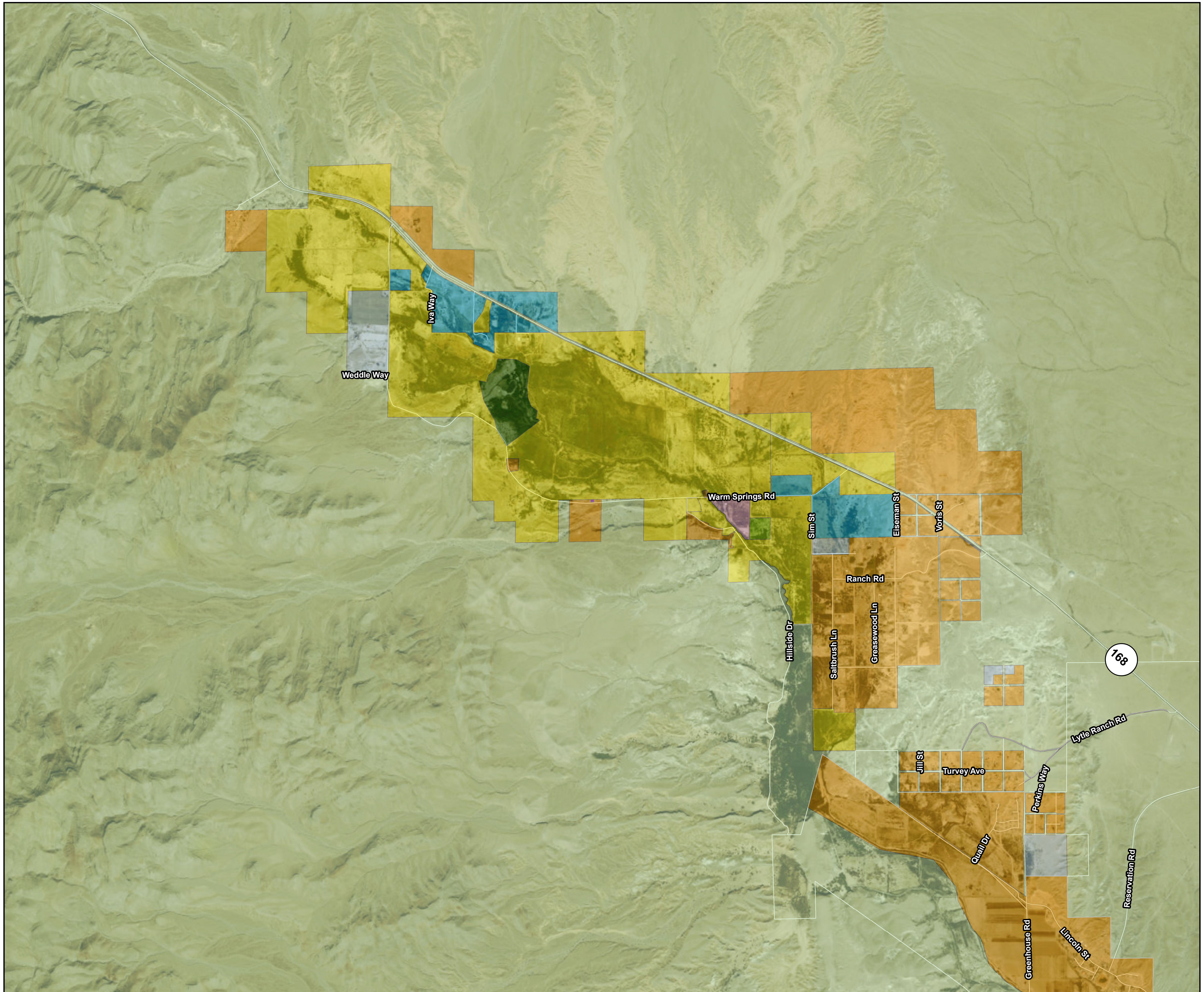
Appendix A-1

Land Use Maps

REGIONAL FLOOD CONTROL DISTRICT

2016 FLOOD CONTROL MASTER PLAN UPDATE MUDDY RIVER AND TRIBUTARY WASHES

Land Use Map 1



LEGEND

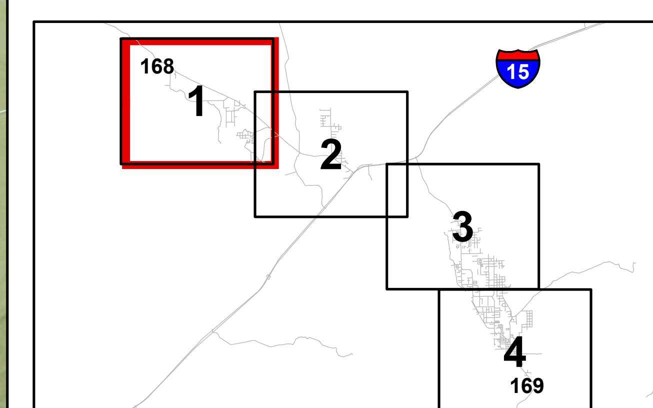
Ultimate Condition Land Use

- 1 Undeveloped Land, Open Desert
- 2 Parks, Golf Courses
- 3 Rural Residential, 1 unit/acre
- 4 Low Density Residential, 2 units/acre
- 5 Medium Density Residential, 3 units/acre
- 6 High Density Residential, 6 units/acre
- 7 Public Facility, Residential Apts/Condos
- 8 Very High Density Residential, 12 units/acre
- 9 Commerical, Retial, Casino, High Rise Condominiums
- 10 Light Industrial
- 12 Schools/Churches
- 13 Lakes
- 14 Agriculture
- 15 Right of Way
- 16 Residential Countryside, 0.5 unit/acre

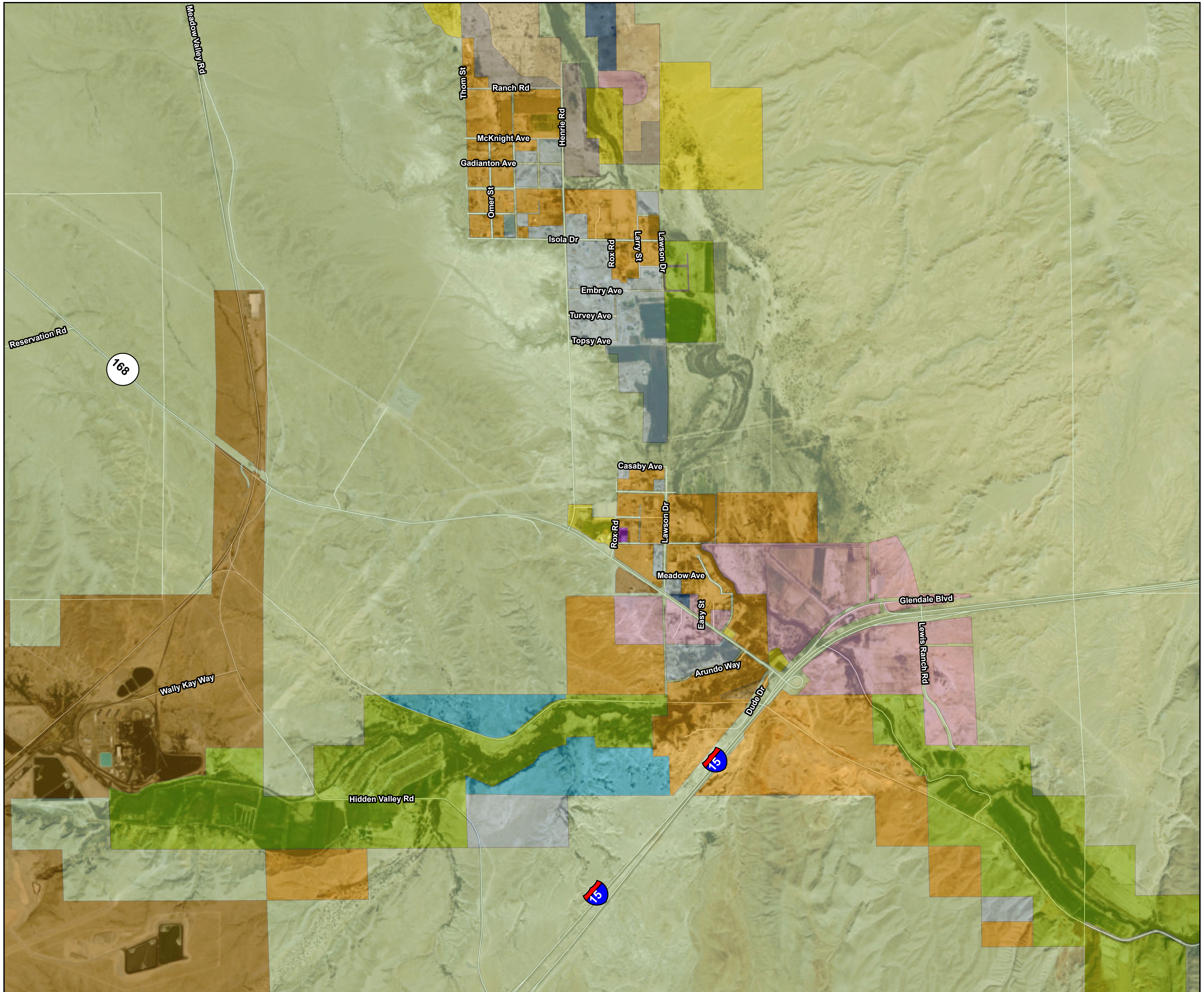
N

0 3,000 Feet

1 inch = 3,000 feet



ATKINS



REGIONAL FLOOD CONTROL DISTRICT

2016 FLOOD CONTROL MASTER PLAN UPDATE MUDDY RIVER AND TRIBUTARY WASHES

Land Use Map 2

LEGEND

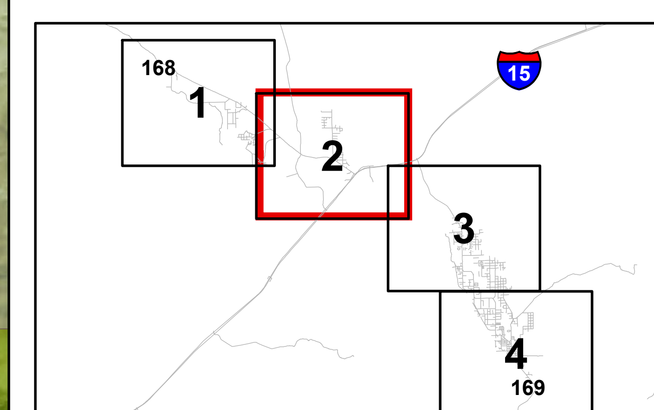
Ultimate Condition Land Use

- 1 Undeveloped Land, Open Desert
- 2 Parks, Golf Courses
- 3 Rural Residential, 1 unit/acre
- 4 Low Density Residential, 2 units/acre
- 5 Medium Density Residential, 3 units/acre
- 6 High Density Residential, 6 units/acre
- 7 Public Facility, Residential Apts/Condos
- 8 Very High Density Residential, 12 units/acre
- 9 Commercial, Retial, Casino, High Rise Condominiums
- 10 Light Industrial
- 12 Schools/Churches
- 13 Lakes
- 14 Agriculture
- 15 Right of Way
- 16 Residential Countryside, 0.5 unit/acre

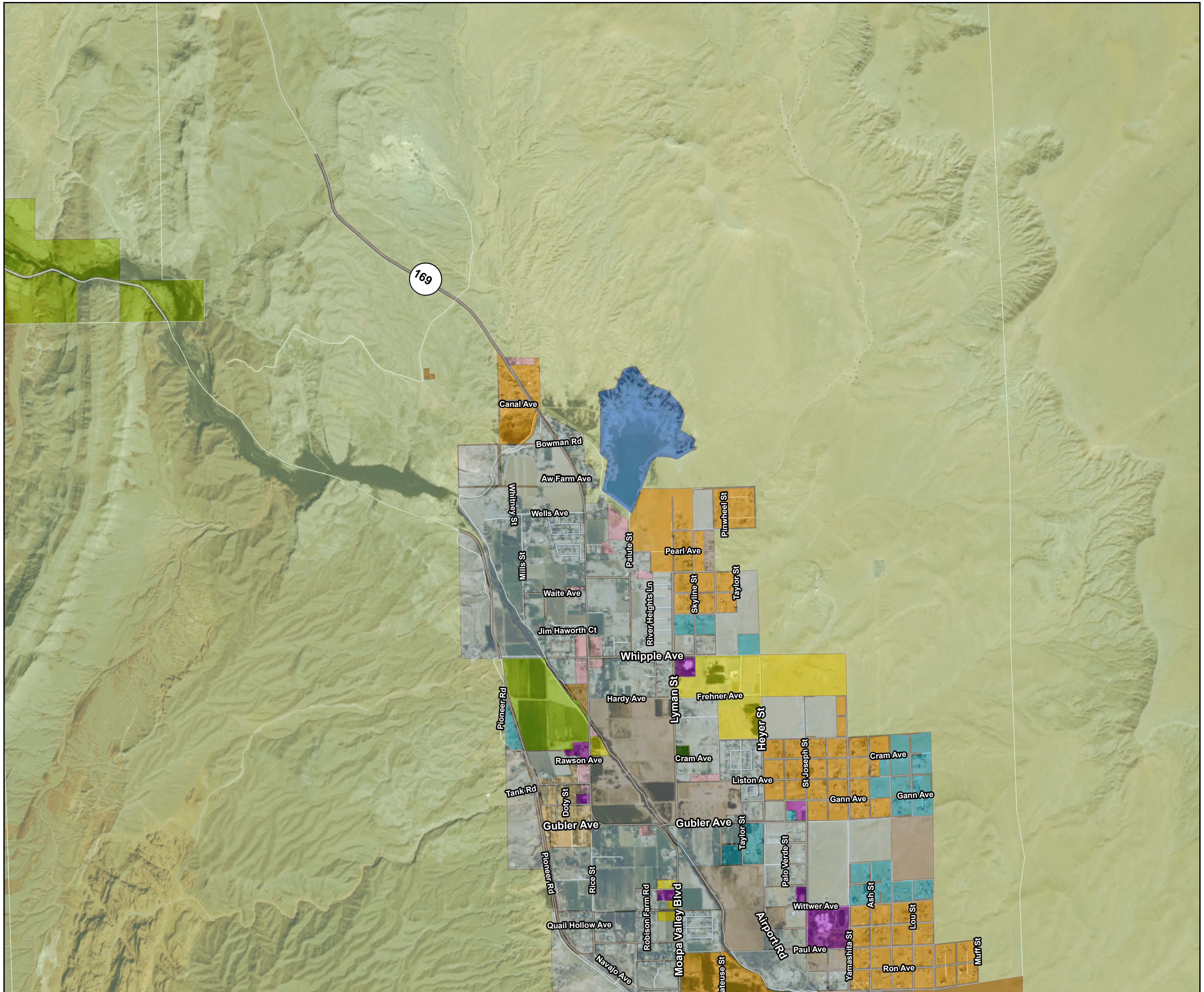
N

0 2,500 Feet

1 inch = 2,500 feet



ATKINS



REGIONAL FLOOD CONTROL DISTRICT

2016 FLOOD CONTROL MASTER PLAN UPDATE MUDDY RIVER AND TRIBUTARY WASHES

Land Use Map 3

LEGEND

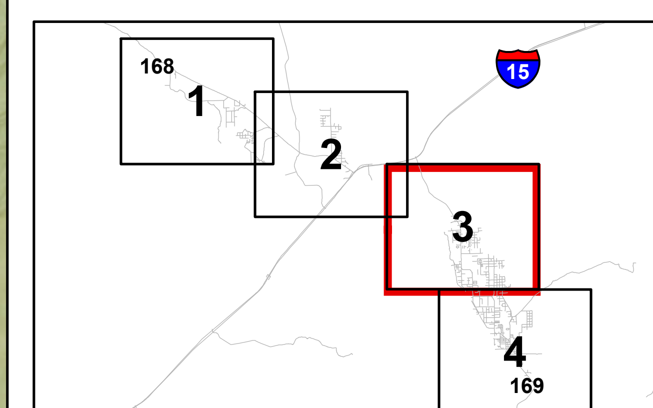
Ultimate Condition Land Use

- 1 Undeveloped Land, Open Desert
- 2 Parks, Golf Courses
- 3 Rural Residential, 1 unit/acre
- 4 Low Density Residential, 2 units/acre
- 5 Medium Density Residential, 3 units/acre
- 6 High Density Residential, 6 units/acre
- 7 Public Facility, Residential Apts/Condos
- 8 Very High Density Residential, 12 units/acre
- 9 Commercial, Retial, Casino, High Rise Condominiums
- 10 Light Industrial
- 12 Schools/Churches
- 13 Lakes
- 14 Agriculture
- 15 Right of Way
- 16 Residential Countryside, 0.5 unit/acre

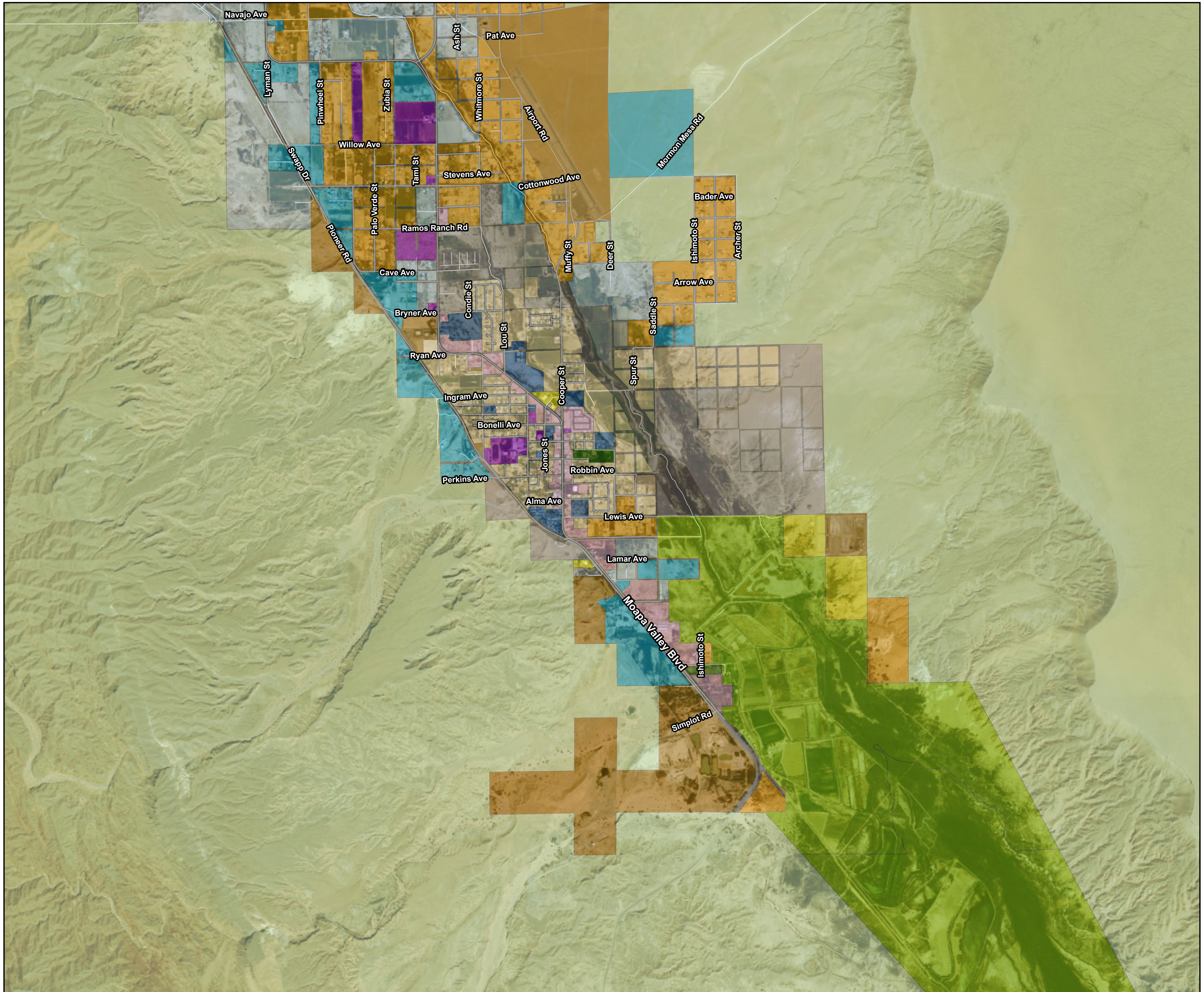
N

0 3,000 Feet

1 inch = 3,000 feet



ATKINS



REGIONAL FLOOD CONTROL DISTRICT

2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

Land Use Map 4

LEGEND

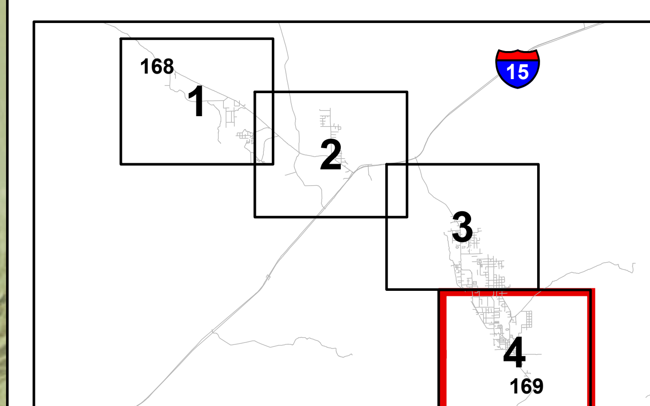
Ultimate Condition Land Use

- 1 Undeveloped Land, Open Desert
- 2 Parks, Golf Courses
- 3 Rural Residential, 1 unit/acre
- 4 Low Density Residential, 2 units/acre
- 5 Medium Density Residential, 3 units/acre
- 6 High Density Residential, 6 units/acre
- 7 Public Facility, Residential Apts/Condos
- 8 Very High Density Residential, 12 units/acre
- 9 Commercial, Retail, Casino, High Rise Condominiums
- 10 Light Industrial
- 12 Schools/Churches
- 13 Lakes
- 14 Agriculture
- 15 Right of Way
- 16 Residential Countryside, 0.5 unit/acre

N

0 3,000 Feet

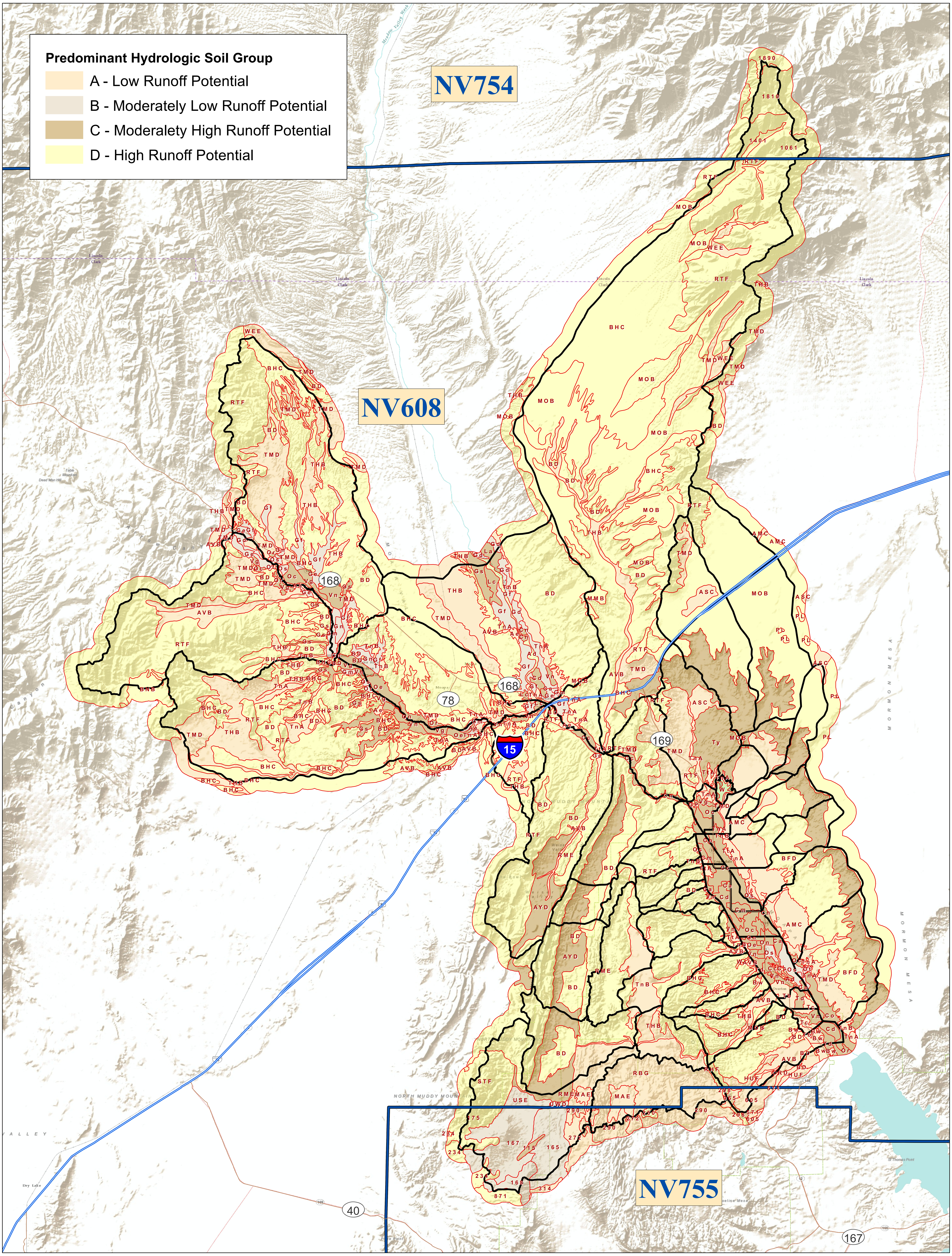
1 inch = 3,000 feet



ATKINS

Appendix A-2

Soil Map



2016
FLOOD CONTROL
MASTER PLAN UPDATE
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SOIL MAP

N

0 3
Miles
1 in = 1.5 miles

LEGEND

Soil Survey Area
Subbasins
272 Soil Map Unit Symbol

REGIONAL FLOOD CONTROL DISTRICT

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Appendix A-3

Hydrologic Parameters

Curve Number Calculations

2016 Muddy River and Tributrary Washes Flood Control Master Plan Update - Composite Curve Number Breakdown

2016 MPU BASINID	LAND USE INDEX NUMBER	SOIL MAP UNIT SYMBOL	SUBREGION CN	SUBREGION AREA (SQ MI)	SUBBASIN AREA (SQ MI)	PERCENT OF SUBBASIN	CUMULATIVE PERCENT	AREAL WEIGHTED CN	CUMULATIVE CN	COMPOSITE CN
AWASH1	1	AYD	85	1.4025	4.5676	30.7%	30.7%	26.10	26.10	
AWASH1	1	BD	90	0.9772	4.5676	21.4%	52.1%	19.26	45.36	
AWASH1	1	RME	81	0.8979	4.5676	19.7%	71.8%	15.92	61.28	
AWASH1	1	RTF	89	1.2898	4.5676	28.2%	100.0%	25.13	86.41	
AWASH1	1	RME	81	0.0000	4.5676	0.0%	100.0%	0.00	86.41	**86.413**
AWASH2	1	AYD	85	0.6383	1.6310	39.1%	39.1%	33.27	33.27	
AWASH2	1	BD	90	0.4553	1.6310	27.9%	67.1%	25.13	58.39	
AWASH2	1	RME	81	0.1122	1.6310	6.9%	73.9%	5.57	63.96	
AWASH2	1	RTF	89	0.4251	1.6310	26.1%	100.0%	23.20	87.16	**87.164**
AWASH3	1	AYD	85	1.2682	5.0325	25.2%	25.2%	21.42	21.42	
AWASH3	1	BD	90	0.9887	5.0325	19.6%	44.8%	17.68	39.10	
AWASH3	1	Cc	85	0.0133	5.0325	0.3%	45.1%	0.22	39.33	
AWASH3	1	Cn	85	0.1441	5.0325	2.9%	48.0%	2.43	41.76	
AWASH3	1	RME	81	0.0246	5.0325	0.5%	48.5%	0.40	42.16	
AWASH3	1	RTF	89	2.5146	5.0325	50.0%	98.4%	44.47	86.63	
AWASH3	14	Cc	78	0.0341	5.0325	0.7%	99.1%	0.53	87.16	
AWASH3	14	RTF	88	0.0449	5.0325	0.9%	100.0%	0.79	87.94	**87.941**
BMN1	1	ASC	63	0.4174	3.7250	11.2%	11.2%	7.06	7.06	
BMN1	1	BD	90	0.0006	3.7250	0.0%	11.2%	0.01	7.07	
BMN1	1	MOB	87	2.2264	3.7250	59.8%	71.0%	52.00	59.07	
BMN1	1	RTF	89	0.7083	3.7250	19.0%	90.0%	16.92	76.00	
BMN1	1	TMD	66	0.3722	3.7250	10.0%	100.0%	6.59	82.59	**82.593**
BMN2	1	AMC	63	0.0019	4.0808	0.0%	0.0%	0.03	0.03	
BMN2	1	MOB	87	3.3434	4.0808	81.9%	82.0%	71.28	71.31	
BMN2	1	RTF	89	0.7356	4.0808	18.0%	100.0%	16.04	87.35	**87.350**
BMN3	1	ASC	63	0.0392	5.1166	0.8%	0.8%	0.48	0.48	
BMN3	1	MOB	87	2.4180	5.1166	47.3%	48.0%	41.11	41.60	
BMN3	1	Ty	84	2.6593	5.1166	52.0%	100.0%	43.66	85.26	**85.257**
BMN4	1	MOB	87	5.6059	6.9816	80.3%	80.3%	69.86	69.86	
BMN4	1	PL	90	0.0502	6.9816	0.7%	81.0%	0.65	70.50	
BMN4	1	Ty	84	1.3256	6.9816	19.0%	100.0%	15.95	86.45	**86.452**
BMN5	1	AMC	63	0.6411	1.4835	43.2%	43.2%	27.23	27.23	
BMN5	1	MOB	87	0.1930	1.4835	13.0%	56.2%	11.32	38.54	
BMN5	1	Ty	84	0.6494	1.4835	43.8%	100.0%	36.77	75.32	**75.315**
BMN6	1	AMC	63	0.0289	2.0643	1.4%	1.4%	0.88	0.88	
BMN6	1	ASC	63	0.0625	2.0643	3.0%	4.4%	1.91	2.79	
BMN6	1	BFD	88	0.0010	2.0643	0.0%	4.5%	0.04	2.83	
BMN6	1	MOB	87	1.2986	2.0643	62.9%	67.4%	54.73	57.56	
BMN6	1	Ty	84	0.6733	2.0643	32.6%	100.0%	27.40	84.96	**84.959**

2016 Muddy River and Tributrary Washes Flood Control Master Plan Update - Composite Curve Number Breakdown

2016 MPU BASINID	LAND USE INDEX NUMBER	SOIL MAP UNIT SYMBOL	SUBREGION CN	SUBREGION AREA (SQ MI)	SUBBASIN AREA (SQ MI)	PERCENT OF SUBBASIN	CUMULATIVE PERCENT	AREAL WEIGHTED CN	CUMULATIVE CN	COMPOSITE CN
BMN7	1	AMC	63	0.1087	0.4495	24.2%	24.2%	15.24	15.24	
BMN7	1	BFD	88	0.2540	0.4495	56.5%	80.7%	49.73	64.98	
BMN7	1	Ty	84	0.0867	0.4495	19.3%	100.0%	16.21	81.18	**81.180**
BMN8	1	AMC	63	0.9459	1.2726	74.3%	74.3%	46.82	46.82	
BMN8	1	MOB	87	0.0081	1.2726	0.6%	75.0%	0.55	47.38	
BMN8	1	TnA	63	0.0067	1.2726	0.5%	75.5%	0.33	47.71	
BMN8	1	Ty	84	0.2959	1.2726	23.2%	98.7%	19.53	67.24	
BMN8	13	AMC	30	0.0002	1.2726	0.0%	98.8%	0.01	67.24	
BMN8	13	TnA	30	0.0035	1.2726	0.3%	99.0%	0.08	67.33	
BMN8	13	Ty	30	0.0124	1.2726	1.0%	100.0%	0.29	67.62	**67.618**
BOWMAN	1	AMC	63	0.0148	0.2977	5.0%	5.0%	3.13	3.13	
BOWMAN	1	TMD	66	0.0004	0.2977	0.1%	5.1%	0.08	3.20	
BOWMAN	1	TnA	63	0.0002	0.2977	0.1%	5.1%	0.03	3.24	
BOWMAN	1	Ty	84	0.0062	0.2977	2.1%	7.2%	1.74	4.98	
BOWMAN	13	AMC	30	0.0079	0.2977	2.7%	9.9%	0.80	5.77	
BOWMAN	13	TMD	30	0.0222	0.2977	7.5%	17.3%	2.24	8.01	
BOWMAN	13	TnA	30	0.0320	0.2977	10.8%	28.1%	3.23	11.24	
BOWMAN	13	Ty	30	0.0713	0.2977	23.9%	52.0%	7.18	18.42	
BOWMAN	13	W	30	0.1378	0.2977	46.3%	98.3%	13.89	32.31	
BOWMAN	16	AMC	65	0.0038	0.2977	1.3%	99.6%	0.83	33.14	
BOWMAN	16	TMD	68	0.0012	0.2977	0.4%	100.0%	0.28	33.42	**33.422**
EWASH1	1	AMC	63	0.1374	6.3260	2.2%	2.2%	1.37	1.37	
EWASH1	1	BFD	88	1.9794	6.3260	31.3%	33.5%	27.54	28.90	
EWASH1	1	MOB	87	0.2335	6.3260	3.7%	37.2%	3.21	32.12	
EWASH1	1	TMD	66	0.3824	6.3260	6.0%	43.2%	3.99	36.11	
EWASH1	1	TnA	63	0.0003	6.3260	0.0%	43.2%	0.00	36.11	
EWASH1	1	Ty	84	1.4240	6.3260	22.5%	65.7%	18.91	55.02	
EWASH1	3	AMC	65	0.0596	6.3260	0.9%	66.7%	0.61	55.63	
EWASH1	3	BFD	88	0.0492	6.3260	0.8%	67.4%	0.68	56.31	
EWASH1	3	Ot	78	0.0102	6.3260	0.2%	67.6%	0.13	56.44	
EWASH1	3	TMD	68	0.0151	6.3260	0.2%	67.8%	0.16	56.60	
EWASH1	4	AMC	63	0.0001	6.3260	0.0%	67.8%	0.00	56.60	
EWASH1	4	Oc	84	0.0142	6.3260	0.2%	68.1%	0.19	56.79	
EWASH1	4	Ot	76	0.0001	6.3260	0.0%	68.1%	0.00	56.79	
EWASH1	4	TMD	65	0.0488	6.3260	0.8%	68.8%	0.50	57.29	
EWASH1	4	TnA	62	0.0245	6.3260	0.4%	69.2%	0.24	57.53	
EWASH1	5	BFD	85	0.0921	6.3260	1.5%	70.7%	1.24	58.77	
EWASH1	5	Co	81	0.1809	6.3260	2.9%	73.5%	2.32	61.09	
EWASH1	5	Oc	81	0.0230	6.3260	0.4%	73.9%	0.30	61.38	

2016 Muddy River and Tributary Washes Flood Control Master Plan Update - Composite Curve Number Breakdown

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EWASH1	5	Os	72	0.0292	6.3260	0.5%	74.4%	0.33	61.71	
EWASH1	5	Ot	72	0.0073	6.3260	0.1%	74.5%	0.08	61.80	
EWASH1	5	TMD	59	0.4194	6.3260	6.6%	81.1%	3.91	65.71	
EWASH1	5	TnA	56	0.0003	6.3260	0.0%	81.1%	0.00	65.71	
EWASH1	6	BFD	91	0.0191	6.3260	0.3%	81.4%	0.27	65.99	
EWASH1	6	Co	89	0.0411	6.3260	0.6%	82.1%	0.58	66.56	
EWASH1	6	Os	84	0.0102	6.3260	0.2%	82.2%	0.14	66.70	
EWASH1	6	Ot	84	0.0334	6.3260	0.5%	82.7%	0.44	67.14	
EWASH1	6	TMD	77	0.1054	6.3260	1.7%	84.4%	1.28	68.43	
EWASH1	6	TnA	76	0.0129	6.3260	0.2%	84.6%	0.15	68.58	
EWASH1	7	Co	91	0.0094	6.3260	0.1%	84.8%	0.14	68.71	
EWASH1	7	TMD	83	0.1032	6.3260	1.6%	86.4%	1.35	70.07	
EWASH1	7	TnB	81	0.0003	6.3260	0.0%	86.4%	0.00	70.07	
EWASH1	10	BFD	94	0.0003	6.3260	0.0%	86.4%	0.01	70.08	
EWASH1	10	TMD	85	0.0631	6.3260	1.0%	87.4%	0.85	70.93	
EWASH1	14	Co	78	0.2123	6.3260	3.4%	90.8%	2.62	73.54	
EWASH1	14	Tc	49	0.0053	6.3260	0.1%	90.8%	0.04	73.58	
EWASH1	14	TMD	52	0.0407	6.3260	0.6%	91.5%	0.33	73.92	
EWASH1	14	TnB	49	0.0114	6.3260	0.2%	91.7%	0.09	74.01	
EWASH1	14	Vn	78	0.0296	6.3260	0.5%	92.1%	0.36	74.37	
EWASH1	15	Ad	96	0.0150	6.3260	0.2%	92.4%	0.23	74.60	
EWASH1	15	AMC	84	0.0089	6.3260	0.1%	92.5%	0.12	74.72	
EWASH1	15	BFD	94	0.0398	6.3260	0.6%	93.1%	0.59	75.31	
EWASH1	15	Ca	92	0.0000	6.3260	0.0%	93.1%	0.00	75.31	
EWASH1	15	Co	92	0.0507	6.3260	0.8%	93.9%	0.74	76.05	
EWASH1	15	Oc	92	0.0005	6.3260	0.0%	94.0%	0.01	76.05	
EWASH1	15	Os	89	0.0182	6.3260	0.3%	94.2%	0.26	76.31	
EWASH1	15	Ot	89	0.0308	6.3260	0.5%	94.7%	0.43	76.74	
EWASH1	15	Tc	83	0.0011	6.3260	0.0%	94.7%	0.01	76.76	
EWASH1	15	TMD	84	0.0674	6.3260	1.1%	95.8%	0.90	77.65	
EWASH1	15	TnA	83	0.0021	6.3260	0.0%	95.8%	0.03	77.68	
EWASH1	16	AMC	65	0.0413	6.3260	0.7%	96.5%	0.42	78.10	
EWASH1	16	BFD	88	0.1315	6.3260	2.1%	98.6%	1.83	79.93	
EWASH1	16	Oc	85	0.0001	6.3260	0.0%	98.6%	0.00	79.93	
EWASH1	16	Os	78	0.0045	6.3260	0.1%	98.6%	0.06	79.99	
EWASH1	16	Ot	78	0.0116	6.3260	0.2%	98.8%	0.14	80.13	
EWASH1	16	TMD	68	0.0668	6.3260	1.1%	99.9%	0.72	80.85	
EWASH1	16	TnA	65	0.0070	6.3260	0.1%	100.0%	0.07	80.92	**80.925**
EWASH2	1	AMC	63	0.1452	4.8000	3.0%	3.0%	1.91	1.91	

2016 Muddy River and Tributary Washes Flood Control Master Plan Update - Composite Curve Number Breakdown

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EWASH2	1	BFD	88	2.0816	4.8000	43.4%	46.4%	38.16	40.07	
EWASH2	1	MOB	87	0.1135	4.8000	2.4%	48.8%	2.06	42.13	
EWASH2	1	TMD	66	0.0247	4.8000	0.5%	49.3%	0.34	42.47	
EWASH2	1	Ty	84	0.8750	4.8000	18.2%	67.5%	15.31	57.78	
EWASH2	3	AMC	65	0.1109	4.8000	2.3%	69.8%	1.50	59.28	
EWASH2	3	BFD	88	0.0397	4.8000	0.8%	70.6%	0.73	60.01	
EWASH2	3	Ca	85	0.0027	4.8000	0.1%	70.7%	0.05	60.06	
EWASH2	3	Cc	85	0.0002	4.8000	0.0%	70.7%	0.00	60.06	
EWASH2	3	TMD	68	0.0000	4.8000	0.0%	70.7%	0.00	60.06	
EWASH2	4	AMC	63	0.0028	4.8000	0.1%	70.8%	0.04	60.10	
EWASH2	4	Cc	84	0.0000	4.8000	0.0%	70.8%	0.00	60.10	
EWASH2	4	Cn	84	0.0033	4.8000	0.1%	70.8%	0.06	60.15	
EWASH2	4	Oc	84	0.0313	4.8000	0.7%	71.5%	0.55	60.70	
EWASH2	4	Os	76	0.0001	4.8000	0.0%	71.5%	0.00	60.70	
EWASH2	4	TMD	65	0.0708	4.8000	1.5%	73.0%	0.96	61.66	
EWASH2	5	Oc	81	0.0025	4.8000	0.1%	73.0%	0.04	61.71	
EWASH2	5	Os	72	0.0016	4.8000	0.0%	73.0%	0.02	61.73	
EWASH2	10	AMC	84	0.6535	4.8000	13.6%	86.7%	11.44	73.17	
EWASH2	10	BFD	94	0.0137	4.8000	0.3%	86.9%	0.27	73.43	
EWASH2	10	TMD	85	0.0069	4.8000	0.1%	87.1%	0.12	73.56	
EWASH2	15	AMC	84	0.0602	4.8000	1.3%	88.3%	1.05	74.61	
EWASH2	15	BFD	94	0.0017	4.8000	0.0%	88.4%	0.03	74.64	
EWASH2	15	Ca	92	0.0017	4.8000	0.0%	88.4%	0.03	74.67	
EWASH2	15	Cc	92	0.0003	4.8000	0.0%	88.4%	0.01	74.68	
EWASH2	15	Cn	92	0.0088	4.8000	0.2%	88.6%	0.17	74.85	
EWASH2	15	Oc	92	0.0025	4.8000	0.1%	88.7%	0.05	74.90	
EWASH2	15	Os	89	0.0061	4.8000	0.1%	88.8%	0.11	75.01	
EWASH2	15	TMD	84	0.0429	4.8000	0.9%	89.7%	0.75	75.76	
EWASH2	16	AMC	65	0.2187	4.8000	4.6%	94.2%	2.96	78.72	
EWASH2	16	BFD	88	0.0063	4.8000	0.1%	94.4%	0.12	78.84	
EWASH2	16	Ca	85	0.0043	4.8000	0.1%	94.4%	0.08	78.91	
EWASH2	16	Cc	85	0.0090	4.8000	0.2%	94.6%	0.16	79.07	
EWASH2	16	Cn	85	0.0445	4.8000	0.9%	95.6%	0.79	79.86	
EWASH2	16	Oc	85	0.0042	4.8000	0.1%	95.6%	0.07	79.93	
EWASH2	16	Os	78	0.0130	4.8000	0.3%	95.9%	0.21	80.14	
EWASH2	16	TMD	68	0.1959	4.8000	4.1%	100.0%	2.78	82.92	**82.919**
EWASH3	1	AMC	63	0.0544	1.7670	3.1%	3.1%	1.94	1.94	
EWASH3	1	BFD	88	0.3434	1.7670	19.4%	22.5%	17.10	19.04	
EWASH3	3	AMC	65	0.0842	1.7670	4.8%	27.3%	3.10	22.14	

2016 Muddy River and Tributrary Washes Flood Control Master Plan Update - Composite Curve Number Breakdown

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EWASH3	3	BFD	88	0.1039	1.7670	5.9%	33.2%	5.17	27.31	
EWASH3	3	Cc	85	0.0029	1.7670	0.2%	33.3%	0.14	27.45	
EWASH3	3	TMD	68	0.0000	1.7670	0.0%	33.3%	0.00	27.46	
EWASH3	3	TnA	65	0.0394	1.7670	2.2%	35.6%	1.45	28.91	
EWASH3	4	AMC	63	0.2572	1.7670	14.6%	50.1%	9.17	38.08	
EWASH3	4	BFD	87	0.0127	1.7670	0.7%	50.8%	0.62	38.70	
EWASH3	4	Cc	84	0.1093	1.7670	6.2%	57.0%	5.19	43.89	
EWASH3	4	Cn	84	0.0002	1.7670	0.0%	57.0%	0.01	43.90	
EWASH3	4	Os	76	0.0255	1.7670	1.4%	58.5%	1.10	45.00	
EWASH3	4	TMD	65	0.0913	1.7670	5.2%	63.6%	3.36	48.36	
EWASH3	4	TnA	62	0.0275	1.7670	1.6%	65.2%	0.97	49.33	
EWASH3	5	AMC	57	0.0949	1.7670	5.4%	70.6%	3.06	52.39	
EWASH3	5	BFD	85	0.0170	1.7670	1.0%	71.5%	0.82	53.21	
EWASH3	5	Cc	81	0.1081	1.7670	6.1%	77.6%	4.96	58.16	
EWASH3	5	Os	72	0.0126	1.7670	0.7%	78.4%	0.51	58.68	
EWASH3	5	TMD	59	0.0409	1.7670	2.3%	80.7%	1.37	60.04	
EWASH3	5	TnA	56	0.0122	1.7670	0.7%	81.4%	0.39	60.43	
EWASH3	12	AMC	69	0.0659	1.7670	3.7%	85.1%	2.57	63.00	
EWASH3	12	TMD	71	0.0054	1.7670	0.3%	85.4%	0.22	63.22	
EWASH3	15	AMC	84	0.0576	1.7670	3.3%	88.7%	2.74	65.96	
EWASH3	15	BFD	94	0.0194	1.7670	1.1%	89.8%	1.03	66.99	
EWASH3	15	Cc	92	0.0041	1.7670	0.2%	90.0%	0.21	67.20	
EWASH3	15	Cn	92	0.0003	1.7670	0.0%	90.0%	0.02	67.22	
EWASH3	15	Os	89	0.0010	1.7670	0.1%	90.1%	0.05	67.27	
EWASH3	15	TMD	84	0.0137	1.7670	0.8%	90.8%	0.65	67.92	
EWASH3	15	TnA	83	0.0111	1.7670	0.6%	91.5%	0.52	68.44	
EWASH3	16	AMC	65	0.1128	1.7670	6.4%	97.9%	4.15	72.59	
EWASH3	16	BFD	88	0.0156	1.7670	0.9%	98.7%	0.78	73.37	
EWASH3	16	Cc	85	0.0016	1.7670	0.1%	98.8%	0.08	73.45	
EWASH3	16	Cn	85	0.0120	1.7670	0.7%	99.5%	0.58	74.02	
EWASH3	16	TMD	68	0.0087	1.7670	0.5%	100.0%	0.34	74.36	**74.359**
EWASH4	1	AMC	63	0.0023	2.0285	0.1%	0.1%	0.07	0.07	
EWASH4	1	BFD	88	0.4915	2.0285	24.2%	24.3%	21.32	21.39	
EWASH4	2	TnA	44	0.0058	2.0285	0.3%	24.6%	0.13	21.52	
EWASH4	2	TtA	46	0.0003	2.0285	0.0%	24.6%	0.01	21.53	
EWASH4	3	AMC	65	0.0034	2.0285	0.2%	24.8%	0.11	21.64	
EWASH4	3	BFD	88	0.0173	2.0285	0.9%	25.7%	0.75	22.39	
EWASH4	4	AMC	63	0.2472	2.0285	12.2%	37.8%	7.68	30.06	
EWASH4	4	Cc	84	0.0590	2.0285	2.9%	40.8%	2.44	32.51	

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EWASH4	4	Cn	84	0.0138	2.0285	0.7%	41.4%	0.57	33.08	
EWASH4	4	TnA	62	0.1065	2.0285	5.3%	46.7%	3.26	36.33	
EWASH4	4	TnB	62	0.0190	2.0285	0.9%	47.6%	0.58	36.92	
EWASH4	4	TtA	63	0.0076	2.0285	0.4%	48.0%	0.23	37.15	
EWASH4	5	AMC	57	0.0082	2.0285	0.4%	48.4%	0.23	37.38	
EWASH4	5	Cc	81	0.2004	2.0285	9.9%	58.3%	8.00	45.38	
EWASH4	5	Cn	81	0.0088	2.0285	0.4%	58.7%	0.35	45.73	
EWASH4	5	TnA	56	0.0736	2.0285	3.6%	62.3%	2.03	47.77	
EWASH4	5	TtA	58	0.0370	2.0285	1.8%	64.2%	1.06	48.82	
EWASH4	7	AMC	82	0.2658	2.0285	13.1%	77.3%	10.75	59.57	
EWASH4	7	BFD	93	0.0334	2.0285	1.6%	78.9%	1.53	61.10	
EWASH4	7	TnA	81	0.0010	2.0285	0.0%	79.0%	0.04	61.14	
EWASH4	9	Cc	96	0.0143	2.0285	0.7%	79.7%	0.68	61.82	
EWASH4	9	TnA	92	0.0074	2.0285	0.4%	80.0%	0.34	62.15	
EWASH4	9	TtA	92	0.0000	2.0285	0.0%	80.0%	0.00	62.16	
EWASH4	10	Cc	92	0.0056	2.0285	0.3%	80.3%	0.25	62.41	
EWASH4	10	Cn	92	0.0081	2.0285	0.4%	80.7%	0.37	62.78	
EWASH4	12	AMC	69	0.0130	2.0285	0.6%	81.4%	0.44	63.22	
EWASH4	14	Cn	78	0.0006	2.0285	0.0%	81.4%	0.02	63.24	
EWASH4	15	AMC	84	0.0634	2.0285	3.1%	84.5%	2.63	65.87	
EWASH4	15	BFD	94	0.0192	2.0285	0.9%	85.5%	0.89	66.76	
EWASH4	15	Cc	92	0.0158	2.0285	0.8%	86.2%	0.72	67.48	
EWASH4	15	Cn	92	0.0041	2.0285	0.2%	86.4%	0.19	67.66	
EWASH4	15	TMD	84	0.0000	2.0285	0.0%	86.4%	0.00	67.66	
EWASH4	15	TnA	83	0.0147	2.0285	0.7%	87.2%	0.60	68.26	
EWASH4	15	TnB	83	0.0018	2.0285	0.1%	87.3%	0.07	68.34	
EWASH4	15	TtA	84	0.0024	2.0285	0.1%	87.4%	0.10	68.44	
EWASH4	16	AMC	65	0.2003	2.0285	9.9%	97.2%	6.42	74.85	
EWASH4	16	BFD	88	0.0558	2.0285	2.8%	100.0%	2.42	77.27	**77.275**
EWASH5	1	AMC	63	0.1118	0.5819	19.2%	19.2%	12.10	12.10	
EWASH5	1	TMD	66	0.0025	0.5819	0.4%	19.6%	0.29	12.39	
EWASH5	4	AMC	63	0.0988	0.5819	17.0%	36.6%	10.70	23.08	
EWASH5	4	Cc	84	0.0482	0.5819	8.3%	44.9%	6.95	30.03	
EWASH5	4	Cn	84	0.0023	0.5819	0.4%	45.3%	0.33	30.36	
EWASH5	4	Oc	84	0.1139	0.5819	19.6%	64.9%	16.45	46.81	
EWASH5	4	TMD	65	0.0191	0.5819	3.3%	68.1%	2.13	48.94	
EWASH5	4	TnA	62	0.0162	0.5819	2.8%	70.9%	1.72	50.66	
EWASH5	4	TnB	62	0.0032	0.5819	0.5%	71.5%	0.34	51.00	
EWASH5	9	AMC	92	0.0055	0.5819	0.9%	72.4%	0.87	51.87	

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EWASH5	9	Cc	96	0.0161	0.5819	2.8%	75.2%	2.66	54.53	
EWASH5	9	Oc	96	0.0049	0.5819	0.8%	76.0%	0.81	55.34	
EWASH5	9	TMD	93	0.0101	0.5819	1.7%	77.8%	1.61	56.95	
EWASH5	13	TMD	30	0.0002	0.5819	0.0%	77.8%	0.01	56.96	
EWASH5	15	AMC	84	0.0115	0.5819	2.0%	79.8%	1.66	58.62	
EWASH5	15	Cc	92	0.0083	0.5819	1.4%	81.2%	1.32	59.94	
EWASH5	15	Cn	92	0.0003	0.5819	0.0%	81.2%	0.04	59.98	
EWASH5	15	Oc	92	0.0078	0.5819	1.3%	82.6%	1.23	61.21	
EWASH5	15	TMD	84	0.0010	0.5819	0.2%	82.7%	0.14	61.35	
EWASH5	15	TnA	83	0.0010	0.5819	0.2%	82.9%	0.14	61.49	
EWASH5	15	TnB	83	0.0010	0.5819	0.2%	83.1%	0.15	61.64	
EWASH5	16	AMC	65	0.0908	0.5819	15.6%	98.7%	10.15	71.78	
EWASH5	16	TMD	68	0.0076	0.5819	1.3%	100.0%	0.88	72.67	**72.666**
EWASH6	1	Cn	85	0.0002	0.7831	0.0%	0.0%	0.02	0.02	
EWASH6	1	Oc	85	0.0023	0.7831	0.3%	0.3%	0.24	0.26	
EWASH6	1	RTF	89	0.0001	0.7831	0.0%	0.3%	0.01	0.27	
EWASH6	1	TMD	66	0.0128	0.7831	1.6%	2.0%	1.08	1.35	
EWASH6	1	TnA	63	0.0009	0.7831	0.1%	2.1%	0.07	1.42	
EWASH6	1	TtA	64	0.0058	0.7831	0.7%	2.8%	0.47	1.90	
EWASH6	1	Ty	84	0.0218	0.7831	2.8%	5.6%	2.34	4.24	
EWASH6	1	Vg	85	0.0001	0.7831	0.0%	5.6%	0.01	4.25	
EWASH6	4	Cc	84	0.1993	0.7831	25.4%	31.1%	21.38	25.62	
EWASH6	4	Cn	84	0.0441	0.7831	5.6%	36.7%	4.73	30.36	
EWASH6	4	GP	92	0.0070	0.7831	0.9%	37.6%	0.82	31.18	
EWASH6	4	Oc	84	0.1684	0.7831	21.5%	59.1%	18.06	49.24	
EWASH6	4	RTF	90	0.0385	0.7831	4.9%	64.0%	4.43	53.67	
EWASH6	4	TMD	65	0.0066	0.7831	0.8%	64.8%	0.55	54.22	
EWASH6	4	TnA	62	0.0655	0.7831	8.4%	73.2%	5.18	59.40	
EWASH6	4	TtA	63	0.0639	0.7831	8.2%	81.4%	5.14	64.54	
EWASH6	4	Ty	84	0.0180	0.7831	2.3%	83.7%	1.93	66.47	
EWASH6	4	Vg	84	0.0793	0.7831	10.1%	93.8%	8.51	74.98	
EWASH6	9	Cc	96	0.0039	0.7831	0.5%	94.3%	0.47	75.45	
EWASH6	9	Oc	96	0.0078	0.7831	1.0%	95.3%	0.95	76.41	
EWASH6	9	TMD	93	0.0003	0.7831	0.0%	95.3%	0.03	76.44	
EWASH6	13	TMD	30	0.0004	0.7831	0.1%	95.4%	0.02	76.45	
EWASH6	13	Ty	30	0.0002	0.7831	0.0%	95.4%	0.01	76.46	
EWASH6	15	Cc	92	0.0067	0.7831	0.9%	96.3%	0.79	77.25	
EWASH6	15	Oc	92	0.0033	0.7831	0.4%	96.7%	0.39	77.65	
EWASH6	15	RTF	95	0.0046	0.7831	0.6%	97.3%	0.56	78.21	

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EWASH6	15	TnA	83	0.0097	0.7831	1.2%	98.5%	1.03	79.24	
EWASH6	15	TtA	84	0.0042	0.7831	0.5%	99.1%	0.45	79.69	
EWASH6	15	Ty	92	0.0010	0.7831	0.1%	99.2%	0.12	79.81	
EWASH6	15	Vg	92	0.0039	0.7831	0.5%	99.7%	0.46	80.27	
EWASH6	16	TnA	65	0.0025	0.7831	0.3%	100.0%	0.21	80.48	**80.475**
EWASH7	1	ASC	63	0.5202	6.3882	8.1%	8.1%	5.13	5.13	
EWASH7	1	Cn	85	0.0000	6.3882	0.0%	8.1%	0.00	5.13	
EWASH7	1	MOB	87	0.2020	6.3882	3.2%	11.3%	2.75	7.88	
EWASH7	1	RTF	89	0.4240	6.3882	6.6%	17.9%	5.91	13.79	
EWASH7	1	TMD	66	1.7789	6.3882	27.8%	45.8%	18.38	32.17	
EWASH7	1	TnA	63	0.1925	6.3882	3.0%	48.8%	1.90	34.06	
EWASH7	1	TtA	64	0.1142	6.3882	1.8%	50.6%	1.14	35.21	
EWASH7	1	Ty	84	2.9398	6.3882	46.0%	96.6%	38.66	73.87	
EWASH7	4	RTF	90	0.0612	6.3882	1.0%	97.6%	0.86	74.73	
EWASH7	4	TnA	62	0.0007	6.3882	0.0%	97.6%	0.01	74.73	
EWASH7	9	TnA	92	0.0050	6.3882	0.1%	97.7%	0.07	74.81	
EWASH7	9	Ty	96	0.0019	6.3882	0.0%	97.7%	0.03	74.83	
EWASH7	11	TMD	91	0.0031	6.3882	0.0%	97.7%	0.04	74.88	
EWASH7	13	Ty	30	0.0019	6.3882	0.0%	97.8%	0.01	74.89	
EWASH7	15	RTF	95	0.0102	6.3882	0.2%	97.9%	0.15	75.04	
EWASH7	15	TMD	84	0.0212	6.3882	0.3%	98.3%	0.28	75.32	
EWASH7	15	TnA	83	0.0104	6.3882	0.2%	98.4%	0.14	75.45	
EWASH7	15	Ty	92	0.0001	6.3882	0.0%	98.4%	0.00	75.45	
EWASH7	16	RTF	90	0.0185	6.3882	0.3%	98.7%	0.26	75.71	
EWASH7	16	TMD	68	0.0033	6.3882	0.1%	98.8%	0.04	75.75	
EWASH7	16	TnA	65	0.0657	6.3882	1.0%	99.8%	0.67	76.42	
EWASH7	16	TtA	66	0.0000	6.3882	0.0%	99.8%	0.00	76.42	
EWASH7	16	Ty	85	0.0135	6.3882	0.2%	100.0%	0.18	76.60	**76.598**
EWASH8	1	Cc	85	0.0575	3.4727	1.7%	1.7%	1.41	1.41	
EWASH8	1	Cn	85	0.0898	3.4727	2.6%	4.2%	2.20	3.60	
EWASH8	1	RTF	89	2.0044	3.4727	57.7%	62.0%	51.37	54.97	
EWASH8	1	TMD	66	1.1977	3.4727	34.5%	96.4%	22.76	77.74	
EWASH8	1	Ty	84	0.0113	3.4727	0.3%	96.8%	0.27	78.01	
EWASH8	14	AVB	49	0.0001	3.4727	0.0%	96.8%	0.00	78.01	
EWASH8	14	Cc	78	0.0540	3.4727	1.6%	98.3%	1.21	79.22	
EWASH8	14	RTF	88	0.0494	3.4727	1.4%	99.8%	1.25	80.48	
EWASH8	14	TtA	50	0.0002	3.4727	0.0%	99.8%	0.00	80.48	
EWASH8	15	RTF	95	0.0039	3.4727	0.1%	99.9%	0.11	80.58	
EWASH8	15	TMD	84	0.0046	3.4727	0.1%	100.0%	0.11	80.69	**80.694**

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EWDB	1	BFD	88	0.7956	1.8880	42.1%	42.1%	37.08	37.08	
EWDB	1	MOB	87	0.3116	1.8880	16.5%	58.6%	14.36	51.44	
EWDB	1	Ty	84	0.7721	1.8880	40.9%	99.5%	34.35	85.79	
EWDB	3	BFD	88	0.0081	1.8880	0.4%	100.0%	0.38	86.17	
EWDB	15	BFD	94	0.0005	1.8880	0.0%	100.0%	0.03	86.20	**86.201**
FGDB	1	AMC	63	0.2266	1.9217	11.8%	11.8%	7.43	7.43	
FGDB	1	BFD	88	0.9482	1.9217	49.3%	61.1%	43.42	50.85	
FGDB	1	MOB	87	0.0821	1.9217	4.3%	65.4%	3.72	54.57	
FGDB	1	Ty	84	0.6648	1.9217	34.6%	100.0%	29.06	83.63	**83.626**
FGDB1	1	AMC	63	0.0384	0.3929	9.8%	9.8%	6.16	6.16	
FGDB1	1	BFD	88	0.1638	0.3929	41.7%	51.5%	36.69	42.85	
FGDB1	4	AMC	63	0.0272	0.3929	6.9%	58.4%	4.36	47.21	
FGDB1	4	BFD	87	0.0000	0.3929	0.0%	58.4%	0.01	47.21	
FGDB1	5	AMC	57	0.0076	0.3929	1.9%	60.3%	1.11	48.32	
FGDB1	5	BFD	85	0.0067	0.3929	1.7%	62.0%	1.44	49.76	
FGDB1	9	AMC	92	0.0003	0.3929	0.1%	62.1%	0.06	49.82	
FGDB1	15	AMC	84	0.0153	0.3929	3.9%	66.0%	3.26	53.08	
FGDB1	15	BFD	94	0.0044	0.3929	1.1%	67.1%	1.05	54.13	
FGDB1	16	AMC	65	0.1069	0.3929	27.2%	94.3%	17.69	71.82	
FGDB1	16	BFD	88	0.0224	0.3929	5.7%	100.0%	5.01	76.83	**76.828**
FGDB2	1	AMC	63	0.0404	0.4600	8.8%	8.8%	5.53	5.53	
FGDB2	1	BFD	88	0.1414	0.4600	30.7%	39.5%	27.06	32.59	
FGDB2	3	AMC	65	0.0441	0.4600	9.6%	49.1%	6.24	38.83	
FGDB2	4	AMC	63	0.1083	0.4600	23.6%	72.7%	14.84	53.66	
FGDB2	4	BFD	87	0.0027	0.4600	0.6%	73.2%	0.50	54.16	
FGDB2	7	AMC	82	0.0064	0.4600	1.4%	74.6%	1.15	55.31	
FGDB2	7	BFD	93	0.0000	0.4600	0.0%	74.6%	0.00	55.31	
FGDB2	12	AMC	69	0.0108	0.4600	2.4%	77.0%	1.62	56.93	
FGDB2	15	AMC	84	0.0297	0.4600	6.5%	83.5%	5.42	62.36	
FGDB2	15	BFD	94	0.0002	0.4600	0.1%	83.5%	0.05	62.40	
FGDB2	16	AMC	65	0.0745	0.4600	16.2%	99.7%	10.53	72.93	
FGDB2	16	BFD	88	0.0014	0.4600	0.3%	100.0%	0.26	73.19	**73.194**
LOG1	1	BD	90	0.0006	0.4112	0.1%	0.1%	0.13	0.13	
LOG1	4	BD	92	0.0001	0.4112	0.0%	0.2%	0.01	0.14	
LOG1	4	Cc	84	0.0103	0.4112	2.5%	2.7%	2.10	2.24	
LOG1	4	Cm	84	0.0282	0.4112	6.9%	9.5%	5.76	8.01	
LOG1	4	Cn	84	0.0006	0.4112	0.1%	9.7%	0.11	8.12	
LOG1	4	TtA	63	0.0023	0.4112	0.6%	10.2%	0.35	8.47	
LOG1	5	Cc	81	0.0711	0.4112	17.3%	27.5%	14.01	22.48	

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2016 MPU BASINID	LAND USE INDEX NUMBER	SOIL MAP UNIT SYMBOL	SUBREGION CN	SUBREGION AREA (SQ MI)	SUBBASIN AREA (SQ MI)	PERCENT OF SUBBASIN	CUMULATIVE PERCENT	AREAL WEIGHTED CN	CUMULATIVE CN	COMPOSITE CN
LOG1	5	Cm	81	0.0004	0.4112	0.1%	27.6%	0.08	22.56	
LOG1	6	Cc	89	0.0038	0.4112	0.9%	28.5%	0.83	23.39	
LOG1	6	Cm	89	0.0126	0.4112	3.1%	31.6%	2.72	26.12	
LOG1	6	TtA	76	0.0163	0.4112	4.0%	35.6%	3.02	29.14	
LOG1	7	Cc	91	0.0097	0.4112	2.4%	37.9%	2.15	31.29	
LOG1	9	Cc	96	0.0121	0.4112	2.9%	40.9%	2.83	34.11	
LOG1	9	Cm	96	0.0001	0.4112	0.0%	40.9%	0.01	34.13	
LOG1	9	Cn	96	0.0015	0.4112	0.4%	41.3%	0.35	34.47	
LOG1	10	Cn	92	0.0005	0.4112	0.1%	41.4%	0.11	34.59	
LOG1	12	Cc	86	0.0130	0.4112	3.2%	44.5%	2.72	37.30	
LOG1	12	Cm	86	0.0028	0.4112	0.7%	45.2%	0.58	37.89	
LOG1	14	BD	90	0.0031	0.4112	0.8%	46.0%	0.68	38.57	
LOG1	14	Cc	78	0.1367	0.4112	33.3%	79.2%	25.94	64.50	
LOG1	14	Cm	78	0.0389	0.4112	9.5%	88.7%	7.38	71.88	
LOG1	14	Cn	78	0.0126	0.4112	3.1%	91.7%	2.38	74.26	
LOG1	14	Oc	78	0.0020	0.4112	0.5%	92.2%	0.38	74.64	
LOG1	15	BD	96	0.0011	0.4112	0.3%	92.5%	0.26	74.90	
LOG1	15	Cc	92	0.0072	0.4112	1.7%	94.2%	1.60	76.50	
LOG1	15	Cm	92	0.0086	0.4112	2.1%	96.3%	1.92	78.43	
LOG1	15	Cn	92	0.0044	0.4112	1.1%	97.4%	0.99	79.42	
LOG1	15	Oc	92	0.0008	0.4112	0.2%	97.6%	0.17	79.59	
LOG1	15	TnB	83	0.0022	0.4112	0.5%	98.1%	0.44	80.03	
LOG1	15	TtA	84	0.0077	0.4112	1.9%	100.0%	1.58	81.61	**81.610**
LOG2	1	Cd	85	0.0004	1.6208	0.0%	0.0%	0.02	0.02	
LOG2	3	Cc	85	0.0320	1.6208	2.0%	2.0%	1.68	1.70	
LOG2	3	Cd	85	0.0383	1.6208	2.4%	4.4%	2.01	3.70	
LOG2	3	Cm	85	0.0252	1.6208	1.6%	5.9%	1.32	5.02	
LOG2	3	Oc	85	0.0431	1.6208	2.7%	8.6%	2.26	7.29	
LOG2	3	Oe	85	0.0038	1.6208	0.2%	8.8%	0.20	7.48	
LOG2	3	Vn	85	0.0047	1.6208	0.3%	9.1%	0.25	7.73	
LOG2	4	Ca	84	0.0729	1.6208	4.5%	13.6%	3.78	11.51	
LOG2	4	Cc	84	0.3092	1.6208	19.1%	32.7%	16.02	27.53	
LOG2	4	Cd	84	0.2697	1.6208	16.6%	49.3%	13.98	41.51	
LOG2	4	Cm	84	0.0475	1.6208	2.9%	52.2%	2.46	43.97	
LOG2	4	Oc	84	0.0011	1.6208	0.1%	52.3%	0.06	44.03	
LOG2	4	TtA	63	0.0250	1.6208	1.5%	53.8%	0.97	45.00	
LOG2	4	Vn	84	0.0132	1.6208	0.8%	54.7%	0.68	45.68	
LOG2	6	Ca	89	0.0000	1.6208	0.0%	54.7%	0.00	45.68	
LOG2	6	Cm	89	0.0284	1.6208	1.8%	56.4%	1.56	47.24	

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LOG2	6	TnB	76	0.0016	1.6208	0.1%	56.5%	0.08	47.32	
LOG2	6	TtA	76	0.0346	1.6208	2.1%	58.6%	1.62	48.94	
LOG2	7	Ca	91	0.0086	1.6208	0.5%	59.2%	0.48	49.42	
LOG2	7	Cc	91	0.0072	1.6208	0.4%	59.6%	0.40	49.82	
LOG2	9	Cc	96	0.0041	1.6208	0.3%	59.9%	0.25	50.07	
LOG2	9	Cm	96	0.0006	1.6208	0.0%	59.9%	0.04	50.11	
LOG2	12	Ca	86	0.0052	1.6208	0.3%	60.2%	0.28	50.38	
LOG2	12	Cc	86	0.0161	1.6208	1.0%	61.2%	0.86	51.24	
LOG2	12	Cm	86	0.0026	1.6208	0.2%	61.4%	0.14	51.38	
LOG2	12	Oc	86	0.0284	1.6208	1.8%	63.1%	1.51	52.88	
LOG2	12	Oe	86	0.0481	1.6208	3.0%	66.1%	2.55	55.44	
LOG2	12	On	86	0.0029	1.6208	0.2%	66.3%	0.16	55.59	
LOG2	15	Ca	92	0.0156	1.6208	1.0%	67.3%	0.89	56.48	
LOG2	15	Cc	92	0.0332	1.6208	2.0%	69.3%	1.88	58.36	
LOG2	15	Cd	92	0.0279	1.6208	1.7%	71.0%	1.59	59.95	
LOG2	15	Cm	92	0.0117	1.6208	0.7%	71.7%	0.66	60.61	
LOG2	15	Oc	92	0.0253	1.6208	1.6%	73.3%	1.44	62.05	
LOG2	15	Oe	92	0.0058	1.6208	0.4%	73.7%	0.33	62.38	
LOG2	15	On	92	0.0038	1.6208	0.2%	73.9%	0.22	62.59	
LOG2	15	TnB	83	0.0008	1.6208	0.0%	74.0%	0.04	62.64	
LOG2	15	TtA	84	0.0056	1.6208	0.3%	74.3%	0.29	62.93	
LOG2	15	Vn	92	0.0035	1.6208	0.2%	74.5%	0.20	63.13	
LOG2	16	Ca	85	0.0382	1.6208	2.4%	76.9%	2.01	65.13	
LOG2	16	Cc	85	0.0565	1.6208	3.5%	80.4%	2.96	68.10	
LOG2	16	Cd	85	0.0177	1.6208	1.1%	81.5%	0.93	69.02	
LOG2	16	Cm	85	0.0228	1.6208	1.4%	82.9%	1.19	70.22	
LOG2	16	Cn	85	0.0001	1.6208	0.0%	82.9%	0.01	70.22	
LOG2	16	Oc	85	0.2153	1.6208	13.3%	96.2%	11.29	81.52	
LOG2	16	Oe	85	0.0460	1.6208	2.8%	99.0%	2.41	83.93	
LOG2	16	On	85	0.0158	1.6208	1.0%	100.0%	0.83	84.76	
LOG2	16	TMD	68	0.0005	1.6208	0.0%	100.0%	0.02	84.78	**84.783**
LOG3	3	Cc	85	0.0022	0.5057	0.4%	0.4%	0.37	0.37	
LOG3	3	Cd	85	0.0000	0.5057	0.0%	0.4%	0.00	0.37	
LOG3	3	Cm	85	0.0026	0.5057	0.5%	1.0%	0.44	0.81	
LOG3	4	Cc	84	0.1921	0.5057	38.0%	38.9%	31.91	32.72	
LOG3	4	Cm	84	0.0652	0.5057	12.9%	51.8%	10.83	43.55	
LOG3	4	Oc	84	0.0047	0.5057	0.9%	52.8%	0.78	44.32	
LOG3	5	Cc	81	0.0444	0.5057	8.8%	61.5%	7.11	51.44	
LOG3	5	Cm	81	0.0002	0.5057	0.0%	61.6%	0.03	51.47	

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LOG3	15	Cc	92	0.0226	0.5057	4.5%	66.0%	4.11	55.58	
LOG3	15	Cd	92	0.0001	0.5057	0.0%	66.1%	0.02	55.60	
LOG3	15	Cm	92	0.0095	0.5057	1.9%	67.9%	1.72	57.32	
LOG3	15	Cn	92	0.0000	0.5057	0.0%	67.9%	0.00	57.32	
LOG3	15	Oc	92	0.0015	0.5057	0.3%	68.2%	0.27	57.59	
LOG3	16	Cc	85	0.1081	0.5057	21.4%	89.6%	18.16	75.76	
LOG3	16	Cm	85	0.0495	0.5057	9.8%	99.4%	8.33	84.08	
LOG3	16	Cn	85	0.0004	0.5057	0.1%	99.5%	0.06	84.15	
LOG3	16	Oc	85	0.0027	0.5057	0.5%	100.0%	0.45	84.60	**84.595**
LWASH1	1	RME	81	2.9571	4.0270	73.4%	73.4%	59.48	59.48	
LWASH1	1	RTF	89	0.3421	4.0270	8.5%	81.9%	7.56	67.04	
LWASH1	1	TnB	63	0.7279	4.0270	18.1%	100.0%	11.39	78.43	
LWASH1	1	RME	81	0.0000	4.0270	0.0%	100.0%	0.00	78.43	**78.426**
LWASH2	1	BD	90	0.0034	0.6994	0.5%	0.5%	0.44	0.44	
LWASH2	1	RME	81	0.5490	0.6994	78.5%	79.0%	63.58	64.02	
LWASH2	1	RTF	89	0.1470	0.6994	21.0%	100.0%	18.70	82.73	**82.725**
LWASH3	1	BD	90	0.1684	1.1721	14.4%	14.4%	12.93	12.93	
LWASH3	1	RTF	89	0.9506	1.1721	81.1%	95.5%	72.18	85.11	
LWASH3	1	TnB	63	0.0001	1.1721	0.0%	95.5%	0.00	85.11	
LWASH3	4	BD	92	0.0351	1.1721	3.0%	98.5%	2.75	87.86	
LWASH3	4	Cm	84	0.0000	1.1721	0.0%	98.5%	0.00	87.86	
LWASH3	4	TnB	62	0.0115	1.1721	1.0%	99.4%	0.61	88.47	
LWASH3	4	TtA	63	0.0000	1.1721	0.0%	99.4%	0.00	88.47	
LWASH3	15	BD	96	0.0011	1.1721	0.1%	99.5%	0.09	88.56	
LWASH3	15	Cm	92	0.0006	1.1721	0.0%	99.6%	0.04	88.61	
LWASH3	15	TnB	83	0.0041	1.1721	0.4%	99.9%	0.29	88.90	
LWASH3	15	TtA	84	0.0007	1.1721	0.1%	100.0%	0.05	88.95	**88.951**
MAGW1	1	250	83	0.0361	5.5236	0.7%	0.7%	0.54	0.54	
MAGW1	1	272	68	0.2510	5.5236	4.5%	5.2%	3.09	3.63	
MAGW1	1	290	77	1.1693	5.5236	21.2%	26.4%	16.30	19.93	
MAGW1	1	298	83	0.0218	5.5236	0.4%	26.8%	0.33	20.26	
MAGW1	1	965	70	0.0141	5.5236	0.3%	27.0%	0.18	20.44	
MAGW1	1	MAE	68	0.4536	5.5236	8.2%	35.2%	5.58	26.02	
MAGW1	1	RBG	77	3.5229	5.5236	63.8%	99.0%	49.11	75.13	
MAGW1	1	RHF	83	0.0550	5.5236	1.0%	100.0%	0.83	75.96	**75.957**
MAGW2	1	298	83	0.0398	4.8097	0.8%	0.8%	0.69	0.69	
MAGW2	1	605	75	0.2866	4.8097	6.0%	6.8%	4.47	5.16	
MAGW2	1	965	70	0.1152	4.8097	2.4%	9.2%	1.68	6.83	
MAGW2	1	AVB	63	0.5386	4.8097	11.2%	20.4%	7.05	13.89	

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MAGW2	1	BD	90	2.1047	4.8097	43.8%	64.1%	39.38	53.27	
MAGW2	1	Bw	63	0.0354	4.8097	0.7%	64.9%	0.46	53.73	
MAGW2	1	HUF	75	0.4026	4.8097	8.4%	73.2%	6.28	60.01	
MAGW2	1	MOB	87	0.1307	4.8097	2.7%	76.0%	2.36	62.38	
MAGW2	1	RHF	83	0.1312	4.8097	2.7%	78.7%	2.26	64.64	
MAGW2	1	Tb	63	0.0015	4.8097	0.0%	78.7%	0.02	64.66	
MAGW2	2	Bw	44	0.0015	4.8097	0.0%	78.8%	0.01	64.67	
MAGW2	2	Tb	44	0.0106	4.8097	0.2%	79.0%	0.10	64.77	
MAGW2	3	AVB	65	0.0063	4.8097	0.1%	79.1%	0.08	64.86	
MAGW2	3	BD	92	0.0187	4.8097	0.4%	79.5%	0.36	65.21	
MAGW2	3	Bw	65	0.0060	4.8097	0.1%	79.6%	0.08	65.30	
MAGW2	3	Tb	65	0.0449	4.8097	0.9%	80.6%	0.61	65.90	
MAGW2	3	Tc	65	0.0009	4.8097	0.0%	80.6%	0.01	65.91	
MAGW2	5	BD	92	0.0159	4.8097	0.3%	80.9%	0.30	66.22	
MAGW2	5	Tb	56	0.0011	4.8097	0.0%	80.9%	0.01	66.23	
MAGW2	5	Tc	56	0.0006	4.8097	0.0%	80.9%	0.01	66.24	
MAGW2	5	Vn	81	0.0039	4.8097	0.1%	81.0%	0.06	66.30	
MAGW2	7	BD	96	0.0010	4.8097	0.0%	81.0%	0.02	66.32	
MAGW2	7	Vn	91	0.0007	4.8097	0.0%	81.1%	0.01	66.34	
MAGW2	9	Bw	92	0.0238	4.8097	0.5%	81.5%	0.45	66.79	
MAGW2	9	Tb	92	0.0275	4.8097	0.6%	82.1%	0.53	67.32	
MAGW2	9	Tc	92	0.0000	4.8097	0.0%	82.1%	0.00	67.32	
MAGW2	9	Td	96	0.0005	4.8097	0.0%	82.1%	0.01	67.33	
MAGW2	10	AVB	84	0.2729	4.8097	5.7%	87.8%	4.77	72.09	
MAGW2	10	BD	96	0.0781	4.8097	1.6%	89.4%	1.56	73.65	
MAGW2	10	Bw	84	0.0395	4.8097	0.8%	90.2%	0.69	74.34	
MAGW2	10	HUF	89	0.0045	4.8097	0.1%	90.3%	0.08	74.42	
MAGW2	10	Tb	84	0.0312	4.8097	0.6%	91.0%	0.54	74.97	
MAGW2	10	Tc	84	0.0062	4.8097	0.1%	91.1%	0.11	75.08	
MAGW2	14	Bw	49	0.0156	4.8097	0.3%	91.4%	0.16	75.24	
MAGW2	14	Cd	78	0.1884	4.8097	3.9%	95.4%	3.05	78.29	
MAGW2	14	Co	78	0.0682	4.8097	1.4%	96.8%	1.11	79.40	
MAGW2	14	Or	78	0.0008	4.8097	0.0%	96.8%	0.01	79.41	
MAGW2	14	Tb	49	0.0120	4.8097	0.2%	97.0%	0.12	79.53	
MAGW2	14	Tc	49	0.0066	4.8097	0.1%	97.2%	0.07	79.60	
MAGW2	14	Td	78	0.1068	4.8097	2.2%	99.4%	1.73	81.33	
MAGW2	15	BD	96	0.0000	4.8097	0.0%	99.4%	0.00	81.33	
MAGW2	15	Bw	83	0.0040	4.8097	0.1%	99.5%	0.07	81.40	
MAGW2	15	Tb	83	0.0171	4.8097	0.4%	99.8%	0.29	81.70	

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MAGW2	15	Tc	83	0.0000	4.8097	0.0%	99.8%	0.00	81.70	
MAGW2	15	Vn	92	0.0008	4.8097	0.0%	99.9%	0.01	81.71	
MAGW2	16	Tb	65	0.0068	4.8097	0.1%	100.0%	0.09	81.80	
MAGW2	16	Td	85	0.0002	4.8097	0.0%	100.0%	0.00	81.81	**81.806**
MDW	1	Ad	90	0.2577	19.4372	1.3%	1.3%	1.19	1.19	
MDW	1	Ae	63	0.0023	19.4372	0.0%	1.3%	0.01	1.20	
MDW	1	AVB	63	0.0153	19.4372	0.1%	1.4%	0.05	1.25	
MDW	1	BD	90	8.6496	19.4372	44.5%	45.9%	40.05	41.30	
MDW	1	BHC	87	1.8748	19.4372	9.6%	55.6%	8.39	49.69	
MDW	1	Cd	85	0.0719	19.4372	0.4%	55.9%	0.31	50.01	
MDW	1	Cn	85	0.0219	19.4372	0.1%	56.0%	0.10	50.10	
MDW	1	Gd	77	0.1942	19.4372	1.0%	57.0%	0.77	50.87	
MDW	1	Ge	77	0.0018	19.4372	0.0%	57.1%	0.01	50.88	
MDW	1	Gf	77	0.7013	19.4372	3.6%	60.7%	2.78	53.66	
MDW	1	Gm	77	0.0021	19.4372	0.0%	60.7%	0.01	53.67	
MDW	1	Gs	85	0.1499	19.4372	0.8%	61.4%	0.66	54.32	
MDW	1	La	85	0.1286	19.4372	0.7%	62.1%	0.56	54.88	
MDW	1	Lc	85	0.0710	19.4372	0.4%	62.5%	0.31	55.19	
MDW	1	MMB	88	0.0767	19.4372	0.4%	62.9%	0.35	55.54	
MDW	1	MOB	87	0.2018	19.4372	1.0%	63.9%	0.90	56.44	
MDW	1	THB	65	2.0503	19.4372	10.5%	74.5%	6.86	63.30	
MDW	1	TMD	66	1.3856	19.4372	7.1%	81.6%	4.70	68.01	
MDW	1	TnA	63	0.4630	19.4372	2.4%	84.0%	1.50	69.51	
MDW	1	TnB	63	0.1496	19.4372	0.8%	84.7%	0.48	69.99	
MDW	1	Vn	85	0.0777	19.4372	0.4%	85.1%	0.34	70.33	
MDW	4	Ad	92	0.0000	19.4372	0.0%	85.1%	0.00	70.33	
MDW	4	Ae	62	0.0066	19.4372	0.0%	85.2%	0.02	70.35	
MDW	4	AVB	62	0.0068	19.4372	0.0%	85.2%	0.02	70.37	
MDW	4	BD	92	0.2357	19.4372	1.2%	86.4%	1.12	71.49	
MDW	4	Cn	84	0.0103	19.4372	0.1%	86.5%	0.04	71.53	
MDW	4	Gd	76	0.0009	19.4372	0.0%	86.5%	0.00	71.54	
MDW	4	Gf	76	0.1238	19.4372	0.6%	87.1%	0.48	72.02	
MDW	4	Lc	84	0.0066	19.4372	0.0%	87.1%	0.03	72.05	
MDW	4	TnA	62	0.0002	19.4372	0.0%	87.1%	0.00	72.05	
MDW	5	Ad	92	0.0007	19.4372	0.0%	87.1%	0.00	72.05	
MDW	5	BD	92	0.0002	19.4372	0.0%	87.1%	0.00	72.05	
MDW	5	Gd	72	0.0158	19.4372	0.1%	87.2%	0.06	72.11	
MDW	5	Gf	72	0.1253	19.4372	0.6%	87.9%	0.46	72.58	
MDW	5	Gs	81	0.0069	19.4372	0.0%	87.9%	0.03	72.61	

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MDW	5	Lc	81	0.0186	19.4372	0.1%	88.0%	0.08	72.68	
MDW	5	TnA	56	0.0021	19.4372	0.0%	88.0%	0.01	72.69	
MDW	6	Ad	95	0.0000	19.4372	0.0%	88.0%	0.00	72.69	
MDW	6	BD	95	0.0154	19.4372	0.1%	88.1%	0.08	72.76	
MDW	6	Gd	84	0.0344	19.4372	0.2%	88.3%	0.15	72.91	
MDW	6	Gf	84	0.0848	19.4372	0.4%	88.7%	0.37	73.28	
MDW	6	Gs	89	0.1063	19.4372	0.5%	89.3%	0.49	73.77	
MDW	6	Lc	89	0.1738	19.4372	0.9%	90.1%	0.80	74.56	
MDW	6	TnA	76	0.0371	19.4372	0.2%	90.3%	0.14	74.71	
MDW	6	TnB	76	0.0251	19.4372	0.1%	90.5%	0.10	74.80	
MDW	7	Ad	96	0.0185	19.4372	0.1%	90.6%	0.09	74.90	
MDW	7	BD	96	0.1749	19.4372	0.9%	91.5%	0.86	75.76	
MDW	7	Gd	88	0.0302	19.4372	0.2%	91.6%	0.14	75.90	
MDW	7	Gf	88	0.0269	19.4372	0.1%	91.8%	0.12	76.02	
MDW	7	Gs	91	0.0389	19.4372	0.2%	92.0%	0.18	76.20	
MDW	7	Lc	91	0.0000	19.4372	0.0%	92.0%	0.00	76.20	
MDW	7	TnA	81	0.1364	19.4372	0.7%	92.7%	0.57	76.77	
MDW	8	Ad	97	0.0009	19.4372	0.0%	92.7%	0.00	76.77	
MDW	8	Gd	92	0.0196	19.4372	0.1%	92.8%	0.09	76.87	
MDW	8	Gf	92	0.0217	19.4372	0.1%	92.9%	0.10	76.97	
MDW	8	Lc	94	0.0183	19.4372	0.1%	93.0%	0.09	77.06	
MDW	8	TnB	89	0.0129	19.4372	0.1%	93.0%	0.06	77.12	
MDW	9	Ad	97	0.0167	19.4372	0.1%	93.1%	0.08	77.20	
MDW	9	Ae	92	0.0306	19.4372	0.2%	93.3%	0.15	77.34	
MDW	9	BD	97	0.0506	19.4372	0.3%	93.5%	0.25	77.60	
MDW	9	Ca	96	0.0393	19.4372	0.2%	93.7%	0.19	77.79	
MDW	9	Cd	96	0.0122	19.4372	0.1%	93.8%	0.06	77.85	
MDW	9	Gd	94	0.0275	19.4372	0.1%	93.9%	0.13	77.98	
MDW	9	Ge	94	0.0910	19.4372	0.5%	94.4%	0.44	78.42	
MDW	9	Gf	94	0.0415	19.4372	0.2%	94.6%	0.20	78.63	
MDW	9	Gm	94	0.0381	19.4372	0.2%	94.8%	0.18	78.81	
MDW	9	Lc	96	0.0169	19.4372	0.1%	94.9%	0.08	78.89	
MDW	9	TnA	92	0.0208	19.4372	0.1%	95.0%	0.10	78.99	
MDW	10	BD	96	0.0126	19.4372	0.1%	95.1%	0.06	79.05	
MDW	10	BHC	93	0.0005	19.4372	0.0%	95.1%	0.00	79.06	
MDW	10	Gf	89	0.0002	19.4372	0.0%	95.1%	0.00	79.06	
MDW	10	Lc	92	0.0029	19.4372	0.0%	95.1%	0.01	79.07	
MDW	12	BD	94	0.0041	19.4372	0.0%	95.1%	0.02	79.09	
MDW	14	Ad	90	0.0319	19.4372	0.2%	95.3%	0.15	79.24	

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MDW	14	Cn	78	0.0147	19.4372	0.1%	95.4%	0.06	79.30	
MDW	14	Gf	67	0.0755	19.4372	0.4%	95.7%	0.26	79.56	
MDW	14	TnA	49	0.0005	19.4372	0.0%	95.8%	0.00	79.56	
MDW	15	Ad	96	0.0027	19.4372	0.0%	95.8%	0.01	79.57	
MDW	15	Cn	92	0.0019	19.4372	0.0%	95.8%	0.01	79.58	
MDW	15	Gf	89	0.0004	19.4372	0.0%	95.8%	0.00	79.58	
MDW	16	Ad	91	0.0372	19.4372	0.2%	96.0%	0.17	79.76	
MDW	16	Ae	65	0.0630	19.4372	0.3%	96.3%	0.21	79.97	
MDW	16	AVB	65	0.0157	19.4372	0.1%	96.4%	0.05	80.02	
MDW	16	BD	91	0.2430	19.4372	1.3%	97.6%	1.14	81.16	
MDW	16	BHC	87	0.0110	19.4372	0.1%	97.7%	0.05	81.21	
MDW	16	Cd	85	0.0716	19.4372	0.4%	98.0%	0.31	81.52	
MDW	16	Cn	85	0.0226	19.4372	0.1%	98.2%	0.10	81.62	
MDW	16	Gd	78	0.0015	19.4372	0.0%	98.2%	0.01	81.62	
MDW	16	Gf	78	0.2667	19.4372	1.4%	99.5%	1.07	82.69	
MDW	16	Gs	85	0.0005	19.4372	0.0%	99.5%	0.00	82.70	
MDW	16	Lc	85	0.0228	19.4372	0.1%	99.7%	0.10	82.80	
MDW	16	TnA	65	0.0652	19.4372	0.3%	100.0%	0.22	83.01	
MDW	1	MOB	87	0.0000	19.4372	0.0%	100.0%	0.00	83.01	**83.015**
MRIV1	1	Ah	63	0.0003	22.9104	0.0%	0.0%	0.00	0.00	
MRIV1	1	BD	90	7.1959	22.9104	31.4%	31.4%	28.27	28.27	
MRIV1	1	BHC	87	1.8249	22.9104	8.0%	39.4%	6.93	35.20	
MRIV1	1	Gd	77	0.0004	22.9104	0.0%	39.4%	0.00	35.20	
MRIV1	1	Ge	77	0.0085	22.9104	0.0%	39.4%	0.03	35.23	
MRIV1	1	Gf	77	1.0529	22.9104	4.6%	44.0%	3.54	38.77	
MRIV1	1	Gm	77	0.1278	22.9104	0.6%	44.6%	0.43	39.20	
MRIV1	1	Gn	77	0.0105	22.9104	0.0%	44.6%	0.04	39.23	
MRIV1	1	Gs	85	0.0032	22.9104	0.0%	44.6%	0.01	39.24	
MRIV1	1	Oc	85	0.0013	22.9104	0.0%	44.6%	0.00	39.25	
MRIV1	1	RTF	89	3.6180	22.9104	15.8%	60.4%	14.05	53.30	
MRIV1	1	THB	65	1.2482	22.9104	5.4%	65.9%	3.54	56.84	
MRIV1	1	TMD	66	3.9981	22.9104	17.5%	83.3%	11.52	68.36	
MRIV1	1	Vg	85	0.0051	22.9104	0.0%	83.3%	0.02	68.38	
MRIV1	1	Vn	85	0.0040	22.9104	0.0%	83.4%	0.01	68.40	
MRIV1	2	Ah	45	0.0072	22.9104	0.0%	83.4%	0.01	68.41	
MRIV1	2	Os	64	0.0000	22.9104	0.0%	83.4%	0.00	68.41	
MRIV1	3	Ah	65	0.0174	22.9104	0.1%	83.5%	0.05	68.46	
MRIV1	3	BD	92	0.0117	22.9104	0.1%	83.5%	0.05	68.51	
MRIV1	3	Gf	78	0.0357	22.9104	0.2%	83.7%	0.12	68.63	

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MRIV1	3	Gn	78	0.0117	22.9104	0.1%	83.7%	0.04	68.67	
MRIV1	3	Gs	85	0.0070	22.9104	0.0%	83.8%	0.03	68.69	
MRIV1	3	Or	85	0.0106	22.9104	0.0%	83.8%	0.04	68.73	
MRIV1	3	Os	78	0.0181	22.9104	0.1%	83.9%	0.06	68.79	
MRIV1	3	TMD	68	0.1222	22.9104	0.5%	84.4%	0.36	69.16	
MRIV1	3	Vn	85	0.1035	22.9104	0.5%	84.9%	0.38	69.54	
MRIV1	4	Vn	84	0.0216	22.9104	0.1%	85.0%	0.08	69.62	
MRIV1	7	Ah	82	0.1291	22.9104	0.6%	85.5%	0.46	70.08	
MRIV1	7	BD	96	0.1427	22.9104	0.6%	86.2%	0.60	70.68	
MRIV1	7	BHC	92	0.0382	22.9104	0.2%	86.3%	0.15	70.83	
MRIV1	7	Gd	88	0.0001	22.9104	0.0%	86.3%	0.00	70.83	
MRIV1	7	Ge	88	0.1329	22.9104	0.6%	86.9%	0.51	71.35	
MRIV1	7	Gf	88	0.2201	22.9104	1.0%	87.9%	0.85	72.19	
MRIV1	7	Gm	88	0.0366	22.9104	0.2%	88.0%	0.14	72.33	
MRIV1	7	Gn	88	0.0262	22.9104	0.1%	88.1%	0.10	72.43	
MRIV1	7	Gs	91	0.0405	22.9104	0.2%	88.3%	0.16	72.59	
MRIV1	7	Oc	91	0.2540	22.9104	1.1%	89.4%	1.01	73.60	
MRIV1	7	Or	91	0.0040	22.9104	0.0%	89.4%	0.02	73.62	
MRIV1	7	Os	88	0.1005	22.9104	0.4%	89.9%	0.39	74.00	
MRIV1	7	TMD	83	0.0737	22.9104	0.3%	90.2%	0.27	74.27	
MRIV1	7	Vg	91	0.1694	22.9104	0.7%	90.9%	0.67	74.94	
MRIV1	7	Vn	91	0.2021	22.9104	0.9%	91.8%	0.80	75.75	
MRIV1	9	Ah	92	0.0148	22.9104	0.1%	91.9%	0.06	75.81	
MRIV1	9	Vg	96	0.0170	22.9104	0.1%	92.0%	0.07	75.88	
MRIV1	9	Vn	96	0.0018	22.9104	0.0%	92.0%	0.01	75.88	
MRIV1	10	Ah	84	0.0015	22.9104	0.0%	92.0%	0.01	75.89	
MRIV1	14	Ah	49	0.0058	22.9104	0.0%	92.0%	0.01	75.90	
MRIV1	14	Vg	78	0.0090	22.9104	0.0%	92.0%	0.03	75.93	
MRIV1	14	Vn	78	0.0010	22.9104	0.0%	92.0%	0.00	75.94	
MRIV1	15	BD	96	0.0014	22.9104	0.0%	92.0%	0.01	75.94	
MRIV1	16	BD	91	1.1814	22.9104	5.2%	97.2%	4.69	80.63	
MRIV1	16	BHC	87	0.0558	22.9104	0.2%	97.4%	0.21	80.85	
MRIV1	16	Gf	78	0.2570	22.9104	1.1%	98.6%	0.88	81.72	
MRIV1	16	Gm	78	0.0344	22.9104	0.2%	98.7%	0.12	81.84	
MRIV1	16	Gn	78	0.1431	22.9104	0.6%	99.3%	0.49	82.33	
MRIV1	16	Gs	85	0.0168	22.9104	0.1%	99.4%	0.06	82.39	
MRIV1	16	TMD	68	0.0970	22.9104	0.4%	99.8%	0.29	82.68	
MRIV1	16	Vn	85	0.0368	22.9104	0.2%	100.0%	0.14	82.81	**82.812**
MRIV2	1	Ah	63	0.0131	18.3698	0.1%	0.1%	0.05	0.05	

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MRIV2	1	AVB	63	1.0634	18.3698	5.8%	5.9%	3.65	3.69	
MRIV2	1	BD	90	1.1051	18.3698	6.0%	11.9%	5.41	9.11	
MRIV2	1	BHC	87	1.6641	18.3698	9.1%	20.9%	7.88	16.99	
MRIV2	1	BNB	88	0.3492	18.3698	1.9%	22.8%	1.67	18.66	
MRIV2	1	Gd	77	0.0003	18.3698	0.0%	22.8%	0.00	18.66	
MRIV2	1	Gm	77	0.1246	18.3698	0.7%	23.5%	0.52	19.18	
MRIV2	1	Gn	77	0.0003	18.3698	0.0%	23.5%	0.00	19.18	
MRIV2	1	Gs	85	0.1044	18.3698	0.6%	24.1%	0.48	19.67	
MRIV2	1	RTF	89	10.8235	18.3698	58.9%	83.0%	52.44	72.11	
MRIV2	1	THB	65	0.2092	18.3698	1.1%	84.1%	0.74	72.85	
MRIV2	1	TMD	66	1.1044	18.3698	6.0%	90.2%	3.97	76.81	
MRIV2	1	TnB	63	0.0998	18.3698	0.5%	90.7%	0.34	77.16	
MRIV2	1	Vg	85	0.0017	18.3698	0.0%	90.7%	0.01	77.16	
MRIV2	2	Ah	45	0.0257	18.3698	0.1%	90.8%	0.06	77.23	
MRIV2	2	BD	90	0.0422	18.3698	0.2%	91.1%	0.21	77.43	
MRIV2	2	Ge	64	0.0004	18.3698	0.0%	91.1%	0.00	77.44	
MRIV2	2	Or	76	0.0185	18.3698	0.1%	91.2%	0.08	77.51	
MRIV2	2	Ot	64	0.0091	18.3698	0.0%	91.2%	0.03	77.54	
MRIV2	2	TMD	48	0.0095	18.3698	0.1%	91.3%	0.02	77.57	
MRIV2	3	Ah	65	0.0159	18.3698	0.1%	91.4%	0.06	77.62	
MRIV2	3	Gd	78	0.0133	18.3698	0.1%	91.4%	0.06	77.68	
MRIV2	3	Ge	78	0.0011	18.3698	0.0%	91.4%	0.00	77.69	
MRIV2	3	TMD	68	0.0111	18.3698	0.1%	91.5%	0.04	77.73	
MRIV2	4	BD	92	0.0000	18.3698	0.0%	91.5%	0.00	77.73	
MRIV2	4	Gd	76	0.0001	18.3698	0.0%	91.5%	0.00	77.73	
MRIV2	4	Ge	76	0.0481	18.3698	0.3%	91.8%	0.20	77.93	
MRIV2	4	TMD	65	0.0768	18.3698	0.4%	92.2%	0.27	78.20	
MRIV2	7	Ah	82	0.1131	18.3698	0.6%	92.8%	0.50	78.70	
MRIV2	7	AVB	81	0.0284	18.3698	0.2%	93.0%	0.13	78.83	
MRIV2	7	BD	96	0.1292	18.3698	0.7%	93.7%	0.68	79.50	
MRIV2	7	BHC	92	0.0319	18.3698	0.2%	93.8%	0.16	79.66	
MRIV2	7	Gd	88	0.1184	18.3698	0.6%	94.5%	0.57	80.23	
MRIV2	7	Ge	88	0.2576	18.3698	1.4%	95.9%	1.23	81.47	
MRIV2	7	Gf	88	0.0058	18.3698	0.0%	95.9%	0.03	81.49	
MRIV2	7	Gm	88	0.0001	18.3698	0.0%	95.9%	0.00	81.49	
MRIV2	7	Gs	91	0.0001	18.3698	0.0%	95.9%	0.00	81.49	
MRIV2	7	Oc	91	0.0349	18.3698	0.2%	96.1%	0.17	81.67	
MRIV2	7	Or	91	0.0372	18.3698	0.2%	96.3%	0.18	81.85	
MRIV2	7	Ot	88	0.0013	18.3698	0.0%	96.3%	0.01	81.86	

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MRIV2	7	RTF	95	0.0927	18.3698	0.5%	96.8%	0.48	82.34	
MRIV2	7	TMD	83	0.3838	18.3698	2.1%	98.9%	1.73	84.07	
MRIV2	7	Vg	91	0.1129	18.3698	0.6%	99.5%	0.56	84.63	
MRIV2	9	Ah	92	0.0015	18.3698	0.0%	99.5%	0.01	84.64	
MRIV2	10	Ah	84	0.0004	18.3698	0.0%	99.5%	0.00	84.64	
MRIV2	12	TMD	71	0.0003	18.3698	0.0%	99.5%	0.00	84.64	
MRIV2	16	Ah	65	0.0031	18.3698	0.0%	99.6%	0.01	84.65	
MRIV2	16	AVB	65	0.0106	18.3698	0.1%	99.6%	0.04	84.69	
MRIV2	16	BD	91	0.0002	18.3698	0.0%	99.6%	0.00	84.69	
MRIV2	16	BHC	87	0.0383	18.3698	0.2%	99.8%	0.18	84.87	
MRIV2	16	Ge	78	0.0009	18.3698	0.0%	99.8%	0.00	84.88	
MRIV2	16	Gm	78	0.0000	18.3698	0.0%	99.8%	0.00	84.88	
MRIV2	16	Gn	78	0.0010	18.3698	0.0%	99.8%	0.00	84.88	
MRIV2	16	Gs	85	0.0004	18.3698	0.0%	99.8%	0.00	84.88	
MRIV2	16	Or	85	0.0044	18.3698	0.0%	99.9%	0.02	84.90	
MRIV2	16	TMD	68	0.0264	18.3698	0.1%	100.0%	0.10	85.00	**85.000**
MRIV3	1	Ae	63	0.0388	21.9924	0.2%	0.2%	0.11	0.11	
MRIV3	1	BD	90	6.5699	21.9924	29.9%	30.0%	26.89	27.00	
MRIV3	1	BHC	87	3.8111	21.9924	17.3%	47.4%	15.08	42.07	
MRIV3	1	BNB	88	0.0000	21.9924	0.0%	47.4%	0.00	42.07	
MRIV3	1	Gm	77	0.0560	21.9924	0.3%	47.6%	0.20	42.27	
MRIV3	1	Gn	77	0.0018	21.9924	0.0%	47.6%	0.01	42.28	
MRIV3	1	Gs	85	1.0705	21.9924	4.9%	52.5%	4.14	46.41	
MRIV3	1	Oe	85	0.0036	21.9924	0.0%	52.5%	0.01	46.43	
MRIV3	1	On	85	0.0063	21.9924	0.0%	52.6%	0.02	46.45	
MRIV3	1	Os	77	0.0318	21.9924	0.1%	52.7%	0.11	46.56	
MRIV3	1	Ot	77	0.0356	21.9924	0.2%	52.9%	0.12	46.69	
MRIV3	1	RTF	89	2.7000	21.9924	12.3%	65.1%	10.93	57.61	
MRIV3	1	THB	65	3.8632	21.9924	17.6%	82.7%	11.42	69.03	
MRIV3	1	TMD	66	0.9088	21.9924	4.1%	86.8%	2.73	71.76	
MRIV3	1	TnA	63	0.5922	21.9924	2.7%	89.5%	1.70	73.46	
MRIV3	1	TnB	63	0.1059	21.9924	0.5%	90.0%	0.30	73.76	
MRIV3	1	Vg	85	0.1220	21.9924	0.6%	90.6%	0.47	74.23	
MRIV3	1	Vn	85	0.0807	21.9924	0.4%	90.9%	0.31	74.54	
MRIV3	10	BD	96	0.3030	21.9924	1.4%	92.3%	1.32	75.87	
MRIV3	10	BHC	93	0.5261	21.9924	2.4%	94.7%	2.22	78.09	
MRIV3	10	Gs	92	0.0860	21.9924	0.4%	95.1%	0.36	78.45	
MRIV3	10	Oe	92	0.0128	21.9924	0.1%	95.2%	0.05	78.50	
MRIV3	10	On	92	0.0495	21.9924	0.2%	95.4%	0.21	78.71	

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MRIV3	10	Vg	92	0.0286	21.9924	0.1%	95.5%	0.12	78.83	
MRIV3	10	Vn	92	0.1912	21.9924	0.9%	96.4%	0.80	79.63	
MRIV3	14	Ad	90	0.0163	21.9924	0.1%	96.4%	0.07	79.70	
MRIV3	14	Ae	49	0.0538	21.9924	0.2%	96.7%	0.12	79.82	
MRIV3	14	BD	90	0.0998	21.9924	0.5%	97.1%	0.41	80.22	
MRIV3	14	BHC	82	0.0059	21.9924	0.0%	97.2%	0.02	80.25	
MRIV3	14	Gm	67	0.1183	21.9924	0.5%	97.7%	0.36	80.61	
MRIV3	14	Oe	78	0.1602	21.9924	0.7%	98.4%	0.57	81.17	
MRIV3	14	On	78	0.0003	21.9924	0.0%	98.4%	0.00	81.18	
MRIV3	14	TnA	49	0.0110	21.9924	0.1%	98.5%	0.02	81.20	
MRIV3	14	Vg	78	0.1026	21.9924	0.5%	99.0%	0.36	81.56	
MRIV3	14	Vn	78	0.0245	21.9924	0.1%	99.1%	0.09	81.65	
MRIV3	16	Ae	65	0.0075	21.9924	0.0%	99.1%	0.02	81.67	
MRIV3	16	BD	91	0.0611	21.9924	0.3%	99.4%	0.25	81.93	
MRIV3	16	BHC	87	0.0080	21.9924	0.0%	99.4%	0.03	81.96	
MRIV3	16	Gn	78	0.0045	21.9924	0.0%	99.4%	0.02	81.97	
MRIV3	16	Oe	85	0.0281	21.9924	0.1%	99.6%	0.11	82.08	
MRIV3	16	On	85	0.0541	21.9924	0.2%	99.8%	0.21	82.29	
MRIV3	16	Ot	78	0.0004	21.9924	0.0%	99.8%	0.00	82.29	
MRIV3	16	Vg	85	0.0402	21.9924	0.2%	100.0%	0.16	82.45	
MRIV3	16	Vn	85	0.0008	21.9924	0.0%	100.0%	0.00	82.45	**82.450**
MRIV4	1	Ad	90	0.0000	10.4539	0.0%	0.0%	0.00	0.00	
MRIV4	1	BD	90	3.1786	10.4539	30.4%	30.4%	27.37	27.37	
MRIV4	1	BHC	87	3.2297	10.4539	30.9%	61.3%	26.88	54.24	
MRIV4	1	Gf	77	0.1049	10.4539	1.0%	62.3%	0.77	55.02	
MRIV4	1	Gm	77	0.0035	10.4539	0.0%	62.3%	0.03	55.04	
MRIV4	1	Gn	77	0.0233	10.4539	0.2%	62.6%	0.17	55.21	
MRIV4	1	Lc	85	0.0037	10.4539	0.0%	62.6%	0.03	55.24	
MRIV4	1	Oe	85	0.0023	10.4539	0.0%	62.6%	0.02	55.26	
MRIV4	1	Os	77	0.0012	10.4539	0.0%	62.6%	0.01	55.27	
MRIV4	1	Ot	77	0.0003	10.4539	0.0%	62.6%	0.00	55.27	
MRIV4	1	TMD	66	0.0818	10.4539	0.8%	63.4%	0.52	55.79	
MRIV4	1	TnA	63	0.0147	10.4539	0.1%	63.6%	0.09	55.88	
MRIV4	1	TnB	63	0.0043	10.4539	0.0%	63.6%	0.03	55.90	
MRIV4	1	Vg	85	0.0020	10.4539	0.0%	63.6%	0.02	55.92	
MRIV4	3	Ad	92	0.0025	10.4539	0.0%	63.6%	0.02	55.94	
MRIV4	3	BD	92	0.0442	10.4539	0.4%	64.1%	0.39	56.33	
MRIV4	3	TMD	68	0.0630	10.4539	0.6%	64.7%	0.41	56.74	
MRIV4	3	TnA	65	0.0022	10.4539	0.0%	64.7%	0.01	56.75	

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MRIV4	4	BD	92	0.0361	10.4539	0.3%	65.0%	0.32	57.07	
MRIV4	4	Gf	76	0.0426	10.4539	0.4%	65.4%	0.31	57.38	
MRIV4	4	Gn	76	0.0057	10.4539	0.1%	65.5%	0.04	57.42	
MRIV4	4	Lc	84	0.0015	10.4539	0.0%	65.5%	0.01	57.44	
MRIV4	4	TnB	62	0.0351	10.4539	0.3%	65.8%	0.21	57.64	
MRIV4	7	Ad	96	0.0001	10.4539	0.0%	65.8%	0.00	57.65	
MRIV4	7	BD	96	0.0043	10.4539	0.0%	65.9%	0.04	57.68	
MRIV4	7	Gf	88	0.0014	10.4539	0.0%	65.9%	0.01	57.70	
MRIV4	7	Lc	91	0.0020	10.4539	0.0%	65.9%	0.02	57.71	
MRIV4	7	TnA	81	0.0009	10.4539	0.0%	65.9%	0.01	57.72	
MRIV4	9	Ad	97	0.0004	10.4539	0.0%	65.9%	0.00	57.72	
MRIV4	9	BD	97	0.0305	10.4539	0.3%	66.2%	0.28	58.01	
MRIV4	9	Gf	94	0.0152	10.4539	0.1%	66.4%	0.14	58.14	
MRIV4	9	Lc	96	0.0188	10.4539	0.2%	66.5%	0.17	58.32	
MRIV4	9	TnA	92	0.0065	10.4539	0.1%	66.6%	0.06	58.37	
MRIV4	10	BD	96	0.9117	10.4539	8.7%	75.3%	8.37	66.75	
MRIV4	10	BHC	93	0.3483	10.4539	3.3%	78.7%	3.10	69.85	
MRIV4	10	Oe	92	0.0634	10.4539	0.6%	79.3%	0.56	70.40	
MRIV4	10	On	92	0.1968	10.4539	1.9%	81.2%	1.73	72.14	
MRIV4	10	Or	92	0.0564	10.4539	0.5%	81.7%	0.50	72.63	
MRIV4	10	TMD	85	0.0775	10.4539	0.7%	82.4%	0.63	73.26	
MRIV4	10	Vg	92	0.0137	10.4539	0.1%	82.6%	0.12	73.38	
MRIV4	10	Vn	92	0.0012	10.4539	0.0%	82.6%	0.01	73.39	
MRIV4	14	Ad	90	0.0437	10.4539	0.4%	83.0%	0.38	73.77	
MRIV4	14	BD	90	0.0032	10.4539	0.0%	83.0%	0.03	73.80	
MRIV4	14	BHC	82	0.0672	10.4539	0.6%	83.7%	0.53	74.32	
MRIV4	14	Gm	67	0.0271	10.4539	0.3%	83.9%	0.17	74.50	
MRIV4	14	Oe	78	0.0005	10.4539	0.0%	83.9%	0.00	74.50	
MRIV4	14	On	78	0.0003	10.4539	0.0%	83.9%	0.00	74.50	
MRIV4	14	TMD	52	0.0731	10.4539	0.7%	84.6%	0.36	74.87	
MRIV4	14	TnA	49	0.0288	10.4539	0.3%	84.9%	0.14	75.00	
MRIV4	14	Vg	78	0.0228	10.4539	0.2%	85.1%	0.17	75.17	
MRIV4	14	Vn	78	0.0000	10.4539	0.0%	85.1%	0.00	75.17	
MRIV4	15	BD	96	0.0042	10.4539	0.0%	85.2%	0.04	75.21	
MRIV4	15	BHC	93	0.0020	10.4539	0.0%	85.2%	0.02	75.23	
MRIV4	15	Gf	89	0.0041	10.4539	0.0%	85.2%	0.03	75.26	
MRIV4	16	Ad	91	0.0113	10.4539	0.1%	85.3%	0.10	75.36	
MRIV4	16	BD	91	0.4824	10.4539	4.6%	89.9%	4.20	79.56	
MRIV4	16	BHC	87	0.0203	10.4539	0.2%	90.1%	0.17	79.73	

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MRIV4	16	Gf	78	0.1511	10.4539	1.4%	91.6%	1.13	80.86	
MRIV4	16	Gn	78	0.2470	10.4539	2.4%	94.0%	1.84	82.70	
MRIV4	16	Lc	85	0.0351	10.4539	0.3%	94.3%	0.29	82.99	
MRIV4	16	Oe	85	0.3266	10.4539	3.1%	97.4%	2.66	85.64	
MRIV4	16	On	85	0.0036	10.4539	0.0%	97.4%	0.03	85.67	
MRIV4	16	Os	78	0.0043	10.4539	0.0%	97.5%	0.03	85.70	
MRIV4	16	Ot	78	0.0019	10.4539	0.0%	97.5%	0.01	85.72	
MRIV4	16	TMD	68	0.0188	10.4539	0.2%	97.7%	0.12	85.84	
MRIV4	16	TnA	65	0.0039	10.4539	0.0%	97.7%	0.02	85.86	
MRIV4	16	TnB	65	0.0171	10.4539	0.2%	97.9%	0.11	85.97	
MRIV4	16	Vg	85	0.2211	10.4539	2.1%	100.0%	1.80	87.77	**87.768**
MRIV5	1	Ad	90	0.0043	3.2564	0.1%	0.1%	0.12	0.12	
MRIV5	1	BD	90	0.7539	3.2564	23.2%	23.3%	20.84	20.96	
MRIV5	1	BHC	87	0.3658	3.2564	11.2%	34.5%	9.77	30.73	
MRIV5	1	Lc	85	0.0000	3.2564	0.0%	34.5%	0.00	30.73	
MRIV5	1	RTF	89	1.0725	3.2564	32.9%	67.5%	29.31	60.04	
MRIV5	1	THB	65	0.3379	3.2564	10.4%	77.8%	6.75	66.79	
MRIV5	1	Vn	85	0.0212	3.2564	0.7%	78.5%	0.55	67.34	
MRIV5	3	BD	92	0.0836	3.2564	2.6%	81.0%	2.36	69.70	
MRIV5	3	BHC	87	0.0728	3.2564	2.2%	83.3%	1.95	71.65	
MRIV5	3	TnA	65	0.0227	3.2564	0.7%	84.0%	0.45	72.10	
MRIV5	3	Vn	85	0.0080	3.2564	0.2%	84.2%	0.21	72.31	
MRIV5	4	BD	92	0.0337	3.2564	1.0%	85.3%	0.95	73.26	
MRIV5	4	BHC	86	0.0558	3.2564	1.7%	87.0%	1.47	74.73	
MRIV5	7	Ad	96	0.0024	3.2564	0.1%	87.0%	0.07	74.80	
MRIV5	7	Lc	91	0.0002	3.2564	0.0%	87.1%	0.00	74.81	
MRIV5	7	Vn	91	0.0035	3.2564	0.1%	87.2%	0.10	74.90	
MRIV5	9	Ad	97	0.0028	3.2564	0.1%	87.2%	0.08	74.99	
MRIV5	9	Lc	96	0.0007	3.2564	0.0%	87.3%	0.02	75.01	
MRIV5	9	RTF	97	0.0130	3.2564	0.4%	87.7%	0.39	75.40	
MRIV5	9	Vn	96	0.0008	3.2564	0.0%	87.7%	0.02	75.42	
MRIV5	10	Ad	96	0.0057	3.2564	0.2%	87.9%	0.17	75.59	
MRIV5	10	Vn	92	0.0030	3.2564	0.1%	88.0%	0.08	75.67	
MRIV5	14	Ad	90	0.0267	3.2564	0.8%	88.8%	0.74	76.41	
MRIV5	14	BD	90	0.0185	3.2564	0.6%	89.3%	0.51	76.92	
MRIV5	14	BHC	82	0.0001	3.2564	0.0%	89.3%	0.00	76.92	
MRIV5	14	TnA	49	0.0008	3.2564	0.0%	89.4%	0.01	76.93	
MRIV5	14	Vn	78	0.0694	3.2564	2.1%	91.5%	1.66	78.60	
MRIV5	16	Ad	91	0.0201	3.2564	0.6%	92.1%	0.56	79.16	

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MRIV5	16	BD	91	0.1409	3.2564	4.3%	96.4%	3.94	83.09	
MRIV5	16	BHC	87	0.0027	3.2564	0.1%	96.5%	0.07	83.17	
MRIV5	16	Lc	85	0.0000	3.2564	0.0%	96.5%	0.00	83.17	
MRIV5	16	RTF	90	0.0669	3.2564	2.1%	98.6%	1.85	85.02	
MRIV5	16	Vn	85	0.0462	3.2564	1.4%	100.0%	1.21	86.22	**86.221**
MRIV6	1	Ad	90	0.0020	2.1742	0.1%	0.1%	0.08	0.08	
MRIV6	1	Ae	63	0.0019	2.1742	0.1%	0.2%	0.05	0.14	
MRIV6	1	BD	90	1.3741	2.1742	63.2%	63.4%	56.88	57.02	
MRIV6	1	Cc	85	0.0026	2.1742	0.1%	63.5%	0.10	57.12	
MRIV6	1	Gf	77	0.0470	2.1742	2.2%	65.7%	1.67	58.78	
MRIV6	1	MOB	87	0.0244	2.1742	1.1%	66.8%	0.98	59.76	
MRIV6	1	TnA	63	0.0623	2.1742	2.9%	69.6%	1.81	61.57	
MRIV6	9	Ad	97	0.0099	2.1742	0.5%	70.1%	0.44	62.01	
MRIV6	9	Ae	92	0.0107	2.1742	0.5%	70.6%	0.45	62.46	
MRIV6	9	BD	97	0.1080	2.1742	5.0%	75.6%	4.82	67.28	
MRIV6	9	Ge	94	0.0001	2.1742	0.0%	75.6%	0.00	67.28	
MRIV6	9	Gf	94	0.1508	2.1742	6.9%	82.5%	6.52	73.80	
MRIV6	9	TnA	92	0.0391	2.1742	1.8%	84.3%	1.66	75.45	
MRIV6	14	Ad	90	0.0085	2.1742	0.4%	84.7%	0.35	75.81	
MRIV6	14	Ae	49	0.0872	2.1742	4.0%	88.7%	1.96	77.77	
MRIV6	14	BD	90	0.0750	2.1742	3.4%	92.1%	3.10	80.87	
MRIV6	14	Cc	78	0.1114	2.1742	5.1%	97.3%	4.00	84.87	
MRIV6	14	Gf	67	0.0085	2.1742	0.4%	97.7%	0.26	85.14	
MRIV6	14	RTF	88	0.0003	2.1742	0.0%	97.7%	0.01	85.15	
MRIV6	14	TnA	49	0.0120	2.1742	0.6%	98.2%	0.27	85.42	
MRIV6	14	TtA	50	0.0372	2.1742	1.7%	99.9%	0.86	86.28	
MRIV6	16	Ad	91	0.0008	2.1742	0.0%	100.0%	0.03	86.31	
MRIV6	16	Ae	65	0.0003	2.1742	0.0%	100.0%	0.01	86.32	
MRIV6	16	Gf	78	0.0000	2.1742	0.0%	100.0%	0.00	86.32	
MRIV6	1	MOB	87	0.0000	2.1742	0.0%	100.0%	0.00	86.32	**86.321**
MRIV7	1	Ad	90	0.0025	12.4057	0.0%	0.0%	0.02	0.02	
MRIV7	1	AVB	63	0.2770	12.4057	2.2%	2.3%	1.41	1.43	
MRIV7	1	AYD	85	2.0537	12.4057	16.6%	18.8%	14.07	15.50	
MRIV7	1	BD	90	0.9727	12.4057	7.8%	26.6%	7.06	22.55	
MRIV7	1	Ge	77	0.0028	12.4057	0.0%	26.7%	0.02	22.57	
MRIV7	1	RME	81	0.3388	12.4057	2.7%	29.4%	2.21	24.78	
MRIV7	1	RTF	89	7.7603	12.4057	62.6%	92.0%	55.67	80.46	
MRIV7	1	TtA	64	0.0000	12.4057	0.0%	92.0%	0.00	80.46	
MRIV7	4	RTF	90	0.0323	12.4057	0.3%	92.2%	0.23	80.69	

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MRIV7	9	Ad	97	0.0094	12.4057	0.1%	92.3%	0.07	80.76	
MRIV7	9	BD	97	0.0178	12.4057	0.1%	92.4%	0.14	80.90	
MRIV7	9	RTF	97	0.0119	12.4057	0.1%	92.5%	0.09	81.00	
MRIV7	14	Ad	90	0.0045	12.4057	0.0%	92.6%	0.03	81.03	
MRIV7	14	Ae	49	0.0221	12.4057	0.2%	92.7%	0.09	81.12	
MRIV7	14	AVB	49	0.0282	12.4057	0.2%	93.0%	0.11	81.23	
MRIV7	14	BD	90	0.0410	12.4057	0.3%	93.3%	0.30	81.52	
MRIV7	14	Cc	78	0.1294	12.4057	1.0%	94.3%	0.81	82.34	
MRIV7	14	Ge	67	0.0130	12.4057	0.1%	94.5%	0.07	82.41	
MRIV7	14	RTF	88	0.2727	12.4057	2.2%	96.7%	1.93	84.34	
MRIV7	14	TtA	50	0.0052	12.4057	0.0%	96.7%	0.02	84.36	
MRIV7	16	Ad	91	0.0017	12.4057	0.0%	96.7%	0.01	84.38	
MRIV7	16	Ae	65	0.0249	12.4057	0.2%	96.9%	0.13	84.51	
MRIV7	16	BD	91	0.1223	12.4057	1.0%	97.9%	0.90	85.40	
MRIV7	16	RTF	90	0.2615	12.4057	2.1%	100.0%	1.90	87.30	**87.301**
OVR1	3	AVB	65	0.0024	1.8789	0.1%	0.1%	0.08	0.08	
OVR1	3	BD	92	0.0001	1.8789	0.0%	0.1%	0.00	0.09	
OVR1	3	Ca	85	0.0272	1.8789	1.4%	1.6%	1.23	1.32	
OVR1	3	Cc	85	0.0011	1.8789	0.1%	1.6%	0.05	1.36	
OVR1	3	Oc	85	0.0096	1.8789	0.5%	2.1%	0.43	1.80	
OVR1	3	Oe	85	0.0255	1.8789	1.4%	3.5%	1.15	2.95	
OVR1	3	On	85	0.0002	1.8789	0.0%	3.5%	0.01	2.96	
OVR1	3	Os	78	0.0008	1.8789	0.0%	3.6%	0.03	2.99	
OVR1	3	Tb	65	0.0001	1.8789	0.0%	3.6%	0.00	2.99	
OVR1	3	Td	85	0.0420	1.8789	2.2%	5.8%	1.90	4.89	
OVR1	3	TnB	65	0.0152	1.8789	0.8%	6.6%	0.53	5.42	
OVR1	3	TtA	66	0.0012	1.8789	0.1%	6.7%	0.04	5.46	
OVR1	3	Vn	85	0.0250	1.8789	1.3%	8.0%	1.13	6.59	
OVR1	4	Oe	84	0.0121	1.8789	0.6%	8.6%	0.54	7.13	
OVR1	4	On	84	0.0268	1.8789	1.4%	10.1%	1.20	8.33	
OVR1	4	Os	76	0.0013	1.8789	0.1%	10.1%	0.05	8.38	
OVR1	4	Td	84	0.0117	1.8789	0.6%	10.8%	0.53	8.91	
OVR1	4	Vn	84	0.0133	1.8789	0.7%	11.5%	0.59	9.50	
OVR1	5	Ad	92	0.0093	1.8789	0.5%	12.0%	0.46	9.96	
OVR1	5	Ca	81	0.0794	1.8789	4.2%	16.2%	3.42	13.38	
OVR1	5	Cc	81	0.0000	1.8789	0.0%	16.2%	0.00	13.38	
OVR1	5	Os	72	0.1910	1.8789	10.2%	26.4%	7.32	20.70	
OVR1	5	Td	81	0.0008	1.8789	0.0%	26.4%	0.03	20.74	
OVR1	5	Vn	81	0.0208	1.8789	1.1%	27.5%	0.90	21.63	

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OVR1	6	Ad	95	0.0489	1.8789	2.6%	30.1%	2.47	24.11	
OVR1	6	AVB	76	0.0032	1.8789	0.2%	30.3%	0.13	24.24	
OVR1	6	BD	95	0.0014	1.8789	0.1%	30.3%	0.07	24.30	
OVR1	6	Ca	89	0.0155	1.8789	0.8%	31.2%	0.73	25.04	
OVR1	6	Cc	89	0.0299	1.8789	1.6%	32.8%	1.42	26.45	
OVR1	6	Os	84	0.1808	1.8789	9.6%	42.4%	8.08	34.54	
OVR1	6	Tb	76	0.1008	1.8789	5.4%	47.8%	4.08	38.61	
OVR1	6	Td	89	0.0613	1.8789	3.3%	51.0%	2.90	41.52	
OVR1	6	Vg	89	0.0163	1.8789	0.9%	51.9%	0.77	42.29	
OVR1	6	Vn	89	0.0623	1.8789	3.3%	55.2%	2.95	45.24	
OVR1	7	Ad	96	0.0037	1.8789	0.2%	55.4%	0.19	45.43	
OVR1	7	Vn	91	0.0086	1.8789	0.5%	55.9%	0.41	45.85	
OVR1	8	Ad	97	0.0359	1.8789	1.9%	57.8%	1.85	47.70	
OVR1	8	Cc	94	0.0133	1.8789	0.7%	58.5%	0.66	48.36	
OVR1	8	Os	92	0.0013	1.8789	0.1%	58.5%	0.07	48.43	
OVR1	8	Tb	89	0.0092	1.8789	0.5%	59.0%	0.44	48.87	
OVR1	8	Td	94	0.0004	1.8789	0.0%	59.1%	0.02	48.89	
OVR1	8	Vn	94	0.0442	1.8789	2.4%	61.4%	2.21	51.10	
OVR1	9	Ad	97	0.0087	1.8789	0.5%	61.9%	0.45	51.55	
OVR1	9	Cc	96	0.0011	1.8789	0.1%	61.9%	0.05	51.60	
OVR1	9	On	96	0.0058	1.8789	0.3%	62.2%	0.30	51.90	
OVR1	9	Os	94	0.0006	1.8789	0.0%	62.3%	0.03	51.92	
OVR1	9	Tb	92	0.0167	1.8789	0.9%	63.1%	0.82	52.74	
OVR1	9	Td	96	0.0038	1.8789	0.2%	63.4%	0.19	52.93	
OVR1	9	Vg	96	0.0010	1.8789	0.1%	63.4%	0.05	52.98	
OVR1	9	Vn	96	0.0690	1.8789	3.7%	67.1%	3.53	56.51	
OVR1	10	AVB	84	0.0005	1.8789	0.0%	67.1%	0.02	56.53	
OVR1	10	Tb	84	0.0018	1.8789	0.1%	67.2%	0.08	56.61	
OVR1	10	Td	92	0.0277	1.8789	1.5%	68.7%	1.36	57.97	
OVR1	10	Vg	92	0.0001	1.8789	0.0%	68.7%	0.01	57.97	
OVR1	10	Vn	92	0.0112	1.8789	0.6%	69.3%	0.55	58.52	
OVR1	12	AVB	69	0.0000	1.8789	0.0%	69.3%	0.00	58.52	
OVR1	12	Oe	86	0.0149	1.8789	0.8%	70.1%	0.68	59.20	
OVR1	12	On	86	0.0235	1.8789	1.3%	71.3%	1.08	60.28	
OVR1	12	Os	80	0.0019	1.8789	0.1%	71.4%	0.08	60.36	
OVR1	12	Tb	69	0.0400	1.8789	2.1%	73.5%	1.47	61.83	
OVR1	12	Td	86	0.0029	1.8789	0.2%	73.7%	0.13	61.96	
OVR1	12	Vn	86	0.0046	1.8789	0.2%	73.9%	0.21	62.17	
OVR1	15	Ad	96	0.0128	1.8789	0.7%	74.6%	0.66	62.83	

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OVR1	15	AVB	83	0.0102	1.8789	0.5%	75.2%	0.45	63.27	
OVR1	15	BD	96	0.0044	1.8789	0.2%	75.4%	0.22	63.50	
OVR1	15	Ca	92	0.0213	1.8789	1.1%	76.5%	1.04	64.54	
OVR1	15	Cc	92	0.0065	1.8789	0.3%	76.9%	0.32	64.86	
OVR1	15	Oc	92	0.0074	1.8789	0.4%	77.3%	0.36	65.22	
OVR1	15	Oe	92	0.0216	1.8789	1.2%	78.4%	1.06	66.28	
OVR1	15	On	92	0.0174	1.8789	0.9%	79.3%	0.85	67.13	
OVR1	15	Os	89	0.0645	1.8789	3.4%	82.8%	3.05	70.18	
OVR1	15	Tb	83	0.0483	1.8789	2.6%	85.3%	2.13	72.31	
OVR1	15	Td	92	0.0189	1.8789	1.0%	86.3%	0.93	73.24	
OVR1	15	TnB	83	0.0071	1.8789	0.4%	86.7%	0.31	73.55	
OVR1	15	TtA	84	0.0012	1.8789	0.1%	86.8%	0.05	73.60	
OVR1	15	Vg	92	0.0006	1.8789	0.0%	86.8%	0.03	73.63	
OVR1	15	Vn	92	0.0538	1.8789	2.9%	89.7%	2.63	76.27	
OVR1	16	Ca	85	0.0019	1.8789	0.1%	89.8%	0.09	76.35	
OVR1	16	Cc	85	0.0001	1.8789	0.0%	89.8%	0.01	76.36	
OVR1	16	Oc	85	0.0032	1.8789	0.2%	90.0%	0.15	76.50	
OVR1	16	Oe	85	0.0758	1.8789	4.0%	94.0%	3.43	79.93	
OVR1	16	On	85	0.0783	1.8789	4.2%	98.2%	3.54	83.47	
OVR1	16	Os	78	0.0059	1.8789	0.3%	98.5%	0.25	83.72	
OVR1	16	TnB	65	0.0044	1.8789	0.2%	98.7%	0.15	83.87	
OVR1	16	Vn	85	0.0242	1.8789	1.3%	100.0%	1.10	84.97	**84.967**
OVR2	2	Tb	44	0.0064	0.4694	1.4%	1.4%	0.60	0.60	
OVR2	2	Td	76	0.0120	0.4694	2.6%	3.9%	1.95	2.55	
OVR2	5	Ad	92	0.0013	0.4694	0.3%	4.2%	0.26	2.81	
OVR2	5	Tb	56	0.0001	0.4694	0.0%	4.2%	0.01	2.82	
OVR2	5	Tc	56	0.0129	0.4694	2.7%	7.0%	1.54	4.36	
OVR2	6	Ad	95	0.0115	0.4694	2.5%	9.4%	2.33	6.68	
OVR2	6	Ca	89	0.0021	0.4694	0.4%	9.9%	0.40	7.08	
OVR2	6	Tb	76	0.0599	0.4694	12.8%	22.6%	9.70	16.78	
OVR2	6	Tc	76	0.0217	0.4694	4.6%	27.2%	3.51	20.29	
OVR2	6	Td	89	0.0606	0.4694	12.9%	40.2%	11.50	31.78	
OVR2	8	Ad	97	0.0012	0.4694	0.3%	40.4%	0.24	32.03	
OVR2	8	Tb	89	0.0317	0.4694	6.8%	47.2%	6.02	38.05	
OVR2	8	Td	94	0.0065	0.4694	1.4%	48.6%	1.30	39.35	
OVR2	9	Tb	92	0.0436	0.4694	9.3%	57.9%	8.55	47.90	
OVR2	9	Tc	92	0.0001	0.4694	0.0%	57.9%	0.01	47.91	
OVR2	14	Tc	49	0.0325	0.4694	6.9%	64.8%	3.39	51.31	
OVR2	14	Vn	78	0.0002	0.4694	0.0%	64.8%	0.03	51.34	

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OVR2	15	Ad	96	0.0261	0.4694	5.6%	70.4%	5.34	56.67	
OVR2	15	AVB	83	0.0000	0.4694	0.0%	70.4%	0.00	56.67	
OVR2	15	Ca	92	0.0094	0.4694	2.0%	72.4%	1.85	58.52	
OVR2	15	Co	92	0.0018	0.4694	0.4%	72.8%	0.35	58.87	
OVR2	15	Tb	83	0.0281	0.4694	6.0%	78.8%	4.97	63.84	
OVR2	15	Tc	83	0.0192	0.4694	4.1%	82.9%	3.40	67.24	
OVR2	15	Td	92	0.0236	0.4694	5.0%	87.9%	4.62	71.86	
OVR2	15	Vn	92	0.0002	0.4694	0.0%	87.9%	0.03	71.89	
OVR2	16	Tb	65	0.0005	0.4694	0.1%	88.0%	0.07	71.96	
OVR2	16	Tc	65	0.0176	0.4694	3.8%	91.8%	2.44	74.41	
OVR2	16	Td	85	0.0386	0.4694	8.2%	100.0%	6.98	81.39	**81.386**
OVR3	3	Tb	65	0.0469	0.4529	10.4%	10.4%	6.74	6.74	
OVR3	3	Tc	65	0.0264	0.4529	5.8%	16.2%	3.79	10.52	
OVR3	3	Vn	85	0.0391	0.4529	8.6%	24.8%	7.34	17.86	
OVR3	4	Tc	62	0.0347	0.4529	7.7%	32.5%	4.76	22.62	
OVR3	4	Vn	84	0.0174	0.4529	3.8%	36.3%	3.22	25.84	
OVR3	5	Tc	56	0.0058	0.4529	1.3%	37.6%	0.71	26.55	
OVR3	5	Vn	81	0.0039	0.4529	0.9%	38.5%	0.69	27.24	
OVR3	7	Vn	91	0.0039	0.4529	0.9%	39.3%	0.78	28.02	
OVR3	9	Bw	92	0.0005	0.4529	0.1%	39.4%	0.10	28.12	
OVR3	9	Tb	92	0.0085	0.4529	1.9%	41.3%	1.73	29.86	
OVR3	9	Tc	92	0.0638	0.4529	14.1%	55.4%	12.96	42.81	
OVR3	9	Vn	96	0.0162	0.4529	3.6%	59.0%	3.44	46.25	
OVR3	10	Tc	84	0.0144	0.4529	3.2%	62.1%	2.66	48.91	
OVR3	14	Co	78	0.0113	0.4529	2.5%	64.6%	1.94	50.85	
OVR3	14	Tc	49	0.0321	0.4529	7.1%	71.7%	3.47	54.32	
OVR3	14	Vn	78	0.0839	0.4529	18.5%	90.2%	14.45	68.77	
OVR3	15	Tb	83	0.0052	0.4529	1.1%	91.4%	0.95	69.72	
OVR3	15	Tc	83	0.0259	0.4529	5.7%	97.1%	4.75	74.47	
OVR3	15	Vn	92	0.0132	0.4529	2.9%	100.0%	2.67	77.14	**77.141**
OWASH1	1	RBG	77	0.8775	2.4357	36.0%	36.0%	27.74	27.74	
OWASH1	1	RHF	83	0.0290	2.4357	1.2%	37.2%	0.99	28.73	
OWASH1	1	RME	81	0.0794	2.4357	3.3%	40.5%	2.64	31.37	
OWASH1	1	RTF	89	0.7107	2.4357	29.2%	69.7%	25.97	57.34	
OWASH1	1	THB	65	0.3790	2.4357	15.6%	85.2%	10.12	67.45	
OWASH1	1	TnB	63	0.3600	2.4357	14.8%	100.0%	9.31	76.77	**76.766**
OWASH2	1	AVB	63	0.3265	2.4343	13.4%	13.4%	8.45	8.45	
OWASH2	1	BD	90	1.2927	2.4343	53.1%	66.5%	47.79	56.24	
OWASH2	1	BHC	87	0.1439	2.4343	5.9%	72.4%	5.14	61.39	

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OWASH2	1	MOB	87	0.0680	2.4343	2.8%	75.2%	2.43	63.82	
OWASH2	1	RHF	83	0.0815	2.4343	3.3%	78.6%	2.78	66.60	
OWASH2	1	RTF	89	0.3363	2.4343	13.8%	92.4%	12.30	78.89	
OWASH2	1	Tb	63	0.0000	2.4343	0.0%	92.4%	0.00	78.89	
OWASH2	1	THB	65	0.0916	2.4343	3.8%	96.1%	2.44	81.34	
OWASH2	3	AVB	65	0.0298	2.4343	1.2%	97.4%	0.79	82.13	
OWASH2	3	BD	92	0.0171	2.4343	0.7%	98.1%	0.65	82.78	
OWASH2	3	Tb	65	0.0037	2.4343	0.2%	98.2%	0.10	82.88	
OWASH2	5	AVB	56	0.0098	2.4343	0.4%	98.6%	0.23	83.11	
OWASH2	5	BD	92	0.0208	2.4343	0.9%	99.5%	0.79	83.89	
OWASH2	5	Tb	56	0.0014	2.4343	0.1%	99.5%	0.03	83.93	
OWASH2	15	AVB	83	0.0087	2.4343	0.4%	99.9%	0.30	84.22	
OWASH2	15	BD	96	0.0013	2.4343	0.1%	100.0%	0.05	84.27	
OWASH2	15	Tb	83	0.0010	2.4343	0.0%	100.0%	0.03	84.31	**84.309**
OWASH3	1	AVB	63	0.0010	0.3215	0.3%	0.3%	0.20	0.20	
OWASH3	1	BD	90	0.2066	0.3215	64.3%	64.6%	57.83	58.03	
OWASH3	1	MOB	87	0.0855	0.3215	26.6%	91.2%	23.12	81.16	
OWASH3	5	AVB	56	0.0004	0.3215	0.1%	91.3%	0.07	81.23	
OWASH3	5	BD	92	0.0214	0.3215	6.7%	98.0%	6.13	87.36	
OWASH3	5	Tb	56	0.0054	0.3215	1.7%	99.6%	0.93	88.29	
OWASH3	15	BD	96	0.0002	0.3215	0.1%	99.7%	0.05	88.34	
OWASH3	15	Tb	83	0.0011	0.3215	0.3%	100.0%	0.27	88.62	**88.619**
OWASHN	1	AYD	85	1.5557	5.9526	26.1%	26.1%	22.21	22.21	
OWASHN	1	BD	90	0.9985	5.9526	16.8%	42.9%	15.10	37.31	
OWASHN	1	RBG	77	0.8390	5.9526	14.1%	57.0%	10.85	48.16	
OWASHN	1	RME	81	1.2068	5.9526	20.3%	77.3%	16.42	64.58	
OWASHN	1	RTF	89	1.1500	5.9526	19.3%	96.6%	17.19	81.78	
OWASHN	1	THB	65	0.0864	5.9526	1.5%	98.0%	0.94	82.72	
OWASHN	1	TnB	63	0.1162	5.9526	2.0%	100.0%	1.23	83.95	**83.953**
OWASHS	1	115	83	0.1334	11.4290	1.2%	1.2%	0.97	0.97	
OWASHS	1	165	75	1.7723	11.4290	15.5%	16.7%	11.63	12.60	
OWASHS	1	167	81	2.6158	11.4290	22.9%	39.6%	18.54	31.14	
OWASHS	1	168	77	0.4859	11.4290	4.3%	43.8%	3.27	34.41	
OWASHS	1	175	86	0.8432	11.4290	7.4%	51.2%	6.34	40.76	
OWASHS	1	234	86	0.1123	11.4290	1.0%	52.2%	0.85	41.60	
OWASHS	1	272	68	0.3759	11.4290	3.3%	55.5%	2.24	43.84	
OWASHS	1	290	77	0.2502	11.4290	2.2%	57.7%	1.69	45.52	
OWASHS	1	871	84	0.0108	11.4290	0.1%	57.7%	0.08	45.60	
OWASHS	1	AYD	85	0.4089	11.4290	3.6%	61.3%	3.04	48.64	

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OWASHS	1	MAE	68	0.1936	11.4290	1.7%	63.0%	1.15	49.80	
OWASHS	1	RBG	77	0.9193	11.4290	8.0%	71.1%	6.19	55.99	
OWASHS	1	RME	81	0.0168	11.4290	0.1%	71.2%	0.12	56.11	
OWASHS	1	RTF	89	1.1353	11.4290	9.9%	81.1%	8.84	64.95	
OWASHS	1	STF	86	1.5823	11.4290	13.8%	95.0%	11.91	76.86	
OWASHS	1	THB	65	0.0019	11.4290	0.0%	95.0%	0.01	76.87	
OWASHS	1	USE	81	0.4812	11.4290	4.2%	99.2%	3.41	80.28	
OWASHS	1	UWD	75	0.0899	11.4290	0.8%	100.0%	0.59	80.87	**80.867**
WIWASH	1	AVB	63	0.1219	3.4993	3.5%	3.5%	2.20	2.20	
WIWASH	1	BD	90	0.3359	3.4993	9.6%	13.1%	8.64	10.83	
WIWASH	1	BHC	87	0.0090	3.4993	0.3%	13.3%	0.22	11.06	
WIWASH	1	RME	81	0.2704	3.4993	7.7%	21.1%	6.26	17.32	
WIWASH	1	RTF	89	1.8053	3.4993	51.6%	72.7%	45.92	63.23	
WIWASH	1	TnB	63	0.8974	3.4993	25.6%	98.3%	16.16	79.39	
WIWASH	4	AVB	62	0.0038	3.4993	0.1%	98.4%	0.07	79.46	
WIWASH	4	BD	92	0.0062	3.4993	0.2%	98.6%	0.16	79.62	
WIWASH	10	AVB	84	0.0261	3.4993	0.7%	99.3%	0.63	80.25	
WIWASH	10	BD	96	0.0173	3.4993	0.5%	99.8%	0.47	80.72	
WIWASH	10	Oe	92	0.0000	3.4993	0.0%	99.8%	0.00	80.72	
WIWASH	10	TnB	84	0.0046	3.4993	0.1%	100.0%	0.11	80.83	
WIWASH	15	AVB	83	0.0002	3.4993	0.0%	100.0%	0.00	80.84	
WIWASH	15	BD	96	0.0002	3.4993	0.0%	100.0%	0.01	80.84	
WIWASH	15	Oe	92	0.0001	3.4993	0.0%	100.0%	0.00	80.84	
WIWASH	15	TnB	83	0.0009	3.4993	0.0%	100.0%	0.02	80.86	**80.864**
WSWASH	1	1061	86	1.7665	61.3077	2.9%	2.9%	2.48	2.48	
WSWASH	1	1401	82	0.2267	61.3077	0.4%	3.3%	0.30	2.78	
WSWASH	1	1810	88	0.9848	61.3077	1.6%	4.9%	1.41	4.19	
WSWASH	1	1890	88	0.0295	61.3077	0.0%	4.9%	0.04	4.24	
WSWASH	1	AVB	63	0.4324	61.3077	0.7%	5.6%	0.44	4.68	
WSWASH	1	BD	90	8.5612	61.3077	14.0%	19.6%	12.57	17.25	
WSWASH	1	BHC	87	15.6255	61.3077	25.5%	45.1%	22.17	39.42	
WSWASH	1	MMB	88	0.2851	61.3077	0.5%	45.5%	0.41	39.83	
WSWASH	1	MOB	87	15.9488	61.3077	26.0%	71.5%	22.63	62.46	
WSWASH	1	RTF	89	13.2582	61.3077	21.6%	93.2%	19.25	81.71	
WSWASH	1	THB	65	1.4365	61.3077	2.3%	95.5%	1.52	83.23	
WSWASH	1	TMD	66	1.2863	61.3077	2.1%	97.6%	1.38	84.62	
WSWASH	1	TtA	64	0.0028	61.3077	0.0%	97.6%	0.00	84.62	
WSWASH	1	Ty	84	0.7297	61.3077	1.2%	98.8%	1.00	85.62	
WSWASH	1	WEE	63	0.6887	61.3077	1.1%	99.9%	0.71	86.33	

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2016 MPU BASINID	LAND USE INDEX NUMBER	SOIL MAP UNIT SYMBOL	SUBREGION CN	SUBREGION AREA (SQ MI)	SUBBASIN AREA (SQ MI)	PERCENT OF SUBBASIN	CUMULATIVE PERCENT	AREAL WEIGHTED CN	CUMULATIVE CN	COMPOSITE CN
WSWASH	14	AVB	49	0.0034	61.3077	0.0%	99.9%	0.00	86.33	
WSWASH	14	BD	90	0.0100	61.3077	0.0%	99.9%	0.01	86.35	
WSWASH	14	RTF	88	0.0220	61.3077	0.0%	100.0%	0.03	86.38	
WSWASH	14	TtA	50	0.0095	61.3077	0.0%	100.0%	0.01	86.39	**86.387**
WWASH1A	1	AVB	63	0.0307	1.2534	2.4%	2.4%	1.54	1.54	
WWASH1A	1	BD	90	0.8905	1.2534	71.0%	73.5%	63.94	65.49	
WWASH1A	1	BHC	87	0.1293	1.2534	10.3%	83.8%	8.97	74.46	
WWASH1A	1	Bw	63	0.0290	1.2534	2.3%	86.1%	1.46	75.92	
WWASH1A	1	RTF	89	0.1045	1.2534	8.3%	94.5%	7.42	83.34	
WWASH1A	1	THB	65	0.0002	1.2534	0.0%	94.5%	0.01	83.35	
WWASH1A	3	BD	92	0.0397	1.2534	3.2%	97.6%	2.91	86.26	
WWASH1A	3	Bw	65	0.0090	1.2534	0.7%	98.4%	0.46	86.73	
WWASH1A	3	Td	85	0.0190	1.2534	1.5%	99.9%	1.29	88.01	
WWASH1A	15	BD	96	0.0007	1.2534	0.1%	99.9%	0.05	88.07	
WWASH1A	15	Td	92	0.0009	1.2534	0.1%	100.0%	0.07	88.13	**88.132**
WWASH1B	1	AVB	63	0.0899	2.6311	3.4%	3.4%	2.15	2.15	
WWASH1B	1	BD	90	1.3320	2.6311	50.6%	54.0%	45.56	47.72	
WWASH1B	1	BHC	87	0.2536	2.6311	9.6%	63.7%	8.38	56.10	
WWASH1B	1	RTF	89	0.8721	2.6311	33.1%	96.8%	29.50	85.60	
WWASH1B	1	TnB	63	0.0000	2.6311	0.0%	96.8%	0.00	85.60	
WWASH1B	1	W	90	0.0373	2.6311	1.4%	98.2%	1.28	86.88	
WWASH1B	3	BD	92	0.0038	2.6311	0.1%	98.4%	0.13	87.01	
WWASH1B	3	Td	85	0.0123	2.6311	0.5%	98.9%	0.40	87.41	
WWASH1B	10	AVB	84	0.0177	2.6311	0.7%	99.5%	0.56	87.97	
WWASH1B	10	BD	96	0.0042	2.6311	0.2%	99.7%	0.15	88.13	
WWASH1B	10	Td	92	0.0005	2.6311	0.0%	99.7%	0.02	88.14	
WWASH1B	10	TnB	84	0.0003	2.6311	0.0%	99.7%	0.01	88.15	
WWASH1B	10	Vn	92	0.0004	2.6311	0.0%	99.7%	0.01	88.17	
WWASH1B	10	W	96	0.0043	2.6311	0.2%	99.9%	0.16	88.32	
WWASH1B	15	AVB	83	0.0003	2.6311	0.0%	99.9%	0.01	88.33	
WWASH1B	15	BD	96	0.0006	2.6311	0.0%	99.9%	0.02	88.35	
WWASH1B	15	Td	92	0.0014	2.6311	0.1%	100.0%	0.05	88.40	
WWASH1B	15	TnB	83	0.0002	2.6311	0.0%	100.0%	0.01	88.41	
WWASH1B	15	Vn	92	0.0002	2.6311	0.0%	100.0%	0.01	88.42	**88.416**
WWASH2	1	BD	90	0.1941	1.9042	10.2%	10.2%	9.17	9.17	
WWASH2	1	RTF	89	1.6477	1.9042	86.5%	96.7%	77.01	86.18	
WWASH2	1	TnB	63	0.0491	1.9042	2.6%	99.3%	1.63	87.81	
WWASH2	1	Vn	85	0.0015	1.9042	0.1%	99.4%	0.07	87.87	
WWASH2	4	BD	92	0.0096	1.9042	0.5%	99.9%	0.47	88.34	

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WWASH2	4	Vn	84	0.0022	1.9042	0.1%	100.0%	0.10	88.44	**88.437**
WWASH2A	1	BD	90	0.0582	0.3937	14.8%	14.8%	13.30	13.30	
WWASH2A	3	BD	92	0.0002	0.3937	0.0%	14.8%	0.04	13.34	
WWASH2A	3	Cd	85	0.0019	0.3937	0.5%	15.3%	0.41	13.75	
WWASH2A	3	Oc	85	0.0027	0.3937	0.7%	16.0%	0.57	14.32	
WWASH2A	3	TtA	66	0.0042	0.3937	1.1%	17.1%	0.71	15.03	
WWASH2A	3	Vn	85	0.0149	0.3937	3.8%	20.8%	3.22	18.25	
WWASH2A	4	BD	92	0.1480	0.3937	37.6%	58.4%	34.59	52.84	
WWASH2A	4	Cd	84	0.0098	0.3937	2.5%	60.9%	2.09	54.93	
WWASH2A	4	Oc	84	0.0060	0.3937	1.5%	62.5%	1.29	56.22	
WWASH2A	4	TtA	63	0.0461	0.3937	11.7%	74.2%	7.38	63.61	
WWASH2A	4	Vn	84	0.0837	0.3937	21.2%	95.4%	17.85	81.45	
WWASH2A	10	BD	96	0.0060	0.3937	1.5%	96.9%	1.45	82.90	
WWASH2A	10	Oc	92	0.0000	0.3937	0.0%	96.9%	0.01	82.91	
WWASH2A	10	Oe	92	0.0005	0.3937	0.1%	97.1%	0.11	83.02	
WWASH2A	10	TtA	84	0.0021	0.3937	0.5%	97.6%	0.45	83.47	
WWASH2A	15	Cd	92	0.0026	0.3937	0.7%	98.3%	0.60	84.07	
WWASH2A	15	Oc	92	0.0015	0.3937	0.4%	98.6%	0.35	84.41	
WWASH2A	15	Oe	92	0.0002	0.3937	0.0%	98.7%	0.04	84.45	
WWASH2A	15	TtA	84	0.0001	0.3937	0.0%	98.7%	0.01	84.47	
WWASH2A	15	Vn	92	0.0052	0.3937	1.3%	100.0%	1.21	85.68	**85.676**
WWASH3	1	BD	90	0.4249	0.4516	94.1%	94.1%	84.67	84.67	
WWASH3	1	Cd	85	0.0149	0.4516	3.3%	97.4%	2.81	87.49	
WWASH3	1	RTF	89	0.0026	0.4516	0.6%	98.0%	0.50	87.99	
WWASH3	3	BD	92	0.0001	0.4516	0.0%	98.0%	0.02	88.01	
WWASH3	3	Cd	85	0.0046	0.4516	1.0%	99.0%	0.86	88.87	
WWASH3	4	BD	92	0.0031	0.4516	0.7%	99.7%	0.63	89.50	
WWASH3	15	Cd	92	0.0015	0.4516	0.3%	100.0%	0.30	89.80	**89.799**
WWASH3A	1	BD	90	0.3477	0.4916	70.7%	70.7%	63.65	63.65	
WWASH3A	1	Ca	85	0.0001	0.4916	0.0%	70.7%	0.02	63.67	
WWASH3A	1	Cd	85	0.0005	0.4916	0.1%	70.9%	0.09	63.76	
WWASH3A	1	RTF	89	0.0420	0.4916	8.5%	79.4%	7.60	71.36	
WWASH3A	4	BD	92	0.0524	0.4916	10.7%	90.0%	9.80	81.16	
WWASH3A	4	Ca	84	0.0128	0.4916	2.6%	92.7%	2.19	83.35	
WWASH3A	4	Cd	84	0.0011	0.4916	0.2%	92.9%	0.18	83.54	
WWASH3A	4	Vn	84	0.0308	0.4916	6.3%	99.1%	5.26	88.80	
WWASH3A	15	Ca	92	0.0041	0.4916	0.8%	100.0%	0.77	89.57	
WWASH3A	15	Cd	92	0.0001	0.4916	0.0%	100.0%	0.03	89.59	**89.593**
WWASH4	1	BD	90	0.2563	0.5838	43.9%	43.9%	39.51	39.51	

ATKINS

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WWASH4	1	Ca	85	0.0041	0.5838	0.7%	44.6%	0.60	40.11	
WWASH4	1	RTF	89	0.3176	0.5838	54.4%	99.0%	48.42	88.53	
WWASH4	4	BD	92	0.0007	0.5838	0.1%	99.1%	0.12	88.65	
WWASH4	4	Ca	84	0.0006	0.5838	0.1%	99.2%	0.09	88.73	
WWASH4	15	BD	96	0.0002	0.5838	0.0%	99.3%	0.03	88.76	
WWASH4	15	Ca	92	0.0043	0.5838	0.7%	100.0%	0.67	89.43	**89.433**
WWASH4A	1	BD	90	0.2453	0.3149	77.9%	77.9%	70.09	70.09	
WWASH4A	1	Ca	85	0.0013	0.3149	0.4%	78.3%	0.36	70.45	
WWASH4A	1	RTF	89	0.0020	0.3149	0.6%	79.0%	0.58	71.03	
WWASH4A	4	BD	92	0.0522	0.3149	16.6%	95.5%	15.25	86.28	
WWASH4A	4	Ca	84	0.0001	0.3149	0.0%	95.6%	0.04	86.32	
WWASH4A	4	TnB	62	0.0012	0.3149	0.4%	95.9%	0.23	86.55	
WWASH4A	4	TtA	63	0.0036	0.3149	1.1%	97.1%	0.71	87.26	
WWASH4A	15	BD	96	0.0014	0.3149	0.4%	97.5%	0.42	87.68	
WWASH4A	15	Ca	92	0.0020	0.3149	0.6%	98.1%	0.59	88.26	
WWASH4A	15	TnB	83	0.0013	0.3149	0.4%	98.6%	0.34	88.60	
WWASH4A	15	TtA	84	0.0046	0.3149	1.4%	100.0%	1.21	89.82	**89.817**
WWASH5	1	BD	90	0.6046	1.6143	37.5%	37.5%	33.71	33.71	
WWASH5	1	Oc	85	0.0001	1.6143	0.0%	37.5%	0.01	33.71	
WWASH5	1	RTF	89	0.9687	1.6143	60.0%	97.5%	53.41	87.12	
WWASH5	3	BD	92	0.0065	1.6143	0.4%	97.9%	0.37	87.49	
WWASH5	3	Cm	85	0.0045	1.6143	0.3%	98.1%	0.23	87.73	
WWASH5	3	Oc	85	0.0057	1.6143	0.4%	98.5%	0.30	88.03	
WWASH5	4	BD	92	0.0159	1.6143	1.0%	99.5%	0.91	88.93	
WWASH5	4	Cm	84	0.0014	1.6143	0.1%	99.6%	0.07	89.01	
WWASH5	15	BD	96	0.0024	1.6143	0.1%	99.7%	0.14	89.15	
WWASH5	15	Cc	92	0.0002	1.6143	0.0%	99.7%	0.01	89.16	
WWASH5	15	Cm	92	0.0038	1.6143	0.2%	100.0%	0.22	89.38	
WWASH5	15	Oc	92	0.0005	1.6143	0.0%	100.0%	0.03	89.40	**89.405**
WWASH6	1	BD	90	0.0805	1.2033	6.7%	6.7%	6.02	6.02	
WWASH6	1	Cn	85	0.0156	1.2033	1.3%	8.0%	1.10	7.12	
WWASH6	1	RTF	89	0.8941	1.2033	74.3%	82.3%	66.12	73.25	
WWASH6	4	BD	92	0.0377	1.2033	3.1%	85.4%	2.88	76.13	
WWASH6	4	Cc	84	0.0586	1.2033	4.9%	90.3%	4.09	80.22	
WWASH6	4	Cn	84	0.0182	1.2033	1.5%	91.8%	1.27	81.49	
WWASH6	4	RTF	90	0.0827	1.2033	6.9%	98.7%	6.18	87.67	
WWASH6	15	BD	96	0.0013	1.2033	0.1%	98.8%	0.10	87.78	
WWASH6	15	Cc	92	0.0053	1.2033	0.4%	99.2%	0.41	88.18	
WWASH6	15	RTF	95	0.0094	1.2033	0.8%	100.0%	0.74	88.93	**88.927**

Curve Number Matrix

	COMPONENTS			LAND USE CLASSIFICATION INDEX NUMBER															
MAP #	OPEN DESERT	OPEN GOOD	% IMP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	% --->			100	10	60	35	0	0	0	0	0	15	7	0	0	40	0	78
		% --->		0	85	20	40	71	38	28	15	10	15	8	50	0	60	25	10
			% --->	0	5	20	25	29	62	72	85	90	70	85	50	0	0	75	12
	CN	CN	CN	SOIL TYPE COMPOSITE CN FOR LAND USE TYPE															
115	83	71	98	83.0	74.0	84.0	82.0	79.0	88.0	90.0	94.0	95.0	92.0	95.0	85.0	30.0	76.0	91.0	84.0
165	75	59	98	75.0	63.0	76.0	74.0	70.0	83.0	87.0	92.0	94.0	89.0	93.0	79.0	30.0	65.0	88.0	76.0
167	81	68	98	81.0	71.0	82.0	80.0	77.0	87.0	90.0	94.0	95.0	91.0	94.0	83.0	30.0	73.0	91.0	82.0
168	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	78.0
175	86	78	98	86.0	80.0	87.0	86.0	84.0	90.0	92.0	95.0	96.0	93.0	96.0	88.0	30.0	81.0	93.0	87.0
234	86	77	98	86.0	79.0	87.0	85.0	83.0	90.0	92.0	95.0	96.0	93.0	95.0	88.0	30.0	81.0	93.0	87.0
250	83	71	98	83.0	74.0	84.0	82.0	79.0	88.0	90.0	94.0	95.0	92.0	95.0	85.0	30.0	76.0	91.0	84.0
272	68	49	98	68.0	53.0	70.0	68.0	63.0	79.0	84.0	91.0	93.0	86.0	92.0	74.0	30.0	57.0	86.0	70.0
290	77	66	98	77.0	69.0	79.0	78.0	75.0	86.0	89.0	93.0	95.0	90.0	94.0	82.0	30.0	70.0	90.0	78.0
298	83	75	98	83.0	77.0	84.0	84.0	82.0	89.0	92.0	95.0	96.0	92.0	95.0	87.0	30.0	78.0	92.0	84.0
605	75	62	98	75.0	65.0	77.0	76.0	72.0	84.0	88.0	93.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	76.0
871	84	73	98	84.0	75.0	85.0	83.0	80.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	77.0	92.0	85.0
965	70	50	98	70.0	54.0	72.0	69.0	64.0	80.0	85.0	91.0	93.0	87.0	92.0	74.0	30.0	58.0	86.0	71.0
1061	86	78	98	86.0	80.0	87.0	86.0	84.0	90.0	92.0	95.0	96.0	93.0	96.0	88.0	30.0	81.0	93.0	87.0
1401	82	70	98	82.0	73.0	83.0	81.0	78.0	87.0	90.0	94.0	95.0	91.0	95.0	84.0	30.0	75.0	91.0	83.0
1810	88	82	98	88.0	83.0	89.0	88.0	87.0	92.0	94.0	96.0	96.0	94.0	96.0	90.0	30.0	84.0	94.0	89.0
1890	88	82	98	88.0	83.0	89.0	88.0	87.0	92.0	94.0	96.0	96.0	94.0	96.0	90.0	30.0	84.0	94.0	89.0
Ad	90	90	98	90.0	90.0	92.0	92.0	92.0	95.0	96.0	97.0	97.0	96.0	97.0	94.0	30.0	90.0	96.0	91.0
Ae	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	83.0	65.0
Ah	63	40	98	63.0	45.0	65.0	63.0	57.0	76.0	82.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	84.0	65.0
AMC	63	40	98	63.0	45.0	65.0	63.0	57.0	76.0	82.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	84.0	65.0
ASC	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	83.0	65.0
AVB	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	83.0	65.0
AYD	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
BD	90	90	98	90.0	90.0	92.0	92.0	92.0	95.0	96.0	97.0	97.0	96.0	97.0	94.0	30.0	90.0	96.0	91.0
BFD	88	80	98	88.0	82.0	88.0	87.0	85.0	91.0	93.0	95.0	96.0	94.0	96.0	89.0	30.0	83.0	94.0	88.0
BHC	87	78	98	87.0	80.0	87.0	86.0	84.0	90.0	92.0	95.0	96.0	93.0	96.0	88.0	30.0	82.0	93.0	87.0
BNB	88	80	98	88.0	82.0	88.0	87.0	85.0	91.0	93.0	95.0	96.0	94.0	96.0	89.0	30.0	83.0	94.0	88.0
Bw	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	83.0	65.0
Ca	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
Cc	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
Cd	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
Cm	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0

Curve Number Matrix

	COMPONENTS			LAND USE CLASSIFICATION INDEX NUMBER															
MAP #	OPEN DESERT	OPEN GOOD	% IMP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	% --->			100	10	60	35	0	0	0	0	0	15	7	0	0	40	0	78
		% --->		0	85	20	40	71	38	28	15	10	15	8	50	0	60	25	10
			% --->	0	5	20	25	29	62	72	85	90	70	85	50	0	0	75	12
	CN	CN	CN	SOIL TYPE COMPOSITE CN FOR LAND USE TYPE															
Cn	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
Co	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
CRD	65	43	98	65.0	48.0	67.0	64.0	59.0	77.0	83.0	90.0	93.0	85.0	91.0	71.0	30.0	52.0	84.0	67.0
Gd	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	78.0
Ge	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	78.0
Gf	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	78.0
Gm	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	78.0
Gn	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	78.0
GP	90	90	98	90.0	90.0	92.0	92.0	92.0	95.0	96.0	97.0	97.0	96.0	97.0	94.0	30.0	90.0	96.0	91.0
Gs	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
HUF	75	62	98	75.0	65.0	77.0	76.0	72.0	84.0	88.0	93.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	76.0
La	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
Lc	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
MAE	68	49	98	68.0	53.0	70.0	68.0	63.0	79.0	84.0	91.0	93.0	86.0	92.0	74.0	30.0	57.0	86.0	70.0
MMB	88	80	98	88.0	82.0	88.0	87.0	85.0	91.0	93.0	95.0	96.0	94.0	96.0	89.0	30.0	83.0	94.0	88.0
MOB	87	78	98	87.0	80.0	87.0	86.0	84.0	90.0	92.0	95.0	96.0	93.0	96.0	88.0	30.0	82.0	93.0	87.0
Oc	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
Oe	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
On	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
Or	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
Os	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	78.0
Ot	77	61	98	77.0	64.0	78.0	76.0	72.0	84.0	88.0	92.0	94.0	89.0	94.0	80.0	30.0	67.0	89.0	78.0
PL	90	90	98	90.0	90.0	92.0	92.0	92.0	95.0	96.0	97.0	97.0	96.0	97.0	94.0	30.0	90.0	96.0	91.0
RBG	77	66	98	77.0	69.0	79.0	78.0	75.0	86.0	89.0	93.0	95.0	90.0	94.0	82.0	30.0	70.0	90.0	78.0
RHF	83	75	98	83.0	77.0	84.0	84.0	82.0	89.0	92.0	95.0	96.0	92.0	95.0	87.0	30.0	78.0	92.0	84.0
RME	81	73	98	81.0	75.0	83.0	82.0	80.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	76.0	92.0	82.0
RTF	89	87	98	89.0	88.0	90.0	90.0	90.0	94.0	95.0	96.0	97.0	95.0	96.0	93.0	30.0	88.0	95.0	90.0
STF	86	78	98	86.0	80.0	87.0	86.0	84.0	90.0	92.0	95.0	96.0	93.0	96.0	88.0	30.0	81.0	93.0	87.0
Tb	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	83.0	65.0
Tc	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	83.0	65.0
Td	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
THB	65	41	98	65.0	46.0	67.0	64.0	58.0	76.0	82.0	89.0	92.0	85.0	91.0	70.0	30.0	51.0	84.0	67.0
TMD	66	43	98	66.0	48.0	68.0	65.0	59.0	77.0	83.0	90.0	93.0	85.0	91.0	71.0	30.0	52.0	84.0	68.0

Curve Number Matrix

	COMPONENTS			LAND USE CLASSIFICATION INDEX NUMBER															
MAP #	OPEN DESERT	OPEN GOOD	% IMP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	% --->			100	10	60	35	0	0	0	0	0	15	7	0	0	40	0	78
		% --->		0	85	20	40	71	38	28	15	10	15	8	50	0	60	25	10
			% --->	0	5	20	25	29	62	72	85	90	70	85	50	0	0	75	12
	CN	CN	CN	SOIL TYPE COMPOSITE CN FOR LAND USE TYPE															
TnA	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	83.0	65.0
TnB	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	83.0	65.0
TtA	64	41	98	64.0	46.0	66.0	63.0	58.0	76.0	82.0	89.0	92.0	84.0	91.0	70.0	30.0	50.0	84.0	66.0
Ty	84	75	98	84.0	77.0	85.0	84.0	82.0	89.0	92.0	95.0	96.0	92.0	95.0	87.0	30.0	79.0	92.0	85.0
USE	81	68	98	81.0	71.0	82.0	80.0	77.0	87.0	90.0	94.0	95.0	91.0	94.0	83.0	30.0	73.0	91.0	82.0
UWD	75	59	98	75.0	63.0	76.0	74.0	70.0	83.0	87.0	92.0	94.0	89.0	93.0	79.0	30.0	65.0	88.0	76.0
Vg	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
Vn	85	74	98	85.0	76.0	85.0	84.0	81.0	89.0	91.0	94.0	96.0	92.0	95.0	86.0	30.0	78.0	92.0	85.0
W	90	90	98	90.0	90.0	92.0	92.0	92.0	95.0	96.0	97.0	97.0	96.0	97.0	94.0	30.0	90.0	96.0	91.0
WEE	63	39	98	63.0	44.0	65.0	62.0	56.0	76.0	81.0	89.0	92.0	84.0	91.0	69.0	30.0	49.0	83.0	65.0

PERVIOUS AREA CURVE NUMBERS

CONDITION 1: -----------> DESERT SHRUB POOR HYDROLOGIC CONDITION
CONDITION 2: -----------> LANDSCAPED, LAWNS, TREES, GOOD HYDROLOGIC CONDITION

NV608 U.S. Department of Agriculture, NRCS, Soil Survey of Virgin River Area, Nevada and Arizona dated August 2014 (Soil Survey Symbol: NV608)

NV754 U.S. Department of Agriculture, NRCS, Soil Survey of Lincoln County, Nevada, South Part, dated August 2014 (Soil Survey Symbol: NV754)

NV755 U.S. Department of Agriculture, NRCS, Soil Survey of Clark County Area, Nevada, dated August 2014 (Soil Survey Symbol: NV755)

CN VALUES

CONDITION		HYDROLOGIC SOIL GROUP				
		A	B	C	D	ROCK
1	----------->	63	77	85	88	90
2	----------->	39	61	74	80	90

SOIL SURVEY AREA SYMBOL	MAP UNIT SYMBOL	HYDROLOGIC SOIL GROUP					CONDITION 1	CONDITION 2
		%A	%B	%C	%D	%ROCK	CN	CN
NV755	115	4	30	35	29	2	83	71
NV755	165	32	40	15	7	6	75	59
NV755	167	0	67	0	28	5	81	68
NV755	168	6	85	5	4	0	77	61
NV755	175	10	0	0	70	20	86	78
NV755	234	7	0	0	93	0	86	77
NV755	250	10	25	0	65	0	83	71
NV755	272	80	0	0	0	20	68	49
NV755	290	46	0	0	9	45	77	66
NV755	298	21	0	5	39	35	83	75
NV755	605	50	10	0	0	40	75	62
NV755	871	17	0	0	83	0	84	73
NV755	965	58	36	0	4	2	70	50
NV754	1061	9	0	0	70	21	86	78
NV754	1401	23	2	0	75	0	82	70
NV754	1810	0	0	0	80	20	88	82
NV754	1890	0	0	2	77	21	88	82
NV608	Ad	0	0	0	0	100	90	90
NV608	Ae	100	0	0	0	0	63	39
NV608	Ah	95	0	2	0	0	63	40
NV608	AMC	98	0	2	0	0	63	40
NV608	ASC	100	0	0	0	0	63	39
NV608	AVB	100	0	0	0	0	63	39
NV608	AYD	0	0	100	0	0	85	74
NV608	BD	0	0	0	0	100	90	90
NV608	BFD	0	0	0	100	0	88	80
NV608	BHC	6	0	0	92	2	87	78
NV608	BNB	0	0	0	100	0	88	80
NV608	Bw	100	0	0	0	0	63	39
NV608	Ca	0	0	100	0	0	85	74
NV608	Cc	0	0	100	0	0	85	74
NV608	Cd	0	0	100	0	0	85	74
NV608	Cm	0	0	100	0	0	85	74

PERVIOUS AREA CURVE NUMBERS

SOIL SURVEY AREA SYMBOL	MAP UNIT SYMBOL	HYDROLOGIC SOIL GROUP					CONDITION 1	CONDITION 2
		%A	%B	%C	%D	%ROCK	CN	CN
NV608	Cn	0	0	100	0	0	85	74
NV608	Co	0	0	97	0	0	85	74
NV608	CRD	92	2	0	0	6	65	43
NV608	Gd	0	100	0	0	0	77	61
NV608	Ge	0	100	0	0	0	77	61
NV608	Gf	0	100	0	0	0	77	61
NV608	Gm	0	100	0	0	0	77	61
NV608	Gn	0	100	0	0	0	77	61
NV608	GP	0	0	0	0	100	90	90
NV608	Gs	0	0	100	0	0	85	74
NV608	HUF	50	10	0	0	40	75	62
NV608	La	0	0	100	0	0	85	74
NV608	Lc	0	0	100	0	0	85	74
NV608	MAE	80	0	0	0	20	68	49
NV608	MMB	0	0	0	100	0	88	80
NV608	MOB	5	0	0	95	0	87	78
NV608	Oc	0	0	100	0	0	85	74
NV608	Oe	0	0	100	0	0	85	74
NV608	On	0	0	100	0	0	85	74
NV608	Or	0	0	100	0	0	85	74
NV608	Os	0	100	0	0	0	77	61
NV608	Ot	0	100	0	0	0	77	61
NV608	PL	0	0	0	0	100	90	90
NV608	RBG	46	0	0	9	45	77	66
NV608	RHF	21	0	5	39	35	83	75
NV608	RME	30	0	0	0	60	81	73
NV608	RTF	0	0	0	30	60	89	87
NV608	STF	10	0	0	70	20	86	78
NV608	Tb	100	0	0	0	0	63	39
NV608	Tc	100	0	0	0	0	63	39
NV608	Td	0	0	100	0	0	85	74
NV608	THB	94	0	0	6	0	65	41
NV608	TMD	90	0	0	10	0	66	43
NV608	TnA	100	0	0	0	0	63	39
NV608	TnB	100	0	0	0	0	63	39
NV608	TtA	95	0	5	0	0	64	41
NV608	Ty	15	0	45	0	40	84	75
NV608	USE	0	67	0	28	5	81	68
NV608	UWD	32	40	15	7	6	75	59
NV608	Vg	0	0	92	8	0	85	74
NV608	Vn	0	0	92	0	0	85	74
NV608	W	0	0	0	0	100	90	90
NV608	WEE	100	0	0	0	0	63	39

Lag Time Calculations

2016 Muddy River and Tributary Washes Flood Control Master Plan Update
USBR Lag Time Calculations

Basin	Area	Lc	Lc	L	L	Sa	S	Kn	Tlag	Remarks
	(sq mi)	(ft)	(mi)	(ft)	(mi)	(ft/ft)	(ft/mi)		(hrs)	
AWASH1	4.57	8310.06	1.57	23684.58	4.49	0.040	209.790	0.050	0.79	OK
AWASH2	1.63	5534.49	1.05	13350.89	2.53	0.079	417.410	0.050	0.51	OK
AWASH3	5.03	13464.49	2.55	28254.35	5.35	0.035	186.474	0.050	1.00	OK
BMN1	3.72	4900.08	0.93	15845.36	3.00	0.047	248.445	0.050	0.56	OK
BMN2	4.08	7689.33	1.46	19031.42	3.60	0.039	207.150	0.050	0.72	OK
BMN3	5.12	15779.68	2.99	27831.36	5.27	0.016	83.878	0.050	1.20	OK
BMN4	6.98	16695.38	3.16	34050.00	6.45	0.013	68.994	0.050	1.34	OK
BMN5	1.48	6178.66	1.17	14930.66	2.83	0.031	163.680	0.050	0.64	OK
BMN6	2.06	13577.32	2.57	24265.11	4.60	0.019	102.305	0.050	1.05	OK
BMN8	1.27	5098.83	0.97	9900.08	1.88	0.034	180.402	0.050	0.52	OK
EWASH1	6.33	18104.99	3.43	29141.31	5.52	0.022	116.308	0.050	1.20	OK
EWASH2	4.80	10878.45	2.06	25097.31	4.75	0.027	140.839	0.050	0.94	OK
EWASH3	1.77	9020.90	1.71	16420.35	3.11	0.019	99.348	0.050	0.81	OK
EWASH4	2.03	5646.62	1.07	12298.14	2.33	0.023	121.250	0.050	0.61	OK
EWASH7	6.39	12072.50	2.29	27139.25	5.14	0.022	118.594	0.030	0.62	OK
EWASH8	3.47	17313.09	3.28	30266.76	5.73	0.018	95.447	0.050	1.24	OK
EWDB	1.89	6859.13	1.30	17099.97	3.24	0.026	135.780	0.030	0.43	OK
FGDB	1.92	7362.75	1.39	15733.38	2.98	0.028	145.691	0.030	0.42	OK
LOG2	1.62	10429.12	1.98	19472.67	3.69	0.005	27.134	0.030	0.67	OK
LWASH1	4.03	14653.78	2.78	25907.79	4.91	0.013	69.379	0.030	0.71	OK
LWASH3	1.17	8121.32	1.54	14247.95	2.70	0.021	110.975	0.030	0.44	OK
MAGW1	5.52	16021.05	3.03	34486.97	6.53	0.018	95.246	0.050	1.26	OK
MAGW2	4.81	13702.75	2.60	26054.29	4.93	0.022	116.054	0.050	1.06	OK
MDW	19.44	21188.26	4.01	47617.49	9.02	0.007	37.187	0.030	1.08	OK
MRIV1	22.91	35495.73	6.72	68302.22	12.94	0.015	79.517	0.050	2.12	OK
MRIV2	18.37	27946.37	5.29	60248.83	11.41	0.029	153.447	0.050	1.69	OK
MRIV3	21.99	41915.03	7.94	62695.68	11.87	0.024	126.414	0.050	2.02	OK
MRIV4	10.45	25795.27	4.89	38197.06	7.23	0.008	41.274	0.050	1.76	OK
MRIV5	3.26	8755.77	1.66	19701.29	3.73	0.031	165.364	0.050	0.79	OK
MRIV6	2.17	19602.21	3.71	30369.41	5.75	0.015	80.356	0.050	1.33	OK
MRIV7	12.41	17004.26	3.22	41317.67	7.83	0.037	195.481	0.050	1.21	OK
OVR1	1.88	8636.76	1.64	15915.74	3.01	0.004	21.315	0.030	0.61	OK
OWASH1	2.44	9650.76	1.83	19005.45	3.60	0.035	185.692	0.050	0.79	OK
OWASH2	2.43	6326.66	1.20	16747.82	3.17	0.054	287.169	0.050	0.61	OK
OWASHN	5.95	10612.25	2.01	24601.37	4.66	0.033	172.614	0.050	0.89	OK
OWASHS	11.43	21180.31	4.01	36773.79	6.96	0.026	135.949	0.030	0.80	OK
WIWASH	3.50	12622.35	2.39	22914.77	4.34	0.036	187.461	0.050	0.91	OK
WSWASH	61.31	76881.19	14.56	138801.07	26.29	0.041	216.142	0.030	1.76	OK
WWASH1A	1.25	5213.62	0.99	15722.17	2.98	0.051	267.495	0.030	0.34	OK
WWASH1B	2.63	9069.94	1.72	18844.24	3.57	0.052	271.920	0.030	0.43	OK
WWASH2	1.90	12947.36	2.45	22076.55	4.18	0.037	193.649	0.030	0.54	OK
WWASH5	1.61	7301.45	1.38	14716.33	2.79	0.035	186.780	0.030	0.40	OK
WWASH6	1.20	6726.85	1.27	14604.01	2.77	0.031	165.840	0.030	0.39	OK

Definitions

Lc Length along longest watercourse measured upstream to a point opposite the centroid of the basin.

L Length of longest watercourse

Sa Representative slope of the longest water course in feet per feet

S Representative slope of the longest water course in feet per mile

Kn Mannings roughness factor for the basin channels

$Tlag = 20Kn(LLc/S^{0.5})^{0.33}$

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

TIME OF CONCENTRATION

Atkins **Muddy River MPU**

File: Lag Time.xls

BY: **HYD**

DATE: **11/22/15**

SUB-BASIN DATA							INITIAL / OVERLAND TIME (Ti)			TRAVEL TIME (Tt)					Tc	Tc Check	Tlag
DESIG: (1)	DEV./EX. (D or E)	CN	K (2)	AREA Ac (3)	AREA Mi^2	TOTAL LENGTH Feet	INITIAL LENGTH Feet (4)	SLOPE % (5)	Ti Min (6)	TRAVEL LENGTH Feet (7)	SLOPE % (8)	V1 VELOCITY FPS (9a)	V2 VELOCITY FPS (9b)	Tt Min (10)	Min (13)	Tc = (L/180)+10 Min (14)	Tlag= 0.6Tc/60 Hours
Desert Condtions																	
BOWMAN	E	33.4	0.0512	190.53	0.298	4660.196	500	0.4	57.3	4160.196	0.4	0.9	1.9	41.7	99.0	N/A	**0.990**
BMN7	E	81.2	0.6816	287.66	0.449	7751.468	500	12.4	7.3	7251.468	2.4	2.3	4.5	28.4	35.7	N/A	**0.357**
LWASH2	E	82.7	0.7020	447.61	0.699	10782.379	500	27.4	5.3	10282.379	1.9	2.0	4.0	44.6	49.9	N/A	**0.499**
OWASH3	E	88.6	0.7798	205.76	0.322	7153.522	500	3.2	8.7	6653.522	4.5	3.1	6.2	19.1	27.8	N/A	**0.278**
WWASH2A	E	85.7	0.7409	252.00	0.394	5950.367	500	47.9	4.0	5450.367	1.1	1.5	3.0	32.6	36.6	N/A	**0.366**
WWASH3	E	89.8	0.7953	289.02	0.452	4850.799	500	10.3	5.6	4350.799	8.3	4.3	8.5	9.5	15.2	N/A	**0.152**
WWASH3A	E	89.6	0.7926	314.62	0.492	10548.489	500	14.1	5.1	10048.489	4.9	3.3	6.5	27.1	32.2	N/A	**0.322**
WWASH4	E	89.4	0.7905	373.61	0.584	13662.725	500	12.9	5.3	13162.725	5.7	3.5	7.0	32.3	37.7	N/A	**0.377**
WWASH4A	E	89.8	0.7956	201.55	0.315	6856.489	500	16.5	4.8	6356.489	4.6	3.2	6.3	18.1	22.9	N/A	**0.229**
Urbanized Conditions																	
EWASH5	D	72.7	0.5692	372.45	0.582	11430.906	100	1.0	9.6	11330.906	1.0	2.0	3.1	63.1	72.7	73.5	**0.727**
EWASH6	D	80.5	0.6723	501.21	0.783	10195.204	100	1.0	7.7	10095.204	0.7	1.7	2.6	67.4	75.1	66.6	**0.666**
LOG1	D	81.6	0.6873	263.15	0.411	7320.666	100	1.0	7.4	7220.666	0.6	1.6	2.4	52.6	60.0	50.7	**0.507**
LOG3	D	84.6	0.7267	323.64	0.506	11803.384	100	1.0	6.7	11703.384	0.7	1.7	2.6	77.9	84.6	75.6	**0.756**
OVR2	D	81.4	0.6843	300.43	0.469	6451.233	100	1.0	7.5	6351.233	0.6	1.6	2.4	46.5	54.0	45.8	**0.458**
OVR3	D	77.1	0.6283	289.85	0.453	6125.529	100	1.0	8.5	6025.529	0.5	1.4	2.2	48.4	56.9	44.0	**0.440**
FGDB1	D	76.8	0.6241	251.46	0.393	4845.572	100	1.0	8.6	4745.572	1.1	2.1	3.2	26.0	34.5	36.9	**0.345**
FGDB2	D	73.2	0.5762	294.37	0.460	6650.058	100	1.0	9.4	6550.058	2.7	3.3	5.0	22.6	32.0	46.9	**0.320**

Tc = Ti + Tt Tlag = 0.6 Tc

Ti = 1.8 (1.1 - K) L^1/2 / S^1/3

K = 0.0132 (CN) - 0.39

Tc Check = L/180+10

For the travel time (Tt) calculations,
V1 applies to the first 500 feet of travel distance;
V2 applies to the remaining travel distance.

Existing V1 = 14.8*(S/500)^1/2 Developed V1 = 20.2*(S/100)^1/2

Existing V2 = 29.4*(S/500)^1/2 Developed V2 = 30.6*(S/100)^1/2

REFERENCE : **STANDARD FORM 4**

Routing Calculations

2016 Muddy River and Tributary Washes Flood Control Master Plan Update
Muskingum Cunge

ROUTEID	LENGTH(FT)	SLOPE(FT/FT)	N	SHAPE	WIDTH	SIDE SLOPE
RDBFGLS	6081	0.007	0.013	CIRC	6	0
RCFGDB1	2611	0.009	0.013	CIRC	6	0
RCFGDB2	3976	0.009	0.015	TRAP	7	0
RCLWASH3	3556	0.012	0.013	CIRC	20	0
RCMR0	5862	0.011	0.04	TRAP	20	4
RCMR1	6490	0.003	0.04	TRAP	20	4
RCMR2	9445	0.001	0.025	TRAP	200	3
RCMR3	4979	0.001	0.025	TRAP	200	3
RCMR4	5007	0.004	0.025	TRAP	200	3
RCMR5	4696	0.002	0.025	TRAP	400	3
RCMR6	3336	0.003	0.025	TRAP	600	3
RCMR7	2035	0.004	0.025	TRAP	600	3
RCMR8	2730	0.004	0.025	TRAP	600	3
RCMR9	2796	0.004	0.025	TRAP	600	3
RCMRIV1	31433	0.004	0.04	TRAP	20	4
RCMRIV3	10746	0.003	0.04	TRAP	20	4
RCMRIV5	13545	0.002	0.04	TRAP	20	4
RCMRIV7	18735	0.002	0.04	TRAP	20	4
RCOWASH2	2591	0.004	0.015	TRAP	12	2
RCOWASH3	4701	0.005	0.015	TRAP	12	2
RCWIWASH	4030	0.004	0.015	TRAP	12	2
RCWWAS1A	3078	0.004	0.015	TRAP	12	2
RCWWAS1B	1606	0.004	0.015	TRAP	12	2
RCWWASH2	2310	0.004	0.015	TRAP	12	2
RCWWASH3	4532	0.004	0.015	TRAP	12	2
RCWWASH4	5392	0.005	0.015	TRAP	12	2
RDBEWGA	10278	0.012	0.013	CIRC	4	0
RDBFGWS	5302	0.012	0.013	CIRC	4	0
RDBWWCA	2608	0.020	0.013	CIRC	5	0

2016 Muddy River and Tributary Washes Flood Control Master Plan Update
Muskingum

Route Name	Length (mi)	Hydraulic Radius	Slope (ft/ft)	n	Time Step (min)	Velocity (ft/s)	NSTPS	K (Hours)	X	Channel Shape
RAWASH1	1.14	1.5	0.011	0.040	5	8.17	2	0.20	0.15	Rectangular
RBMN1	5.23	2.5	0.016	0.040	5	13.94	7	0.55	0.15	Rectangular
RBMN2	6.71	2.5	0.013	0.040	5	12.33	10	0.80	0.15	Rectangular
RCAWASH2	4.73	2.5	0.012	0.040	5	11.99	7	0.58	0.15	Rectangular
RCBMN34	1.78	2.5	0.011	0.040	5	11.77	3	0.22	0.15	Rectangular
RCBMN56	0.64	2.5	0.013	0.040	5	12.66	1	0.07	0.15	Rectangular
RCLWASH1	2.70	2.5	0.021	0.040	5	15.91	3	0.25	0.15	Rectangular
RCOWASH1	2.51	2.5	0.023	0.040	5	16.50	3	0.22	0.15	Rectangular
RCOWASHS	2.82	2.5	0.015	0.040	5	13.44	4	0.31	0.15	Rectangular
REWASH7	1.94	1.5	0.007	0.040	5	6.46	5	0.44	0.15	Rectangular
RMAGW1	4.39	2.5	0.013	0.040	5	12.45	6	0.52	0.15	Rectangular
RWWASH5	1.29	2.5	0.007	0.040	5	9.45	2	0.20	0.15	Rectangular

Notes:

R	Description	Routing Method
0.6	Large flood plain storage - Shallow sheet flow	Undeveloped - Muskingum Method
1.5	Normal Natural condition- poorly defined natural channels	
2.5	Flows primarily confined within a major wash	

Equations

$V = 1.49 R^{2/3} S^{1/2}/n$

Vwave = 8/5V

K = L/3600Vwave

NSTPS = $60K/\Delta t$

Dt= Simulation timestep (HEC-1)

Parameters

V= Average channel velocity

Vwave= Wave velocity

K= Travel time

X= Floodplain storage

NSTPS = Timesteps

L= Length of the routing reach

S= Slope

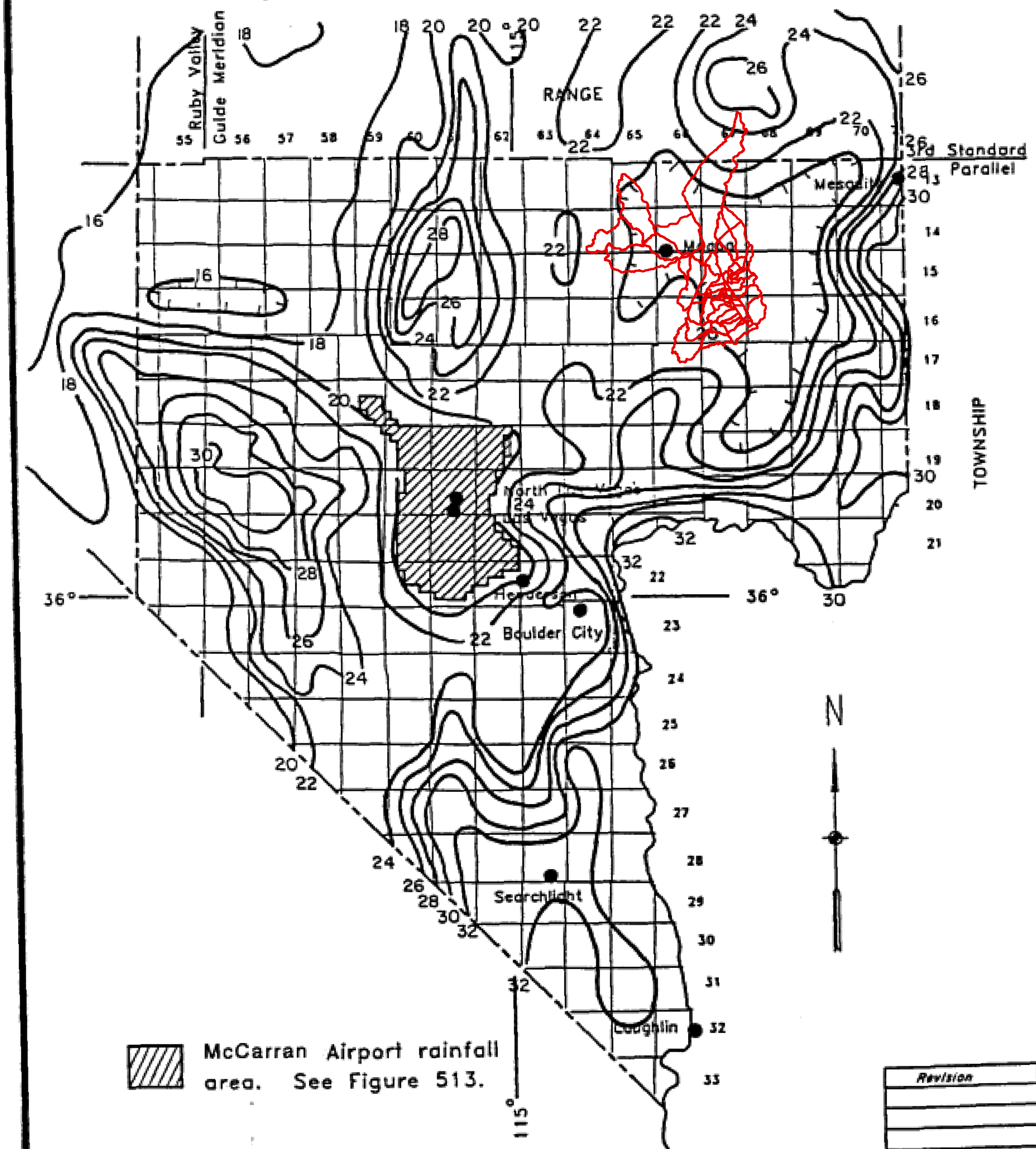
n= Roughness coefficient

R= Hydraulic radius

Rainfall Maps

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

RAINFALL DEPTH–DURATION–FREQUENCY
100–YEAR, 6–HOUR
(DEPTHS IN TENTHS OF INCHES)



Revision	Date

WRC ENGINEERING

REFERENCE:
NOAA ATLAS 2, VOLUME VII NEVADA, 1973

FIGURE 506

N

2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

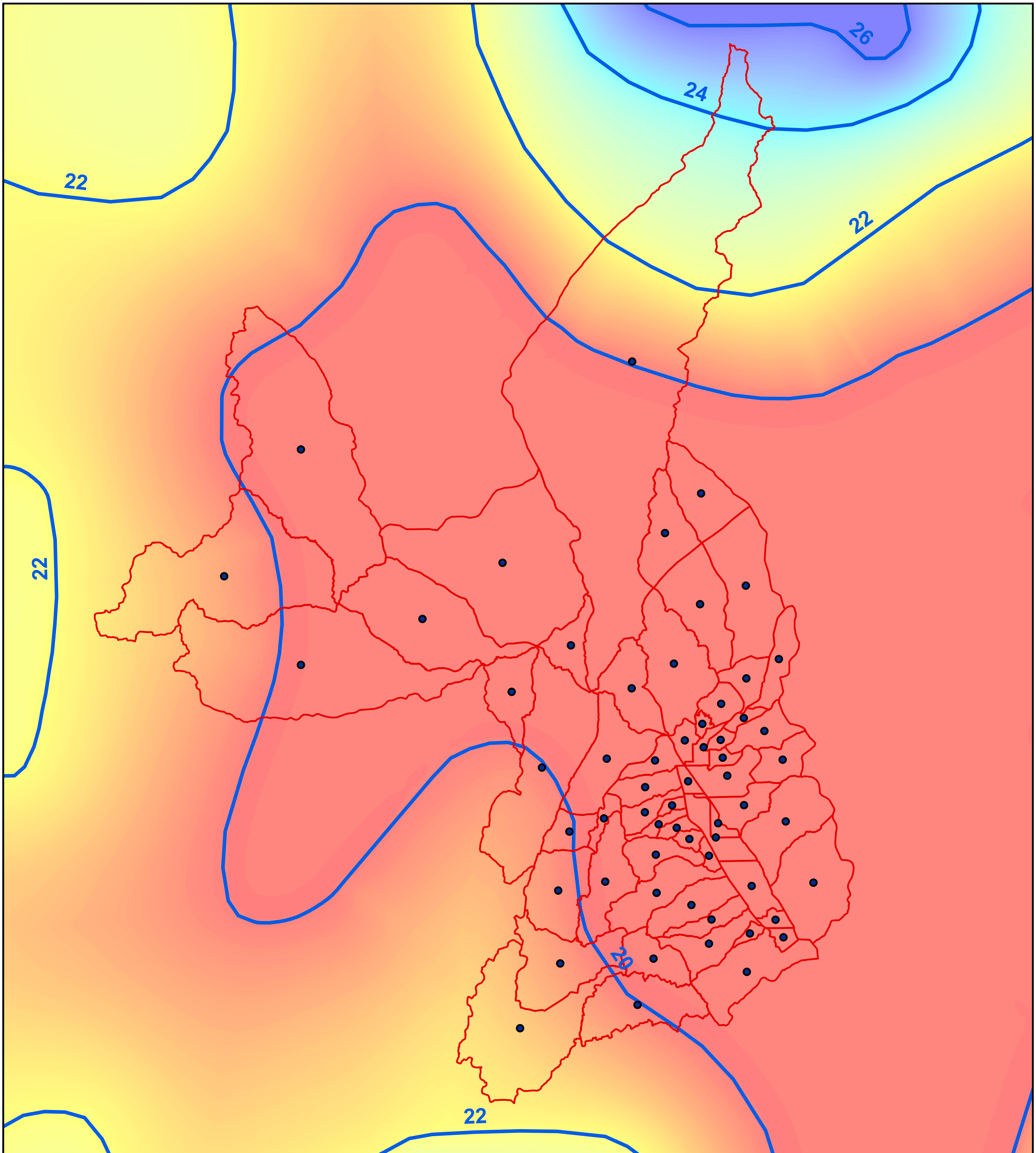
100 YEAR 6 HOUR
RAINFALL EXHIBIT

LEGEND

Subbasins

REGIONAL FLOOD CONTROL DISTRICT

ATKINS



N

0 2 4

Miles

1 in = 4 miles

2016
FLOOD CONTROL
MASTER PLAN UPDATE
MUDDY RIVER AND
TRIBUTARY WASHES

100 YEAR 6 HOUR RAINFALL MAP

LEGEND

- Subbasin Centroid
- Rainfall Contours
- Subbasin Boundary

Rainfall (Tenths of Inches)
High : 26.4
Low : 20.0

REGIONAL FLOOD CONTROL DISTRICT

ATKINS

Appendix A-4

HEC-1 Models

- MRMPU3.DAT (SDN3)
- MRMPU4.DAT (SDN4)
- MRMPU5.DAT (SDN5)

```
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   03MAY16  TIME  11:42:34   *                                              *          (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

                        *DIAGRAM
 *** FREE ***
             1          ID   2016 FLOOD CONTROL MASTER PLAN UPDATE
             2          ID   MUDDY RIVER AND TRIBUTARY WASHES
             3          ID   INPUT FILE = MRMPU3.DAT
             4          ID   INPUT FILE DATE = APR, 2016
             5          ID   DESIGN STORM = 100-YEAR 6-HR STORM
             6          ID   STORM DISTRIBUTION = SDN #3
             7          ID   MODELED BY ATKINS (HONGYU DENG, E.I.T, CFM)
             8          ID   CHECKED BY ATKINS (BRIAN ROWLEY, P.E. , CFM)
             9          ID   STORM CENTERING = ENTIRE WATERSHED
            10          ID
            11          ID   JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:
            12          ID
            13          ID           AREA    DARF
            14          ID           SQ.MI.
            15          ID                   SDN 3   SDN 4   SDN 5
            16          ID           0 - 0.5 0.99
            17          ID           0.5 - 1 0.975
            18          ID           1 - 2   0.95
            19          ID           2 - 3   0.925
            20          ID           3 - 4   0.915
            21          ID           4 - 5   0.908
            22          ID           5 - 6   0.903
            23          ID           6 - 7   0.895
            24          ID           7 - 8   0.885
            25          ID           8 - 9           0.875
            26          ID           9 - 10          0.865
            27          ID           10 - 11         0.857
            28          ID           11 - 12         0.85
            29          ID           12 - 16                 0.832
            30          ID           16 - 20                 0.804
            31          ID           20 - 30                 0.765
            32          ID           30 - 40                 0.725
            33          ID           40 - 50                 0.695
            34          ID           50 - 100                0.64
            35          ID           100 - 150               0.58
            36          ID           150 - 200               0.53
            37          ID           200 - 300               0.49
            38          IT       5       0       0     300
            39          IN       5       0       0
            40          IO       5
            41          JR    PREC    0.99   0.975    0.95   0.925   0.915   0.908   0.903   0.895   0.885

            42          KK   MRIV2
            43          BA   18.37
            44          PB    2.92
            45          PC       0    0.02   0.057    0.07   0.087   0.108   0.124    0.13    0.13    0.13
            46          PC    0.13    0.13    0.13   0.133    0.14   0.142   0.148   0.158   0.172   0.181
            47          PC    0.19   0.197   0.199     0.2   0.201   0.204   0.214   0.229   0.241   0.249
            48          PC   0.251   0.256    0.27   0.278   0.281   0.283   0.295   0.322   0.352   0.409
            49          PC   0.499    0.59    0.71   0.744   0.781   0.812   0.819   0.835   0.851   0.856
            50          PC    0.86   0.868   0.876   0.888    0.91   0.926   0.937    0.95    0.97   0.976
            51          PC   0.982   0.985   0.987   0.989    0.99   0.993   0.993   0.994   0.995   0.998
            52          PC   0.998   0.999       1
1                                        HEC-1 INPUT                                        PAGE  2
```

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

  53           LS       0    85.0
  54           UD    1.69
               *

  55           KK   MRIV1
  56           BA   22.91
  57           PB    2.86
  58           LS       0    82.8
  59           UD    2.12
               *

  60           KK  CMRIV1
  61           HC       2
               *

  62           KK RCMRIV1
  63           RD   31433   0.004    0.04       0    TRAP      20       4
               *

  64           KK   MRIV3
  65           BA   21.99
  66           PB    2.86
  67           LS       0    82.5
  68           UD    2.02
               *

  69           KK  CMRIV3
  70           HC       2
               *

  71           KK RCMRIV3
  72           RD   10746   0.003    0.04       0    TRAP      20       4
               *

  73           KK   MRIV4
  74           BA   10.45
  75           PB    2.86
  76           LS       0    87.8
  77           UD    1.76
               *

  78           KK     MDW
  79           BA   19.44
  80           PB    2.86
  81           LS       0    83.0
  82           UD    1.08
               *

  83           KK   MRIV5
  84           BA    3.26
  85           PB    2.86
  86           LS       0    86.2
  87           UD    0.79
               *
1                                                HEC-1 INPUT                                        PAGE  3

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


  88           KK  CMRIV5
  89           HC       4
               *

  90           KK RCMRIV5
  91           RD   13545   0.002    0.04       0    TRAP      20       4
               *

  92           KK   MRIV6
  93           BA    2.17
  94           PB    2.86
  95           LS       0    86.3
  96           UD    1.33
               *

  97           KK   MRIV7
  98           BA   12.41
  99           PB    2.86
 100           LS       0    87.3
 101           UD    1.21
               *

 102           KK  WSWASH
 103           BA   61.31
 104           PB    2.86
 105           LS       0    86.4
 106           UD    1.76
               *

 107           KK  CMRIV7
 108           HC       4
               *

 109           KK RCMRIV7
```

```
  110          RD   18735   0.002    0.04       0    TRAP      20       4
               *

  111          KK  EWASH8
  112          BA    3.47
  113          PB    2.86
  114          LS       0    80.7
  115          UD    1.24
               *

  116          KK  AWASH1
  117          BA    4.57
  118          PB    2.88
  119          LS       0    86.4
  120          UD    0.79
               *
1                                            HEC-1 INPUT                                            PAGE  4

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


  121          KK RAWASH1
  122          RM       2    0.20    0.15
               *

  123          KK  AWASH2
  124          BA    1.63
  125          PB    2.86
  126          LS       0    87.2
  127          UD    0.51
               *

  128          KK CAWASH2
  129          HC       2
               *

  130          KKRCAWASH2
  131          RM       7    0.58    0.15
               *

  132          KK  AWASH3
  133          BA    5.03
  134          PB    2.86
  135          LS       0    87.9
  136          UD    1.00
               *

  137          KK CAWASH3
  138          HC       2
               *

  139          KK    CMR0
  140          HC       3
               *

  141          KK   RCMR0
  142          RD    5862   0.011    0.04       0    TRAP      20       4
               *

  143          KK  WWASH6
  144          BA    1.20
  145          PB    2.86
  146          LS       0    88.9
  147          UD    0.39
               *

  148          KK  EWASH7
  149          BA    6.39
  150          PB    2.86
  151          LS       0    76.6
  152          UD    0.62
               *
1                                            HEC-1 INPUT                                            PAGE  5

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


  153          KK REWASH7
  154          RM       5    0.44    0.15
               *

  155          KK  EWASH6
  156          BA    0.78
  157          PB    2.86
  158          LS       0    80.5
  159          UD    0.67
               *

  160          KK CEWASH6
  161          HC       2
               *

  162          KK    BMN1
  163          BA    3.72
  164          PB    2.86
```

```
165           LS       0    82.6
166           UD    0.56
              *

167           KK   RBMN1
168           RM       7    0.55    0.15
              *

169           KK    BMN3
170           BA    5.12
171           PB    2.86
172           LS       0    85.3
173           UD    1.20
              *

174           KK   CBMN3
175           HC       2
              *

176           KK    BMN2
177           BA    4.08
178           PB    2.86
179           LS       0    87.3
180           UD    0.72
              *

181           KK   RBMN2
182           RM      10    0.80    0.15
              *

183           KK    BMN4
184           BA    6.98
185           PB    2.86
186           LS       0    86.5
187           UD    1.34
              *
```



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


188           KK   CBMN4
189           HC       2
              *

190           KK  CBMN34
191           HC       2
              *

192           KK RCBMN34
193           RM       3    0.22    0.15
              *

194           KK    BMN5
195           BA    1.48
196           PB    2.86
197           LS       0    75.3
198           UD    0.64
              *

199           KK    BMN6
200           BA    2.06
201           PB    2.86
202           LS       0    85.0
203           UD    1.05
              *

204           KK  CBMN56
205           HC       3
              *

206           KK RCBMN56
207           RM       1    0.07    0.15
              *

208           KK    BMN7
209           BA    0.45
210           PB    2.86
211           LS       0    81.2
212           UD    0.36
              *

213           KK   CBMN7
214           HC       2
              *

215           KK  DBFGLS
216           KM   FACILITY = FAIRGROUNDS LYMAN STREET DETENTION BASIN
217           KM   FACILITY # = FGLS 0167
218           KM   STORAGE VOLUME = 1247 AC-FT
219           KM   OUTFALL = 42" ORIFICE
220           KO       3
221           RS       1    STOR       0
222           SV       0    0.01    0.01   10.59   91.13  184.34  279.72  377.11  476.44   577.7
223           SV     681  786.23  893.49  947.86 1002.72 1058.05  1113.8 1169.91 1226.31   1282.
```

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

  224          SE    1474    1476    1478    1480    1482    1484    1486    1488    1490    1492
  225          SE    1494    1496    1498    1499    1500    1501    1502    1503    1504    1505
  226          SQ       0      25      75     103     125     144     161     176     189     202
  227          SQ     214     226     237     242     247     252     257     262     267     271
               *

  228          KK RDBFGLS
  229          RD    6081   0.007   0.013       0    CIRC       6       0
               *

  230          KK   FGDB1
  231          BA    0.39
  232          PB    2.86
  233          LS       0    76.8
  234          UD    0.35
               *

  235          KK   DETBN
  236          KM   LOCAL DETENTION BASIN FROM LOUIS BERGER
  237          KM   FAIRGROUNDS DETENTION BASIN PRELIMINARY DESIGN
  238          RS       1    STOR       0
  239          SA   0.189   0.195   1.255   1.315   1.376   1.438     1.5   1.562   1.626    1.69
  240          SA   1.754   1.819   1.884   1.947  1.9602  1.9734  1.9866  1.9998   2.013
  241          SE    1413    1414    1415    1416    1417    1418    1419    1420    1421    1422
  242          SE    1423    1424    1425    1426  1426.2  1426.4  1426.6  1426.8    1427
  243          SQ       0   14.29   25.19   32.63   38.66   43.87   48.53   52.78    56.7   60.38
  244          SQ   63.84   67.13   70.26   73.25   89.84   99.62  111.99  125.57  141.13
               *

  245          KK  CFGDB1
  246          HC       2
               *

  247          KK RCFGDB1
  248          RD    2611   0.009   0.013       0    CIRC       6       0
               *

  249          KK    FGDB
  250          BA    1.92
  251          PB    2.86
  252          LS       0    83.6
  253          UD    0.42
               *

  254          KK  DBFGWS
  255          KM   FACILITY = FAIRGROUNDS WHIPPLE DETENTION BASIN
  256          KM   REFERENCE FROM LOUIS BERGER
  257          KM   FAIRGROUNDS DETENTION BASIN PRELIMINARY DESIGN
  258          KM   FACILITY # = FGWS 0166
  259          KM   STORAGE VOLUME = 139 AC-FT
  260          KM   OUTFALL = 18" ORIFICE
  261          KO       3
  262          RS       1    STOR       0
  263          SV       0     2.6     6.3    10.9    16.5    23.2    31.1    40.3    50.6    62.2
  264          SV   75.07    89.3   104.8   121.7   140.1   160.2     182   205.8   231.5   259.2
```



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

  265          SE    1469    1481    1482    1483    1484    1485    1486    1487    1488    1489
  266          SE    1490    1491    1492    1493    1494    1495    1496    1497    1498    1499
  267          SQ       0      31      32   33.55    34.8      36   37.16   38.28   39.38   40.44
  268          SQ      41      42      43   44.45   45.39  215.07    1934    4604    7959   11878
               *

  269          KK RDBFGWS
  270          RD    5302   0.012   0.013       0    CIRC       4       0
               *

  271          KK   FGDB2
  272          BA    0.46
  273          PB    2.86
  274          LS       0    73.2
  275          UD    0.32
               *

  276          KKCRDBFGWS
  277          HC       2
               *

  278          KK  CFGDB2
  279          HC       2
               *

  280          KK RCFGDB2
  281          RD    3976   0.009   0.015       0    TRAP       7       0
               *

  282          KK  EWASH5
  283          BA    0.58
  284          PB    2.86
```

```
 285           LS       0    72.7
 286           UD    0.73
               *

 287           KK CEWASH5
 288           HC       2
               *

 289           KK    CMR1
 290           HC       4
               *

 291           KK   RCMR1
 292           RD    6490   0.003    0.04       0    TRAP      20       4
               *

 293           KK    EWDB
 294           BA    1.89
 295           PB    2.86
 296           LS       0    86.2
 297           UD    0.43
1                                      HEC-1 INPUT                                               PAGE  9

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


 298           KK  DBEWGA
 299           KM   FACILITY = GUBLER AVENUE DETENTION BASIN
 300           KM   FACILITY # = EWGA 0196
 301           KM   STORAGE VOLUME = 157 AC-FT
 302           KM   OUTFALL = 30" ORIFICE
 303           KO       3
 304           RS       1    ELEV      -1
 305           SA       1       5      10      20      22
 306           SE    1472    1476    1480    1484    1488
 307           SQ       0      42      67      84      98
               *

 308           KK RDBEWGA
 309           RD   10278   0.012   0.013       0    CIRC       4       0
               *

 310           KK  EWASH4
 311           BA    2.03
 312           PB    2.86
 313           LS       0    77.3
 314           UD    0.61
               *

 315           KK CEWASH4
 316           HC       2
               *

 317           KK  LWASH1
 318           BA    4.03
 319           PB    2.86
 320           LS       0    78.4
 321           UD    0.71
               *

 322           KK  LWASH2
 323           BA    0.70
 324           PB    2.86
 325           LS       0    82.7
 326           UD    0.50
               *

 327           KK CLWASH1
 328           HC       2
               *

 329           KKRCLWASH1
 330           RM       3    0.25    0.15
               *
1                                      HEC-1 INPUT                                               PAGE 10

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


 331           KK  LWASH3
 332           BA    1.17
 333           PB    2.86
 334           LS       0    89.0
 335           UD    0.44
               *

 336           KK CLWASH3
 337           HC       2
               *

 338           KKRCLWASH3
 339           RD    3556   0.012   0.013       0    CIRC      20       0
               *

 340           KK  WWASH5
```

```
 341           BA    1.61
 342           PB    2.86
 343           LS       0    89.4
 344           UD    0.40
               *

 345           KK RWWASH5
 346           RM       2    0.20    0.15
               *

 347           KK    LOG1
 348           BA    0.41
 349           PB    2.86
 350           LS       0    81.6
 351           UD    0.51
               *

 352           KK    CMR2
 353           HC       5
               *

 354           KK   RCMR2
 355           RD    9445   0.001   0.025       0    TRAP     200       3
               *

 356           KK  EWASH3
 357           BA    1.77
 358           PB    2.86
 359           LS       0    74.4
 360           UD    0.81
               *

 361           KK    LOG3
 362           BA    0.51
 363           PB    2.86
 364           LS       0    84.6
 365           UD    0.76
               *
```



```
 366           KK    CMR3
 367           HC       3
               *

 368           KK   RCMR3
 369           RD    4979   0.001   0.025       0    TRAP     200       3
               *

 370           KK    LOG2
 371           BA    1.62
 372           PB    2.86
 373           LS       0    84.8
 374           UD    0.67
               *

 375           KK    CMR4
 376           HC       2
               *

 377           KK   RCMR4
 378           RD    5007   0.004   0.025       0    TRAP     200       3
               *

 379           KK  EWASH2
 380           BA    4.80
 381           PB    2.86
 382           LS       0    82.9
 383           UD    0.94
               *

 384           KK    CMR5
 385           HC       2
               *

 386           KK   RCMR5
 387           RD    4696   0.002   0.025       0    TRAP     400       3
               *

 388           KK    OVR1
 389           BA    1.88
 390           PB    2.86
 391           LS       0    85.0
 392           UD    0.61
               *

 393           KK    CMR6
 394           HC       2
               *
```

```
 395           KK   RCMR6
 396           RD    3336   0.003   0.025       0    TRAP     600       3
               *

 397           KK WWASH4A
 398           BA    0.31
 399           PB    2.86
 400           LS       0    89.8
 401           UD    0.23
               *

 402           KK  WWASH4
 403           BA    0.58
 404           PB    2.86
 405           LS       0    89.4
 406           UD    0.38
               *

 407           KK CWWASH4
 408           HC       2
               *

 409           KK  DBWWWT
 410           KM   FACILITY = WITTWER AVENUE DETENTION BASIN
 411           KM   FACILITY # = WWWT 0004
 412           KM   STORAGE VOLUME = 91 ACRE-FEET
 413           KM   OUTFALL = 18" ORIFICE
 414           KO       3
 415           RS       1    ELEV      -1
 416           SA       5       6       7       8
 417           SE    1365    1370    1375    1380
 418           SQ       0      19      28      35
               *

 419           KKRCWWASH4
 420           RD    5392   0.005   0.015       0    TRAP      12       2
               *

 421           KK WWASH3A
 422           BA    0.49
 423           PB    2.86
 424           LS       0    89.6
 425           UD    0.32
               *

 426           KKCWWASH3A
 427           HC       2
               *
```



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


 428           KK  WWASH3
 429           BA    0.45
 430           PB    2.86
 431           LS       0    89.8
 432           UD    0.15
               *

 433           KK  DBWWDA
 434           KM   FACILITY = DUESING AVENUE DETENTION BASIN
 435           KM   FACILITY # = WWDA 0009
 436           KM   STORAGE VOLUME = 49 ACRE-FEET
 437           KM   OUTFALL = 18" ORIFICE
 438           KO       3
 439           RS       1    ELEV      -1
 440           SA       1       4       6       7       8
 441           SE    1335    1337    1340    1342    1345
 442           SQ       0      10      19      23      28
               *

 443           KK CWWASH3
 444           HC       2
               *

 445           KKRCWWASH3
 446           RD    4532   0.004   0.015       0    TRAP      12       2
               *

 447           KK WWASH2A
 448           BA    0.39
 449           PB    2.86
 450           LS       0    85.7
 451           UD    0.37
               *

 452           KKCWWASH2A
 453           HC       2
               *

 454           KK  WWASH2
 455           BA    1.90
 456           PB    2.86
```

```
 457           LS       0    88.4
 458           UD    0.54
               *

 459           KK  DBWWCA
 460           KM   FACILITY = COTTONWOOD AVENUE DETENTION BASIN
 461           KM   FACILITY # = WWCA 0050
 462           KM   STORAGE VOLUME = 156 ACRE-FEET
 463           KM   OUTFALL  = 30" ORIFICE
 464           KO       3
 465           RS       1    ELEV      -1
 466           SA       1       3       6       8       9      10
 467           SE    1365    1370    1375    1380    1385    1390
```



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

 468           SQ       0      50      76      95     111     125
               *

 469           KK RDBWWCA
 470           RD    2608   0.020   0.013       0    CIRC       5       0
               *

 471           KK CWWASH2
 472           HC       2
               *

 473           KKRCWWASH2
 474           RD    2310   0.004   0.015       0    TRAP      12       2
               *

 475           KK  WIWASH
 476           BA    3.50
 477           PB    2.86
 478           LS       0    80.9
 479           UD    0.91
               *

 480           KK  DBWWWI
 481           KM   FACILITY = WEIBER WASH DETENTION BASIN
 482           KM   FACILITY # = WWWI 0027
 483           KM   STORAGE VOLUME = 182 ACRE-FEET
 484           KM   OUTFALL = 30" ORIFICE
 485           KO       3
 486           RS       1    ELEV      -1
 487           SA       3       4       6       8      10
 488           SE    1325    1332    1340    1347    1355
 489           SQ       0      61      95     117     137
               *

 490           KK CWIWASH
 491           HC       2
               *

 492           KKRCWIWASH
 493           RD    4030   0.004   0.015       0    TRAP      12       2
               *

 494           KK WWASH1B
 495           BA    2.63
 496           PB    2.86
 497           LS       0    88.4
 498           UD    0.43
               *

 499           KK  DBWWWA
 500           KM   FACILITY = WEST WASH 1 DETENTION BASIN
 501           KM   FACILITY # = WWWA 0017
 502           KM   STORAGE VOLUME = 235 ACRE-FEET
 503           KM   OUTFALL = 36" ORIFICE
 504           KO       3
```



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

 505           RS       1    ELEV      -1
 506           SA       2      11      20      26      30
 507           SE    1300    1303    1307    1311    1315
 508           SQ       0      45      86     114     135
               *

 509           KKCWWASH1B
 510           HC       2
               *

 511           KKRCWWAS1B
 512           RD    1606   0.004   0.015       0    TRAP      12       2
               *

 513           KK WWASH1A
 514           BA    1.25
 515           PB    2.86
 516           LS       0    88.1
 517           UD    0.34
```

```
                *

   518          KK  DBWWIA
   519          KM   Facility = INGRAM AVENUE DETENTION BASIN
   520          KM   Facility # = WWWA 0016
   521          KM   STORAGE VOLUME = 108 ACRE-FEET
   522          KM   OUTLET = 30" ORIFICE
   523          KO       3
   524          RS       1    ELEV      -1
   525          SA       1       6      11      14
   526          SE    1295    1300    1305    1310
   527          SQ       0      50      76      95
                *

   528          KKCWWASH1A
   529          HC       2
                *

   530          KKRCWWAS1A
   531          RD    3078   0.004   0.015       0    TRAP      12       2
                *

   532          KK  OWASHS
   533          BA   11.43
   534          PB    3.02
   535          LS       0    80.9
   536          UD    0.80
                *

   537          KK  OWASHN
   538          BA    5.95
   539          PB    2.90
   540          LS       0    84.0
   541          UD    0.89
                *
```



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


   542          KK COWASHS
   543          HC       2
                *

   544          KKRCOWASHS
   545          RM       4    0.31    0.15
                *

   546          KK  OWASH1
   547          BA    2.44
   548          PB    2.86
   549          LS       0    76.8
   550          UD    0.79
                *

   551          KK COWASH1
   552          HC       2
                *

   553          KK  RORIDG
   554          KM   Route through Overton Ridge from USCOE
   555          KM   Dentention Basin cards from 1988 and 1994 MVMPU
   556          RS       1    STOR       0       0
   557          SV      10      20      40      80     160     270     500
   558          SQ       0     350    1070    3580    7600   13000   20580
                *

   559          KKRCOWASH1
   560          RM       3    0.22    0.15
                *

   561          KK  OWASH2
   562          BA    2.43
   563          PB    2.86
   564          LS       0    84.3
   565          UD    0.61
                *

   566          KKCCOWASH2
   567          HC       2
                *

   568          KK  DBWWPA
   569          KM   FACILITY = PERKINS AVENUE DETENTION BASIN
   570          KM   Facility # = WWPA 0018
   571          KM   STORAGE VOLUME = 992 ACRE-FEET
   572          KM   OUTLET = 42" ORIFICE
   573          KO       3
   574          RS       1    ELEV      -1
   575          SA       1      12      32      49      56
   576          SE    1290    1300    1308    1315    1325
   577          SQ       0     144     202     242     289
                *
```

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


 578          KK COWASH2
 579          HC       2
              *

 580          KKRCOWASH2
 581          RD    2591   0.004   0.015       0    TRAP      12       2
              *

 582          KK  OWASH3
 583          BA    0.32
 584          PB    2.86
 585          LS       0    88.6
 586          UD    0.28
              *

 587          KK COWASH3
 588          HC       2
              *

 589          KKRCOWASH3
 590          RD    4701   0.005   0.015       0    TRAP      12       2
              *

 591          KK    OVR2
 592          BA    0.47
 593          PB    2.86
 594          LS       0    81.4
 595          UD    0.46
              *

 596          KK   COVR2
 597          HC       2
              *

 598          KK    CMR7
 599          HC       2
              *

 600          KK   RCMR7
 601          RD    2035   0.004   0.025       0    TRAP     600       3
              *

 602          KK    OVR3
 603          BA    0.45
 604          PB    2.86
 605          LS       0    77.1
 606          UD    0.44
              *
```



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


 607          KK    CMR8
 608          HC       2
              *

 609          KK   RCMR8
 610          RD    2730   0.004   0.025       0    TRAP     600       3
              *

 611          KK  EWASH1
 612          BA    6.33
 613          PB    2.86
 614          LS       0    80.9
 615          UD    1.20
              *

 616          KK    CMR9
 617          HC       2
              *

 618          KK   RCMR9
 619          RD    2796   0.004   0.025       0    TRAP     600       3
              *

 620          KK   MAGW1
 621          BA    5.52
 622          PB    2.86
 623          LS       0    76.0
 624          UD    1.26
              *

 625          KK  RMAGW1
 626          RM       6    0.52    0.15
              *

 627          KK   MAGW2
 628          BA    4.81
 629          PB    2.86
 630          LS       0    81.8
 631          UD    1.06
```

```
                    *

           632           KK  CMAGW2
           633           HC       2
                         *

           634           KK   CMR10
           635           HC       2
                         *
1                                                       HEC-1 INPUT                                          PAGE 19

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


           636           KK    BMN8
           637           BA    1.27
           638           PB    2.86
           639           LS       0    67.6
           640           UD    0.52
                         *

           641           KK  BOWMAN
           642           BA    0.30
           643           PB    2.86
           644           LS       0    33.4
           645           UD    0.99
                         *

           646           KK CBOWMAN
           647           HC       2
                         *
           648           ZZ
1
                  SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE       (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

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

    42        MRIV2
                  .
                  .
    55            .       MRIV1
                  .           .
                  .           .
    60       CMRIV1............
                  V
                  V
    62      RCMRIV1
                  .
                  .
    64            .       MRIV3
                  .           .
                  .           .
    69       CMRIV3............
                  V
                  V
    71      RCMRIV3
                  .
                  .
    73            .       MRIV4
                  .           .
                  .           .
    78            .           .         MDW
                  .           .           .
                  .           .           .
    83            .           .           .       MRIV5
                  .           .           .           .
                  .           .           .           .
    88       CMRIV5....................................
                  V
                  V
    90      RCMRIV5
                  .
                  .
    92            .       MRIV6
                  .           .
                  .           .
    97            .           .       MRIV7
                  .           .           .
                  .           .           .
   102            .           .           .      WSWASH
                  .           .           .           .
                  .           .           .           .
   107       CMRIV7....................................
                  V
                  V
   109      RCMRIV7
                  .
                  .
   111            .      EWASH8
                  .           .
                  .           .
   116            .           .      AWASH1
                  .           .           V
```

```
              .           .           V
121           .           .     RAWASH1
              .           .           .
              .           .           .
123           .           .           .      AWASH2
              .           .           .           .
              .           .           .           .
128           .           .     CAWASH2............
              .           .           V
              .           .           V
130           .           .    RCAWASH2
              .           .           .
              .           .           .
132           .           .           .      AWASH3
              .           .           .           .
              .           .           .           .
137           .           .     CAWASH3............
              .           .           .
              .           .           .
139        CMR0........................
              V
              V
141       RCMR0
              .
              .
143           .      WWASH6
              .           .
              .           .
148           .           .      EWASH7
              .           .           V
              .           .           V
153           .           .     REWASH7
              .           .           .
              .           .           .
155           .           .           .      EWASH6
              .           .           .           .
              .           .           .           .
160           .           .     CEWASH6............
              .           .           .
              .           .           .
162           .           .           .        BMN1
              .           .           .           V
              .           .           .           V
167           .           .           .       RBMN1
              .           .           .           .
              .           .           .           .
169           .           .           .           .        BMN3
              .           .           .           .           .
              .           .           .           .           .
174           .           .           .       CBMN3............
              .           .           .           .
              .           .           .           .
176           .           .           .           .        BMN2
              .           .           .           .           V
              .           .           .           .           V
181           .           .           .           .       RBMN2
              .           .           .           .           .
              .           .           .           .           .
183           .           .           .           .           .        BMN4
              .           .           .           .           .           .
              .           .           .           .           .           .
188           .           .           .           .       CBMN4............
              .           .           .           .           .
              .           .           .           .           .
190           .           .           .      CBMN34............
              .           .           .           V
              .           .           .           V
192           .           .           .     RCBMN34
              .           .           .           .
              .           .           .           .
194           .           .           .           .        BMN5
              .           .           .           .           .
              .           .           .           .           .
199           .           .           .           .           .        BMN6
              .           .           .           .           .           .
              .           .           .           .           .           .
204           .           .           .      CBMN56........................
              .           .           .           V
              .           .           .           V
206           .           .           .     RCBMN56
              .           .           .           .
              .           .           .           .
208           .           .           .           .        BMN7
              .           .           .           .           .
              .           .           .           .           .
213           .           .           .       CBMN7............
              .           .           .           V
              .           .           .           V
215           .           .           .      DBFGLS
              .           .           .           V
              .           .           .           V
228           .           .           .     RDBFGLS
              .           .           .           .
              .           .           .           .
230           .           .           .           .       FGDB1
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              .           .           .           .           V
              .           .           .           .           V
235           .           .           .           .       DETBN
              .           .           .           .           .
              .           .           .           .           .
245           .           .           .      CFGDB1............
              .           .           .           V
              .           .           .           V
247           .           .           .     RCFGDB1
              .           .           .           .
              .           .           .           .
249           .           .           .           .        FGDB
              .           .           .           .           V
              .           .           .           .           V
254           .           .           .           .      DBFGWS
              .           .           .           .           V
              .           .           .           .           V
269           .           .           .           .     RDBFGWS
              .           .           .           .           .
              .           .           .           .           .
271           .           .           .           .           .       FGDB2
              .           .           .           .           .           .
              .           .           .           .           .           .
276           .           .           .           .    CRDBFGWS............
              .           .           .           .           .
              .           .           .           .           .
278           .           .           .      CFGDB2............
              .           .           .           V
              .           .           .           V
280           .           .           .     RCFGDB2
              .           .           .           .
              .           .           .           .
282           .           .           .           .      EWASH5
              .           .           .           .           .
              .           .           .           .           .
287           .           .           .     CEWASH5............
              .           .           .           .
              .           .           .           .
289        CMR1....................................
              V
              V
291       RCMR1
              .
              .
293           .        EWDB
              .           V
              .           V
298           .      DBEWGA
              .           V
              .           V
308           .     RDBEWGA
              .           .
              .           .
310           .           .      EWASH4
              .           .           .
              .           .           .
315           .     CEWASH4............
              .           .
              .           .
317           .           .      LWASH1
              .           .           .
              .           .           .
322           .           .           .      LWASH2
              .           .           .           .
              .           .           .           .
327           .           .     CLWASH1............
              .           .           V
              .           .           V
329           .           .    RCLWASH1
              .           .           .
              .           .           .
331           .           .           .      LWASH3
              .           .           .           .
              .           .           .           .
336           .           .     CLWASH3............
              .           .           V
              .           .           V
338           .           .    RCLWASH3
              .           .           .
              .           .           .
340           .           .           .      WWASH5
              .           .           .           V
              .           .           .           V
345           .           .           .     RWWASH5
              .           .           .           .
              .           .           .           .
347           .           .           .           .        LOG1
              .           .           .           .           .
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352        CMR2................................................
              V
              V
354       RCMR2
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356           .      EWASH3
              .           .
              .           .
361           .           .        LOG3
              .           .           .
              .           .           .
366        CMR3........................
              V
              V
368       RCMR3
              .
              .
370           .        LOG2
              .           .
              .           .
375        CMR4............
              V
              V
377       RCMR4
              .
              .
379           .      EWASH2
              .           .
              .           .
384        CMR5............
              V
              V
386       RCMR5
              .
              .
388           .        OVR1
              .           .
              .           .
393        CMR6............
              V
              V
395       RCMR6
              .
              .
397           .     WWASH4A
              .           .
              .           .
402           .           .      WWASH4
              .           .           .
              .           .           .
407           .     CWWASH4............
              .           V
              .           V
409           .      DBWWWT
              .           V
              .           V
419           .    RCWWASH4
              .           .
              .           .
421           .           .     WWASH3A
              .           .           .
              .           .           .
426           .    CWWASH3A............
              .           .
              .           .
428           .           .      WWASH3
              .           .           V
              .           .           V
433           .           .      DBWWDA
              .           .           .
              .           .           .
443           .     CWWASH3............
              .           V
              .           V
445           .    RCWWASH3
              .           .
              .           .
447           .           .     WWASH2A
              .           .           .
              .           .           .
452           .    CWWASH2A............
              .           .
              .           .
454           .           .      WWASH2
              .           .           V
              .           .           V
459           .           .      DBWWCA
              .           .           V
              .           .           V
469           .           .     RDBWWCA
              .           .           .
              .           .           .
471           .     CWWASH2............
              .           V
              .           V
473           .    RCWWASH2
              .           .
              .           .
475           .           .      WIWASH
              .           .           V
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              .           .           V
480           .           .      DBWWWI
              .           .           .
              .           .           .
490           .     CWIWASH............
              .           V
              .           V
492           .    RCWIWASH
              .           .
              .           .
494           .           .     WWASH1B
              .           .           V
              .           .           V
499           .           .      DBWWWA
              .           .           .
              .           .           .
509           .    CWWASH1B............
              .           V
              .           V
511           .    RCWWAS1B
              .           .
              .           .
513           .           .     WWASH1A
              .           .           V
              .           .           V
518           .           .      DBWWIA
              .           .           .
              .           .           .
528           .    CWWASH1A............
              .           V
              .           V
530           .    RCWWAS1A
              .           .
              .           .
532           .           .      OWASHS
              .           .           .
              .           .           .
537           .           .           .      OWASHN
              .           .           .           .
              .           .           .           .
542           .           .     COWASHS............
              .           .           V
              .           .           V
544           .           .    RCOWASHS
              .           .           .
              .           .           .
546           .           .           .      OWASH1
              .           .           .           .
              .           .           .           .
551           .           .     COWASH1............
              .           .           V
              .           .           V
553           .           .      RORIDG
              .           .           V
              .           .           V
559           .           .    RCOWASH1
              .           .           .
              .           .           .
561           .           .           .      OWASH2
              .           .           .           .
              .           .           .           .
566           .           .    CCOWASH2............
              .           .           V
              .           .           V
568           .           .      DBWWPA
              .           .           .
              .           .           .
578           .     COWASH2............
              .           V
              .           V
580           .    RCOWASH2
              .           .
              .           .
582           .           .      OWASH3
              .           .           .
              .           .           .
587           .     COWASH3............
              .           V
              .           V
589           .    RCOWASH3
              .           .
              .           .
591           .           .        OVR2
              .           .           .
              .           .           .
596           .       COVR2............
              .           .
              .           .
598        CMR7............
              V
              V
600       RCMR7
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602           .        OVR3
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              .           .
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  607        CMR8............
              V
              V
  609       RCMR8
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  611         .      EWASH1
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              .           .
  616        CMR9............
              V
              V
  618       RCMR9
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              .
  620         .       MAGW1
              .           V
              .           V
  625         .      RMAGW1
              .           .
              .           .
  627         .           .       MAGW2
              .           .           .
              .           .           .
  632         .      CMAGW2............
              .           .
              .           .
  634       CMR10............
              .
              .
  636         .        BMN8
              .           .
              .           .
  641         .           .      BOWMAN
              .           .           .
              .           .           .
  646         .     CBOWMAN............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
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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   03MAY16  TIME  11:42:34   *                                      *          (916) 756-1104             *
 *                                       *                                      *                                     *
 *****************************************                                      ***************************************
```

```
                         2016 FLOOD CONTROL MASTER PLAN UPDATE
                         MUDDY RIVER AND TRIBUTARY WASHES
                         INPUT FILE = MRMPU3.DAT
                         INPUT FILE DATE = APR, 2016
                         DESIGN STORM = 100-YEAR 6-HR STORM
                         STORM DISTRIBUTION = SDN #3
                         MODELED BY ATKINS (HONGYU DENG, E.I.T, CFM)
                         CHECKED BY ATKINS (BRIAN ROWLEY, P.E. , CFM)
                         STORM CENTERING = ENTIRE WATERSHED

                         JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:

                                 AREA    DARF
                                 SQ.MI.
                                         SDN 3   SDN 4   SDN 5
                                 0 - 0.5 0.99
                                 0.5 - 1 0.975
                                 1 - 2   0.95
                                 2 - 3   0.925
                                 3 - 4   0.915
                                 4 - 5   0.908
                                 5 - 6   0.903
                                 6 - 7   0.895
                                 7 - 8   0.885
                                 8 - 9           0.875
                                 9 - 10          0.865
                                 10 - 11         0.857
                                 11 - 12         0.85
                                 12 - 16                 0.832
                                 16 - 20                 0.804
                                 20 - 30                 0.765
                                 30 - 40                 0.725
                                 40 - 50                 0.695
                                 50 - 100                0.64
                                 100 - 150               0.58
                                 150 - 200               0.53
                                 200 - 300               0.49

  40 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      1    0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2    0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   24.92 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

     JP         MULTI-PLAN OPTION
                    NPLAN          1  NUMBER OF PLANS

     JR         MULTI-RATIO OPTION
                   RATIOS OF PRECIPITATION
                  .99       .98       .95       .93       .92       .91       .90       .89       .88


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


            **************
            *            *
 215 KK     *    DBFGLS  *
            *            *
            **************

 220 KO         OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

              HYDROGRAPH ROUTING DATA

 221 RS         STORAGE ROUTING
                    NSTPS          1  NUMBER OF SUBREACHES
                     ITYP       STOR  TYPE OF INITIAL CONDITION
                   RSVRIC        .00  INITIAL CONDITION
                        X        .00 WORKING R AND D COEFFICIENT

 222 SV           STORAGE          .0        .0        .0      10.6      91.1     184.3     279.7     377.1     476.4     577.7
                                681.0     786.2     893.5     947.9    1002.7    1058.1    1113.8    1169.9    1226.3    1282.0

 224 SE         ELEVATION     1474.00   1476.00   1478.00   1480.00   1482.00   1484.00   1486.00   1488.00   1490.00   1492.00
                              1494.00   1496.00   1498.00   1499.00   1500.00   1501.00   1502.00   1503.00   1504.00   1505.00

 226 SQ         DISCHARGE          0.       25.       75.      103.      125.      144.      161.      176.      189.      202.
                                 214.      226.      237.      242.      247.      252.      257.      262.      267.      271.
                                                                ***

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN        0. TO       25.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

WARNING --- ROUTED OUTFLOW (    272.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (    275.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (    278.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (    280.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (    283.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (    285.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (    287.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

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WARNING --- ROUTED OUTFLOW (    296.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE
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                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .99

   PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                           (CFS)
 +     302.      8.50                299.        253.        244.         244.
                        (INCHES)     .117        .394        .394         .394
                         (AC-FT)     148.        502.        502.         502.

  PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
      1714.      8.50               1678.       1271.       1225.        1225.

   PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1512.77      8.50             1512.11     1504.19     1503.08      1503.08

                        CUMULATIVE AREA =   23.89 SQ MI

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HYDROGRAPH AT STATION DBFGLS
FOR PLAN 1, RATIO = .98

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 299.	8.50		296.	251.	241.	241.
		(INCHES)	.115	.390	.390	.390
		(AC-FT)	147.	497.	497.	497.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
1671.	8.50	1635.	1237.	1192.	1192.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1511.99	8.50	1511.34	1503.56	1502.47	1502.47

CUMULATIVE AREA = 23.89 SQ MI

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                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .95

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+     294.      8.50                  291.        246.        237.         237.
                        (INCHES)      .113        .383        .383         .383
                        (AC-FT)       144.        488.        488.         488.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
    1600.       8.50                 1564.       1180.       1137.        1137.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1510.71      8.50               1510.07     1502.52     1501.47      1501.47

                        CUMULATIVE AREA =   23.89 SQ MI

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                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .93

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                         6-HR        24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                             (CFS)
 +     289.      8.50                    286.         242.        233.         233.
                           (INCHES)      .111         .376        .376         .376
                            (AC-FT)      142.         479.        479.         479.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                         6-HR        24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
      1529.      8.50                   1494.        1124.       1083.        1083.

   PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                         6-HR        24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
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 1509.43      8.50               1508.80     1501.49     1500.48      1500.48

                     CUMULATIVE AREA =   23.89 SQ MI

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HYDROGRAPH AT STATION DBFGLS
FOR PLAN 1, RATIO = .92

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 287.	8.50		284.	240.	231.	231.
		(INCHES)	.111	.373	.373	.373
		(AC-FT)	141.	476.	476.	476.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
1501.	8.50	1466.	1102.	1061.	1061.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1508.92	8.50	1508.30	1501.09	1500.09	1500.09

CUMULATIVE AREA = 23.89 SQ MI

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                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .91

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     285.      8.50                  283.        239.        230.        230.
                        (INCHES)      .110        .371        .371        .371
                         (AC-FT)      140.        473.        473.        473.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
    1481.       8.50                 1446.       1086.       1046.       1046.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1508.57      8.50               1507.95     1500.80     1499.81     1499.81

                        CUMULATIVE AREA =   23.89 SQ MI

WARNING --- ROUTED OUTFLOW (    271.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

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HYDROGRAPH AT STATION DBFGLS
FOR PLAN 1, RATIO = .90

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 284.	8.50		282.	238.	229.	229.
		(INCHES)	.110	.370	.370	.370
		(AC-FT)	140.	471.	471.	471.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
1467.	8.50	1432.	1075.	1036.	1036.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1508.32	8.50	1507.70	1500.60	1499.62	1499.62

CUMULATIVE AREA = 23.89 SQ MI

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                          HYDROGRAPH AT STATION   DBFGLS
                            FOR PLAN 1, RATIO =  .89

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+     283.      8.50                  280.        236.        227.         227.
                         (INCHES)     .109        .368        .368         .368
                          (AC-FT)     139.        468.        468.         468.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1444.      8.50                 1410.       1057.       1018.        1018.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1507.92      8.50               1507.30     1500.27     1499.31      1499.31

                         CUMULATIVE AREA =   23.89 SQ MI


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                        HYDROGRAPH AT STATION   DBFGLS
                          FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+     281.      8.42                 278.        234.        226.         226.
                       (INCHES)      .108        .365        .365         .365
                        (AC-FT)      138.        465.        465.         465.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1416.      8.50                1383.       1035.        997.         997.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1507.41      8.50              1506.81     1499.87     1498.92      1498.92

                       CUMULATIVE AREA =    23.89 SQ MI


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            *            *
 254 KK     *    DBFGWS  *
            *            *
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 261 KO          OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

 262 RS          STORAGE ROUTING
                       NSTPS          1  NUMBER OF SUBREACHES
                        ITYP       STOR  TYPE OF INITIAL CONDITION
                      RSVRIC        .00  INITIAL CONDITION
                           X        .00 WORKING R AND D COEFFICIENT

 263 SV            STORAGE          .0       2.6       6.3      10.9      16.5      23.2      31.1      40.3      50.6      62.2
                                  75.1      89.3     104.8     121.7     140.1     160.2     182.0     205.8     231.5     259.2

 265 SE          ELEVATION     1469.00   1481.00   1482.00   1483.00   1484.00   1485.00   1486.00   1487.00   1488.00   1489.00
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		1490.00	1491.00	1492.00	1493.00	1494.00	1495.00	1496.00	1497.00	1498.00	1499.00
267 SQ	DISCHARGE	0.	31.	32.	34.	35.	36.	37.	38.	39.	40.
		41.	42.	43.	44.	45.	215.	1934.	4604.	7959.	11878.

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HYDROGRAPH AT STATION DBFGWS
FOR PLAN 1, RATIO = .99

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 45.	6.25		44.	39.	38.	38.
		(INCHES)	.214	.758	.758	.758
		(AC-FT)	22.	78.	78.	78.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
125.	6.25	118.	83.	80.	80.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1493.17	6.25	1492.77	1489.29	1488.55	1488.55

CUMULATIVE AREA = 1.92 SQ MI

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HYDROGRAPH AT STATION DBFGWS
FOR PLAN 1, RATIO = .98

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 44.	6.25		44.	39.	37.	37.
		(INCHES)	.212	.753	.753	.753
		(AC-FT)	22.	77.	77.	77.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
121.	6.25	115.	80.	77.	77.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1492.99	6.25	1492.58	1489.09	1488.35	1488.35

CUMULATIVE AREA = 1.92 SQ MI

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HYDROGRAPH AT STATION DBFGWS
FOR PLAN 1, RATIO = .95

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 44.	6.25		43.	38.	37.	37.
		(INCHES)	.210	.745	.745	.745
		(AC-FT)	22.	76.	76.	76.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
116.	6.25	109.	76.	73.	73.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1492.66	6.25	1492.26	1488.74	1488.01	1488.01

CUMULATIVE AREA = 1.92 SQ MI

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HYDROGRAPH AT STATION DBFGWS
FOR PLAN 1, RATIO = .93

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 43.	6.25		43.	38.	37.	37.

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                    (INCHES)      .208        .737        .737         .737
                     (AC-FT)       21.         76.         76.          76.

 PEAK STORAGE   TIME                     MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
      110.      6.25               104.         71.        68.          68.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1492.34      6.25            1491.93     1488.37    1487.66      1487.66

                     CUMULATIVE AREA =    1.92 SQ MI


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                      HYDROGRAPH AT STATION   DBFGWS
                        FOR PLAN 1, RATIO =  .92

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                      (CFS)
+      43.      6.25                43.         38.        37.          37.
                    (INCHES)      .207        .734       .734         .734
                     (AC-FT)       21.         75.        75.          75.

 PEAK STORAGE   TIME                     MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
      108.      6.25               102.         69.        67.          67.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1492.21      6.25            1491.80     1488.23    1487.52      1487.52

                     CUMULATIVE AREA =    1.92 SQ MI


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

                      HYDROGRAPH AT STATION   DBFGWS
                        FOR PLAN 1, RATIO =  .91

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                      (CFS)
+      43.      6.25                43.         38.        36.          36.
                    (INCHES)      .207        .732       .732         .732
                     (AC-FT)       21.         75.        75.          75.

 PEAK STORAGE   TIME                     MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
      107.      6.25               100.         68.        65.          65.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1492.12      6.25            1491.70     1488.12    1487.42      1487.42

                     CUMULATIVE AREA =    1.92 SQ MI


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

                      HYDROGRAPH AT STATION   DBFGWS
                        FOR PLAN 1, RATIO =  .90

  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                      (CFS)
+      43.      6.25                43.         38.        36.          36.
                    (INCHES)      .206        .730       .730         .730
                     (AC-FT)       21.         75.        75.          75.

 PEAK STORAGE   TIME                     MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
      106.      6.25                99.         67.        65.          65.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1492.06      6.25            1491.63     1488.05    1487.35      1487.35

                     CUMULATIVE AREA =    1.92 SQ MI


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                        HYDROGRAPH AT STATION   DBFGWS
                          FOR PLAN 1, RATIO =  .89

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      43.      6.17                   43.         38.         36.          36.
                        (INCHES)      .206        .728        .728         .728
                         (AC-FT)       21.         75.         75.          75.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      104.      6.25                   97.         66.         63.          63.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1491.95      6.25               1491.52     1487.93     1487.23      1487.23

                       CUMULATIVE AREA =    1.92 SQ MI


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

                        HYDROGRAPH AT STATION   DBFGWS
                          FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      43.      6.17                   42.         37.         36.          36.
                        (INCHES)      .205        .724        .724         .724
                         (AC-FT)       21.         74.         74.          74.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      102.      6.25                   95.         64.         61.          61.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1491.81      6.25               1491.39     1487.77     1487.08      1487.08

                       CUMULATIVE AREA =    1.92 SQ MI



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            *            *
  298 KK    *    DBEWGA  *
            *            *
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  303 KO         OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  304 RS         STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC       -1.00  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

  305 SA              AREA         1.0       5.0      10.0      20.0      22.0

  306 SE         ELEVATION     1472.00   1476.00   1480.00   1484.00   1488.00

  307 SQ         DISCHARGE          0.       42.       67.       84.       98.

                                                                               ***

                                                               COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     10.98     40.41     99.27    183.23
          ELEVATION    1472.00   1476.00   1480.00   1484.00   1488.00

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

                        HYDROGRAPH AT STATION   DBEWGA
                          FOR PLAN 1, RATIO =  .99

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
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+   (CFS)       (HR)
                          (CFS)
+      90.      5.92                  87.        68.        66.         66.
                        (INCHES)     .430      1.342      1.342       1.342
                         (AC-FT)      43.       135.       135.        135.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
      133.      5.92                 120.        68.        65.         65.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1485.59      5.92              1484.97    1481.12    1480.79     1480.79

                         CUMULATIVE AREA =    1.89 SQ MI


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

                          HYDROGRAPH AT STATION   DBEWGA
                            FOR PLAN 1, RATIO =  .98

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      89.      5.92                  87.        67.        65.         65.
                        (INCHES)     .427      1.324      1.324       1.324
                         (AC-FT)      43.       133.       133.        133.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
      129.      5.92                 116.        65.        63.         63.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1485.43      5.92              1484.81    1480.93    1480.61     1480.61

                         CUMULATIVE AREA =    1.89 SQ MI


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

                          HYDROGRAPH AT STATION   DBEWGA
                            FOR PLAN 1, RATIO =  .95

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      88.      5.92                  86.        66.        63.         63.
                        (INCHES)     .423      1.293      1.293       1.293
                         (AC-FT)      43.       130.       130.        130.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
      124.      5.92                 111.        61.        59.         59.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1485.16      5.92              1484.55    1480.62    1480.30     1480.30

                         CUMULATIVE AREA =    1.89 SQ MI


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

                          HYDROGRAPH AT STATION   DBEWGA
                            FOR PLAN 1, RATIO =  .93

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      87.      5.92                  85.        64.        62.         62.
                        (INCHES)     .417      1.261      1.261       1.261
                         (AC-FT)      42.       127.       127.        127.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
      118.      5.92                 106.        57.        55.         55.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1484.90      5.92              1484.27    1480.30    1479.99     1479.99

                         CUMULATIVE AREA =    1.89 SQ MI
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      ***            ***            ***            ***            ***

                       HYDROGRAPH AT STATION   DBEWGA
                         FOR PLAN 1, RATIO =  .92

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      87.      5.92                   84.         63.         61.          61.
                        (INCHES)      .415       1.248       1.248        1.248
                         (AC-FT)       42.        126.        126.         126.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      116.      5.92                  103.         55.         53.          53.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1484.79      5.92               1484.15     1480.17     1479.87      1479.87

                      CUMULATIVE AREA =    1.89 SQ MI


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

                       HYDROGRAPH AT STATION   DBEWGA
                         FOR PLAN 1, RATIO =  .91

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      87.      5.92                   84.         63.         61.          61.
                        (INCHES)      .414       1.238       1.238        1.238
                         (AC-FT)       42.        125.        125.         125.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      114.      5.92                  102.         54.         52.          52.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1484.72      5.92               1484.07     1480.08     1479.78      1479.78

                      CUMULATIVE AREA =    1.89 SQ MI


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

                       HYDROGRAPH AT STATION   DBEWGA
                         FOR PLAN 1, RATIO =  .90

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      86.      5.92                   84.         63.         60.          60.
                        (INCHES)      .413       1.231       1.231        1.231
                         (AC-FT)       42.        124.        124.         124.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      113.      5.92                  101.         53.         51.          51.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1484.67      5.92               1484.01     1480.01     1479.71      1479.71

                      CUMULATIVE AREA =    1.89 SQ MI


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

                       HYDROGRAPH AT STATION   DBEWGA
                         FOR PLAN 1, RATIO =  .89

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      86.      5.92                   84.         62.         60.          60.
                        (INCHES)      .411       1.219       1.219        1.219
                         (AC-FT)       41.        123.        123.         123.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
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+  (AC-FT)      (HR)
      112.      5.92                  99.        52.        50.         50.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR      24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1484.58      5.92              1483.92    1479.90    1479.61      1479.61

                         CUMULATIVE AREA =    1.89 SQ MI


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

                          HYDROGRAPH AT STATION   DBEWGA
                            FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR      24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      86.      5.92                  83.        61.        59.         59.
                        (INCHES)     .408      1.204      1.204       1.204
                         (AC-FT)      41.       121.       121.        121.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR      24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
      109.      5.92                  97.        51.        49.         49.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR      24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1484.48      5.92              1483.80    1479.76    1479.48      1479.48

                         CUMULATIVE AREA =    1.89 SQ MI



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

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            *            *
  409 KK    *    DBWWWT  *
            *            *
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  414 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  415 RS         STORAGE ROUTING
                       NSTPS          1  NUMBER OF SUBREACHES
                        ITYP       ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC      -1.00  INITIAL CONDITION
                           X        .00 WORKING R AND D COEFFICIENT

  416 SA              AREA         5.0       6.0       7.0       8.0

  417 SE         ELEVATION     1365.00   1370.00   1375.00   1380.00

  418 SQ         DISCHARGE          0.       19.       28.       35.

                                                              ***

                                                  COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     27.46     59.93     97.40
          ELEVATION    1365.00   1370.00   1375.00   1380.00

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

                          HYDROGRAPH AT STATION   DBWWWT
                            FOR PLAN 1, RATIO =  .99

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR      24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      31.      5.92                  30.        24.        23.         23.
                        (INCHES)     .318      1.012      1.013       1.013
                         (AC-FT)      15.        48.        48.         48.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR      24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
       78.      6.00                  73.        51.        50.         50.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR      24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
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  1377.40      6.00             1376.77    1373.54    1373.23     1373.23

                    CUMULATIVE AREA =     .89 SQ MI


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

                     HYDROGRAPH AT STATION   DBWWWT
                       FOR PLAN 1, RATIO =  .98

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                       (CFS)
+      31.      5.92                30.        24.        23.         23.
                    (INCHES)      .315       .999       .999        .999
                     (AC-FT)       15.        47.        47.         47.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                   6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
       76.      6.00                71.        50.        48.         48.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                   6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
  1377.17      6.00             1376.54    1373.35    1373.04     1373.04

                    CUMULATIVE AREA =     .89 SQ MI


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

                     HYDROGRAPH AT STATION   DBWWWT
                       FOR PLAN 1, RATIO =  .95

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                       (CFS)
+      30.      5.92                30.        23.        23.         23.
                    (INCHES)      .310       .976       .976        .976
                     (AC-FT)       15.        46.        46.         46.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                   6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
       73.      5.92                69.        48.        46.         46.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                   6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
  1376.78      5.92             1376.17    1373.03    1372.73     1372.73

                    CUMULATIVE AREA =     .89 SQ MI


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

                     HYDROGRAPH AT STATION   DBWWWT
                       FOR PLAN 1, RATIO =  .93

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                       (CFS)
+      30.      5.92                29.        23.        22.         22.
                    (INCHES)      .304       .953       .953        .953
                     (AC-FT)       14.        45.        45.         45.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                   6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
       70.      5.92                66.        46.        44.         44.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                   6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
  1376.40      5.92             1375.80    1372.71    1372.42     1372.42

                    CUMULATIVE AREA =     .89 SQ MI


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

                     HYDROGRAPH AT STATION   DBWWWT
                       FOR PLAN 1, RATIO =  .92

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                       (CFS)
+      30.      5.92                29.        23.        22.         22.
                    (INCHES)      .302       .944       .944        .944
                     (AC-FT)       14.        45.        45.         45.
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 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       69.      5.92                  65.         45.         43.          43.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1376.25      5.92              1375.65     1372.58     1372.30      1372.30

                          CUMULATIVE AREA =     .89 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWWT
                             FOR PLAN 1, RATIO =  .91

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+      30.      5.92                  29.         22.         22.          22.
                          (INCHES)      .300        .938        .938         .938
                           (AC-FT)      14.         45.         45.          45.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       68.      5.92                  64.         44.         43.          43.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1376.14      5.92              1375.55     1372.49     1372.21      1372.21

                          CUMULATIVE AREA =     .89 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWWT
                             FOR PLAN 1, RATIO =  .90

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+      29.      5.92                  29.         22.         22.          22.
                          (INCHES)      .299        .933        .933         .933
                           (AC-FT)      14.         44.         44.          44.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       68.      5.92                  63.         44.         42.          42.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1376.07      5.92              1375.47     1372.42     1372.15      1372.15

                          CUMULATIVE AREA =     .89 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWWT
                             FOR PLAN 1, RATIO =  .89

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+      29.      5.92                  28.         22.         21.          21.
                          (INCHES)      .297        .925        .925         .925
                           (AC-FT)      14.         44.         44.          44.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       67.      5.92                  63.         43.         42.          42.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1375.95      5.92              1375.35     1372.32     1372.05      1372.05

                          CUMULATIVE AREA =     .89 SQ MI


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                           HYDROGRAPH AT STATION   DBWWWT
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```
                         FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                               (CFS)
+      29.      5.92                        28.         22.         21.          21.
                            (INCHES)      .295        .916        .916         .916
                             (AC-FT)       14.         43.         43.          43.

 PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       66.      5.92                        62.         42.         41.          41.

  PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1375.79      5.92                    1375.20     1372.19     1371.93      1371.93

                      CUMULATIVE AREA =     .89 SQ MI



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  433 KK     *    DBWWDA  *
             *            *
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  438 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

  439 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC       -1.00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  440 SA               AREA         1.0       4.0       6.0       7.0       8.0

  441 SE          ELEVATION     1335.00   1337.00   1340.00   1342.00   1345.00

  442 SQ          DISCHARGE          0.       10.       19.       23.       28.
                                                                    ***

                                                        COMPUTED STORAGE-ELEVATION DATA

             STORAGE        .00      4.67     19.57     32.55     55.04
           ELEVATION    1335.00   1337.00   1340.00   1342.00   1345.00

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

                       HYDROGRAPH AT STATION   DBWWDA
                         FOR PLAN 1, RATIO =  .99

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                               (CFS)
+      24.      5.33                        23.         18.         17.          17.
                            (INCHES)      .483       1.461       1.462        1.462
                             (AC-FT)       12.         35.         35.          35.

 PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       38.      5.33                        34.         21.         20.          20.

  PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1342.74      5.33                    1342.24     1339.91     1339.73      1339.73

                      CUMULATIVE AREA =     .45 SQ MI


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

                       HYDROGRAPH AT STATION   DBWWDA
                         FOR PLAN 1, RATIO =  .98

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                               (CFS)
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+      24.      5.33                 23.        17.        17.          17.
                        (INCHES)     .479      1.440      1.441        1.441
                         (AC-FT)      11.        35.        35.          35.

  PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
       37.      5.33                  34.        20.        19.          19.

   PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
    1342.63     5.33              1342.13    1339.80    1339.63      1339.63

                         CUMULATIVE AREA =     .45 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWDA
                            FOR PLAN 1, RATIO =  .95

   PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR      72-HR     24.92-HR
+    (CFS)      (HR)
                          (CFS)
+      24.      5.33                 23.        17.        16.          16.
                        (INCHES)     .472      1.405      1.406        1.406
                         (AC-FT)      11.        34.        34.          34.

  PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
       36.      5.33                  32.        19.        18.          18.

   PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
    1342.44     5.33              1341.94    1339.63    1339.46      1339.46

                         CUMULATIVE AREA =     .45 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWDA
                            FOR PLAN 1, RATIO =  .93

   PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR      72-HR     24.92-HR
+    (CFS)      (HR)
                          (CFS)
+      23.      5.33                 22.        17.        16.          16.
                        (INCHES)     .464      1.370      1.370        1.370
                         (AC-FT)      11.        33.        33.          33.

  PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
       34.      5.33                  31.        18.        17.          17.

   PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
    1342.25     5.33              1341.74    1339.46    1339.30      1339.30

                         CUMULATIVE AREA =     .45 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWDA
                            FOR PLAN 1, RATIO =  .92

   PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR      72-HR     24.92-HR
+    (CFS)      (HR)
                          (CFS)
+      23.      5.33                 22.        16.        16.          16.
                        (INCHES)     .461      1.355      1.356        1.356
                         (AC-FT)      11.        33.        33.          33.

  PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
       34.      5.33                  30.        18.        17.          17.

   PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
    1342.18     5.33              1341.66    1339.39    1339.23      1339.23

                         CUMULATIVE AREA =     .45 SQ MI
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     ***            ***            ***            ***            ***

                           HYDROGRAPH AT STATION   DBWWDA
                             FOR PLAN 1, RATIO =  .91

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                           6-HR        24-HR        72-HR     24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      23.      5.33                       22.         16.          16.          16.
                            (INCHES)       .459       1.345        1.346        1.346
                             (AC-FT)        11.         32.          32.          32.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR        24-HR        72-HR     24.92-HR
 +  (AC-FT)      (HR)
        33.      5.33                       30.         17.          17.          17.

   PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                           6-HR        24-HR        72-HR     24.92-HR
 +   (FEET)      (HR)
    1342.12      5.33                   1341.61     1339.34      1339.18      1339.18

                          CUMULATIVE AREA =     .45 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWDA
                             FOR PLAN 1, RATIO =  .90

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                           6-HR        24-HR        72-HR     24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      23.      5.33                       22.         16.          16.          16.
                            (INCHES)       .457       1.338        1.338        1.338
                             (AC-FT)        11.         32.          32.          32.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR        24-HR        72-HR     24.92-HR
 +  (AC-FT)      (HR)
        33.      5.33                       30.         17.          17.          17.

   PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                           6-HR        24-HR        72-HR     24.92-HR
 +   (FEET)      (HR)
    1342.09      5.33                   1341.57     1339.31      1339.15      1339.15

                          CUMULATIVE AREA =     .45 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWDA
                             FOR PLAN 1, RATIO =  .89

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                           6-HR        24-HR        72-HR     24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      23.      5.33                       22.         16.          15.          15.
                            (INCHES)       .455       1.326        1.327        1.327
                             (AC-FT)        11.         32.          32.          32.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR        24-HR        72-HR     24.92-HR
 +  (AC-FT)      (HR)
        33.      5.33                       29.         17.          16.          16.

   PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                           6-HR        24-HR        72-HR     24.92-HR
 +   (FEET)      (HR)
    1342.03      5.33                   1341.50     1339.25      1339.10      1339.10

                          CUMULATIVE AREA =     .45 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWDA
                             FOR PLAN 1, RATIO =  .88

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                           6-HR        24-HR        72-HR     24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      23.      5.33                       22.         16.          15.          15.
                            (INCHES)       .451       1.312        1.312        1.312
                             (AC-FT)        11.         31.          31.          31.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR        24-HR        72-HR     24.92-HR
 +  (AC-FT)      (HR)
        32.      5.33                       29.         17.          16.          16.
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  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1341.95      5.33              1341.42     1339.18     1339.03      1339.03

                     CUMULATIVE AREA =     .45 SQ MI



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


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            *            *
  459 KK    *    DBWWCA  *
            *            *
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  464 KO         OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  465 RS         STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC       -1.00  INITIAL CONDITION
                          X          .00 WORKING R AND D COEFFICIENT

  466 SA              AREA         1.0       3.0       6.0       8.0       9.0      10.0

  467 SE         ELEVATION     1365.00   1370.00   1375.00   1380.00   1385.00   1390.00

  468 SQ         DISCHARGE          0.       50.       76.       95.      111.      125.
                                                                 ***

                                                     COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00      9.55     31.62     66.50    108.98    156.46
          ELEVATION    1365.00   1370.00   1375.00   1380.00   1385.00   1390.00

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

                      HYDROGRAPH AT STATION   DBWWCA
                        FOR PLAN 1, RATIO =  .99

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+     121.      6.00                 116.         83.         80.          80.
                       (INCHES)      .566       1.633       1.633        1.633
                        (AC-FT)       57.        165.        165.         165.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      142.      6.00                 125.         63.         61.          61.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1388.43      6.00              1386.70     1378.34     1377.85      1377.85

                     CUMULATIVE AREA =    1.90 SQ MI


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

                      HYDROGRAPH AT STATION   DBWWCA
                        FOR PLAN 1, RATIO =  .98

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+     120.      6.00                 115.         82.         79.          79.
                       (INCHES)      .562       1.604       1.604        1.604
                        (AC-FT)       57.        163.        163.         163.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      138.      6.00                 122.         61.         59.          59.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1388.07      6.00              1386.35     1378.01     1377.53      1377.53
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                       CUMULATIVE AREA =    1.90 SQ MI


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                        HYDROGRAPH AT STATION   DBWWCA
                          FOR PLAN 1, RATIO =  .95

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                             (CFS)
 +     118.      6.00                   113.         79.         76.          76.
                           (INCHES)      .553       1.554       1.554        1.554
                            (AC-FT)       56.        157.        158.         158.

  PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                         6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
       133.      6.00                   117.         57.         55.          55.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                         6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1387.48      6.00                1385.77     1377.44     1376.99      1376.99

                       CUMULATIVE AREA =    1.90 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWCA
                          FOR PLAN 1, RATIO =  .93

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                             (CFS)
 +     116.      6.00                   111.         77.         74.          74.
                           (INCHES)      .545       1.502       1.502        1.502
                            (AC-FT)       55.        152.        152.         152.

  PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                         6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
       127.      6.00                   111.         54.         52.          52.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                         6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1386.89      6.00                1385.18     1376.88     1376.44      1376.44

                       CUMULATIVE AREA =    1.90 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWCA
                          FOR PLAN 1, RATIO =  .92

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                             (CFS)
 +     116.      6.00                   111.         76.         73.          73.
                           (INCHES)      .541       1.480       1.480        1.480
                            (AC-FT)       55.        150.        150.         150.

  PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                         6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
       125.      6.00                   109.         52.         50.          50.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                         6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1386.65      6.00                1384.95     1376.65     1376.22      1376.22

                       CUMULATIVE AREA =    1.90 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWCA
                          FOR PLAN 1, RATIO =  .91

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                             (CFS)
 +     115.      6.00                   110.         75.         72.          72.
                           (INCHES)      .539       1.465       1.465        1.465
                            (AC-FT)       55.        148.        148.         148.

  PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
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                                        6-HR      24-HR      72-HR    24.92-HR
 +  (AC-FT)      (HR)
       123.      6.00                   108.        51.        49.         49.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                        6-HR      24-HR      72-HR    24.92-HR
 +   (FEET)      (HR)
    1386.49      6.00                1384.78    1376.49    1376.07     1376.07

                          CUMULATIVE AREA =    1.90 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWCA
                             FOR PLAN 1, RATIO =  .90

   PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR      24-HR      72-HR    24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +     115.      6.00                   110.        74.        72.         72.
                          (INCHES)      .537      1.454      1.454       1.454
                           (AC-FT)       54.       147.       147.        147.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                        6-HR      24-HR      72-HR    24.92-HR
 +  (AC-FT)      (HR)
       122.      6.00                   107.        51.        49.         49.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                        6-HR      24-HR      72-HR    24.92-HR
 +   (FEET)      (HR)
    1386.37      6.00                1384.66    1376.38    1375.96     1375.96

                          CUMULATIVE AREA =    1.90 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWCA
                             FOR PLAN 1, RATIO =  .89

   PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR      24-HR      72-HR    24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +     114.      6.00                   109.        73.        71.         71.
                          (INCHES)      .534      1.436      1.436       1.436
                           (AC-FT)       54.       146.       146.        146.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                        6-HR      24-HR      72-HR    24.92-HR
 +  (AC-FT)      (HR)
       120.      6.00                   105.        50.        48.         48.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                        6-HR      24-HR      72-HR    24.92-HR
 +   (FEET)      (HR)
    1386.18      6.00                1384.48    1376.19    1375.78     1375.78

                          CUMULATIVE AREA =    1.90 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWCA
                             FOR PLAN 1, RATIO =  .88

   PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR      24-HR      72-HR    24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +     114.      6.00                   108.        72.        70.         70.
                          (INCHES)      .531      1.414      1.414       1.414
                           (AC-FT)       54.       143.       143.        143.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                        6-HR      24-HR      72-HR    24.92-HR
 +  (AC-FT)      (HR)
       118.      6.00                   103.        48.        46.         46.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                        6-HR      24-HR      72-HR    24.92-HR
 +   (FEET)      (HR)
    1385.95      6.00                1384.24    1375.97    1375.56     1375.56

                          CUMULATIVE AREA =    1.90 SQ MI



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              *            *
  480 KK      *   DBWWWI   *
              *            *
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  485 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

  486 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC       -1.00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  487 SA               AREA         3.0       4.0       6.0       8.0      10.0

  488 SE          ELEVATION     1325.00   1332.00   1340.00   1347.00   1355.00

  489 SQ          DISCHARGE          0.       61.       95.      117.      137.

                                                                ***

                                                  COMPUTED STORAGE-ELEVATION DATA

              STORAGE        .00     24.42     64.15    112.98    184.83
            ELEVATION    1325.00   1332.00   1340.00   1347.00   1355.00

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

                          HYDROGRAPH AT STATION   DBWWWI
                            FOR PLAN 1, RATIO =  .99

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+     137.      6.92                    132.         96.         92.         92.
                         (INCHES)       .350       1.016       1.016       1.016
                          (AC-FT)        65.        190.        190.        190.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      184.      6.92                    167.         92.         89.         89.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1354.86      6.92                 1352.96     1342.63     1341.98     1341.98

                         CUMULATIVE AREA =    3.50 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWWI
                            FOR PLAN 1, RATIO =  .98

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+     135.      6.83                    130.         94.         90.         90.
                         (INCHES)       .347        .998        .998        .998
                          (AC-FT)        65.        186.        186.        186.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      178.      6.83                    161.         89.         85.         85.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1354.25      6.83                 1352.38     1342.11     1341.48     1341.48

                         CUMULATIVE AREA =    3.50 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWWI
                            FOR PLAN 1, RATIO =  .95

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+     133.      6.83                    128.         91.         88.         88.
                         (INCHES)       .340        .968        .968        .968
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                         (AC-FT)       63.        181.        181.         181.

  PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
        169.     6.83                   153.         83.         80.          80.

   PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1353.25      6.83                1351.42     1341.24     1340.65      1340.65

                        CUMULATIVE AREA =    3.50 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWWI
                            FOR PLAN 1, RATIO =  .93

   PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                          (CFS)
 +      130.     6.83                   126.         88.         85.          85.
                        (INCHES)        .334        .935        .935         .935
                         (AC-FT)         62.        175.        175.         175.

  PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
        160.     6.83                   144.         77.         74.          74.

   PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1352.27      6.83                1350.47     1340.37     1339.81      1339.81

                        CUMULATIVE AREA =    3.50 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWWI
                            FOR PLAN 1, RATIO =  .92

   PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                          (CFS)
 +      129.     6.83                   125.         87.         84.          84.
                        (INCHES)        .331        .921        .921         .921
                         (AC-FT)         62.        172.        172.         172.

  PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
        157.     6.83                   141.         74.         72.          72.

   PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1351.88      6.83                1350.09     1340.03     1339.47      1339.47

                        CUMULATIVE AREA =    3.50 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWWI
                            FOR PLAN 1, RATIO =  .91

   PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                          (CFS)
 +      129.     6.83                   124.         86.         83.          83.
                        (INCHES)        .330        .912        .912         .912
                         (AC-FT)         62.        170.        170.         170.

  PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
        154.     6.83                   138.         73.         70.          70.

   PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1351.61      6.83                1349.83     1339.78     1339.24      1339.24

                        CUMULATIVE AREA =    3.50 SQ MI


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                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .90

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+     128.      6.83                    124.         85.         82.          82.
                          (INCHES)      .328        .905        .905         .905
                           (AC-FT)       61.        169.        169.         169.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      153.      6.83                    137.         72.         69.          69.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1351.41      6.83                 1349.65     1339.61     1339.07      1339.07

                        CUMULATIVE AREA =    3.50 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .89

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+     127.      6.83                    123.         84.         81.          81.
                          (INCHES)      .326        .893        .893         .893
                           (AC-FT)       61.        167.        167.         167.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      150.      6.83                    134.         70.         67.          67.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1351.10      6.83                 1349.35     1339.33     1338.80      1338.80

                        CUMULATIVE AREA =    3.50 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+     126.      6.83                    122.         83.         80.          80.
                          (INCHES)      .324        .878        .878         .878
                           (AC-FT)       60.        164.        164.         164.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      146.      6.83                    131.         68.         65.          65.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1350.72      6.83                 1348.97     1338.98     1338.46      1338.46

                        CUMULATIVE AREA =    3.50 SQ MI



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

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             *            *
  499 KK     *    DBWWWA  *
             *            *
             **************

  504 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

  505 RS          STORAGE ROUTING
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                    NSTPS          1  NUMBER OF SUBREACHES
                     ITYP       ELEV  TYPE OF INITIAL CONDITION
                   RSVRIC      -1.00  INITIAL CONDITION
                        X        .00 WORKING R AND D COEFFICIENT

  506 SA              AREA         2.0      11.0      20.0      26.0      30.0

  507 SE         ELEVATION     1300.00   1303.00   1307.00   1311.00   1315.00

  508 SQ         DISCHARGE          0.       45.       86.      114.      135.

                                                                ***

                                                COMPUTED STORAGE-ELEVATION DATA

           STORAGE        .00     17.69     78.80    170.54    282.44
         ELEVATION    1300.00   1303.00   1307.00   1311.00   1315.00

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

                      HYDROGRAPH AT STATION   DBWWWA
                        FOR PLAN 1, RATIO =  .99

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     121.      6.00                   118.         92.         88.          88.
                        (INCHES)       .417       1.296       1.296        1.296
                         (AC-FT)        58.        182.        182.         182.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       209.     6.00                   191.        118.        114.         114.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1312.36      6.00                1311.73     1308.34     1308.03      1308.03

                     CUMULATIVE AREA =    2.63 SQ MI


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

                      HYDROGRAPH AT STATION   DBWWWA
                        FOR PLAN 1, RATIO =  .98

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     120.      6.00                   117.         90.         87.          87.
                        (INCHES)       .413       1.279       1.279        1.279
                         (AC-FT)        58.        179.        179.         179.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       204.     6.00                   186.        115.        110.         110.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1312.19      6.00                1311.56     1308.18     1307.88      1307.88

                     CUMULATIVE AREA =    2.63 SQ MI


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

                      HYDROGRAPH AT STATION   DBWWWA
                        FOR PLAN 1, RATIO =  .95

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     119.      5.92                   115.         88.         85.          85.
                        (INCHES)       .407       1.249       1.249        1.249
                         (AC-FT)        57.        175.        175.         175.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       196.     6.00                   178.        109.        105.         105.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1311.90      6.00                1311.26     1307.90     1307.61      1307.61

                     CUMULATIVE AREA =    2.63 SQ MI
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      ***             ***             ***             ***             ***

                               HYDROGRAPH AT STATION   DBWWWA
                                 FOR PLAN 1, RATIO =  .93

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                                 (CFS)
 +     117.      5.92                      113.         86.         83.          83.
                              (INCHES)      .401       1.218       1.218        1.218
                               (AC-FT)       56.        171.        171.         171.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
       188.      5.92                      171.        103.         99.          99.

   PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1311.61      5.92                   1310.96     1307.62     1307.34      1307.34

                              CUMULATIVE AREA =    2.63 SQ MI

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

                               HYDROGRAPH AT STATION   DBWWWA
                                 FOR PLAN 1, RATIO =  .92

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                                 (CFS)
 +     117.      5.92                      113.         85.         82.          82.
                              (INCHES)      .398       1.206       1.206        1.206
                               (AC-FT)       56.        169.        169.         169.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
       184.      5.92                      168.        100.         97.          97.

   PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1311.50      5.92                   1310.84     1307.51     1307.23      1307.23

                              CUMULATIVE AREA =    2.63 SQ MI

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

                               HYDROGRAPH AT STATION   DBWWWA
                                 FOR PLAN 1, RATIO =  .91

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                                 (CFS)
 +     116.      5.92                      112.         85.         82.          82.
                              (INCHES)      .396       1.197       1.197        1.197
                               (AC-FT)       56.        168.        168.         168.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
       182.      5.92                      165.         99.         95.          95.

   PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1311.42      5.92                   1310.75     1307.43     1307.16      1307.16

                              CUMULATIVE AREA =    2.63 SQ MI

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

                               HYDROGRAPH AT STATION   DBWWWA
                                 FOR PLAN 1, RATIO =  .90

   PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                                 (CFS)
 +     116.      5.92                      112.         84.         81.          81.
                              (INCHES)      .395       1.190       1.190        1.190
                               (AC-FT)       55.        167.        167.         167.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
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     181.      5.92                164.        98.        94.         94.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                  6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1311.36      5.92             1310.69    1307.38    1307.11     1307.11

                        CUMULATIVE AREA =    2.63 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWA
                           FOR PLAN 1, RATIO =  .89

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+     115.      5.92                111.        83.        80.         80.
                         (INCHES)      .393      1.180      1.180       1.180
                          (AC-FT)       55.       166.       166.        166.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                  6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
     178.       5.92                161.        96.        92.         92.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                  6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1311.27      5.92             1310.59    1307.29    1307.02     1307.02

                        CUMULATIVE AREA =    2.63 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWA
                           FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+     115.      5.92                110.        83.        79.         79.
                         (INCHES)      .390      1.167      1.167       1.167
                          (AC-FT)       55.       164.       164.        164.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                  6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
     175.       5.92                158.        94.        90.         90.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                  6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1311.15      5.92             1310.46    1307.18    1306.91     1306.91

                        CUMULATIVE AREA =    2.63 SQ MI



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             *            *
  518 KK     *    DBWWIA  *
             *            *
             **************

  523 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

  524 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC       -1.00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  525 SA              AREA         1.0       6.0      11.0      14.0

  526 SE          ELEVATION     1295.00   1300.00   1305.00   1310.00

  527 SQ          DISCHARGE          0.       50.       76.       95.

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                                                   COMPUTED STORAGE-ELEVATION DATA
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            STORAGE        .00     15.75     57.62    119.97
          ELEVATION    1295.00   1300.00   1305.00   1310.00

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                           HYDROGRAPH AT STATION   DBWWIA
                             FOR PLAN 1, RATIO =  .99

   PEAK FLOW     TIME                                  MAXIMUM AVERAGE FLOW
                                               6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      87.      5.58                            83.         54.         52.          52.
                        (INCHES)               .617       1.621       1.621        1.621
                         (AC-FT)                41.        108.        108.         108.

  PEAK STORAGE   TIME                                 MAXIMUM AVERAGE STORAGE
                                               6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       93.      5.58                            80.         38.         37.          37.

   PEAK STAGE    TIME                                  MAXIMUM AVERAGE STAGE
                                               6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
    1307.80     5.58                       1306.83     1301.87     1301.62      1301.62

                          CUMULATIVE AREA =    1.25 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWIA
                             FOR PLAN 1, RATIO =  .98

   PEAK FLOW     TIME                                  MAXIMUM AVERAGE FLOW
                                               6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      86.      5.58                            82.         53.         51.          51.
                        (INCHES)               .612       1.588       1.588        1.588
                         (AC-FT)                41.        106.        106.         106.

  PEAK STORAGE   TIME                                 MAXIMUM AVERAGE STORAGE
                                               6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       90.      5.58                            78.         37.         36.          36.

   PEAK STAGE    TIME                                  MAXIMUM AVERAGE STAGE
                                               6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
    1307.62     5.58                       1306.66     1301.70     1301.45      1301.45

                          CUMULATIVE AREA =    1.25 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWIA
                             FOR PLAN 1, RATIO =  .95

   PEAK FLOW     TIME                                  MAXIMUM AVERAGE FLOW
                                               6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      85.      5.58                            81.         51.         50.          50.
                        (INCHES)               .604       1.532       1.532        1.532
                         (AC-FT)                40.        102.        102.         102.

  PEAK STORAGE   TIME                                 MAXIMUM AVERAGE STORAGE
                                               6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       87.      5.58                            75.         35.         33.          33.

   PEAK STAGE    TIME                                  MAXIMUM AVERAGE STAGE
                                               6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
    1307.33     5.58                       1306.38     1301.40     1301.17      1301.17

                          CUMULATIVE AREA =    1.25 SQ MI


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

                           HYDROGRAPH AT STATION   DBWWIA
                             FOR PLAN 1, RATIO =  .93

   PEAK FLOW     TIME                                  MAXIMUM AVERAGE FLOW
                                               6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      84.      5.58                            80.         50.         48.          48.
                        (INCHES)               .596       1.476       1.476        1.476
                         (AC-FT)                40.         98.         98.          98.
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 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                    6-HR      24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       83.      5.58                 71.        33.         31.          31.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                    6-HR      24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1307.03      5.58             1306.10    1301.11     1300.89      1300.89

                        CUMULATIVE AREA =    1.25 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWIA
                           FOR PLAN 1, RATIO =  .92

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR      24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      83.      5.58                 80.        49.         47.          47.
                        (INCHES)    .593      1.453       1.453        1.453
                         (AC-FT)     40.        97.         97.          97.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                    6-HR      24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       81.      5.58                 70.        32.         31.          31.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                    6-HR      24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1306.91      5.58             1305.98    1301.00     1300.78      1300.78

                        CUMULATIVE AREA =    1.25 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWIA
                           FOR PLAN 1, RATIO =  .91

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR      24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      83.      5.58                 79.        48.         47.          47.
                        (INCHES)    .591      1.437       1.437        1.437
                         (AC-FT)     39.        96.         96.          96.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                    6-HR      24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       80.      5.58                 69.        31.         30.          30.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                    6-HR      24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1306.83      5.58             1305.90    1300.92     1300.70      1300.70

                        CUMULATIVE AREA =    1.25 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWIA
                           FOR PLAN 1, RATIO =  .90

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR      24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      83.      5.58                 79.        48.         46.          46.
                        (INCHES)    .589      1.426       1.426        1.426
                         (AC-FT)     39.        95.         95.          95.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                    6-HR      24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       80.      5.58                 68.        31.         30.          30.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                    6-HR      24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1306.77      5.58             1305.84    1300.86     1300.65      1300.65

                        CUMULATIVE AREA =    1.25 SQ MI


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                         HYDROGRAPH AT STATION   DBWWIA
                           FOR PLAN 1, RATIO =  .89
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  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      82.      5.58                   79.         47.         46.          46.
                        (INCHES)      .586       1.407       1.407        1.407
                         (AC-FT)       39.         94.         94.          94.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       79.      5.58                   67.         30.         29.          29.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
    1306.68     5.58                1305.75     1300.77     1300.56     1300.56

                         CUMULATIVE AREA =    1.25 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWIA
                            FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      82.      5.58                   78.         47.         45.          45.
                        (INCHES)      .582       1.385       1.385        1.385
                         (AC-FT)       39.         92.         92.          92.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       77.      5.58                   66.         29.         28.          28.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
    1306.56     5.58                1305.63     1300.66     1300.45     1300.45

                         CUMULATIVE AREA =    1.25 SQ MI



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  568 KK     *   DBWWPA   *
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  573 KO        OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  574 RS        STORAGE ROUTING
                      NSTPS          1  NUMBER OF SUBREACHES
                       ITYP       ELEV  TYPE OF INITIAL CONDITION
                     RSVRIC      -1.00  INITIAL CONDITION
                          X        .00 WORKING R AND D COEFFICIENT

  575 SA              AREA        1.0      12.0      32.0      49.0      56.0

  576 SE        ELEVATION     1290.00   1300.00   1308.00   1315.00   1325.00

  577 SQ        DISCHARGE          0.      144.      202.      242.      289.

                                                                ***

                                                COMPUTED STORAGE-ELEVATION DATA

             STORAGE        .00     54.88    224.47    505.86   1030.48
           ELEVATION    1290.00   1300.00   1308.00   1315.00   1325.00

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                          HYDROGRAPH AT STATION   DBWWPA
                            FOR PLAN 1, RATIO =  .99

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     324.      8.17                 320.        264.        254.         254.
                        (INCHES)     .134        .441        .441         .441
                         (AC-FT)     159.        523.        523.         523.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1418.      8.17                1377.       1017.        979.         979.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1332.39      8.17              1331.60     1322.81     1321.60      1321.60

                         CUMULATIVE AREA =   22.25 SQ MI

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                           HYDROGRAPH AT STATION   DBWWPA
                             FOR PLAN 1, RATIO =  .98

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                                (CFS)
 +     320.      8.17                    317.        261.        251.         251.
                              (INCHES)   .132        .436        .436         .436
                              (AC-FT)    157.        518.        518.         518.

  PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                         6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
      1379.      8.17                   1338.        986.        950.         950.

   PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                         6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1331.65      8.17                 1330.86     1322.21     1321.03      1321.03

                          CUMULATIVE AREA =   22.25 SQ MI

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HYDROGRAPH AT STATION DBWWPA
FOR PLAN 1, RATIO = .95

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 314.	8.17		311.	256.	247.	247.
		(INCHES)	.130	.428	.428	.428
		(AC-FT)	154.	508.	508.	508.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR

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+  (AC-FT)      (HR)
    1315.      8.17                1274.        935.        901.         901.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1330.42      8.17             1329.65     1321.23     1320.08      1320.08

                        CUMULATIVE AREA =   22.25 SQ MI

 WARNING --- ROUTED OUTFLOW (    291.) IS GREATER THAN MAXIMUM OUTFLOW (    289.) IN STORAGE-OUTFLOW TABLE
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                          HYDROGRAPH AT STATION   DBWWPA
                            FOR PLAN 1, RATIO =  .93

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                             (CFS)
+      309.      8.17                     305.        251.        242.         242.
                           (INCHES)       .128        .420        .420         .420
                            (AC-FT)       151.        499.        499.         499.

 PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1251.      8.17                     1211.        885.        853.         853.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1329.20      8.17                   1328.44     1320.25     1319.14      1319.14

                         CUMULATIVE AREA =   22.25 SQ MI

 WARNING --- ROUTED OUTFLOW (    289.) IS GREATER THAN MAXIMUM OUTFLOW (    289.) IN STORAGE-OUTFLOW TABLE

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                         HYDROGRAPH AT STATION   DBWWPA
                           FOR PLAN 1, RATIO =  .92

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
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+     306.      8.17                   303.       249.       240.        240.
                          (INCHES)      .127       .417       .417        .417
                           (AC-FT)      150.       495.       495.        495.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
    1226.       8.17                  1186.        866.       834.        834.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1328.72      8.17                1327.96     1319.86    1318.76     1318.76

                          CUMULATIVE AREA =    22.25 SQ MI

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HYDROGRAPH AT STATION DBWWPA
FOR PLAN 1, RATIO = .91

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 305.	8.17		301.	248.	239.	239.
		(INCHES)	.126	.415	.415	.415
		(AC-FT)	149.	492.	492.	492.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
1208.	8.17	1169.	852.	820.	820.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1328.38	8.17	1327.63	1319.59	1318.50	1318.50

CUMULATIVE AREA = 22.25 SQ MI

WARNING --- ROUTED OUTFLOW (289.) IS GREATER THAN MAXIMUM OUTFLOW (289.) IN STORAGE-OUTFLOW TABLE

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                          HYDROGRAPH AT STATION   DBWWPA
                            FOR PLAN 1, RATIO =  .90

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+      304.     8.17                 300.        247.        238.         238.
                       (INCHES)      .125        .413        .413         .413
                        (AC-FT)      149.        490.        490.         490.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1195.      8.17                1156.        842.        811.         811.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1328.14      8.17              1327.40     1319.40     1318.32      1318.32

                        CUMULATIVE AREA =    22.25 SQ MI

 WARNING --- ROUTED OUTFLOW (    289.) IS GREATER THAN MAXIMUM OUTFLOW (    289.) IN STORAGE-OUTFLOW TABLE

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                        HYDROGRAPH AT STATION   DBWWPA
                          FOR PLAN 1, RATIO =  .89

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                        (CFS)
+     302.      8.17                   298.        246.        237.        237.
                      (INCHES)         .125        .411        .411        .411
                       (AC-FT)         148.        487.        487.        487.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1175.      8.17                  1136.        826.        796.        796.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1327.76      8.17                1327.02     1319.09     1318.02     1318.02

                       CUMULATIVE AREA =    22.25 SQ MI

WARNING --- ROUTED OUTFLOW (    289.) IS GREATER THAN MAXIMUM OUTFLOW (    289.) IN STORAGE-OUTFLOW TABLE

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                         HYDROGRAPH AT STATION   DBWWPA
                           FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     300.      8.17                 296.        244.        235.         235.
                        (INCHES)     .124        .408        .408         .408
                         (AC-FT)     147.        484.        484.         484.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1150.      8.17                1112.        806.        777.         777.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1327.28      8.17              1326.55     1318.71     1317.66      1317.66

                        CUMULATIVE AREA =    22.25 SQ MI

1

               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                 FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                 TIME TO PEAK IN HOURS


                                                          RATIOS APPLIED TO PRECIPITATION
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OPERATION	STATION	AREA	PLAN		RATIO 1 .99	RATIO 2 .98	RATIO 3 .95	RATIO 4 .93	RATIO 5 .92	RATIO 6 .91	RATIO 7 .90	RATIO 8 .89	RATIO 9 .88
HYDROGRAPH AT +	MRIV2	18.37	1	FLOW	6057.	5913.	5675.	5438.	5343.	5277.	5230.	5155.	5061.
				TIME	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33
HYDROGRAPH AT +	MRIV1	22.91	1	FLOW	5658.	5514.	5276.	5039.	4946.	4881.	4834.	4760.	4667.
				TIME	5.83	5.83	5.83	5.92	5.92	5.92	5.92	5.92	5.92
2 COMBINED AT +	CMRIV1	41.28	1	FLOW	11470.	11189.	10722.	10258.	10074.	9945.	9853.	9706.	9523.
				TIME	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58
ROUTED TO +	RCMRIV1	41.28	1	FLOW	11425.	11146.	10682.	10220.	10036.	9907.	9815.	9668.	9485.
				TIME	6.17	6.17	6.17	6.17	6.17	6.17	6.17	6.17	6.17
HYDROGRAPH AT +	MRIV3	21.99	1	FLOW	5539.	5397.	5162.	4929.	4836.	4771.	4725.	4651.	4560.
				TIME	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75	5.75
2 COMBINED AT +	CMRIV3	63.27	1	FLOW	16814.	16391.	15693.	15003.	14728.	14536.	14399.	14181.	13908.
				TIME	6.00	6.00	6.08	6.08	6.08	6.08	6.08	6.08	6.08
ROUTED TO +	RCMRIV3	63.27	1	FLOW	16780.	16361.	15667.	14975.	14699.	14507.	14370.	14150.	13876.
				TIME	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25
HYDROGRAPH AT +	MRIV4	10.45	1	FLOW	3668.	3587.	3454.	3320.	3267.	3230.	3204.	3161.	3108.
				TIME	5.42	5.42	5.42	5.42	5.42	5.42	5.42	5.42	5.42
HYDROGRAPH AT +	MDW	19.44	1	FLOW	7584.	7389.	7067.	6746.	6619.	6530.	6467.	6365.	6239.
				TIME	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58
HYDROGRAPH AT +	MRIV5	3.26	1	FLOW	1841.	1799.	1728.	1657.	1629.	1609.	1595.	1573.	1545.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
4 COMBINED AT +	CMRIV5	96.42	1	FLOW	23983.	23371.	22354.	21342.	20939.	20658.	20457.	20136.	19742.
				TIME	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.92
ROUTED TO +	RCMRIV5	96.42	1	FLOW	23842.	23232.	22217.	21206.	20803.	20524.	20327.	20012.	19620.
				TIME	6.08	6.08	6.08	6.08	6.08	6.17	6.17	6.17	6.17
HYDROGRAPH AT +	MRIV6	2.17	1	FLOW	858.	838.	805.	773.	760.	750.	744.	734.	721.
				TIME	4.92	4.92	4.92	4.92	4.92	4.92	4.92	4.92	4.92
HYDROGRAPH AT +	MRIV7	12.41	1	FLOW	5459.	5337.	5134.	4932.	4851.	4795.	4754.	4690.	4610.
				TIME	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75
HYDROGRAPH AT +	WSWASH	61.31	1	FLOW	20270.	19806.	19036.	18269.	17963.	17749.	17597.	17353.	17049.
				TIME	5.42	5.42	5.42	5.42	5.42	5.42	5.42	5.42	5.42
4 COMBINED AT +	CMRIV7	172.31	1	FLOW	46418.	45245.	43295.	41351.	40590.	40059.	39679.	39072.	38315.
				TIME	5.75	5.75	5.75	5.75	5.83	5.83	5.83	5.83	5.83
ROUTED TO +	RCMRIV7	172.31	1	FLOW	46104.	44926.	42989.	41077.	40313.	39778.	39393.	38782.	38018.
				TIME	6.00	6.00	6.08	6.08	6.08	6.08	6.08	6.08	6.08
HYDROGRAPH AT +	EWASH8	3.47	1	FLOW	1099.	1069.	1019.	970.	950.	936.	927.	911.	892.
				TIME	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83
HYDROGRAPH AT +	AWASH1	4.57	1	FLOW	2632.	2571.	2471.	2371.	2331.	2303.	2283.	2252.	2212.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
ROUTED TO +	RAWASH1	4.57	1	FLOW	2554.	2495.	2399.	2302.	2263.	2237.	2217.	2187.	2148.
				TIME	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
HYDROGRAPH AT +	AWASH2	1.63	1	FLOW	1263.	1235.	1187.	1140.	1122.	1108.	1099.	1084.	1066.
				TIME	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	4.00
2 COMBINED AT +	CAWASH2	6.20	1	FLOW	3305.	3230.	3105.	2980.	2930.	2895.	2870.	2831.	2781.
				TIME	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33
ROUTED TO +	RCAWASH2	6.20	1	FLOW	3163.	3091.	2971.	2852.	2804.	2771.	2747.	2709.	2662.
				TIME	4.92	4.92	4.92	4.92	4.92	4.92	4.92	4.92	4.92

HYDROGRAPH AT													
+	AWASH3	5.03	1	FLOW	2591.	2534.	2439.	2345.	2308.	2281.	2262.	2232.	2195.
				TIME	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
2 COMBINED AT													
+	CAWASH3	11.23	1	FLOW	5452.	5330.	5127.	4924.	4843.	4787.	4746.	4682.	4602.
				TIME	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75
3 COMBINED AT													
+	CMR0	187.01	1	FLOW	49436.	48159.	46060.	43987.	43158.	42579.	42158.	41495.	40667.
				TIME	5.92	5.92	6.00	6.00	6.00	6.00	6.00	6.00	6.00
ROUTED TO													
+	RCMR0	187.01	1	FLOW	49404.	48138.	46044.	43934.	43104.	42534.	42113.	41464.	40633.
				TIME	6.00	6.00	6.00	6.00	6.00	6.08	6.08	6.08	6.08
HYDROGRAPH AT													
+	WWASH6	1.20	1	FLOW	1162.	1137.	1097.	1056.	1040.	1028.	1020.	1007.	991.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
HYDROGRAPH AT													
+	EWASH7	6.39	1	FLOW	2576.	2495.	2361.	2228.	2176.	2139.	2113.	2072.	2022.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.17	4.17
ROUTED TO													
+	REWASH7	6.39	1	FLOW	2395.	2321.	2197.	2075.	2027.	1993.	1969.	1931.	1884.
				TIME	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58
HYDROGRAPH AT													
+	EWASH6	.78	1	FLOW	372.	362.	345.	328.	322.	317.	314.	308.	302.
				TIME	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
2 COMBINED AT													
+	CEWASH6	7.17	1	FLOW	2655.	2573.	2439.	2306.	2254.	2217.	2191.	2149.	2097.
				TIME	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58
HYDROGRAPH AT													
+	BMN1	3.72	1	FLOW	2215.	2158.	2062.	1968.	1930.	1904.	1885.	1855.	1818.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
ROUTED TO													
+	RBMN1	3.72	1	FLOW	2017.	1965.	1878.	1792.	1758.	1734.	1717.	1690.	1657.
				TIME	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58
HYDROGRAPH AT													
+	BMN3	5.12	1	FLOW	2072.	2023.	1941.	1859.	1827.	1804.	1788.	1762.	1730.
				TIME	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75	4.75
2 COMBINED AT													
+	CBMN3	8.84	1	FLOW	4054.	3954.	3787.	3622.	3556.	3511.	3478.	3425.	3360.
				TIME	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67
HYDROGRAPH AT													
+	BMN2	4.08	1	FLOW	2571.	2514.	2418.	2323.	2285.	2258.	2239.	2209.	2171.
				TIME	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
ROUTED TO													
+	RBMN2	4.08	1	FLOW	2339.	2287.	2200.	2113.	2079.	2055.	2038.	2010.	1976.
				TIME	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
HYDROGRAPH AT													
+	BMN4	6.98	1	FLOW	2770.	2706.	2601.	2496.	2454.	2425.	2404.	2371.	2329.
				TIME	4.92	4.92	4.92	4.92	4.92	4.92	4.92	4.92	4.92
2 COMBINED AT													
+	CBMN4	11.06	1	FLOW	5092.	4977.	4786.	4596.	4520.	4467.	4430.	4369.	4294.
				TIME	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
2 COMBINED AT													
+	CBMN34	19.90	1	FLOW	8791.	8585.	8242.	7901.	7765.	7670.	7602.	7494.	7359.
				TIME	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83
ROUTED TO													
+	RCBMN34	19.90	1	FLOW	8678.	8475.	8137.	7802.	7668.	7574.	7508.	7401.	7268.
				TIME	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08
HYDROGRAPH AT													
+	BMN5	1.48	1	FLOW	541.	524.	495.	466.	455.	447.	441.	432.	421.
				TIME	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
HYDROGRAPH AT													
+	BMN6	2.06	1	FLOW	901.	879.	843.	808.	794.	784.	776.	765.	751.
				TIME	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58
3 COMBINED AT													
+	CBMN56	23.44	1	FLOW	9734.	9503.	9120.	8739.	8587.	8480.	8405.	8284.	8133.
				TIME	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
ROUTED TO													
+	RCBMN56	23.44	1	FLOW	9704.	9474.	9093.	8713.	8562.	8456.	8381.	8260.	8110.
				TIME	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08
HYDROGRAPH AT													
+	BMN7	.45	1	FLOW	320.	311.	297.	283.	278.	274.	271.	266.	261.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83

2 COMBINED AT													
+	CBMN7	23.89	1	FLOW	9800.	9568.	9183.	8800.	8647.	8540.	8464.	8343.	8191.
				TIME	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08
ROUTED TO													
+	DBFGLS	23.89	1	FLOW	302.	299.	294.	289.	287.	285.	284.	283.	281.
				TIME	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.42
			** PEAK STAGES IN FEET **										
			1	STAGE	1512.77	1511.99	1510.71	1509.43	1508.92	1508.57	1508.32	1507.92	1507.41
				TIME	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
ROUTED TO													
+	RDBFGLS	23.89	1	FLOW	302.	299.	294.	289.	287.	285.	284.	283.	281.
				TIME	8.58	8.58	8.58	8.58	8.58	8.58	8.58	8.58	8.58
HYDROGRAPH AT													
+	FGDB1	.39	1	FLOW	222.	215.	204.	193.	188.	185.	183.	179.	175.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
ROUTED TO													
+	DETBN	.39	1	FLOW	58.	57.	55.	54.	53.	53.	52.	52.	51.
				TIME	5.25	5.25	5.25	5.17	5.17	5.17	5.17	5.17	5.17
			** PEAK STAGES IN FEET **										
			1	STAGE	1421.33	1421.09	1420.68	1420.27	1420.11	1419.99	1419.91	1419.78	1419.62
				TIME	5.25	5.25	5.25	5.17	5.17	5.17	5.17	5.17	5.17
2 COMBINED AT													
+	CFGDB1	24.28	1	FLOW	336.	332.	326.	319.	316.	314.	313.	311.	308.
				TIME	7.08	7.08	7.00	6.92	6.92	6.92	6.92	6.92	6.92
ROUTED TO													
+	RCFGDB1	24.28	1	FLOW	336.	332.	326.	319.	316.	314.	313.	311.	308.
				TIME	7.08	7.17	7.08	7.00	7.00	7.00	7.00	7.00	7.00
HYDROGRAPH AT													
+	FGDB	1.92	1	FLOW	1413.	1377.	1318.	1259.	1236.	1220.	1208.	1190.	1166.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
ROUTED TO													
+	DBFGWS	1.92	1	FLOW	45.	44.	44.	43.	43.	43.	43.	43.	43.
				TIME	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.17	6.17
			** PEAK STAGES IN FEET **										
			1	STAGE	1493.17	1492.99	1492.66	1492.34	1492.21	1492.12	1492.06	1491.95	1491.81
				TIME	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25	6.25
ROUTED TO													
+	RDBFGWS	1.92	1	FLOW	45.	44.	44.	43.	43.	43.	43.	43.	43.
				TIME	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33
HYDROGRAPH AT													
+	FGDB2	.46	1	FLOW	216.	209.	197.	185.	180.	177.	174.	170.	166.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
2 COMBINED AT													
+	CRDBFGWS	2.38	1	FLOW	253.	245.	233.	221.	216.	212.	210.	206.	201.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
2 COMBINED AT													
+	CFGDB2	26.66	1	FLOW	405.	396.	381.	367.	361.	358.	356.	354.	351.
				TIME	3.83	3.83	3.83	3.83	3.83	6.92	6.83	6.83	6.92
ROUTED TO													
+	RCFGDB2	26.66	1	FLOW	401.	392.	377.	364.	360.	358.	356.	354.	351.
				TIME	3.83	3.83	3.92	3.92	6.92	6.92	6.92	6.92	6.92
HYDROGRAPH AT													
+	EWASH5	.58	1	FLOW	163.	158.	148.	138.	135.	132.	130.	127.	124.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
2 COMBINED AT													
+	CEWASH5	27.24	1	FLOW	520.	507.	486.	465.	457.	451.	447.	440.	432.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
4 COMBINED AT													
+	CMR1	222.62	1	FLOW	50829.	49506.	47342.	45185.	44335.	43725.	43289.	42611.	41749.
				TIME	5.92	5.92	6.00	6.00	6.00	6.00	6.00	6.00	6.00
ROUTED TO													
+	RCMR1	222.62	1	FLOW	50786.	49465.	47292.	45146.	44289.	43688.	43249.	42567.	41707.
				TIME	6.00	6.00	6.08	6.08	6.08	6.08	6.08	6.08	6.08
HYDROGRAPH AT													
+	EWDB	1.89	1	FLOW	1542.	1507.	1447.	1388.	1364.	1348.	1336.	1317.	1294.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.92	3.92	3.92
ROUTED TO													
+	DBEWGA	1.89	1	FLOW	90.	89.	88.	87.	87.	87.	86.	86.	86.
				TIME	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92
			** PEAK STAGES IN FEET **										
			1	STAGE	1485.59	1485.43	1485.16	1484.90	1484.79	1484.72	1484.67	1484.58	1484.48

				TIME	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92
ROUTED TO													
+	RDBEWGA	1.89	1	FLOW	90.	89.	88.	87.	87.	87.	86.	86.	86.
				TIME	6.08	6.08	6.08	6.08	6.08	6.00	6.08	6.08	6.00
HYDROGRAPH AT													
+	EWASH4	2.03	1	FLOW	864.	837.	793.	750.	733.	721.	712.	699.	682.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08
2 COMBINED AT													
+	CEWASH4	3.92	1	FLOW	935.	908.	864.	820.	802.	790.	781.	767.	750.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08
HYDROGRAPH AT													
+	LWASH1	4.03	1	FLOW	1648.	1599.	1519.	1440.	1409.	1387.	1371.	1346.	1316.
				TIME	4.17	4.17	4.25	4.25	4.25	4.25	4.25	4.25	4.25
HYDROGRAPH AT													
+	LWASH2	.70	1	FLOW	447.	435.	417.	398.	390.	385.	381.	376.	368.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
2 COMBINED AT													
+	CLWASH1	4.73	1	FLOW	2034.	1975.	1878.	1782.	1744.	1718.	1699.	1669.	1631.
				TIME	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
ROUTED TO													
+	RCLWASH1	4.73	1	FLOW	1965.	1909.	1815.	1722.	1685.	1660.	1641.	1612.	1576.
				TIME	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42
HYDROGRAPH AT													
+	LWASH3	1.17	1	FLOW	1059.	1036.	999.	963.	948.	938.	930.	919.	904.
				TIME	3.83	3.83	3.92	3.92	3.92	3.92	3.92	3.92	3.92
2 COMBINED AT													
+	CLWASH3	5.90	1	FLOW	2497.	2429.	2317.	2205.	2161.	2130.	2108.	2073.	2029.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
ROUTED TO													
+	RCLWASH3	5.90	1	FLOW	2488.	2421.	2308.	2198.	2153.	2123.	2100.	2066.	2022.
				TIME	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33
HYDROGRAPH AT													
+	WWASH5	1.61	1	FLOW	1572.	1539.	1485.	1431.	1409.	1394.	1383.	1366.	1344.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
ROUTED TO													
+	RWWASH5	1.61	1	FLOW	1455.	1424.	1374.	1323.	1303.	1289.	1279.	1263.	1242.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
HYDROGRAPH AT													
+	LOG1	.41	1	FLOW	246.	239.	228.	218.	213.	211.	208.	205.	201.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
5 COMBINED AT													
+	CMR2	234.46	1	FLOW	51773.	50431.	48198.	45970.	45078.	44464.	44019.	43327.	42456.
				TIME	6.00	6.00	6.00	6.00	6.00	6.08	6.08	6.08	6.08
ROUTED TO													
+	RCMR2	234.46	1	FLOW	51604.	50255.	48011.	45814.	44937.	44325.	43869.	43170.	42295.
				TIME	6.08	6.08	6.08	6.17	6.17	6.17	6.17	6.17	6.17
HYDROGRAPH AT													
+	EWASH3	1.77	1	FLOW	520.	503.	474.	445.	434.	426.	420.	412.	401.
				TIME	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33
HYDROGRAPH AT													
+	LOG3	.51	1	FLOW	274.	268.	257.	246.	241.	238.	236.	232.	228.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
3 COMBINED AT													
+	CMR3	236.74	1	FLOW	51797.	50442.	48191.	45965.	45086.	44472.	44014.	43313.	42435.
				TIME	6.08	6.08	6.08	6.17	6.17	6.17	6.17	6.17	6.17
ROUTED TO													
+	RCMR3	236.74	1	FLOW	51699.	50354.	48118.	45887.	44997.	44388.	43933.	43237.	42366.
				TIME	6.17	6.17	6.17	6.17	6.25	6.25	6.25	6.25	6.25
HYDROGRAPH AT													
+	LOG2	1.62	1	FLOW	954.	931.	893.	855.	840.	830.	822.	810.	795.
				TIME	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
2 COMBINED AT													
+	CMR4	238.36	1	FLOW	51811.	50464.	48224.	45989.	45097.	44476.	44020.	43323.	42450.
				TIME	6.17	6.17	6.17	6.17	6.17	6.17	6.25	6.25	6.25
ROUTED TO													
+	RCMR4	238.36	1	FLOW	51795.	50436.	48188.	45972.	45083.	44467.	43999.	43298.	42423.
				TIME	6.17	6.17	6.25	6.25	6.25	6.25	6.25	6.25	6.25
HYDROGRAPH AT													
+	EWASH2	4.80	1	FLOW	2052.	2000.	1912.	1825.	1790.	1766.	1749.	1721.	1687.
				TIME	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42
2 COMBINED AT													

+	CMR5	243.16	1	FLOW	52388.	51016.	48730.	46458.	45559.	44935.	44463.	43755.	42872.
				TIME	6.17	6.17	6.17	6.17	6.17	6.25	6.25	6.25	6.25
ROUTED TO +	RCMR5	243.16	1	FLOW	52362.	50980.	48710.	46444.	45543.	44910.	44432.	43727.	42844.
				TIME	6.17	6.25	6.25	6.25	6.25	6.25	6.33	6.33	6.33
HYDROGRAPH AT +	OVR1	1.88	1	FLOW	1191.	1162.	1115.	1068.	1049.	1036.	1027.	1012.	993.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08
2 COMBINED AT +	CMR6	245.04	1	FLOW	52471.	51080.	48799.	46531.	45628.	44994.	44514.	43798.	42914.
				TIME	6.17	6.17	6.25	6.25	6.25	6.25	6.25	6.33	6.33
ROUTED TO +	RCMR6	245.04	1	FLOW	52442.	51061.	48772.	46498.	45597.	44982.	44495.	43792.	42895.
				TIME	6.25	6.25	6.25	6.33	6.33	6.33	6.33	6.33	6.33
HYDROGRAPH AT +	WWASH4A	.31	1	FLOW	395.	387.	374.	360.	355.	351.	349.	344.	339.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
HYDROGRAPH AT +	WWASH4	.58	1	FLOW	579.	567.	547.	528.	520.	514.	510.	504.	496.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
2 COMBINED AT +	CWWASH4	.89	1	FLOW	928.	909.	877.	845.	833.	824.	817.	807.	794.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO +	DBWWWT	.89	1	FLOW	31.	31.	30.	30.	30.	30.	29.	29.	29.
				TIME	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92	5.92
			** PEAK STAGES IN FEET **										
			1	STAGE	1377.40	1377.17	1376.78	1376.40	1376.25	1376.14	1376.07	1375.95	1375.79
				TIME	6.00	6.00	5.92	5.92	5.92	5.92	5.92	5.92	5.92
ROUTED TO +	RCWWASH4	.89	1	FLOW	31.	31.	30.	30.	30.	30.	29.	29.	29.
				TIME	6.17	6.17	6.17	6.17	6.17	6.17	6.08	6.17	6.17
HYDROGRAPH AT +	WWASH3A	.49	1	FLOW	539.	528.	510.	491.	484.	479.	475.	469.	462.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
2 COMBINED AT +	CWWASH3A	1.38	1	FLOW	547.	535.	516.	497.	490.	485.	481.	475.	467.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
HYDROGRAPH AT +	WWASH3	.45	1	FLOW	674.	660.	638.	615.	606.	600.	595.	588.	579.
				TIME	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
ROUTED TO +	DBWWDA	.45	1	FLOW	24.	24.	24.	23.	23.	23.	23.	23.	23.
				TIME	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33
			** PEAK STAGES IN FEET **										
			1	STAGE	1342.74	1342.63	1342.44	1342.25	1342.18	1342.12	1342.09	1342.03	1341.95
				TIME	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33	5.33
2 COMBINED AT +	CWWASH3	1.83	1	FLOW	567.	556.	536.	517.	510.	504.	500.	494.	486.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO +	RCWWASH3	1.83	1	FLOW	567.	556.	536.	517.	509.	504.	500.	494.	486.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
HYDROGRAPH AT +	WWASH2A	.39	1	FLOW	338.	331.	317.	304.	299.	296.	293.	289.	284.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
2 COMBINED AT +	CWWASH2A	2.22	1	FLOW	906.	886.	854.	821.	809.	799.	793.	783.	770.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
HYDROGRAPH AT +	WWASH2	1.90	1	FLOW	1503.	1471.	1417.	1364.	1342.	1327.	1317.	1300.	1278.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
ROUTED TO +	DBWWCA	1.90	1	FLOW	121.	120.	118.	116.	116.	115.	115.	114.	114.
				TIME	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
			** PEAK STAGES IN FEET **										
			1	STAGE	1388.43	1388.07	1387.48	1386.89	1386.65	1386.49	1386.37	1386.18	1385.95
				TIME	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
ROUTED TO +	RDBWWCA	1.90	1	FLOW	121.	120.	118.	116.	116.	115.	115.	114.	114.
				TIME	6.08	6.08	6.00	6.00	6.00	6.00	6.00	6.00	6.00

Operation	Station	Area	Plan		Ratio 1	Ratio 2	Ratio 3	Ratio 4	Ratio 5	Ratio 6	Ratio 7	Ratio 8	Ratio 9
2 COMBINED AT													
+	CWWASH2	4.12	1	FLOW	983.	963.	929.	896.	882.	873.	866.	855.	842.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
ROUTED TO													
+	RCWWASH2	4.12	1	FLOW	962.	945.	912.	879.	866.	855.	850.	841.	826.
				TIME	3.83	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92
HYDROGRAPH AT													
+	WIWASH	3.50	1	FLOW	1383.	1345.	1282.	1220.	1196.	1178.	1166.	1147.	1122.
				TIME	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42
ROUTED TO													
+	DBWWWI	3.50	1	FLOW	137.	135.	133.	130.	129.	129.	128.	127.	126.
				TIME	6.92	6.83	6.83	6.83	6.83	6.83	6.83	6.83	6.83
			** PEAK STAGES IN FEET **										
			1	STAGE	1354.86	1354.25	1353.25	1352.27	1351.88	1351.61	1351.41	1351.10	1350.72
				TIME	6.92	6.83	6.83	6.83	6.83	6.83	6.83	6.83	6.83
2 COMBINED AT													
+	CWIWASH	7.62	1	FLOW	1011.	993.	957.	921.	907.	895.	889.	879.	863.
				TIME	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92
ROUTED TO													
+	RCWIWASH	7.62	1	FLOW	990.	976.	938.	913.	894.	879.	871.	863.	856.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
HYDROGRAPH AT													
+	WWASH1B	2.63	1	FLOW	2361.	2310.	2225.	2140.	2107.	2083.	2066.	2039.	2005.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
ROUTED TO													
+	DBWWWA	2.63	1	FLOW	121.	120.	119.	117.	117.	116.	116.	115.	115.
				TIME	6.00	6.00	5.92	5.92	5.92	5.92	5.92	5.92	5.92
			** PEAK STAGES IN FEET **										
			1	STAGE	1312.36	1312.19	1311.90	1311.61	1311.50	1311.42	1311.36	1311.27	1311.15
				TIME	6.00	6.00	6.00	5.92	5.92	5.92	5.92	5.92	5.92
2 COMBINED AT													
+	CWWASH1B	10.25	1	FLOW	1084.	1070.	1030.	1004.	984.	968.	961.	952.	945.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
ROUTED TO													
+	RCWWAS1B	10.25	1	FLOW	1081.	1068.	1025.	1001.	979.	964.	955.	946.	941.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
HYDROGRAPH AT													
+	WWASH1A	1.25	1	FLOW	1257.	1230.	1184.	1139.	1121.	1108.	1099.	1085.	1067.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO													
+	DBWWIA	1.25	1	FLOW	87.	86.	85.	84.	83.	83.	83.	82.	82.
				TIME	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58
			** PEAK STAGES IN FEET **										
			1	STAGE	1307.80	1307.62	1307.33	1307.03	1306.91	1306.83	1306.77	1306.68	1306.56
				TIME	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58
2 COMBINED AT													
+	CWWASH1A	11.50	1	FLOW	1157.	1143.	1099.	1073.	1051.	1035.	1026.	1016.	1011.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
ROUTED TO													
+	RCWWAS1A	11.50	1	FLOW	1144.	1129.	1089.	1058.	1042.	1028.	1016.	1006.	1000.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08
HYDROGRAPH AT													
+	OWASHS	11.43	1	FLOW	5442.	5296.	5055.	4817.	4723.	4657.	4611.	4536.	4443.
				TIME	4.25	4.25	4.25	4.33	4.33	4.33	4.33	4.33	4.33
HYDROGRAPH AT													
+	OWASHN	5.95	1	FLOW	2848.	2777.	2660.	2545.	2499.	2467.	2444.	2407.	2362.
				TIME	4.33	4.33	4.42	4.42	4.42	4.42	4.42	4.42	4.42
2 COMBINED AT													
+	COWASHS	17.38	1	FLOW	8282.	8068.	7713.	7360.	7220.	7122.	7052.	6940.	6801.
				TIME	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33
ROUTED TO													
+	RCOWASHS	17.38	1	FLOW	8034.	7827.	7483.	7142.	7006.	6911.	6843.	6736.	6601.
				TIME	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67
HYDROGRAPH AT													
+	OWASH1	2.44	1	FLOW	848.	822.	778.	735.	718.	707.	698.	685.	668.
				TIME	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33
2 COMBINED AT													
+	COWASH1	19.82	1	FLOW	8762.	8530.	8147.	7766.	7614.	7509.	7433.	7313.	7163.
				TIME	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58
ROUTED TO													
+	RORIDG	19.82	1	FLOW	8106.	7895.	7546.	7196.	7057.	6960.	6891.	6780.	6642.
				TIME	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83

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 ROUTED TO
+            RCOWASH1    19.82     1  FLOW        8003.    7795.    7450.    7106.    6969.    6874.    6806.    6697.    6561.
                                      TIME        5.08     5.08     5.08     5.08     5.08     5.08     5.08     5.08     5.08

 HYDROGRAPH AT
+              OWASH2     2.43     1  FLOW        1490.    1454.    1393.    1333.    1309.    1293.    1281.    1262.    1238.
                                      TIME        4.08     4.08     4.08     4.08     4.08     4.08     4.08     4.08     4.08

  2 COMBINED AT
+            CCOWASH2    22.25     1  FLOW        8634.    8413.    8046.    7679.    7533.    7432.    7359.    7243.    7099.
                                      TIME        5.08     5.08     5.08     5.08     5.08     5.08     5.08     5.08     5.08

 ROUTED TO
+              DBWWPA    22.25     1  FLOW         324.     320.     314.     309.     306.     305.     304.     302.     300.
                                      TIME        8.17     8.17     8.17     8.17     8.17     8.17     8.17     8.17     8.17

                                   ** PEAK STAGES IN FEET **
                                   1  STAGE     1332.39  1331.65  1330.42  1329.20  1328.72  1328.38  1328.14  1327.76  1327.28
                                      TIME        8.17     8.17     8.17     8.17     8.17     8.17     8.17     8.17     8.17

  2 COMBINED AT
+             COWASH2    33.75     1  FLOW        1297.    1281.    1239.    1207.    1190.    1175.    1162.    1153.    1146.
                                      TIME        4.08     4.08     4.08     4.08     4.08     4.08     4.08     4.08     4.08

 ROUTED TO
+            RCOWASH2    33.75     1  FLOW        1292.    1271.    1227.    1201.    1174.    1161.    1151.    1140.    1131.
                                      TIME        4.08     4.08     4.08     4.08     4.08     4.17     4.17     4.17     4.17

 HYDROGRAPH AT
+              OWASH3      .32     1  FLOW         356.     348.     335.     323.     318.     314.     312.     308.     302.
                                      TIME        3.67     3.67     3.67     3.67     3.67     3.67     3.67     3.67     3.67

  2 COMBINED AT
+             COWASH3    34.07     1  FLOW        1462.    1438.    1388.    1356.    1327.    1308.    1297.    1283.    1272.
                                      TIME        4.08     4.08     4.08     4.08     4.08     4.08     4.08     4.08     4.08

 ROUTED TO
+            RCOWASH3    34.07     1  FLOW        1442.    1419.    1373.    1337.    1322.    1296.    1282.    1267.    1258.
                                      TIME        4.17     4.17     4.17     4.17     4.17     4.17     4.17     4.17     4.17

 HYDROGRAPH AT
+                OVR2      .47     1  FLOW         297.     289.     275.     262.     257.     254.     251.     247.     242.
                                      TIME        3.92     3.92     3.92     3.92     3.92     3.92     3.92     3.92     3.92

  2 COMBINED AT
+               COVR2    34.54     1  FLOW        1706.    1676.    1604.    1556.    1532.    1499.    1483.    1465.    1452.
                                      TIME        4.08     4.08     4.08     4.08     4.08     4.17     4.17     4.17     4.17

  2 COMBINED AT
+                CMR7   279.58     1  FLOW       53319.   51929.   49627.   47333.   46426.   45807.   45317.   44610.   43707.
                                      TIME        6.25     6.25     6.25     6.33     6.33     6.33     6.33     6.33     6.33

 ROUTED TO
+               RCMR7   279.58     1  FLOW       53306.   51910.   49604.   47330.   46421.   45795.   45302.   44588.   43686.
                                      TIME        6.25     6.25     6.33     6.33     6.33     6.33     6.33     6.33     6.33

 HYDROGRAPH AT
+                OVR3      .45     1  FLOW         231.     224.     212.     200.     196.     193.     190.     187.     182.
                                      TIME        3.92     3.92     3.92     3.92     3.92     3.92     3.92     3.92     3.92

  2 COMBINED AT
+                CMR8   280.03     1  FLOW       53316.   51919.   49612.   47337.   46428.   45803.   45309.   44595.   43693.
                                      TIME        6.25     6.25     6.33     6.33     6.33     6.33     6.33     6.33     6.33

 ROUTED TO
+               RCMR8   280.03     1  FLOW       53285.   51898.   49607.   47318.   46404.   45773.   45292.   44580.   43686.
                                      TIME        6.25     6.33     6.33     6.33     6.33     6.33     6.42     6.42     6.42

 HYDROGRAPH AT
+              EWASH1     6.33     1  FLOW        2067.    2010.    1917.    1825.    1788.    1762.    1744.    1715.    1678.
                                      TIME        4.75     4.75     4.75     4.75     4.75     4.75     4.75     4.75     4.75

  2 COMBINED AT
+                CMR9   286.36     1  FLOW       54239.   52814.   50444.   48109.   47181.   46541.   46038.   45305.   44388.
                                      TIME        6.25     6.25     6.25     6.33     6.33     6.33     6.33     6.33     6.33

 ROUTED TO
+               RCMR9   286.36     1  FLOW       54217.   52784.   50435.   48099.   47169.   46522.   46019.   45286.   44374.
                                      TIME        6.25     6.25     6.33     6.33     6.33     6.33     6.33     6.42     6.42

 HYDROGRAPH AT
+               MAGW1     5.52     1  FLOW        1331.    1289.    1220.    1152.    1125.    1106.    1093.    1072.    1046.
                                      TIME        4.92     4.92     4.92     4.92     4.92     4.92     5.00     5.00     5.00

 ROUTED TO
+              RMAGW1     5.52     1  FLOW        1309.    1268.    1201.    1134.    1108.    1090.    1077.    1056.    1030.
                                      TIME        5.50     5.50     5.50     5.50     5.50     5.50     5.50     5.50     5.50

 HYDROGRAPH AT
+               MAGW2     4.81     1  FLOW        1791.    1743.    1664.    1586.    1555.    1533.    1518.    1493.    1462.
                                      TIME        4.58     4.58     4.58     4.58     4.58     4.58     4.58     4.58     4.58

  2 COMBINED AT
+              CMAGW2    10.33     1  FLOW        2703.    2625.    2497.    2370.    2320.    2285.    2260.    2220.    2171.
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                                                    TIME         5.00      5.00      5.00      5.00      5.00      5.00      5.00      5.00      5.00

  2 COMBINED AT
+                 CMR10    296.69      1    FLOW        55880.    54391.    51942.    49514.    48551.    47878.    47354.    46590.    45639.
                                            TIME         6.17      6.17      6.25      6.25      6.25      6.25      6.25      6.25      6.25

 HYDROGRAPH AT
+                  BMN8      1.27      1    FLOW          301.      288.      267.      246.      238.      232.      228.      222.      214.
                                            TIME         4.08      4.08      4.08      4.08      4.08      4.08      4.08      4.08      4.08

 HYDROGRAPH AT
+                BOWMAN       .30      1    FLOW            0.        0.        0.        0.        0.        0.        0.        0.        0.
                                            TIME          .00       .00       .00       .00       .00       .00       .00       .00       .00

  2 COMBINED AT
+               CBOWMAN      1.57      1    FLOW          301.      288.      267.      246.      238.      232.      228.      222.      214.
                                            TIME         4.08      4.08      4.08      4.08      4.08      4.08      4.08      4.08      4.08
1

*** NORMAL END OF HEC-1 ***
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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   03MAY16  TIME  11:43:33   *                                       *           (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
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          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

                        *DIAGRAM
 *** FREE ***
             1          ID   2016 FLOOD CONTROL MASTER PLAN UPDATE
             2          ID   MUDDY RIVER AND TRIBUTARY WASHES
             3          ID   INPUT FILE = MRMPU4.DAT
             4          ID   INPUT FILE DATE = APR, 2016
             5          ID   DESIGN STORM = 100-YEAR 6-HR STORM
             6          ID   STORM DISTRIBUTION = SDN #4
             7          ID   MODELED BY ATKINS (HONGYU DENG, E.I.T, CFM)
             8          ID   CHECKED BY ATKINS (BRIAN ROWLEY, P.E. , CFM)
             9          ID   STORM CENTERING = ENTIRE WATERSHED
            10          ID
            11          ID   JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:
            12          ID
            13          ID          AREA    DARF
            14          ID          SQ.MI.
            15          ID                  SDN 3   SDN 4   SDN 5
            16          ID          0 - 0.5 0.99
            17          ID          0.5 - 1 0.975
            18          ID          1 - 2   0.95
            19          ID          2 - 3   0.925
            20          ID          3 - 4   0.915
            21          ID          4 - 5   0.908
            22          ID          5 - 6   0.903
            23          ID          6 - 7   0.895
            24          ID          7 - 8   0.885
            25          ID          8 - 9           0.875
            26          ID          9 - 10          0.865
            27          ID          10 - 11         0.857
            28          ID          11 - 12         0.85
            29          ID          12 - 16                 0.832
            30          ID          16 - 20                 0.804
            31          ID          20 - 30                 0.765
            32          ID          30 - 40                 0.725
            33          ID          40 - 50                 0.695
            34          ID          50 - 100                0.64
            35          ID          100 - 150               0.58
            36          ID          150 - 200               0.53
            37          ID          200 - 300               0.49
            38          IT      5       0       0     300
            39          IN      5       0       0
            40          IO      5
            41          JR   PREC   0.875   0.865   0.857    0.85

            42          KK   MRIV2
            43          BA   18.37
            44          PB    2.92
            45          PC      0    0.02   0.058   0.075   0.099   0.126   0.137   0.145   0.149   0.151
            46          PC  0.155   0.156   0.159   0.162   0.169   0.172   0.179   0.189   0.201   0.211
            47          PC   0.22   0.228   0.232    0.24   0.246   0.252    0.26   0.269   0.276   0.283
            48          PC  0.286   0.292   0.302   0.312   0.321   0.332   0.352   0.376   0.415   0.462
            49          PC   0.53    0.61    0.71   0.732   0.756   0.782   0.799   0.813   0.823    0.83
            50          PC  0.835   0.844   0.851   0.864   0.885   0.908   0.924   0.944   0.968   0.973
            51          PC  0.978   0.982   0.984   0.986   0.988   0.991   0.992   0.993   0.994   0.997
            52          PC  0.998   0.999       1
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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  53          LS       0    85.0
  54          UD    1.69
              *

  55          KK   MRIV1
  56          BA   22.91
  57          PB    2.86
  58          LS       0    82.8
  59          UD    2.12
              *

  60          KK  CMRIV1
  61          HC       2
              *

  62          KK RCMRIV1
  63          RD   31433   0.004    0.04       0    TRAP      20       4
              *

  64          KK   MRIV3
  65          BA   21.99
  66          PB    2.86
  67          LS       0    82.5
  68          UD    2.02
              *

  69          KK  CMRIV3
  70          HC       2
              *

  71          KK RCMRIV3
  72          RD   10746   0.003    0.04       0    TRAP      20       4
              *

  73          KK   MRIV4
  74          BA   10.45
  75          PB    2.86
  76          LS       0    87.8
  77          UD    1.76
              *

  78          KK     MDW
  79          BA   19.44
  80          PB    2.86
  81          LS       0    83.0
  82          UD    1.08
              *

  83          KK   MRIV5
  84          BA    3.26
  85          PB    2.86
  86          LS       0    86.2
  87          UD    0.79
              *
```



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

  88          KK  CMRIV5
  89          HC       4
              *

  90          KK RCMRIV5
  91          RD   13545   0.002    0.04       0    TRAP      20       4
              *

  92          KK   MRIV6
  93          BA    2.17
  94          PB    2.86
  95          LS       0    86.3
  96          UD    1.33
              *

  97          KK   MRIV7
  98          BA   12.41
  99          PB    2.86
 100          LS       0    87.3
 101          UD    1.21
              *

 102          KK  WSWASH
 103          BA   61.31
 104          PB    2.86
 105          LS       0    86.4
 106          UD    1.76
              *

 107          KK  CMRIV7
 108          HC       4
              *

 109          KK RCMRIV7
```

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 110           RD   18735   0.002    0.04       0    TRAP      20       4
               *

 111           KK  EWASH8
 112           BA    3.47
 113           PB    2.86
 114           LS       0    80.7
 115           UD    1.24
               *

 116           KK  AWASH1
 117           BA    4.57
 118           PB    2.88
 119           LS       0    86.4
 120           UD    0.79
               *
1                                            HEC-1 INPUT                                      PAGE  4

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


 121           KK RAWASH1
 122           RM       2    0.20    0.15
               *

 123           KK  AWASH2
 124           BA    1.63
 125           PB    2.86
 126           LS       0    87.2
 127           UD    0.51
               *

 128           KK CAWASH2
 129           HC       2
               *

 130           KKRCAWASH2
 131           RM       7    0.58    0.15
               *

 132           KK  AWASH3
 133           BA    5.03
 134           PB    2.86
 135           LS       0    87.9
 136           UD    1.00
               *

 137           KK CAWASH3
 138           HC       2
               *

 139           KK    CMR0
 140           HC       3
               *

 141           KK   RCMR0
 142           RD    5862   0.011    0.04       0    TRAP      20       4
               *

 143           KK  WWASH6
 144           BA    1.20
 145           PB    2.86
 146           LS       0    88.9
 147           UD    0.39
               *

 148           KK  EWASH7
 149           BA    6.39
 150           PB    2.86
 151           LS       0    76.6
 152           UD    0.62
               *
1                                            HEC-1 INPUT                                      PAGE  5

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


 153           KK REWASH7
 154           RM       5    0.44    0.15
               *

 155           KK  EWASH6
 156           BA    0.78
 157           PB    2.86
 158           LS       0    80.5
 159           UD    0.67
               *

 160           KK CEWASH6
 161           HC       2
               *

 162           KK    BMN1
 163           BA    3.72
 164           PB    2.86
```

```
 165           LS       0    82.6
 166           UD    0.56
               *

 167           KK   RBMN1
 168           RM       7    0.55    0.15
               *

 169           KK    BMN3
 170           BA    5.12
 171           PB    2.86
 172           LS       0    85.3
 173           UD    1.20
               *

 174           KK   CBMN3
 175           HC       2
               *

 176           KK    BMN2
 177           BA    4.08
 178           PB    2.86
 179           LS       0    87.3
 180           UD    0.72
               *

 181           KK   RBMN2
 182           RM      10    0.80    0.15
               *

 183           KK    BMN4
 184           BA    6.98
 185           PB    2.86
 186           LS       0    86.5
 187           UD    1.34
               *
```



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

 188           KK   CBMN4
 189           HC       2
               *

 190           KK  CBMN34
 191           HC       2
               *

 192           KK RCBMN34
 193           RM       3    0.22    0.15
               *

 194           KK    BMN5
 195           BA    1.48
 196           PB    2.86
 197           LS       0    75.3
 198           UD    0.64
               *

 199           KK    BMN6
 200           BA    2.06
 201           PB    2.86
 202           LS       0    85.0
 203           UD    1.05
               *

 204           KK  CBMN56
 205           HC       3
               *

 206           KK RCBMN56
 207           RM       1    0.07    0.15
               *

 208           KK    BMN7
 209           BA    0.45
 210           PB    2.86
 211           LS       0    81.2
 212           UD    0.36
               *

 213           KK   CBMN7
 214           HC       2
               *

 215           KK  DBFGLS
 216           KM   FACILITY = FAIRGROUNDS LYMAN STREET DETENTION BASIN
 217           KM   FACILITY # = FGLS 0167
 218           KM   STORAGE VOLUME = 1247 AC-FT
 219           KM   OUTFALL = 42" ORIFICE
 220           KO       3
 221           RS       1    STOR       0
 222           SV       0    0.01    0.01   10.59   91.13  184.34  279.72  377.11  476.44   577.7
 223           SV     681  786.23  893.49  947.86 1002.72 1058.05  1113.8 1169.91 1226.31   1282.
```

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

 224          SE    1474    1476    1478    1480    1482    1484    1486    1488    1490    1492
 225          SE    1494    1496    1498    1499    1500    1501    1502    1503    1504    1505
 226          SQ       0      25      75     103     125     144     161     176     189     202
 227          SQ     214     226     237     242     247     252     257     262     267     271
              *

 228          KK RDBFGLS
 229          RD    6081   0.007   0.013       0    CIRC       6       0
              *

 230          KK   FGDB1
 231          BA    0.39
 232          PB    2.86
 233          LS       0    76.8
 234          UD    0.35
              *

 235          KK   DETBN
 236          KM   LOCAL DETENTION BASIN FROM LOUIS BERGER
 237          KM   FAIRGROUNDS DETENTION BASIN PRELIMINARY DESIGN
 238          RS       1    STOR       0
 239          SA   0.189   0.195   1.255   1.315   1.376   1.438     1.5   1.562   1.626    1.69
 240          SA   1.754   1.819   1.884   1.947  1.9602  1.9734  1.9866  1.9998   2.013
 241          SE    1413    1414    1415    1416    1417    1418    1419    1420    1421    1422
 242          SE    1423    1424    1425    1426  1426.2  1426.4  1426.6  1426.8    1427
 243          SQ       0   14.29   25.19   32.63   38.66   43.87   48.53   52.78    56.7   60.38
 244          SQ   63.84   67.13   70.26   73.25   89.84   99.62  111.99  125.57  141.13
              *

 245          KK  CFGDB1
 246          HC       2
              *

 247          KK RCFGDB1
 248          RD    2611   0.009   0.013       0    CIRC       6       0
              *

 249          KK    FGDB
 250          BA    1.92
 251          PB    2.86
 252          LS       0    83.6
 253          UD    0.42
              *

 254          KK  DBFGWS
 255          KM   FACILITY = FAIRGROUNDS WHIPPLE DETENTION BASIN
 256          KM   REFERENCE FROM LOUIS BERGER
 257          KM   FAIRGROUNDS DETENTION BASIN PRELIMINARY DESIGN
 258          KM   FACILITY # = FGWS 0166
 259          KM   STORAGE VOLUME = 139 AC-FT
 260          KM   OUTFALL = 18" ORIFICE
 261          KO       3
 262          RS       1    STOR       0
 263          SV       0     2.6     6.3    10.9    16.5    23.2    31.1    40.3    50.6    62.2
 264          SV   75.07    89.3   104.8   121.7   140.1   160.2     182   205.8   231.5   259.2
```



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

 265          SE    1469    1481    1482    1483    1484    1485    1486    1487    1488    1489
 266          SE    1490    1491    1492    1493    1494    1495    1496    1497    1498    1499
 267          SQ       0      31      32   33.55    34.8      36   37.16   38.28   39.38   40.44
 268          SQ      41      42      43   44.45   45.39  215.07    1934    4604    7959   11878
              *

 269          KK RDBFGWS
 270          RD    5302   0.012   0.013       0    CIRC       4       0
              *

 271          KK   FGDB2
 272          BA    0.46
 273          PB    2.86
 274          LS       0    73.2
 275          UD    0.32
              *

 276          KKCRDBFGWS
 277          HC       2
              *

 278          KK  CFGDB2
 279          HC       2
              *

 280          KK RCFGDB2
 281          RD    3976   0.009   0.015       0    TRAP       7       0
              *

 282          KK  EWASH5
 283          BA    0.58
 284          PB    2.86
```

```
 285           LS       0    72.7
 286           UD    0.73
               *

 287           KK CEWASH5
 288           HC       2
               *

 289           KK    CMR1
 290           HC       4
               *

 291           KK   RCMR1
 292           RD    6490   0.003    0.04       0    TRAP      20       4
               *

 293           KK    EWDB
 294           BA    1.89
 295           PB    2.86
 296           LS       0    86.2
 297           UD    0.43
1                                       HEC-1 INPUT                                    PAGE  9

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


 298           KK  DBEWGA
 299           KM   FACILITY = GUBLER AVENUE DETENTION BASIN
 300           KM   FACILITY # = EWGA 0196
 301           KM   STORAGE VOLUME = 157 AC-FT
 302           KM   OUTFALL = 30" ORIFICE
 303           KO       3
 304           RS       1    ELEV      -1
 305           SA       1       5      10      20      22
 306           SE    1472    1476    1480    1484    1488
 307           SQ       0      42      67      84      98
               *

 308           KK RDBEWGA
 309           RD   10278   0.012   0.013       0    CIRC       4       0
               *

 310           KK  EWASH4
 311           BA    2.03
 312           PB    2.86
 313           LS       0    77.3
 314           UD    0.61
               *

 315           KK CEWASH4
 316           HC       2
               *

 317           KK  LWASH1
 318           BA    4.03
 319           PB    2.86
 320           LS       0    78.4
 321           UD    0.71
               *

 322           KK  LWASH2
 323           BA    0.70
 324           PB    2.86
 325           LS       0    82.7
 326           UD    0.50
               *

 327           KK CLWASH1
 328           HC       2
               *

 329           KKRCLWASH1
 330           RM       3    0.25    0.15
               *
1                                       HEC-1 INPUT                                    PAGE 10

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


 331           KK  LWASH3
 332           BA    1.17
 333           PB    2.86
 334           LS       0    89.0
 335           UD    0.44
               *

 336           KK CLWASH3
 337           HC       2
               *

 338           KKRCLWASH3
 339           RD    3556   0.012   0.013       0    CIRC      20       0
               *

 340           KK  WWASH5
```

```
 341           BA    1.61
 342           PB    2.86
 343           LS       0    89.4
 344           UD    0.40
               *

 345           KK RWWASH5
 346           RM       2    0.20    0.15
               *

 347           KK    LOG1
 348           BA    0.41
 349           PB    2.86
 350           LS       0    81.6
 351           UD    0.51
               *

 352           KK    CMR2
 353           HC       5
               *

 354           KK   RCMR2
 355           RD    9445   0.001   0.025       0    TRAP     200       3
               *

 356           KK  EWASH3
 357           BA    1.77
 358           PB    2.86
 359           LS       0    74.4
 360           UD    0.81
               *

 361           KK    LOG3
 362           BA    0.51
 363           PB    2.86
 364           LS       0    84.6
 365           UD    0.76
               *
```



```
 366           KK    CMR3
 367           HC       3
               *

 368           KK   RCMR3
 369           RD    4979   0.001   0.025       0    TRAP     200       3
               *

 370           KK    LOG2
 371           BA    1.62
 372           PB    2.86
 373           LS       0    84.8
 374           UD    0.67
               *

 375           KK    CMR4
 376           HC       2
               *

 377           KK   RCMR4
 378           RD    5007   0.004   0.025       0    TRAP     200       3
               *

 379           KK  EWASH2
 380           BA    4.80
 381           PB    2.86
 382           LS       0    82.9
 383           UD    0.94
               *

 384           KK    CMR5
 385           HC       2
               *

 386           KK   RCMR5
 387           RD    4696   0.002   0.025       0    TRAP     400       3
               *

 388           KK    OVR1
 389           BA    1.88
 390           PB    2.86
 391           LS       0    85.0
 392           UD    0.61
               *

 393           KK    CMR6
 394           HC       2
               *
```

```
 395           KK   RCMR6
 396           RD    3336   0.003   0.025       0    TRAP     600       3
               *

 397           KK WWASH4A
 398           BA    0.31
 399           PB    2.86
 400           LS       0    89.8
 401           UD    0.23
               *

 402           KK  WWASH4
 403           BA    0.58
 404           PB    2.86
 405           LS       0    89.4
 406           UD    0.38
               *

 407           KK CWWASH4
 408           HC       2
               *

 409           KK  DBWWWT
 410           KM   FACILITY = WITTWER AVENUE DETENTION BASIN
 411           KM   FACILITY # = WWWT 0004
 412           KM   STORAGE VOLUME = 91 ACRE-FEET
 413           KM   OUTFALL = 18" ORIFICE
 414           KO       3
 415           RS       1    ELEV      -1
 416           SA       5       6       7       8
 417           SE    1365    1370    1375    1380
 418           SQ       0      19      28      35
               *

 419           KKRCWWASH4
 420           RD    5392   0.005   0.015       0    TRAP      12       2
               *

 421           KK WWASH3A
 422           BA    0.49
 423           PB    2.86
 424           LS       0    89.6
 425           UD    0.32
               *

 426           KKCWWASH3A
 427           HC       2
               *
```



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


 428           KK  WWASH3
 429           BA    0.45
 430           PB    2.86
 431           LS       0    89.8
 432           UD    0.15
               *

 433           KK  DBWWDA
 434           KM   FACILITY = DUESING AVENUE DETENTION BASIN
 435           KM   FACILITY # = WWDA 0009
 436           KM   STORAGE VOLUME = 49 ACRE-FEET
 437           KM   OUTFALL = 18" ORIFICE
 438           KO       3
 439           RS       1    ELEV      -1
 440           SA       1       4       6       7       8
 441           SE    1335    1337    1340    1342    1345
 442           SQ       0      10      19      23      28
               *

 443           KK CWWASH3
 444           HC       2
               *

 445           KKRCWWASH3
 446           RD    4532   0.004   0.015       0    TRAP      12       2
               *

 447           KK WWASH2A
 448           BA    0.39
 449           PB    2.86
 450           LS       0    85.7
 451           UD    0.37
               *

 452           KKCWWASH2A
 453           HC       2
               *

 454           KK  WWASH2
 455           BA    1.90
 456           PB    2.86
```

```
 457           LS       0    88.4
 458           UD    0.54
               *

 459           KK  DBWWCA
 460           KM   FACILITY = COTTONWOOD AVENUE DETENTION BASIN
 461           KM   FACILITY # = WWCA 0050
 462           KM   STORAGE VOLUME = 156 ACRE-FEET
 463           KM   OUTFALL  = 30" ORIFICE
 464           KO       3
 465           RS       1    ELEV      -1
 466           SA       1       3       6       8       9      10
 467           SE    1365    1370    1375    1380    1385    1390
```


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

 468           SQ       0      50      76      95     111     125
               *

 469           KK RDBWWCA
 470           RD    2608   0.020   0.013       0    CIRC       5       0
               *

 471           KK CWWASH2
 472           HC       2
               *

 473           KKRCWWASH2
 474           RD    2310   0.004   0.015       0    TRAP      12       2
               *

 475           KK  WIWASH
 476           BA    3.50
 477           PB    2.86
 478           LS       0    80.9
 479           UD    0.91
               *

 480           KK  DBWWWI
 481           KM   FACILITY = WEIBER WASH DETENTION BASIN
 482           KM   FACILITY # = WWWI 0027
 483           KM   STORAGE VOLUME = 182 ACRE-FEET
 484           KM   OUTFALL = 30" ORIFICE
 485           KO       3
 486           RS       1    ELEV      -1
 487           SA       3       4       6       8      10
 488           SE    1325    1332    1340    1347    1355
 489           SQ       0      61      95     117     137
               *

 490           KK CWIWASH
 491           HC       2
               *

 492           KKRCWIWASH
 493           RD    4030   0.004   0.015       0    TRAP      12       2
               *

 494           KK WWASH1B
 495           BA    2.63
 496           PB    2.86
 497           LS       0    88.4
 498           UD    0.43
               *

 499           KK  DBWWWA
 500           KM   FACILITY = WEST WASH 1 DETENTION BASIN
 501           KM   FACILITY # = WWWA 0017
 502           KM   STORAGE VOLUME = 235 ACRE-FEET
 503           KM   OUTFALL = 36" ORIFICE
 504           KO       3
```


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

 505           RS       1    ELEV      -1
 506           SA       2      11      20      26      30
 507           SE    1300    1303    1307    1311    1315
 508           SQ       0      45      86     114     135
               *

 509           KKCWWASH1B
 510           HC       2
               *

 511           KKRCWWAS1B
 512           RD    1606   0.004   0.015       0    TRAP      12       2
               *

 513           KK WWASH1A
 514           BA    1.25
 515           PB    2.86
 516           LS       0    88.1
 517           UD    0.34
```

```
               *

 518           KK  DBWWIA
 519           KM   Facility = INGRAM AVENUE DETENTION BASIN
 520           KM   Facility # = WWWA 0016
 521           KM   STORAGE VOLUME = 108 ACRE-FEET
 522           KM   OUTLET = 30" ORIFICE
 523           KO       3
 524           RS       1    ELEV      -1
 525           SA       1       6      11      14
 526           SE    1295    1300    1305    1310
 527           SQ       0      50      76      95
               *

 528           KKCWWASH1A
 529           HC       2
               *

 530           KKRCWWAS1A
 531           RD    3078   0.004   0.015       0    TRAP      12       2
               *

 532           KK  OWASHS
 533           BA   11.43
 534           PB    3.02
 535           LS       0    80.9
 536           UD    0.80
               *

 537           KK  OWASHN
 538           BA    5.95
 539           PB    2.90
 540           LS       0    84.0
 541           UD    0.89
               *
```



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


 542           KK COWASHS
 543           HC       2
               *

 544           KKRCOWASHS
 545           RM       4    0.31    0.15
               *

 546           KK  OWASH1
 547           BA    2.44
 548           PB    2.86
 549           LS       0    76.8
 550           UD    0.79
               *

 551           KK COWASH1
 552           HC       2
               *

 553           KK  RORIDG
 554           KM   Route through Overton Ridge from USCOE
 555           KM   Dentention Basin cards from 1988 and 1994 MVMPU
 556           RS       1    STOR       0       0
 557           SV      10      20      40      80     160     270     500
 558           SQ       0     350    1070    3580    7600   13000   20580
               *

 559           KKRCOWASH1
 560           RM       3    0.22    0.15
               *

 561           KK  OWASH2
 562           BA    2.43
 563           PB    2.86
 564           LS       0    84.3
 565           UD    0.61
               *

 566           KKCCOWASH2
 567           HC       2
               *

 568           KK  DBWWPA
 569           KM   FACILITY = PERKINS AVENUE DETENTION BASIN
 570           KM   Facility # = WWPA 0018
 571           KM   STORAGE VOLUME = 992 ACRE-FEET
 572           KM   OUTLET = 42" ORIFICE
 573           KO       3
 574           RS       1    ELEV      -1
 575           SA       1      12      32      49      56
 576           SE    1290    1300    1308    1315    1325
 577           SQ       0     144     202     242     289
               *
```

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

 578          KK COWASH2
 579          HC       2
              *

 580          KKRCOWASH2
 581          RD    2591   0.004   0.015       0    TRAP      12       2
              *

 582          KK  OWASH3
 583          BA    0.32
 584          PB    2.86
 585          LS       0    88.6
 586          UD    0.28
              *

 587          KK COWASH3
 588          HC       2
              *

 589          KKRCOWASH3
 590          RD    4701   0.005   0.015       0    TRAP      12       2
              *

 591          KK    OVR2
 592          BA    0.47
 593          PB    2.86
 594          LS       0    81.4
 595          UD    0.46
              *

 596          KK   COVR2
 597          HC       2
              *

 598          KK    CMR7
 599          HC       2
              *

 600          KK   RCMR7
 601          RD    2035   0.004   0.025       0    TRAP     600       3
              *

 602          KK    OVR3
 603          BA    0.45
 604          PB    2.86
 605          LS       0    77.1
 606          UD    0.44
              *
```



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

 607          KK    CMR8
 608          HC       2
              *

 609          KK   RCMR8
 610          RD    2730   0.004   0.025       0    TRAP     600       3
              *

 611          KK  EWASH1
 612          BA    6.33
 613          PB    2.86
 614          LS       0    80.9
 615          UD    1.20
              *

 616          KK    CMR9
 617          HC       2
              *

 618          KK   RCMR9
 619          RD    2796   0.004   0.025       0    TRAP     600       3
              *

 620          KK   MAGW1
 621          BA    5.52
 622          PB    2.86
 623          LS       0    76.0
 624          UD    1.26
              *

 625          KK  RMAGW1
 626          RM       6    0.52    0.15
              *

 627          KK   MAGW2
 628          BA    4.81
 629          PB    2.86
 630          LS       0    81.8
 631          UD    1.06
```

```
                      *

          632           KK  CMAGW2
          633           HC       2
                        *

          634           KK   CMR10
          635           HC       2
                        *
```



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


          636           KK    BMN8
          637           BA    1.27
          638           PB    2.86
          639           LS       0    67.6
          640           UD    0.52
                        *

          641           KK  BOWMAN
          642           BA    0.30
          643           PB    2.86
          644           LS       0    33.4
          645           UD    0.99
                        *

          646           KK CBOWMAN
          647           HC       2
                        *
          648           ZZ
```

```
1
               SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

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

    42       MRIV2
                 .
                 .
    55           .       MRIV1
                 .           .
                 .           .
    60      CMRIV1............
                 V
                 V
    62     RCMRIV1
                 .
                 .
    64           .       MRIV3
                 .           .
                 .           .
    69      CMRIV3............
                 V
                 V
    71     RCMRIV3
                 .
                 .
    73           .       MRIV4
                 .           .
                 .           .
    78           .           .         MDW
                 .           .           .
                 .           .           .
    83           .           .           .       MRIV5
                 .           .           .           .
                 .           .           .           .
    88      CMRIV5...................................
                 V
                 V
    90     RCMRIV5
                 .
                 .
    92           .       MRIV6
                 .           .
                 .           .
    97           .           .       MRIV7
                 .           .           .
                 .           .           .
   102           .           .           .      WSWASH
                 .           .           .           .
                 .           .           .           .
   107      CMRIV7...................................
                 V
                 V
   109     RCMRIV7
                 .
                 .
   111           .      EWASH8
                 .           .
                 .           .
   116           .           .      AWASH1
                 .           .           V
```

```
              .           .           V
121           .           .     RAWASH1
              .           .           .
              .           .           .
123           .           .           .      AWASH2
              .           .           .           .
              .           .           .           .
128           .           .     CAWASH2............
              .           .           V
              .           .           V
130           .           .    RCAWASH2
              .           .           .
              .           .           .
132           .           .           .      AWASH3
              .           .           .           .
              .           .           .           .
137           .           .     CAWASH3............
              .           .           .
              .           .           .
139        CMR0........................
              V
              V
141       RCMR0
              .
              .
143           .      WWASH6
              .           .
              .           .
148           .           .      EWASH7
              .           .           V
              .           .           V
153           .           .     REWASH7
              .           .           .
              .           .           .
155           .           .           .      EWASH6
              .           .           .           .
              .           .           .           .
160           .           .     CEWASH6............
              .           .           .
              .           .           .
162           .           .           .        BMN1
              .           .           .           V
              .           .           .           V
167           .           .           .       RBMN1
              .           .           .           .
              .           .           .           .
169           .           .           .           .        BMN3
              .           .           .           .           .
              .           .           .           .           .
174           .           .           .       CBMN3............
              .           .           .           .
              .           .           .           .
176           .           .           .           .        BMN2
              .           .           .           .           V
              .           .           .           .           V
181           .           .           .           .       RBMN2
              .           .           .           .           .
              .           .           .           .           .
183           .           .           .           .           .        BMN4
              .           .           .           .           .           .
              .           .           .           .           .           .
188           .           .           .           .       CBMN4............
              .           .           .           .           .
              .           .           .           .           .
190           .           .           .      CBMN34............
              .           .           .           V
              .           .           .           V
192           .           .           .     RCBMN34
              .           .           .           .
              .           .           .           .
194           .           .           .           .        BMN5
              .           .           .           .           .
              .           .           .           .           .
199           .           .           .           .           .        BMN6
              .           .           .           .           .           .
              .           .           .           .           .           .
204           .           .           .      CBMN56........................
              .           .           .           V
              .           .           .           V
206           .           .           .     RCBMN56
              .           .           .           .
              .           .           .           .
208           .           .           .           .        BMN7
              .           .           .           .           .
              .           .           .           .           .
213           .           .           .       CBMN7............
              .           .           .           V
              .           .           .           V
215           .           .           .      DBFGLS
              .           .           .           V
              .           .           .           V
228           .           .           .     RDBFGLS
              .           .           .           .
              .           .           .           .
230           .           .           .           .       FGDB1
```

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              .           .           .           .           V
              .           .           .           .           V
235           .           .           .           .       DETBN
              .           .           .           .           .
              .           .           .           .           .
245           .           .           .      CFGDB1............
              .           .           .           V
              .           .           .           V
247           .           .           .     RCFGDB1
              .           .           .           .
              .           .           .           .
249           .           .           .           .        FGDB
              .           .           .           .           V
              .           .           .           .           V
254           .           .           .           .      DBFGWS
              .           .           .           .           V
              .           .           .           .           V
269           .           .           .           .     RDBFGWS
              .           .           .           .           .
              .           .           .           .           .
271           .           .           .           .           .       FGDB2
              .           .           .           .           .           .
              .           .           .           .           .           .
276           .           .           .           .    CRDBFGWS............
              .           .           .           .           .
              .           .           .           .           .
278           .           .           .      CFGDB2............
              .           .           .           V
              .           .           .           V
280           .           .           .     RCFGDB2
              .           .           .           .
              .           .           .           .
282           .           .           .           .      EWASH5
              .           .           .           .           .
              .           .           .           .           .
287           .           .           .     CEWASH5............
              .           .           .           .
              .           .           .           .
289        CMR1....................................
              V
              V
291       RCMR1
              .
              .
293           .        EWDB
              .           V
              .           V
298           .      DBEWGA
              .           V
              .           V
308           .     RDBEWGA
              .           .
              .           .
310           .           .      EWASH4
              .           .           .
              .           .           .
315           .     CEWASH4............
              .           .
              .           .
317           .           .      LWASH1
              .           .           .
              .           .           .
322           .           .           .      LWASH2
              .           .           .           .
              .           .           .           .
327           .           .     CLWASH1............
              .           .           V
              .           .           V
329           .           .    RCLWASH1
              .           .           .
              .           .           .
331           .           .           .      LWASH3
              .           .           .           .
              .           .           .           .
336           .           .     CLWASH3............
              .           .           V
              .           .           V
338           .           .    RCLWASH3
              .           .           .
              .           .           .
340           .           .           .      WWASH5
              .           .           .           V
              .           .           .           V
345           .           .           .     RWWASH5
              .           .           .           .
              .           .           .           .
347           .           .           .           .        LOG1
              .           .           .           .           .
              .           .           .           .           .
352        CMR2................................................
              V
              V
354       RCMR2
              .
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356           .      EWASH3
              .           .
              .           .
361           .           .         LOG3
              .           .           .
              .           .           .
366        CMR3........................
              V
              V
368       RCMR3
              .
              .
370           .        LOG2
              .           .
              .           .
375        CMR4............
              V
              V
377       RCMR4
              .
              .
379           .      EWASH2
              .           .
              .           .
384        CMR5............
              V
              V
386       RCMR5
              .
              .
388           .        OVR1
              .           .
              .           .
393        CMR6............
              V
              V
395       RCMR6
              .
              .
397           .     WWASH4A
              .           .
              .           .
402           .           .      WWASH4
              .           .           .
              .           .           .
407           .     CWWASH4............
              .           V
              .           V
409           .      DBWWWT
              .           V
              .           V
419           .    RCWWASH4
              .           .
              .           .
421           .           .     WWASH3A
              .           .           .
              .           .           .
426           .    CWWASH3A............
              .           .
              .           .
428           .           .      WWASH3
              .           .           V
              .           .           V
433           .           .      DBWWDA
              .           .           .
              .           .           .
443           .     CWWASH3............
              .           V
              .           V
445           .    RCWWASH3
              .           .
              .           .
447           .           .     WWASH2A
              .           .           .
              .           .           .
452           .    CWWASH2A............
              .           .
              .           .
454           .           .      WWASH2
              .           .           V
              .           .           V
459           .           .      DBWWCA
              .           .           V
              .           .           V
469           .           .     RDBWWCA
              .           .           .
              .           .           .
471           .     CWWASH2............
              .           V
              .           V
473           .    RCWWASH2
              .           .
              .           .
475           .           .      WIWASH
              .           .           V
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              .           .           V
480           .           .      DBWWWI
              .           .           .
              .           .           .
490           .     CWIWASH............
              .           V
              .           V
492           .    RCWIWASH
              .           .
              .           .
494           .           .     WWASH1B
              .           .           V
              .           .           V
499           .           .      DBWWWA
              .           .           .
              .           .           .
509           .    CWWASH1B............
              .           V
              .           V
511           .    RCWWAS1B
              .           .
              .           .
513           .           .     WWASH1A
              .           .           V
              .           .           V
518           .           .      DBWWIA
              .           .           .
              .           .           .
528           .    CWWASH1A............
              .           V
              .           V
530           .    RCWWAS1A
              .           .
              .           .
532           .           .      OWASHS
              .           .           .
              .           .           .
537           .           .           .      OWASHN
              .           .           .           .
              .           .           .           .
542           .           .     COWASHS............
              .           .           V
              .           .           V
544           .           .    RCOWASHS
              .           .           .
              .           .           .
546           .           .           .      OWASH1
              .           .           .           .
              .           .           .           .
551           .           .     COWASH1............
              .           .           V
              .           .           V
553           .           .      RORIDG
              .           .           V
              .           .           V
559           .           .    RCOWASH1
              .           .           .
              .           .           .
561           .           .           .      OWASH2
              .           .           .           .
              .           .           .           .
566           .           .    CCOWASH2............
              .           .           V
              .           .           V
568           .           .      DBWWPA
              .           .           .
              .           .           .
578           .     COWASH2............
              .           V
              .           V
580           .    RCOWASH2
              .           .
              .           .
582           .           .      OWASH3
              .           .           .
              .           .           .
587           .     COWASH3............
              .           V
              .           V
589           .    RCOWASH3
              .           .
              .           .
591           .           .        OVR2
              .           .           .
              .           .           .
596           .       COVR2............
              .           .
              .           .
598        CMR7............
              V
              V
600       RCMR7
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602           .        OVR3
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                 .           .
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  607        CMR8............
                 V
                 V
  609       RCMR8
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  611            .      EWASH1
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                 .           .
  616        CMR9............
                 V
                 V
  618       RCMR9
                 .
                 .
  620            .       MAGW1
                 .           V
                 .           V
  625            .      RMAGW1
                 .           .
                 .           .
  627            .           .       MAGW2
                 .           .           .
                 .           .           .
  632            .      CMAGW2............
                 .           .
                 .           .
  634       CMR10............
                 .
                 .
  636            .        BMN8
                 .           .
                 .           .
  641            .           .      BOWMAN
                 .           .           .
                 .           .           .
  646            .     CBOWMAN............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *             JUN   1998               *
 *           VERSION 4.1                *
 *                                      *
 *  RUN DATE   03MAY16  TIME  11:43:33  *
 *                                      *
 ****************************************

 ***************************************
 *                                     *
 *    U.S. ARMY CORPS OF ENGINEERS     *
 *    HYDROLOGIC ENGINEERING CENTER    *
 *         609 SECOND STREET           *
 *      DAVIS, CALIFORNIA 95616        *
 *          (916) 756-1104             *
 *                                     *
 ***************************************



                            2016 FLOOD CONTROL MASTER PLAN UPDATE
                            MUDDY RIVER AND TRIBUTARY WASHES
                            INPUT FILE = MRMPU4.DAT
                            INPUT FILE DATE = APR, 2016
                            DESIGN STORM = 100-YEAR 6-HR STORM
                            STORM DISTRIBUTION = SDN #4
                            MODELED BY ATKINS (HONGYU DENG, E.I.T, CFM)
                            CHECKED BY ATKINS (BRIAN ROWLEY, P.E. , CFM)
                            STORM CENTERING = ENTIRE WATERSHED

                            JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:

                                    AREA    DARF
                                    SQ.MI.
                                            SDN 3   SDN 4   SDN 5
                                    0 - 0.5 0.99
                                    0.5 - 1 0.975
                                    1 - 2   0.95
                                    2 - 3   0.925
                                    3 - 4   0.915
                                    4 - 5   0.908
                                    5 - 6   0.903
                                    6 - 7   0.895
                                    7 - 8   0.885
                                    8 - 9           0.875
                                    9 - 10          0.865
                                    10 - 11         0.857
                                    11 - 12         0.85
                                    12 - 16                 0.832
                                    16 - 20                 0.804
                                    20 - 30                 0.765
                                    30 - 40                 0.725
                                    40 - 50                 0.695
                                    50 - 100                0.64
                                    100 - 150               0.58
                                    150 - 200               0.53
                                    200 - 300               0.49

  40 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      1    0  STARTING DATE
                    ITIME        0000  STARTING TIME
                       NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2    0  ENDING DATE
                   NDTIME        0055  ENDING TIME
                    ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL     .08 HOURS
                     TOTAL TIME BASE   24.92 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

    JP          MULTI-PLAN OPTION
                    NPLAN           1  NUMBER OF PLANS

    JR          MULTI-RATIO OPTION
                  RATIOS OF PRECIPITATION
                  .88       .87       .86       .85


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


            **************
            *            *
 215 KK     *    DBFGLS  *
            *            *
            **************

 220 KO         OUTPUT CONTROL VARIABLES
                    IPRNT           3  PRINT CONTROL
                    IPLOT           0  PLOT CONTROL
                    QSCAL          0.  HYDROGRAPH PLOT SCALE

              HYDROGRAPH ROUTING DATA

 221 RS         STORAGE ROUTING
                    NSTPS           1  NUMBER OF SUBREACHES
                     ITYP        STOR  TYPE OF INITIAL CONDITION
                   RSVRIC         .00  INITIAL CONDITION
                        X         .00 WORKING R AND D COEFFICIENT

 222 SV           STORAGE         .0        .0        .0      10.6      91.1     184.3     279.7     377.1     476.4     577.7
                               681.0     786.2     893.5     947.9    1002.7    1058.1    1113.8    1169.9    1226.3    1282.0

 224 SE         ELEVATION    1474.00   1476.00   1478.00   1480.00   1482.00   1484.00   1486.00   1488.00   1490.00   1492.00
                             1494.00   1496.00   1498.00   1499.00   1500.00   1501.00   1502.00   1503.00   1504.00   1505.00

 226 SQ         DISCHARGE         0.       25.       75.      103.      125.      144.      161.      176.      189.      202.
                                214.      226.      237.      242.      247.      252.      257.      262.      267.      271.

                                                                ***

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN        0. TO       25.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

WARNING --- ROUTED OUTFLOW (    271.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

WARNING --- ROUTED OUTFLOW (    272.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

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                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .88

   PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                         (CFS)
 +      278.     8.50                 276.        234.        225.        225.
                        (INCHES)      .107        .364        .364        .364
                        (AC-FT)       137.        464.        464.        464.

  PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
      1384.      8.50                1350.       1010.        973.        973.

   PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1506.82      8.50              1506.22     1499.52     1498.58     1498.58

                        CUMULATIVE AREA =   23.89 SQ MI

 WARNING --- ROUTED OUTFLOW (    271.) IS GREATER THAN MAXIMUM OUTFLOW (    271.) IN STORAGE-OUTFLOW TABLE

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                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .87

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                        (CFS)
+     276.      8.50                  274.        232.        224.        224.
                       (INCHES)       .107        .361        .361        .361
                        (AC-FT)       136.        460.        460.        460.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
    1356.       8.50                 1323.        988.        952.        952.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1506.33      8.50               1505.73     1499.12     1498.20     1498.20

                        CUMULATIVE AREA =   23.89 SQ MI

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                            HYDROGRAPH AT STATION   DBFGLS
                              FOR PLAN 1, RATIO =  .86

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                             (CFS)
 +     275.      8.50                  272.        230.        222.         222.
                           (INCHES)    .106        .359        .359         .359
                            (AC-FT)    135.        457.        457.         457.

  PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
      1334.      8.50                 1301.        971.        935.         935.

   PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1505.93      8.50               1505.34     1498.80     1497.89      1497.89

                           CUMULATIVE AREA =   23.89 SQ MI

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                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .85

   PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                         6-HR        24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                               (CFS)
 +     273.      8.50                    271.         229.        221.         221.
                             (INCHES)    .105         .357        .357         .357
                              (AC-FT)    134.         454.        454.         454.

  PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                         6-HR        24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
      1315.      8.50                   1282.         956.        921.         921.

   PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                         6-HR        24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1505.59      8.50                 1504.99     1498.53     1497.62      1497.62

                        CUMULATIVE AREA =   23.89 SQ MI


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             *            *
  254 KK     *   DBFGWS   *
             *            *
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  261 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE
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              HYDROGRAPH ROUTING DATA

 262 RS          STORAGE ROUTING
                      NSTPS         1  NUMBER OF SUBREACHES
                       ITYP       STOR  TYPE OF INITIAL CONDITION
                     RSVRIC        .00  INITIAL CONDITION
                          X        .00 WORKING R AND D COEFFICIENT

 263 SV            STORAGE          .0       2.6       6.3      10.9      16.5      23.2      31.1      40.3      50.6      62.2
                                  75.1      89.3     104.8     121.7     140.1     160.2     182.0     205.8     231.5     259.2

 265 SE          ELEVATION     1469.00   1481.00   1482.00   1483.00   1484.00   1485.00   1486.00   1487.00   1488.00   1489.00
                               1490.00   1491.00   1492.00   1493.00   1494.00   1495.00   1496.00   1497.00   1498.00   1499.00

 267 SQ          DISCHARGE          0.       31.       32.       34.       35.       36.       37.       38.       39.       40.
                                   41.       42.       43.       44.       45.      215.     1934.     4604.     7959.    11878.

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                        HYDROGRAPH AT STATION   DBFGWS
                          FOR PLAN 1, RATIO =  .88

 PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)      (HR)
                          (CFS)
+      43.     6.25                   42.         38.         36.          36.
                        (INCHES)     .204        .730        .730         .730
                         (AC-FT)      21.         75.         75.          75.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)     (HR)
       98.     6.33                   92.         61.         59.          59.

 PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)     (HR)
   1491.59     6.33               1491.16     1487.76     1487.07      1487.07

                       CUMULATIVE AREA =    1.92 SQ MI


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

                        HYDROGRAPH AT STATION   DBFGWS
                          FOR PLAN 1, RATIO =  .87

 PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)      (HR)
                          (CFS)
+      42.     6.25                   42.         38.         36.          36.
                        (INCHES)     .203        .727        .727         .727
                         (AC-FT)      21.         74.         74.          74.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)     (HR)
       96.     6.33                   90.         59.         57.          57.

 PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)     (HR)
   1491.45     6.33               1491.02     1487.60     1486.92      1486.92

                       CUMULATIVE AREA =    1.92 SQ MI


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

                        HYDROGRAPH AT STATION   DBFGWS
                          FOR PLAN 1, RATIO =  .86

 PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)      (HR)
                          (CFS)
+      42.     6.25                   42.         37.         36.          36.
                        (INCHES)     .203        .724        .724         .724
                         (AC-FT)      21.         74.         74.          74.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)     (HR)
       95.     6.33                   88.         58.         56.          56.

 PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)     (HR)
   1491.35     6.33               1490.91     1487.48     1486.80      1486.80
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                         CUMULATIVE AREA =    1.92 SQ MI


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

                          HYDROGRAPH AT STATION   DBFGWS
                            FOR PLAN 1, RATIO =  .85

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      42.      6.25                  42.         37.         36.          36.
                         (INCHES)      .202        .722        .722         .722
                          (AC-FT)       21.         74.         74.          74.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        93.     6.25                  87.         57.         55.          55.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1491.25      6.25               1490.81     1487.36     1486.69      1486.69

                         CUMULATIVE AREA =    1.92 SQ MI



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             *            *
  298 KK     *    DBEWGA  *
             *            *
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  303 KO         OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  304 RS         STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC       -1.00  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

  305 SA              AREA         1.0       5.0      10.0      20.0      22.0

  306 SE         ELEVATION     1472.00   1476.00   1480.00   1484.00   1488.00

  307 SQ         DISCHARGE          0.       42.       67.       84.       98.

                                                                     ***

                                                COMPUTED STORAGE-ELEVATION DATA

             STORAGE        .00     10.98     40.41     99.27    183.23
           ELEVATION    1472.00   1476.00   1480.00   1484.00   1488.00

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

                          HYDROGRAPH AT STATION   DBEWGA
                            FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      85.      6.00                  82.         61.         58.          58.
                         (INCHES)      .404       1.191       1.191        1.191
                          (AC-FT)       41.        120.        120.         120.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       106.     6.00                  93.         48.         47.          47.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1484.30      6.00               1483.57     1479.60     1479.32      1479.32

                         CUMULATIVE AREA =    1.89 SQ MI


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                          HYDROGRAPH AT STATION   DBEWGA
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                           FOR PLAN 1, RATIO =  .87

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR        24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+       85.     6.00                     82.         60.         57.          57.
                        (INCHES)       .401       1.174       1.174        1.174
                         (AC-FT)        40.        118.        118.         118.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR        24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      103.      6.00                     91.         47.         45.          45.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR        24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1484.20      6.00                1483.45     1479.46     1479.18      1479.18

                        CUMULATIVE AREA =    1.89 SQ MI


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

                         HYDROGRAPH AT STATION   DBEWGA
                           FOR PLAN 1, RATIO =  .86

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR        24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+       84.     6.00                     81.         59.         57.          57.
                        (INCHES)       .399       1.160       1.160        1.160
                         (AC-FT)        40.        117.        117.         117.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR        24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      102.      6.00                     90.         46.         44.          44.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR        24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1484.12      6.00                1483.34     1479.34     1479.07      1479.07

                        CUMULATIVE AREA =    1.89 SQ MI


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

                         HYDROGRAPH AT STATION   DBEWGA
                           FOR PLAN 1, RATIO =  .85

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR        24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+       84.     5.92                     81.         58.         56.          56.
                        (INCHES)       .398       1.147       1.147        1.147
                         (AC-FT)        40.        116.        116.         116.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR        24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      100.      6.00                     88.         45.         43.          43.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR        24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1484.05      6.00                1483.25     1479.24     1478.97      1478.97

                        CUMULATIVE AREA =    1.89 SQ MI



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            *            *
  409 KK    *   DBWWWT   *
            *            *
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  414 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

              HYDROGRAPH ROUTING DATA

  415 RS         STORAGE ROUTING
                       NSTPS          1  NUMBER OF SUBREACHES
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                    ITYP        ELEV  TYPE OF INITIAL CONDITION
                  RSVRIC       -1.00  INITIAL CONDITION
                       X         .00 WORKING R AND D COEFFICIENT

  416 SA               AREA         5.0       6.0       7.0       8.0

  417 SE          ELEVATION     1365.00   1370.00   1375.00   1380.00

  418 SQ          DISCHARGE          0.       19.       28.       35.

                                                                 ***

                                                 COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     27.46     59.93     97.40
          ELEVATION    1365.00   1370.00   1375.00   1380.00

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

                     HYDROGRAPH AT STATION   DBWWWT
                       FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+      29.      6.00               28.         22.         21.          21.
                      (INCHES)     .291        .909        .909         .909
                       (AC-FT)      14.         43.         43.          43.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       64.      6.08               60.         41.         40.          40.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1375.60      6.08            1374.99     1372.06     1371.80      1371.80

                    CUMULATIVE AREA =     .89 SQ MI


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

                     HYDROGRAPH AT STATION   DBWWWT
                       FOR PLAN 1, RATIO =  .87

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+      29.      6.00               28.         22.         21.          21.
                      (INCHES)     .289        .900        .900         .900
                       (AC-FT)      14.         43.         43.          43.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       63.      6.08               59.         41.         39.          39.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1375.45      6.08            1374.83     1371.94     1371.68      1371.68

                    CUMULATIVE AREA =     .89 SQ MI


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

                     HYDROGRAPH AT STATION   DBWWWT
                       FOR PLAN 1, RATIO =  .86

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+      28.      6.00               27.         21.         21.          21.
                      (INCHES)     .287        .892        .892         .892
                       (AC-FT)      14.         42.         42.          42.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       62.      6.00               58.         40.         38.          38.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1375.33      6.08            1374.71     1371.83     1371.58      1371.58

                    CUMULATIVE AREA =     .89 SQ MI
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      ***             ***             ***             ***             ***

                        HYDROGRAPH AT STATION   DBWWWT
                          FOR PLAN 1, RATIO =  .85

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      28.      6.00                   27.         21.         20.          20.
                        (INCHES)      .285        .885        .885         .885
                         (AC-FT)       14.         42.         42.          42.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       62.      6.00                   57.         39.         38.          38.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1375.22      6.00               1374.60     1371.74     1371.50      1371.50

                       CUMULATIVE AREA =     .89 SQ MI


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            *            *
  433 KK    *    DBWWDA  *
            *            *
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  438 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  439 RS         STORAGE ROUTING
                       NSTPS          1  NUMBER OF SUBREACHES
                        ITYP       ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC      -1.00  INITIAL CONDITION
                           X        .00 WORKING R AND D COEFFICIENT

  440 SA              AREA         1.0       4.0       6.0       7.0       8.0

  441 SE         ELEVATION     1335.00   1337.00   1340.00   1342.00   1345.00

  442 SQ         DISCHARGE          0.       10.       19.       23.       28.
                                                                 ***

                                                  COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00      4.67     19.57     32.55     55.04
          ELEVATION    1335.00   1337.00   1340.00   1342.00   1345.00

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

                        HYDROGRAPH AT STATION   DBWWDA
                          FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      23.      5.33                   22.         16.         15.          15.
                        (INCHES)      .445       1.302       1.302        1.302
                         (AC-FT)       11.         31.         31.          31.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       31.      5.42                   28.         16.         15.          15.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1341.79      5.42               1341.27     1339.11     1338.96      1338.96

                       CUMULATIVE AREA =     .45 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWDA
                          FOR PLAN 1, RATIO =  .87

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
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                                        6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      22.      5.33                     21.        16.        15.         15.
                       (INCHES)         .442      1.287      1.287       1.287
                        (AC-FT)          11.        31.        31.         31.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                        6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
       31.      5.42                     27.        16.        15.         15.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1341.71      5.42                 1341.19    1339.04    1338.89     1338.89

                       CUMULATIVE AREA =     .45 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWDA
                          FOR PLAN 1, RATIO =  .86

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      22.      5.33                     21.        15.        15.         15.
                       (INCHES)         .439      1.275      1.275       1.275
                        (AC-FT)          11.        31.        31.         31.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                        6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
       30.      5.42                     27.        15.        15.         15.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1341.64      5.42                 1341.12    1338.99    1338.84     1338.84

                       CUMULATIVE AREA =     .45 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWDA
                          FOR PLAN 1, RATIO =  .85

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      22.      5.33                     21.        15.        15.         15.
                       (INCHES)         .437      1.264      1.265       1.265
                        (AC-FT)          10.        30.        30.         30.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                        6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
       30.      5.33                     27.        15.        14.         14.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1341.58      5.42                 1341.07    1338.94    1338.80     1338.80

                       CUMULATIVE AREA =     .45 SQ MI



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             *            *
  459 KK     *    DBWWCA  *
             *            *
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  464 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  465 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC       -1.00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT
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466 SA	AREA	1.0	3.0	6.0	8.0	9.0	10.0
467 SE	ELEVATION	1365.00	1370.00	1375.00	1380.00	1385.00	1390.00
468 SQ	DISCHARGE	0.	50.	76.	95.	111.	125.

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COMPUTED STORAGE-ELEVATION DATA

STORAGE	.00	9.55	31.62	66.50	108.98	156.46
ELEVATION	1365.00	1370.00	1375.00	1380.00	1385.00	1390.00

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HYDROGRAPH AT STATION DBWWCA
FOR PLAN 1, RATIO = .88

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 112.	6.08		107.	71.	69.	69.
		(INCHES)	.523	1.393	1.393	1.393
		(AC-FT)	53.	141.	141.	141.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
114.	6.08	98.	46.	44.	44.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1385.48	6.08	1383.75	1375.67	1375.27	1375.27

CUMULATIVE AREA = 1.90 SQ MI

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HYDROGRAPH AT STATION DBWWCA
FOR PLAN 1, RATIO = .87

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 112.	6.08		106.	70.	67.	67.
		(INCHES)	.520	1.370	1.370	1.370
		(AC-FT)	53.	139.	139.	139.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
111.	6.08	96.	45.	43.	43.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1385.25	6.08	1383.51	1375.44	1375.06	1375.06

CUMULATIVE AREA = 1.90 SQ MI

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HYDROGRAPH AT STATION DBWWCA
FOR PLAN 1, RATIO = .86

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 111.	6.08		106.	69.	67.	67.
		(INCHES)	.517	1.352	1.352	1.352
		(AC-FT)	52.	137.	137.	137.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
110.	6.08	95.	44.	42.	42.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1385.07	6.08	1383.32	1375.26	1374.89	1374.89

CUMULATIVE AREA = 1.90 SQ MI

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HYDROGRAPH AT STATION DBWWCA

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                         FOR PLAN 1, RATIO =  .85

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                (CFS)
+     111.      6.08                     105.         68.         66.          66.
                             (INCHES)    .514       1.336       1.336        1.336
                              (AC-FT)     52.        135.        135.         135.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                         6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      108.      6.08                      93.         43.         41.          41.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                         6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1384.90      6.08                  1383.16     1375.11     1374.74      1374.74

                      CUMULATIVE AREA =    1.90 SQ MI



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  480 KK    *    DBWWWI  *
            *            *
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  485 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

              HYDROGRAPH ROUTING DATA

  486 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC       -1.00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  487 SA              AREA         3.0       4.0       6.0       8.0      10.0

  488 SE          ELEVATION     1325.00  1332.00  1340.00  1347.00  1355.00

  489 SQ          DISCHARGE          0.       61.       95.      117.      137.

                                                                               ***

                                                         COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     24.42     64.15    112.98    184.83
          ELEVATION    1325.00   1332.00   1340.00   1347.00   1355.00

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                       HYDROGRAPH AT STATION   DBWWWI
                         FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                (CFS)
+     125.      6.92                     121.         81.         78.          78.
                             (INCHES)    .320        .864        .864         .864
                              (AC-FT)     60.        161.        161.         161.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                         6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      142.      6.92                     126.         65.         63.          63.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                         6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1350.21      6.92                  1348.46     1338.59     1338.09      1338.09

                      CUMULATIVE AREA =    3.50 SQ MI


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                       HYDROGRAPH AT STATION   DBWWWI
                         FOR PLAN 1, RATIO =  .87

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                         6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                (CFS)
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+     124.      6.92                 120.         80.         77.          77.
                          (INCHES)      .318        .849        .849         .849
                           (AC-FT)       59.        158.        158.         158.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)       (HR)
       138.      6.92                 123.         63.         60.          60.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)       (HR)
    1349.84      6.92              1348.08     1338.25     1337.76      1337.76

                           CUMULATIVE AREA =    3.50 SQ MI


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                            HYDROGRAPH AT STATION   DBWWWI
                              FOR PLAN 1, RATIO =  .86

   PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)        (HR)
                               (CFS)
+     123.      6.83                 119.         79.         76.          76.
                          (INCHES)      .315        .836        .836         .836
                           (AC-FT)       59.        156.        156.         156.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)       (HR)
       136.      6.92                 121.         61.         59.          59.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)       (HR)
    1349.54      6.92              1347.77     1337.97     1337.49      1337.49

                           CUMULATIVE AREA =    3.50 SQ MI


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

                            HYDROGRAPH AT STATION   DBWWWI
                              FOR PLAN 1, RATIO =  .85

   PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)        (HR)
                               (CFS)
+     123.      6.83                 118.         78.         75.          75.
                          (INCHES)      .313        .825        .825         .825
                           (AC-FT)       59.        154.        154.         154.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)       (HR)
       133.      6.83                 118.         60.         57.          57.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)       (HR)
    1349.28      6.83              1347.50     1337.73     1337.26      1337.26

                           CUMULATIVE AREA =    3.50 SQ MI



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   499 KK    *    DBWWWA  *
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   504 KO          OUTPUT CONTROL VARIABLES
                         IPRNT           3  PRINT CONTROL
                         IPLOT           0  PLOT CONTROL
                         QSCAL          0.  HYDROGRAPH PLOT SCALE

                 HYDROGRAPH ROUTING DATA

   505 RS          STORAGE ROUTING
                         NSTPS           1  NUMBER OF SUBREACHES
                          ITYP        ELEV  TYPE OF INITIAL CONDITION
                        RSVRIC       -1.00  INITIAL CONDITION
                             X         .00 WORKING R AND D COEFFICIENT

   506 SA               AREA         2.0       11.0       20.0       26.0       30.0
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  507 SE          ELEVATION     1300.00   1303.00   1307.00   1311.00   1315.00

  508 SQ          DISCHARGE          0.       45.       86.      114.      135.

                                                                ***

                                                         COMPUTED STORAGE-ELEVATION DATA

             STORAGE        .00     17.69     78.80    170.54    282.44
           ELEVATION    1300.00   1303.00   1307.00   1311.00   1315.00

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                        HYDROGRAPH AT STATION   DBWWWA
                          FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                              (CFS)
+     114.      6.00                    109.         82.         79.          79.
                           (INCHES)     .384       1.158       1.159        1.159
                            (AC-FT)      54.        162.        163.         163.

 PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                        6-HR        24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      170.      6.00                    153.         90.         87.          87.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                        6-HR        24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1310.96      6.00                 1310.24     1307.06     1306.80      1306.80

                       CUMULATIVE AREA =    2.63 SQ MI


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                        HYDROGRAPH AT STATION   DBWWWA
                          FOR PLAN 1, RATIO =  .87

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                              (CFS)
+     113.      6.00                    108.         81.         78.          78.
                           (INCHES)     .381       1.145       1.145        1.145
                            (AC-FT)      53.        161.        161.         161.

 PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                        6-HR        24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      166.      6.00                    150.         88.         85.          85.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                        6-HR        24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1310.82      6.00                 1310.12     1306.95     1306.69      1306.69

                       CUMULATIVE AREA =    2.63 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWWA
                          FOR PLAN 1, RATIO =  .86

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                              (CFS)
+     112.      6.00                    107.         80.         77.          77.
                           (INCHES)     .379       1.134       1.134        1.134
                            (AC-FT)      53.        159.        159.         159.

 PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                        6-HR        24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      164.      6.00                    148.         87.         83.          83.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                        6-HR        24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1310.72      6.00                 1310.01     1306.86     1306.61      1306.61

                       CUMULATIVE AREA =    2.63 SQ MI


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                        HYDROGRAPH AT STATION   DBWWWA
                          FOR PLAN 1, RATIO =  .85

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
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                                         6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                              (CFS)
+     111.      6.00                     106.        80.        77.         77.
                            (INCHES)     .376      1.125      1.125       1.125
                             (AC-FT)      53.       158.       158.        158.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                         6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
      162.      6.00                     146.        85.        82.         82.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                         6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1310.62      6.00                  1309.92    1306.78    1306.53     1306.53

                           CUMULATIVE AREA =    2.63 SQ MI


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  518 KK     *    DBWWIA  *
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  523 KO          OUTPUT CONTROL VARIABLES
                        IPRNT          3  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  524 RS          STORAGE ROUTING
                        NSTPS          1  NUMBER OF SUBREACHES
                         ITYP       ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC      -1.00  INITIAL CONDITION
                            X        .00 WORKING R AND D COEFFICIENT

  525 SA               AREA         1.0       6.0      11.0      14.0

  526 SE          ELEVATION     1295.00   1300.00   1305.00   1310.00

  527 SQ          DISCHARGE          0.       50.       76.       95.
                                                                ***

                                                     COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     15.75     57.62    119.97
          ELEVATION    1295.00   1300.00   1305.00   1310.00

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

                             HYDROGRAPH AT STATION   DBWWIA
                               FOR PLAN 1, RATIO =  .88

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                         6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                              (CFS)
+      81.      5.67                      77.        46.        44.         44.
                            (INCHES)     .574      1.363      1.363       1.363
                             (AC-FT)      38.        91.        91.         91.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                         6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
       74.      5.67                      63.        28.        27.         27.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                         6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1306.33      5.67                  1305.38    1300.52    1300.31     1300.31

                           CUMULATIVE AREA =    1.25 SQ MI


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

                             HYDROGRAPH AT STATION   DBWWIA
                               FOR PLAN 1, RATIO =  .87

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                         6-HR      24-HR      72-HR    24.92-HR
+   (CFS)       (HR)
                              (CFS)
+      81.      5.67                      77.        45.        43.         43.
                            (INCHES)     .570      1.340      1.340       1.340
                             (AC-FT)      38.        89.        89.         89.
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 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       73.      5.67                   62.         27.         26.          26.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1306.21      5.67               1305.26     1300.41     1300.21      1300.21

                         CUMULATIVE AREA =    1.25 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWIA
                            FOR PLAN 1, RATIO =  .86

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      80.      5.67                   76.         44.         43.          43.
                       (INCHES)       .567       1.321       1.321        1.321
                        (AC-FT)        38.         88.         88.          88.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       72.      5.67                   61.         27.         26.          26.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1306.12      5.67               1305.16     1300.32     1300.12      1300.12

                         CUMULATIVE AREA =    1.25 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWIA
                            FOR PLAN 1, RATIO =  .85

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      80.      5.67                   76.         44.         42.          42.
                       (INCHES)       .564       1.305       1.305        1.305
                        (AC-FT)        38.         87.         87.          87.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       71.      5.67                   60.         26.         25.          25.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1306.04      5.67               1305.07     1300.24     1300.05      1300.05

                         CUMULATIVE AREA =    1.25 SQ MI



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  568 KK     *    DBWWPA  *
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  573 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

  574 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC       -1.00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  575 SA               AREA         1.0       12.0       32.0       49.0       56.0

  576 SE          ELEVATION     1290.00   1300.00   1308.00   1315.00   1325.00

  577 SQ          DISCHARGE          0.      144.      202.      242.      289.
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COMPUTED STORAGE-ELEVATION DATA

STORAGE	.00	54.88	224.47	505.86	1030.48
ELEVATION	1290.00	1300.00	1308.00	1315.00	1325.00

WARNING --- ROUTED OUTFLOW (290.) IS GREATER THAN MAXIMUM OUTFLOW (289.) IN STORAGE-OUTFLOW TABLE

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HYDROGRAPH AT STATION DBWWPA
FOR PLAN 1, RATIO = .88

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 297.	8.25		294.	243.	234.	234.
		(INCHES)	.123	.406	.406	.406
		(AC-FT)	146.	482.	482.	482.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
1122.	8.25	1083.	785.	756.	756.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1326.74	8.25	1326.01	1318.36	1317.32	1317.32

CUMULATIVE AREA = 22.25 SQ MI

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                        HYDROGRAPH AT STATION   DBWWPA
                          FOR PLAN 1, RATIO =  .87

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     295.      8.25                    292.        241.        232.         232.
                         (INCHES)       .122        .403        .403         .403
                          (AC-FT)       145.        478.        478.         478.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1097.      8.25                   1059.        765.        737.         737.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1326.27      8.25                 1325.54     1317.98     1316.95      1316.95

                         CUMULATIVE AREA =    22.25 SQ MI

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                         HYDROGRAPH AT STATION   DBWWPA
                           FOR PLAN 1, RATIO =  .86

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                           (CFS)
 +     293.      8.25                290.        240.        231.         231.
                        (INCHES)      .121        .400        .400         .400
                         (AC-FT)      144.        475.        475.         475.

  PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
      1077.      8.25               1039.        750.        722.         722.

   PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
    1325.89      8.25             1325.17     1317.68     1316.66      1316.66

                        CUMULATIVE AREA =   22.25 SQ MI

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HYDROGRAPH AT STATION DBWWPA
FOR PLAN 1, RATIO = .85

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 292.	8.17		288.	238.	229.	229.
		(INCHES)	.120	.398	.398	.398
		(AC-FT)	143.	472.	472.	472.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
1060.	8.25	1023.	736.	709.	709.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1325.56	8.17	1324.85	1317.41	1316.41	1316.41

CUMULATIVE AREA = 22.25 SQ MI

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .88	RATIO 2 .87	RATIO 3 .86	RATIO 4 .85
HYDROGRAPH AT +	MRIV2	18.37	1	FLOW	4667.	4581.	4512.	4453.
				TIME	5.42	5.42	5.50	5.50
HYDROGRAPH AT +	MRIV1	22.91	1	FLOW	4403.	4316.	4246.	4185.
				TIME	6.00	6.00	6.00	6.00
2 COMBINED AT +	CMRIV1	41.28	1	FLOW	8904.	8734.	8597.	8479.
				TIME	5.67	5.67	5.67	5.67
ROUTED TO +	RCMRIV1	41.28	1	FLOW	8866.	8695.	8559.	8442.
				TIME	6.25	6.25	6.33	6.33
HYDROGRAPH AT +	MRIV3	21.99	1	FLOW	4290.	4204.	4136.	4077.
				TIME	5.92	5.92	5.92	5.92
2 COMBINED AT +	CMRIV3	63.27	1	FLOW	13024.	12769.	12565.	12387.
				TIME	6.17	6.17	6.17	6.17
ROUTED TO +	RCMRIV3	63.27	1	FLOW	12997.	12741.	12537.	12358.
				TIME	6.33	6.33	6.33	6.33
HYDROGRAPH AT +	MRIV4	10.45	1	FLOW	2867.	2818.	2779.	2745.
				TIME	5.50	5.50	5.50	5.50
HYDROGRAPH AT +	MDW	19.44	1	FLOW	5526.	5414.	5324.	5246.
				TIME	4.58	4.58	4.58	4.58
HYDROGRAPH AT +	MRIV5	3.26	1	FLOW	1345.	1321.	1301.	1284.
				TIME	4.25	4.25	4.25	4.25
4 COMBINED AT +	CMRIV5	96.42	1	FLOW	18722.	18346.	18047.	17785.

				TIME	5.92	5.92	5.92	5.92
ROUTED TO								
+	RCMRIV5	96.42	1	FLOW	18611.	18235.	17934.	17672.
				TIME	6.17	6.17	6.17	6.17
HYDROGRAPH AT								
+	MRIV6	2.17	1	FLOW	648.	636.	627.	619.
				TIME	4.92	4.92	4.92	4.92
HYDROGRAPH AT								
+	MRIV7	12.41	1	FLOW	4107.	4035.	3978.	3928.
				TIME	4.75	4.75	4.75	4.75
HYDROGRAPH AT								
+	WSWASH	61.31	1	FLOW	15757.	15476.	15252.	15057.
				TIME	5.50	5.50	5.50	5.50
4 COMBINED AT								
+	CMRIV7	172.31	1	FLOW	36367.	35648.	35074.	34572.
				TIME	5.83	5.83	5.83	5.83
ROUTED TO								
+	RCMRIV7	172.31	1	FLOW	36088.	35378.	34811.	34315.
				TIME	6.17	6.17	6.17	6.17
HYDROGRAPH AT								
+	EWASH8	3.47	1	FLOW	799.	781.	767.	755.
				TIME	4.83	4.83	4.83	4.83
HYDROGRAPH AT								
+	AWASH1	4.57	1	FLOW	1925.	1891.	1863.	1839.
				TIME	4.25	4.25	4.25	4.25
ROUTED TO								
+	RAWASH1	4.57	1	FLOW	1876.	1842.	1815.	1791.
				TIME	4.42	4.42	4.42	4.42
HYDROGRAPH AT								
+	AWASH2	1.63	1	FLOW	911.	895.	882.	871.
				TIME	3.92	3.92	3.92	3.92
2 COMBINED AT								
+	CAWASH2	6.20	1	FLOW	2439.	2395.	2360.	2330.
				TIME	4.25	4.25	4.25	4.25
ROUTED TO								
+	RCAWASH2	6.20	1	FLOW	2342.	2300.	2266.	2237.
				TIME	4.92	4.92	4.92	4.92
HYDROGRAPH AT								
+	AWASH3	5.03	1	FLOW	1931.	1897.	1871.	1848.
				TIME	4.50	4.50	4.50	4.50
2 COMBINED AT								
+	CAWASH3	11.23	1	FLOW	4075.	4003.	3946.	3896.
				TIME	4.75	4.75	4.75	4.75
3 COMBINED AT								
+	CMR0	187.01	1	FLOW	38757.	37987.	37371.	36832.
				TIME	6.08	6.08	6.08	6.08
ROUTED TO								
+	RCMR0	187.01	1	FLOW	38727.	37938.	37323.	36797.
				TIME	6.08	6.17	6.08	6.17
HYDROGRAPH AT								
+	WWASH6	1.20	1	FLOW	829.	815.	804.	795.
				TIME	3.83	3.83	3.83	3.83
HYDROGRAPH AT								
+	EWASH7	6.39	1	FLOW	1746.	1702.	1666.	1635.
				TIME	4.08	4.08	4.08	4.08
ROUTED TO								
+	REWASH7	6.39	1	FLOW	1633.	1591.	1559.	1530.
				TIME	4.58	4.58	4.58	4.58
HYDROGRAPH AT								
+	EWASH6	.78	1	FLOW	261.	255.	250.	246.
				TIME	4.17	4.17	4.17	4.17
2 COMBINED AT								
+	CEWASH6	7.17	1	FLOW	1822.	1776.	1740.	1708.
				TIME	4.50	4.50	4.50	4.50
HYDROGRAPH AT								
+	BMN1	3.72	1	FLOW	1559.	1527.	1502.	1480.
				TIME	4.00	4.00	4.00	4.00
ROUTED TO								
+	RBMN1	3.72	1	FLOW	1432.	1403.	1379.	1359.
				TIME	4.58	4.58	4.58	4.58
HYDROGRAPH AT								

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+                 BMN3      5.12     1   FLOW       1542.    1513.    1490.    1470.
                                         TIME       4.75     4.75     4.75     4.75

  2 COMBINED AT
+                CBMN3      8.84     1   FLOW       2948.    2890.    2843.    2803.
                                         TIME       4.58     4.58     4.58     4.58

 HYDROGRAPH AT
+                 BMN2      4.08     1   FLOW       1881.    1848.    1821.    1798.
                                         TIME       4.17     4.17     4.17     4.17

 ROUTED TO
+                RBMN2      4.08     1   FLOW       1724.    1694.    1670.    1649.
                                         TIME       5.00     5.00     5.00     5.00

 HYDROGRAPH AT
+                 BMN4      6.98     1   FLOW       2095.    2057.    2027.    2001.
                                         TIME       4.92     4.92     4.92     4.92

  2 COMBINED AT
+                CBMN4     11.06     1   FLOW       3814.    3746.    3693.    3646.
                                         TIME       5.00     5.00     5.00     5.00

  2 COMBINED AT
+               CBMN34     19.90     1   FLOW       6522.    6401.    6305.    6221.
                                         TIME       4.83     4.83     4.83     4.83

 ROUTED TO
+              RCBMN34     19.90     1   FLOW       6449.    6331.    6236.    6153.
                                         TIME       5.08     5.08     5.08     5.08

 HYDROGRAPH AT
+                 BMN5      1.48     1   FLOW        363.     353.     346.     339.
                                         TIME       4.17     4.17     4.17     4.17

 HYDROGRAPH AT
+                 BMN6      2.06     1   FLOW        663.     650.     640.     632.
                                         TIME       4.58     4.58     4.58     4.58

  3 COMBINED AT
+               CBMN56     23.44     1   FLOW       7265.    7130.    7022.    6927.
                                         TIME       5.00     5.00     5.00     5.00

 ROUTED TO
+              RCBMN56     23.44     1   FLOW       7248.    7113.    7005.    6911.
                                         TIME       5.08     5.08     5.08     5.08

 HYDROGRAPH AT
+                 BMN7       .45     1   FLOW        218.     213.     209.     206.
                                         TIME       3.75     3.75     3.75     3.75

  2 COMBINED AT
+                CBMN7     23.89     1   FLOW       7344.    7208.    7099.    7004.
                                         TIME       5.08     5.08     5.08     5.08

 ROUTED TO
+               DBFGLS     23.89     1   FLOW        278.     276.     275.     273.
                                         TIME       8.50     8.50     8.50     8.50

                                     ** PEAK STAGES IN FEET **
                                     1   STAGE    1506.82  1506.33  1505.93  1505.59
                                         TIME       8.50     8.50     8.50     8.50

 ROUTED TO
+              RDBFGLS     23.89     1   FLOW        278.     276.     275.     273.
                                         TIME       8.58     8.58     8.58     8.58

 HYDROGRAPH AT
+                FGDB1       .39     1   FLOW        146.     142.     139.     137.
                                         TIME       3.83     3.83     3.83     3.83

 ROUTED TO
+                DETBN       .39     1   FLOW         50.      49.      48.      48.
                                         TIME       5.25     5.25     5.25     5.25

                                     ** PEAK STAGES IN FEET **
                                     1   STAGE    1419.25  1419.10  1418.98  1418.88
                                         TIME       5.25     5.25     5.25     5.25

  2 COMBINED AT
+               CFGDB1     24.28     1   FLOW        304.     302.     300.     298.
                                         TIME       7.00     7.00     7.00     7.00

 ROUTED TO
+              RCFGDB1     24.28     1   FLOW        304.     302.     300.     298.
                                         TIME       7.00     7.00     7.00     7.00

 HYDROGRAPH AT
+                 FGDB      1.92     1   FLOW        992.     972.     956.     943.
                                         TIME       3.83     3.83     3.83     3.83

 ROUTED TO
+               DBFGWS      1.92     1   FLOW         43.      42.      42.      42.
                                         TIME       6.25     6.25     6.25     6.25
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                                        ** PEAK STAGES IN FEET **
                                         1   STAGE     1491.59  1491.45  1491.35  1491.25
                                             TIME         6.33     6.33     6.33     6.25

 ROUTED TO
+              RDBFGWS      1.92     1   FLOW           43.      42.      42.      42.
                                             TIME         6.42     6.42     6.33     6.33

 HYDROGRAPH AT
+                FGDB2       .46     1   FLOW          139.     135.     132.     129.
                                             TIME         3.75     3.75     3.75     3.75

  2 COMBINED AT
+             CRDBFGWS      2.38     1   FLOW          174.     170.     166.     163.
                                             TIME         3.75     3.75     3.75     3.75

  2 COMBINED AT
+               CFGDB2     26.66     1   FLOW          349.     345.     342.     340.
                                             TIME         5.08     5.08     7.00     7.00

 ROUTED TO
+              RCFGDB2     26.66     1   FLOW          348.     344.     342.     340.
                                             TIME         5.08     5.08     7.00     7.08

 HYDROGRAPH AT
+               EWASH5       .58     1   FLOW          107.     104.     102.      99.
                                             TIME         4.25     4.25     4.25     4.25

  2 COMBINED AT
+              CEWASH5     27.24     1   FLOW          429.     423.     419.     415.
                                             TIME         5.08     5.08     5.08     5.08

  4 COMBINED AT
+                 CMR1    222.62     1   FLOW        39888.   39075.   38450.   37875.
                                             TIME         6.08     6.08     6.08     6.08

 ROUTED TO
+                RCMR1    222.62     1   FLOW        39844.   39042.   38404.   37842.
                                             TIME         6.17     6.17     6.17     6.17

 HYDROGRAPH AT
+                 EWDB      1.89     1   FLOW         1100.    1080.    1064.    1050.
                                             TIME         3.83     3.83     3.83     3.83

 ROUTED TO
+               DBEWGA      1.89     1   FLOW           85.      85.      84.      84.
                                             TIME         6.00     6.00     6.00     5.92

                                        ** PEAK STAGES IN FEET **
                                         1   STAGE     1484.30  1484.20  1484.12  1484.05
                                             TIME         6.00     6.00     6.00     6.00

 ROUTED TO
+              RDBEWGA      1.89     1   FLOW           85.      85.      84.      84.
                                             TIME         6.17     6.08     6.17     6.17

 HYDROGRAPH AT
+               EWASH4      2.03     1   FLOW          588.     573.     562.     552.
                                             TIME         4.08     4.08     4.08     4.08

  2 COMBINED AT
+              CEWASH4      3.92     1   FLOW          656.     640.     628.     618.
                                             TIME         4.08     4.08     4.08     4.08

 HYDROGRAPH AT
+               LWASH1      4.03     1   FLOW         1142.    1114.    1093.    1074.
                                             TIME         4.17     4.17     4.17     4.17

 HYDROGRAPH AT
+               LWASH2       .70     1   FLOW          314.     307.     302.     298.
                                             TIME         3.92     3.92     3.92     3.92

  2 COMBINED AT
+              CLWASH1      4.73     1   FLOW         1411.    1379.    1353.    1330.
                                             TIME         4.17     4.17     4.17     4.17

 ROUTED TO
+             RCLWASH1      4.73     1   FLOW         1369.    1337.    1312.    1290.
                                             TIME         4.42     4.42     4.42     4.42

 HYDROGRAPH AT
+               LWASH3      1.17     1   FLOW          768.     755.     745.     736.
                                             TIME         3.83     3.83     3.83     3.83

  2 COMBINED AT
+              CLWASH3      5.90     1   FLOW         1778.    1740.    1709.    1682.
                                             TIME         4.25     4.25     4.25     4.25

 ROUTED TO
+             RCLWASH3      5.90     1   FLOW         1772.    1734.    1703.    1677.
                                             TIME         4.25     4.25     4.25     4.25

 HYDROGRAPH AT
+               WWASH5      1.61     1   FLOW         1127.    1109.    1094.    1081.
                                             TIME         3.83     3.83     3.83     3.83
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 ROUTED TO
+             RWWASH5      1.61     1   FLOW       1057.    1040.    1026.    1014.
                                        TIME        4.00     4.00     4.00     4.00

 HYDROGRAPH AT
+                LOG1       .41     1   FLOW        170.     167.     164.     161.
                                        TIME        3.92     4.00     4.00     4.00

  5 COMBINED AT
+                CMR2    234.46     1   FLOW      40609.   39778.   39119.   38548.
                                        TIME        6.08     6.08     6.17     6.17

 ROUTED TO
+               RCMR2    234.46     1   FLOW      40442.   39621.   38963.   38389.
                                        TIME        6.25     6.25     6.25     6.25

 HYDROGRAPH AT
+              EWASH3      1.77     1   FLOW        350.     340.     332.     326.
                                        TIME        4.33     4.33     4.33     4.33

 HYDROGRAPH AT
+                LOG3       .51     1   FLOW        198.     194.     191.     189.
                                        TIME        4.25     4.25     4.25     4.25

  3 COMBINED AT
+                CMR3    236.74     1   FLOW      40578.   39755.   39094.   38519.
                                        TIME        6.25     6.25     6.25     6.25

 ROUTED TO
+               RCMR3    236.74     1   FLOW      40486.   39667.   39010.   38439.
                                        TIME        6.33     6.33     6.33     6.33

 HYDROGRAPH AT
+                LOG2      1.62     1   FLOW        686.     673.     662.     653.
                                        TIME        4.08     4.08     4.08     4.08

  2 COMBINED AT
+                CMR4    238.36     1   FLOW      40569.   39749.   39091.   38518.
                                        TIME        6.33     6.33     6.33     6.33

 ROUTED TO
+               RCMR4    238.36     1   FLOW      40551.   39729.   39065.   38482.
                                        TIME        6.33     6.33     6.33     6.42

 HYDROGRAPH AT
+              EWASH2      4.80     1   FLOW       1485.    1454.    1430.    1409.
                                        TIME        4.42     4.42     4.42     4.42

  2 COMBINED AT
+                CMR5    243.16     1   FLOW      40983.   40153.   39483.   38889.
                                        TIME        6.33     6.33     6.33     6.33

 ROUTED TO
+               RCMR5    243.16     1   FLOW      40955.   40124.   39454.   38869.
                                        TIME        6.42     6.42     6.42     6.42

 HYDROGRAPH AT
+                OVR1      1.88     1   FLOW        851.     835.     822.     811.
                                        TIME        4.08     4.08     4.08     4.08

  2 COMBINED AT
+                CMR6    245.04     1   FLOW      41027.   40191.   39521.   38935.
                                        TIME        6.33     6.42     6.42     6.42

 ROUTED TO
+               RCMR6    245.04     1   FLOW      41014.   40176.   39487.   38903.
                                        TIME        6.42     6.42     6.42     6.50

 HYDROGRAPH AT
+             WWASH4A       .31     1   FLOW        281.     277.     273.     270.
                                        TIME        3.67     3.67     3.67     3.67

 HYDROGRAPH AT
+              WWASH4       .58     1   FLOW        415.     408.     403.     398.
                                        TIME        3.75     3.75     3.75     3.75

  2 COMBINED AT
+             CWWASH4       .89     1   FLOW        661.     651.     642.     635.
                                        TIME        3.75     3.75     3.75     3.75

 ROUTED TO
+              DBWWWT       .89     1   FLOW         29.      29.      28.      28.
                                        TIME        6.00     6.00     6.00     6.00

                                    ** PEAK STAGES IN FEET **
                                    1   STAGE    1375.60  1375.45  1375.33  1375.22
                                        TIME        6.08     6.08     6.08     6.00

 ROUTED TO
+            RCWWASH4       .89     1   FLOW         29.      29.      28.      28.
                                        TIME        6.25     6.25     6.33     6.25

 HYDROGRAPH AT
+             WWASH3A       .49     1   FLOW        384.     378.     373.     369.
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                                          TIME        3.75     3.75     3.75     3.75

  2 COMBINED AT
+            CWWASH3A     1.38     1   FLOW        393.     386.     381.     377.
                                          TIME        3.75     3.75     3.75     3.75

 HYDROGRAPH AT
+              WWASH3      .45     1   FLOW        483.     476.     470.     464.
                                          TIME        3.58     3.58     3.58     3.58

 ROUTED TO
+              DBWWDA      .45     1   FLOW         23.      22.      22.      22.
                                          TIME        5.33     5.33     5.33     5.33

                                    ** PEAK STAGES IN FEET **
                                    1   STAGE     1341.79  1341.71  1341.64  1341.58
                                          TIME        5.42     5.42     5.42     5.42

  2 COMBINED AT
+             CWWASH3     1.83     1   FLOW        411.     405.     400.     395.
                                          TIME        3.75     3.75     3.75     3.75

 ROUTED TO
+            RCWWASH3     1.83     1   FLOW        413.     406.     401.     396.
                                          TIME        3.83     3.83     3.83     3.83

 HYDROGRAPH AT
+             WWASH2A      .39     1   FLOW        238.     233.     230.     227.
                                          TIME        3.75     3.75     3.75     3.75

  2 COMBINED AT
+            CWWASH2A     2.22     1   FLOW        649.     638.     629.     622.
                                          TIME        3.83     3.83     3.83     3.83

 HYDROGRAPH AT
+              WWASH2     1.90     1   FLOW       1086.    1067.    1053.    1040.
                                          TIME        4.00     4.00     4.00     4.00

 ROUTED TO
+              DBWWCA     1.90     1   FLOW        112.     112.     111.     111.
                                          TIME        6.08     6.08     6.08     6.08

                                    ** PEAK STAGES IN FEET **
                                    1   STAGE     1385.48  1385.25  1385.07  1384.90
                                          TIME        6.08     6.08     6.08     6.08

 ROUTED TO
+             RDBWWCA     1.90     1   FLOW        112.     112.     111.     111.
                                          TIME        6.08     6.08     6.08     6.08

  2 COMBINED AT
+             CWWASH2     4.12     1   FLOW        723.     712.     703.     695.
                                          TIME        3.83     3.83     3.83     3.83

 ROUTED TO
+            RCWWASH2     4.12     1   FLOW        711.     698.     688.     681.
                                          TIME        3.83     3.83     3.92     3.83

 HYDROGRAPH AT
+              WIWASH     3.50     1   FLOW        985.     964.     947.     932.
                                          TIME        4.42     4.42     4.42     4.42

 ROUTED TO
+              DBWWWI     3.50     1   FLOW        125.     124.     123.     123.
                                          TIME        6.92     6.92     6.83     6.83

                                    ** PEAK STAGES IN FEET **
                                    1   STAGE     1350.21  1349.84  1349.54  1349.28
                                          TIME        6.92     6.92     6.92     6.83

  2 COMBINED AT
+             CWIWASH     7.62     1   FLOW        752.     738.     729.     721.
                                          TIME        3.92     3.92     3.92     3.92

 ROUTED TO
+            RCWIWASH     7.62     1   FLOW        749.     735.     727.     719.
                                          TIME        4.00     3.92     4.00     4.00

 HYDROGRAPH AT
+             WWASH1B     2.63     1   FLOW       1701.    1673.    1650.    1630.
                                          TIME        3.83     3.83     3.83     3.83

 ROUTED TO
+              DBWWWA     2.63     1   FLOW        114.     113.     112.     111.
                                          TIME        6.00     6.00     6.00     6.00

                                    ** PEAK STAGES IN FEET **
                                    1   STAGE     1310.96  1310.82  1310.72  1310.62
                                          TIME        6.00     6.00     6.00     6.00

  2 COMBINED AT
+            CWWASH1B    10.25     1   FLOW        837.     822.     814.     806.
                                          TIME        4.00     4.00     4.00     4.00

 ROUTED TO
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+             RCWWAS1B    10.25    1   FLOW        835.     821.     811.     803.
                                       TIME        4.00     4.00     4.00     4.00

 HYDROGRAPH AT
+              WWASH1A     1.25    1   FLOW        897.     882.     870.     859.
                                       TIME        3.75     3.75     3.75     3.75

 ROUTED TO
+               DBWWIA     1.25    1   FLOW         81.      81.      80.      80.
                                       TIME        5.67     5.67     5.67     5.67

                                  ** PEAK STAGES IN FEET **
                                   1   STAGE     1306.33  1306.21  1306.12  1306.04
                                       TIME        5.67     5.67     5.67     5.67

  2 COMBINED AT
+             CWWASH1A    11.50    1   FLOW        903.     888.     878.     870.
                                       TIME        4.00     4.00     4.00     4.00

 ROUTED TO
+             RCWWAS1A    11.50    1   FLOW        896.     879.     869.     862.
                                       TIME        4.08     4.08     4.08     4.08

 HYDROGRAPH AT
+               OWASHS    11.43    1   FLOW       3880.    3798.    3732.    3675.
                                       TIME        4.25     4.25     4.25     4.25

 HYDROGRAPH AT
+               OWASHN     5.95    1   FLOW       2072.    2031.    1999.    1971.
                                       TIME        4.33     4.33     4.33     4.33

  2 COMBINED AT
+              COWASHS    17.38    1   FLOW       5937.    5815.    5718.    5633.
                                       TIME        4.33     4.33     4.33     4.33

 ROUTED TO
+             RCOWASHS    17.38    1   FLOW       5772.    5652.    5558.    5475.
                                       TIME        4.58     4.58     4.67     4.67

 HYDROGRAPH AT
+               OWASH1     2.44    1   FLOW        582.     567.     556.     546.
                                       TIME        4.33     4.33     4.33     4.33

  2 COMBINED AT
+              COWASH1    19.82    1   FLOW       6290.    6158.    6053.    5961.
                                       TIME        4.58     4.58     4.58     4.58

 ROUTED TO
+               RORIDG    19.82    1   FLOW       5868.    5747.    5650.    5565.
                                       TIME        4.83     4.83     4.83     4.83

 ROUTED TO
+             RCOWASH1    19.82    1   FLOW       5801.    5681.    5586.    5503.
                                       TIME        5.08     5.08     5.08     5.08

 HYDROGRAPH AT
+               OWASH2     2.43    1   FLOW       1061.    1041.    1024.    1010.
                                       TIME        4.08     4.08     4.08     4.08

  2 COMBINED AT
+             CCOWASH2    22.25    1   FLOW       6366.    6237.    6134.    6044.
                                       TIME        5.08     5.08     5.08     5.08

 ROUTED TO
+               DBWWPA    22.25    1   FLOW        297.     295.     293.     292.
                                       TIME        8.25     8.25     8.25     8.17

                                  ** PEAK STAGES IN FEET **
                                   1   STAGE     1326.74  1326.27  1325.89  1325.56
                                       TIME        8.25     8.25     8.25     8.17

  2 COMBINED AT
+              COWASH2    33.75    1   FLOW       1046.    1028.    1017.    1010.
                                       TIME        4.08     4.08     4.08     4.08

 ROUTED TO
+             RCOWASH2    33.75    1   FLOW       1037.    1021.    1009.     999.
                                       TIME        4.08     4.08     4.08     4.08

 HYDROGRAPH AT
+               OWASH3      .32    1   FLOW        256.     252.     248.     246.
                                       TIME        3.67     3.67     3.67     3.67

  2 COMBINED AT
+              COWASH3    34.07    1   FLOW       1163.    1144.    1131.    1120.
                                       TIME        4.08     4.08     4.08     4.08

 ROUTED TO
+             RCOWASH3    34.07    1   FLOW       1155.    1131.    1117.    1108.
                                       TIME        4.17     4.17     4.17     4.17

 HYDROGRAPH AT
+                 OVR2      .47    1   FLOW        205.     200.     197.     194.
                                       TIME        3.92     3.92     3.92     3.92
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  2 COMBINED AT
+               COVR2     34.54     1   FLOW        1319.    1292.    1275.    1263.
                                        TIME        4.17     4.17     4.17     4.17

  2 COMBINED AT
+                CMR7    279.58     1   FLOW       41819.   40975.   40282.   39693.
                                        TIME        6.42     6.42     6.42     6.42

 ROUTED TO
+               RCMR7    279.58     1   FLOW       41797.   40947.   40262.   39688.
                                        TIME        6.42     6.50     6.50     6.50

 HYDROGRAPH AT
+                OVR3       .45     1   FLOW         154.     150.     147.     145.
                                        TIME        3.92     3.92     3.92     3.92

  2 COMBINED AT
+                CMR8    280.03     1   FLOW       41803.   40952.   40267.   39693.
                                        TIME        6.42     6.50     6.50     6.50

 ROUTED TO
+               RCMR8    280.03     1   FLOW       41792.   40947.   40259.   39676.
                                        TIME        6.50     6.50     6.50     6.50

 HYDROGRAPH AT
+              EWASH1      6.33     1   FLOW        1499.    1467.    1441.    1419.
                                        TIME        4.83     4.83     4.83     4.83

  2 COMBINED AT
+                CMR9    286.36     1   FLOW       42470.   41595.   40891.   40299.
                                        TIME        6.42     6.42     6.50     6.50

 ROUTED TO
+               RCMR9    286.36     1   FLOW       42452.   41587.   40886.   40284.
                                        TIME        6.50     6.50     6.50     6.50

 HYDROGRAPH AT
+               MAGW1      5.52     1   FLOW         945.     922.     903.     887.
                                        TIME        5.08     5.08     5.08     5.08

 ROUTED TO
+              RMAGW1      5.52     1   FLOW         935.     912.     894.     878.
                                        TIME        5.58     5.58     5.58     5.58

 HYDROGRAPH AT
+               MAGW2      4.81     1   FLOW        1294.    1266.    1244.    1225.
                                        TIME        4.58     4.58     4.58     4.58

  2 COMBINED AT
+              CMAGW2     10.33     1   FLOW        1974.    1929.    1893.    1862.
                                        TIME        5.17     5.17     5.17     5.17

  2 COMBINED AT
+               CMR10    296.69     1   FLOW       43645.   42738.   42016.   41377.
                                        TIME        6.42     6.42     6.42     6.42

 HYDROGRAPH AT
+                BMN8      1.27     1   FLOW         181.     174.     169.     164.
                                        TIME        4.08     4.08     4.08     4.08

 HYDROGRAPH AT
+              BOWMAN       .30     1   FLOW           0.       0.       0.       0.
                                        TIME         .00      .00      .00      .00

  2 COMBINED AT
+             CBOWMAN      1.57     1   FLOW         181.     174.     169.     164.
                                        TIME        4.08     4.08     4.08     4.08
1

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

```
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   03MAY16  TIME  11:44:09   *                                                      *          (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

                         *DIAGRAM
 *** FREE ***
             1           ID   2016 FLOOD CONTROL MASTER PLAN UPDATE
             2           ID   MUDDY RIVER AND TRIBUTARY WASHES
             3           ID   INPUT FILE = MRMPU5.DAT
             4           ID   INPUT FILE DATE = APR, 2016
             5           ID   DESIGN STORM = 100-YEAR 6-HR STORM
             6           ID   STORM DISTRIBUTION = SDN #5
             7           ID   MODELED BY ATKINS (HONGYU DENG, E.I.T, CFM)
             8           ID   CHECKED BY ATKINS (BRIAN ROWLEY, P.E. , CFM)
             9           ID   STORM CENTERING = ENTIRE WATERSHED
            10           ID
            11           ID   JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:
            12           ID
            13           ID           AREA    DARF
            14           ID           SQ.MI.
            15           ID                   SDN 3   SDN 4   SDN 5
            16           ID           0 - 0.5 0.99
            17           ID           0.5 - 1 0.975
            18           ID           1 - 2   0.95
            19           ID           2 - 3   0.925
            20           ID           3 - 4   0.915
            21           ID           4 - 5   0.908
            22           ID           5 - 6   0.903
            23           ID           6 - 7   0.895
            24           ID           7 - 8   0.885
            25           ID           8 - 9           0.875
            26           ID           9 - 10          0.865
            27           ID           10 - 11         0.857
            28           ID           11 - 12         0.85
            29           ID           12 - 16                 0.832
            30           ID           16 - 20                 0.804
            31           ID           20 - 30                 0.765
            32           ID           30 - 40                 0.725
            33           ID           40 - 50                 0.695
            34           ID           50 - 100                0.64
            35           ID           100 - 150               0.58
            36           ID           150 - 200               0.53
            37           ID           200 - 300               0.49
            38           IT       5       0       0     300
            39           IN       5       0       0
            40           IO       5
            41           JR    PREC   0.832   0.804   0.765   0.725   0.695    0.64    0.58    0.53    0.49

            42           KK   MRIV2
            43           BA   18.37
            44           PB    2.92
            45           PC       0    0.02   0.059    0.08    0.11   0.144    0.15    0.16   0.168   0.171
            46           PC    0.18   0.182   0.187    0.19   0.197   0.202    0.21    0.22    0.23   0.241
            47           PC    0.25   0.259   0.265    0.28    0.29     0.3   0.305   0.309    0.31   0.317
            48           PC   0.321   0.327   0.333   0.346   0.361   0.381   0.408    0.43   0.477   0.514
            49           PC   0.561    0.63    0.71    0.72   0.731   0.752   0.779    0.79   0.795   0.804
            50           PC    0.81    0.82   0.826    0.84   0.859   0.889    0.91   0.938   0.966    0.97
            51           PC   0.974   0.979   0.981   0.983   0.985   0.989    0.99   0.992   0.993   0.996
            52           PC   0.997   0.999       1
1                                                      HEC-1 INPUT                                              PAGE  2
```

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

  53          LS       0    85.0
  54          UD    1.69
              *

  55          KK   MRIV1
  56          BA   22.91
  57          PB    2.86
  58          LS       0    82.8
  59          UD    2.12
              *

  60          KK  CMRIV1
  61          HC       2
              *

  62          KK RCMRIV1
  63          RD   31433   0.004    0.04       0    TRAP      20       4
              *

  64          KK   MRIV3
  65          BA   21.99
  66          PB    2.86
  67          LS       0    82.5
  68          UD    2.02
              *

  69          KK  CMRIV3
  70          HC       2
              *

  71          KK RCMRIV3
  72          RD   10746   0.003    0.04       0    TRAP      20       4
              *

  73          KK   MRIV4
  74          BA   10.45
  75          PB    2.86
  76          LS       0    87.8
  77          UD    1.76
              *

  78          KK     MDW
  79          BA   19.44
  80          PB    2.86
  81          LS       0    83.0
  82          UD    1.08
              *

  83          KK   MRIV5
  84          BA    3.26
  85          PB    2.86
  86          LS       0    86.2
  87          UD    0.79
              *
```



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

  88          KK  CMRIV5
  89          HC       4
              *

  90          KK RCMRIV5
  91          RD   13545   0.002    0.04       0    TRAP      20       4
              *

  92          KK   MRIV6
  93          BA    2.17
  94          PB    2.86
  95          LS       0    86.3
  96          UD    1.33
              *

  97          KK   MRIV7
  98          BA   12.41
  99          PB    2.86
 100          LS       0    87.3
 101          UD    1.21
              *

 102          KK  WSWASH
 103          BA   61.31
 104          PB    2.86
 105          LS       0    86.4
 106          UD    1.76
              *

 107          KK  CMRIV7
 108          HC       4
              *

 109          KK RCMRIV7
```

```
 110          RD   18735   0.002    0.04       0    TRAP      20       4
              *

 111          KK  EWASH8
 112          BA    3.47
 113          PB    2.86
 114          LS       0    80.7
 115          UD    1.24
              *

 116          KK  AWASH1
 117          BA    4.57
 118          PB    2.88
 119          LS       0    86.4
 120          UD    0.79
              *
```



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


 121          KK RAWASH1
 122          RM       2    0.20    0.15
              *

 123          KK  AWASH2
 124          BA    1.63
 125          PB    2.86
 126          LS       0    87.2
 127          UD    0.51
              *

 128          KK CAWASH2
 129          HC       2
              *

 130          KKRCAWASH2
 131          RM       7    0.58    0.15
              *

 132          KK  AWASH3
 133          BA    5.03
 134          PB    2.86
 135          LS       0    87.9
 136          UD    1.00
              *

 137          KK CAWASH3
 138          HC       2
              *

 139          KK    CMR0
 140          HC       3
              *

 141          KK   RCMR0
 142          RD    5862   0.011    0.04       0    TRAP      20       4
              *

 143          KK  WWASH6
 144          BA    1.20
 145          PB    2.86
 146          LS       0    88.9
 147          UD    0.39
              *

 148          KK  EWASH7
 149          BA    6.39
 150          PB    2.86
 151          LS       0    76.6
 152          UD    0.62
              *
```



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


 153          KK REWASH7
 154          RM       5    0.44    0.15
              *

 155          KK  EWASH6
 156          BA    0.78
 157          PB    2.86
 158          LS       0    80.5
 159          UD    0.67
              *

 160          KK CEWASH6
 161          HC       2
              *

 162          KK    BMN1
 163          BA    3.72
 164          PB    2.86
```

```
 165           LS       0    82.6
 166           UD    0.56
               *

 167           KK   RBMN1
 168           RM       7    0.55    0.15
               *

 169           KK    BMN3
 170           BA    5.12
 171           PB    2.86
 172           LS       0    85.3
 173           UD    1.20
               *

 174           KK   CBMN3
 175           HC       2
               *

 176           KK    BMN2
 177           BA    4.08
 178           PB    2.86
 179           LS       0    87.3
 180           UD    0.72
               *

 181           KK   RBMN2
 182           RM      10    0.80    0.15
               *

 183           KK    BMN4
 184           BA    6.98
 185           PB    2.86
 186           LS       0    86.5
 187           UD    1.34
               *
```



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


 188           KK   CBMN4
 189           HC       2
               *

 190           KK  CBMN34
 191           HC       2
               *

 192           KK RCBMN34
 193           RM       3    0.22    0.15
               *

 194           KK    BMN5
 195           BA    1.48
 196           PB    2.86
 197           LS       0    75.3
 198           UD    0.64
               *

 199           KK    BMN6
 200           BA    2.06
 201           PB    2.86
 202           LS       0    85.0
 203           UD    1.05
               *

 204           KK  CBMN56
 205           HC       3
               *

 206           KK RCBMN56
 207           RM       1    0.07    0.15
               *

 208           KK    BMN7
 209           BA    0.45
 210           PB    2.86
 211           LS       0    81.2
 212           UD    0.36
               *

 213           KK   CBMN7
 214           HC       2
               *

 215           KK  DBFGLS
 216           KM   FACILITY = FAIRGROUNDS LYMAN STREET DETENTION BASIN
 217           KM   FACILITY # = FGLS 0167
 218           KM   STORAGE VOLUME = 1247 AC-FT
 219           KM   OUTFALL = 42" ORIFICE
 220           KO       3
 221           RS       1    STOR       0
 222           SV       0    0.01    0.01   10.59   91.13  184.34  279.72  377.11  476.44   577.7
 223           SV     681  786.23  893.49  947.86 1002.72 1058.05  1113.8 1169.91 1226.31   1282.
```

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

 224          SE    1474    1476    1478    1480    1482    1484    1486    1488    1490    1492
 225          SE    1494    1496    1498    1499    1500    1501    1502    1503    1504    1505
 226          SQ       0      25      75     103     125     144     161     176     189     202
 227          SQ     214     226     237     242     247     252     257     262     267     271
              *

 228          KK RDBFGLS
 229          RD    6081   0.007   0.013       0    CIRC       6       0
              *

 230          KK   FGDB1
 231          BA    0.39
 232          PB    2.86
 233          LS       0    76.8
 234          UD    0.35
              *

 235          KK   DETBN
 236          KM   LOCAL DETENTION BASIN FROM LOUIS BERGER
 237          KM   FAIRGROUNDS DETENTION BASIN PRELIMINARY DESIGN
 238          RS       1    STOR       0
 239          SA   0.189   0.195   1.255   1.315   1.376   1.438     1.5   1.562   1.626    1.69
 240          SA   1.754   1.819   1.884   1.947  1.9602  1.9734  1.9866  1.9998   2.013
 241          SE    1413    1414    1415    1416    1417    1418    1419    1420    1421    1422
 242          SE    1423    1424    1425    1426  1426.2  1426.4  1426.6  1426.8    1427
 243          SQ       0   14.29   25.19   32.63   38.66   43.87   48.53   52.78    56.7   60.38
 244          SQ   63.84   67.13   70.26   73.25   89.84   99.62  111.99  125.57  141.13
              *

 245          KK  CFGDB1
 246          HC       2
              *

 247          KK RCFGDB1
 248          RD    2611   0.009   0.013       0    CIRC       6       0
              *

 249          KK    FGDB
 250          BA    1.92
 251          PB    2.86
 252          LS       0    83.6
 253          UD    0.42
              *

 254          KK  DBFGWS
 255          KM   FACILITY = FAIRGROUNDS WHIPPLE DETENTION BASIN
 256          KM   REFERENCE FROM LOUIS BERGER
 257          KM   FAIRGROUNDS DETENTION BASIN PRELIMINARY DESIGN
 258          KM   FACILITY # = FGWS 0166
 259          KM   STORAGE VOLUME = 139 AC-FT
 260          KM   OUTFALL = 18" ORIFICE
 261          KO       3
 262          RS       1    STOR       0
 263          SV       0     2.6     6.3    10.9    16.5    23.2    31.1    40.3    50.6    62.2
 264          SV   75.07    89.3   104.8   121.7   140.1   160.2     182   205.8   231.5   259.2
```



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

 265          SE    1469    1481    1482    1483    1484    1485    1486    1487    1488    1489
 266          SE    1490    1491    1492    1493    1494    1495    1496    1497    1498    1499
 267          SQ       0      31      32   33.55    34.8      36   37.16   38.28   39.38   40.44
 268          SQ      41      42      43   44.45   45.39  215.07    1934    4604    7959   11878
              *

 269          KK RDBFGWS
 270          RD    5302   0.012   0.013       0    CIRC       4       0
              *

 271          KK   FGDB2
 272          BA    0.46
 273          PB    2.86
 274          LS       0    73.2
 275          UD    0.32
              *

 276          KKCRDBFGWS
 277          HC       2
              *

 278          KK  CFGDB2
 279          HC       2
              *

 280          KK RCFGDB2
 281          RD    3976   0.009   0.015       0    TRAP       7       0
              *

 282          KK  EWASH5
 283          BA    0.58
 284          PB    2.86
```

```
 285           LS       0    72.7
 286           UD    0.73
               *

 287           KK CEWASH5
 288           HC       2
               *

 289           KK    CMR1
 290           HC       4
               *

 291           KK   RCMR1
 292           RD    6490   0.003    0.04       0    TRAP      20       4
               *

 293           KK    EWDB
 294           BA    1.89
 295           PB    2.86
 296           LS       0    86.2
 297           UD    0.43
```



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


 298           KK  DBEWGA
 299           KM   FACILITY = GUBLER AVENUE DETENTION BASIN
 300           KM   FACILITY # = EWGA 0196
 301           KM   STORAGE VOLUME = 157 AC-FT
 302           KM   OUTFALL = 30" ORIFICE
 303           KO       3
 304           RS       1    ELEV      -1
 305           SA       1       5      10      20      22
 306           SE    1472    1476    1480    1484    1488
 307           SQ       0      42      67      84      98
               *

 308           KK RDBEWGA
 309           RD   10278   0.012   0.013       0    CIRC       4       0
               *

 310           KK  EWASH4
 311           BA    2.03
 312           PB    2.86
 313           LS       0    77.3
 314           UD    0.61
               *

 315           KK CEWASH4
 316           HC       2
               *

 317           KK  LWASH1
 318           BA    4.03
 319           PB    2.86
 320           LS       0    78.4
 321           UD    0.71
               *

 322           KK  LWASH2
 323           BA    0.70
 324           PB    2.86
 325           LS       0    82.7
 326           UD    0.50
               *

 327           KK CLWASH1
 328           HC       2
               *

 329           KKRCLWASH1
 330           RM       3    0.25    0.15
               *
```



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


 331           KK  LWASH3
 332           BA    1.17
 333           PB    2.86
 334           LS       0    89.0
 335           UD    0.44
               *

 336           KK CLWASH3
 337           HC       2
               *

 338           KKRCLWASH3
 339           RD    3556   0.012   0.013       0    CIRC      20       0
               *

 340           KK  WWASH5
```

```
 341           BA    1.61
 342           PB    2.86
 343           LS       0    89.4
 344           UD    0.40
               *

 345           KK RWWASH5
 346           RM       2    0.20    0.15
               *

 347           KK    LOG1
 348           BA    0.41
 349           PB    2.86
 350           LS       0    81.6
 351           UD    0.51
               *

 352           KK    CMR2
 353           HC       5
               *

 354           KK   RCMR2
 355           RD    9445   0.001   0.025       0    TRAP     200       3
               *

 356           KK  EWASH3
 357           BA    1.77
 358           PB    2.86
 359           LS       0    74.4
 360           UD    0.81
               *

 361           KK    LOG3
 362           BA    0.51
 363           PB    2.86
 364           LS       0    84.6
 365           UD    0.76
               *
```



```
 366           KK    CMR3
 367           HC       3
               *

 368           KK   RCMR3
 369           RD    4979   0.001   0.025       0    TRAP     200       3
               *

 370           KK    LOG2
 371           BA    1.62
 372           PB    2.86
 373           LS       0    84.8
 374           UD    0.67
               *

 375           KK    CMR4
 376           HC       2
               *

 377           KK   RCMR4
 378           RD    5007   0.004   0.025       0    TRAP     200       3
               *

 379           KK  EWASH2
 380           BA    4.80
 381           PB    2.86
 382           LS       0    82.9
 383           UD    0.94
               *

 384           KK    CMR5
 385           HC       2
               *

 386           KK   RCMR5
 387           RD    4696   0.002   0.025       0    TRAP     400       3
               *

 388           KK    OVR1
 389           BA    1.88
 390           PB    2.86
 391           LS       0    85.0
 392           UD    0.61
               *

 393           KK    CMR6
 394           HC       2
               *
```

```
 395           KK   RCMR6
 396           RD    3336   0.003   0.025       0    TRAP     600       3
               *

 397           KK WWASH4A
 398           BA    0.31
 399           PB    2.86
 400           LS       0    89.8
 401           UD    0.23
               *

 402           KK  WWASH4
 403           BA    0.58
 404           PB    2.86
 405           LS       0    89.4
 406           UD    0.38
               *

 407           KK CWWASH4
 408           HC       2
               *

 409           KK  DBWWWT
 410           KM   FACILITY = WITTWER AVENUE DETENTION BASIN
 411           KM   FACILITY # = WWWT 0004
 412           KM   STORAGE VOLUME = 91 ACRE-FEET
 413           KM   OUTFALL = 18" ORIFICE
 414           KO       3
 415           RS       1    ELEV      -1
 416           SA       5       6       7       8
 417           SE    1365    1370    1375    1380
 418           SQ       0      19      28      35
               *

 419           KKRCWWASH4
 420           RD    5392   0.005   0.015       0    TRAP      12       2
               *

 421           KK WWASH3A
 422           BA    0.49
 423           PB    2.86
 424           LS       0    89.6
 425           UD    0.32
               *

 426           KKCWWASH3A
 427           HC       2
               *
```



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


 428           KK  WWASH3
 429           BA    0.45
 430           PB    2.86
 431           LS       0    89.8
 432           UD    0.15
               *

 433           KK  DBWWDA
 434           KM   FACILITY = DUESING AVENUE DETENTION BASIN
 435           KM   FACILITY # = WWDA 0009
 436           KM   STORAGE VOLUME = 49 ACRE-FEET
 437           KM   OUTFALL = 18" ORIFICE
 438           KO       3
 439           RS       1    ELEV      -1
 440           SA       1       4       6       7       8
 441           SE    1335    1337    1340    1342    1345
 442           SQ       0      10      19      23      28
               *

 443           KK CWWASH3
 444           HC       2
               *

 445           KKRCWWASH3
 446           RD    4532   0.004   0.015       0    TRAP      12       2
               *

 447           KK WWASH2A
 448           BA    0.39
 449           PB    2.86
 450           LS       0    85.7
 451           UD    0.37
               *

 452           KKCWWASH2A
 453           HC       2
               *

 454           KK  WWASH2
 455           BA    1.90
 456           PB    2.86
```

```
 457           LS       0    88.4
 458           UD    0.54
               *

 459           KK  DBWWCA
 460           KM   FACILITY = COTTONWOOD AVENUE DETENTION BASIN
 461           KM   FACILITY # = WWCA 0050
 462           KM   STORAGE VOLUME = 156 ACRE-FEET
 463           KM   OUTFALL  = 30" ORIFICE
 464           KO       3
 465           RS       1    ELEV      -1
 466           SA       1       3       6       8       9      10
 467           SE    1365    1370    1375    1380    1385    1390
```



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

 468           SQ       0      50      76      95     111     125
               *

 469           KK RDBWWCA
 470           RD    2608   0.020   0.013       0    CIRC       5       0
               *

 471           KK CWWASH2
 472           HC       2
               *

 473           KKRCWWASH2
 474           RD    2310   0.004   0.015       0    TRAP      12       2
               *

 475           KK  WIWASH
 476           BA    3.50
 477           PB    2.86
 478           LS       0    80.9
 479           UD    0.91
               *

 480           KK  DBWWWI
 481           KM   FACILITY = WEIBER WASH DETENTION BASIN
 482           KM   FACILITY # = WWWI 0027
 483           KM   STORAGE VOLUME = 182 ACRE-FEET
 484           KM   OUTFALL = 30" ORIFICE
 485           KO       3
 486           RS       1    ELEV      -1
 487           SA       3       4       6       8      10
 488           SE    1325    1332    1340    1347    1355
 489           SQ       0      61      95     117     137
               *

 490           KK CWIWASH
 491           HC       2
               *

 492           KKRCWIWASH
 493           RD    4030   0.004   0.015       0    TRAP      12       2
               *

 494           KK WWASH1B
 495           BA    2.63
 496           PB    2.86
 497           LS       0    88.4
 498           UD    0.43
               *

 499           KK  DBWWWA
 500           KM   FACILITY = WEST WASH 1 DETENTION BASIN
 501           KM   FACILITY # = WWWA 0017
 502           KM   STORAGE VOLUME = 235 ACRE-FEET
 503           KM   OUTFALL = 36" ORIFICE
 504           KO       3
```



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

 505           RS       1    ELEV      -1
 506           SA       2      11      20      26      30
 507           SE    1300    1303    1307    1311    1315
 508           SQ       0      45      86     114     135
               *

 509           KKCWWASH1B
 510           HC       2
               *

 511           KKRCWWAS1B
 512           RD    1606   0.004   0.015       0    TRAP      12       2
               *

 513           KK WWASH1A
 514           BA    1.25
 515           PB    2.86
 516           LS       0    88.1
 517           UD    0.34
```

```
                *

 518            KK  DBWWIA
 519            KM   Facility = INGRAM AVENUE DETENTION BASIN
 520            KM   Facility # = WWWA 0016
 521            KM   STORAGE VOLUME = 108 ACRE-FEET
 522            KM   OUTLET = 30" ORIFICE
 523            KO       3
 524            RS       1    ELEV      -1
 525            SA       1       6      11      14
 526            SE    1295    1300    1305    1310
 527            SQ       0      50      76      95
                *

 528            KKCWWASH1A
 529            HC       2
                *

 530            KKRCWWAS1A
 531            RD    3078   0.004   0.015       0    TRAP      12       2
                *

 532            KK  OWASHS
 533            BA   11.43
 534            PB    3.02
 535            LS       0    80.9
 536            UD    0.80
                *

 537            KK  OWASHN
 538            BA    5.95
 539            PB    2.90
 540            LS       0    84.0
 541            UD    0.89
                *
```



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


 542            KK COWASHS
 543            HC       2
                *

 544            KKRCOWASHS
 545            RM       4    0.31    0.15
                *

 546            KK  OWASH1
 547            BA    2.44
 548            PB    2.86
 549            LS       0    76.8
 550            UD    0.79
                *

 551            KK COWASH1
 552            HC       2
                *

 553            KK  RORIDG
 554            KM   Route through Overton Ridge from USCOE
 555            KM   Dentention Basin cards from 1988 and 1994 MVMPU
 556            RS       1    STOR       0       0
 557            SV      10      20      40      80     160     270     500
 558            SQ       0     350    1070    3580    7600   13000   20580
                *

 559            KKRCOWASH1
 560            RM       3    0.22    0.15
                *

 561            KK  OWASH2
 562            BA    2.43
 563            PB    2.86
 564            LS       0    84.3
 565            UD    0.61
                *

 566            KKCCOWASH2
 567            HC       2
                *

 568            KK  DBWWPA
 569            KM   FACILITY = PERKINS AVENUE DETENTION BASIN
 570            KM   Facility # = WWPA 0018
 571            KM   STORAGE VOLUME = 992 ACRE-FEET
 572            KM   OUTLET = 42" ORIFICE
 573            KO       3
 574            RS       1    ELEV      -1
 575            SA       1      12      32      49      56
 576            SE    1290    1300    1308    1315    1325
 577            SQ       0     144     202     242     289
                *
```

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


 578          KK COWASH2
 579          HC       2
              *

 580          KKRCOWASH2
 581          RD    2591   0.004   0.015       0    TRAP      12       2
              *

 582          KK  OWASH3
 583          BA    0.32
 584          PB    2.86
 585          LS       0    88.6
 586          UD    0.28
              *

 587          KK COWASH3
 588          HC       2
              *

 589          KKRCOWASH3
 590          RD    4701   0.005   0.015       0    TRAP      12       2
              *

 591          KK    OVR2
 592          BA    0.47
 593          PB    2.86
 594          LS       0    81.4
 595          UD    0.46
              *

 596          KK   COVR2
 597          HC       2
              *

 598          KK    CMR7
 599          HC       2
              *

 600          KK   RCMR7
 601          RD    2035   0.004   0.025       0    TRAP     600       3
              *

 602          KK    OVR3
 603          BA    0.45
 604          PB    2.86
 605          LS       0    77.1
 606          UD    0.44
              *
```



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


 607          KK    CMR8
 608          HC       2
              *

 609          KK   RCMR8
 610          RD    2730   0.004   0.025       0    TRAP     600       3
              *

 611          KK  EWASH1
 612          BA    6.33
 613          PB    2.86
 614          LS       0    80.9
 615          UD    1.20
              *

 616          KK    CMR9
 617          HC       2
              *

 618          KK   RCMR9
 619          RD    2796   0.004   0.025       0    TRAP     600       3
              *

 620          KK   MAGW1
 621          BA    5.52
 622          PB    2.86
 623          LS       0    76.0
 624          UD    1.26
              *

 625          KK  RMAGW1
 626          RM       6    0.52    0.15
              *

 627          KK   MAGW2
 628          BA    4.81
 629          PB    2.86
 630          LS       0    81.8
 631          UD    1.06
```

```
                          *

            632           KK  CMAGW2
            633           HC       2
                          *

            634           KK   CMR10
            635           HC       2
                          *
1                                                       HEC-1 INPUT                                                     PAGE 19

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


            636           KK    BMN8
            637           BA    1.27
            638           PB    2.86
            639           LS       0    67.6
            640           UD    0.52
                          *

            641           KK  BOWMAN
            642           BA    0.30
            643           PB    2.86
            644           LS       0    33.4
            645           UD    0.99
                          *

            646           KK CBOWMAN
            647           HC       2
                          *
            648           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

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

    42       MRIV2
                 .
                 .
    55           .       MRIV1
                 .           .
                 .           .
    60      CMRIV1............
                 V
                 V
    62     RCMRIV1
                 .
                 .
    64           .       MRIV3
                 .           .
                 .           .
    69      CMRIV3............
                 V
                 V
    71     RCMRIV3
                 .
                 .
    73           .       MRIV4
                 .           .
                 .           .
    78           .           .         MDW
                 .           .           .
                 .           .           .
    83           .           .           .       MRIV5
                 .           .           .           .
                 .           .           .           .
    88      CMRIV5....................................
                 V
                 V
    90     RCMRIV5
                 .
                 .
    92           .       MRIV6
                 .           .
                 .           .
    97           .           .       MRIV7
                 .           .           .
                 .           .           .
   102           .           .           .      WSWASH
                 .           .           .           .
                 .           .           .           .
   107      CMRIV7....................................
                 V
                 V
   109     RCMRIV7
                 .
                 .
   111           .      EWASH8
                 .           .
                 .           .
   116           .           .      AWASH1
                 .           .           V
```

```
              .           .           V
121           .           .     RAWASH1
              .           .           .
              .           .           .
123           .           .           .      AWASH2
              .           .           .           .
              .           .           .           .
128           .           .     CAWASH2............
              .           .           V
              .           .           V
130           .           .    RCAWASH2
              .           .           .
              .           .           .
132           .           .           .      AWASH3
              .           .           .           .
              .           .           .           .
137           .           .     CAWASH3............
              .           .           .
              .           .           .
139        CMR0........................
              V
              V
141       RCMR0
              .
              .
143           .      WWASH6
              .           .
              .           .
148           .           .      EWASH7
              .           .           V
              .           .           V
153           .           .     REWASH7
              .           .           .
              .           .           .
155           .           .           .      EWASH6
              .           .           .           .
              .           .           .           .
160           .           .     CEWASH6............
              .           .           .
              .           .           .
162           .           .           .        BMN1
              .           .           .           V
              .           .           .           V
167           .           .           .       RBMN1
              .           .           .           .
              .           .           .           .
169           .           .           .           .        BMN3
              .           .           .           .           .
              .           .           .           .           .
174           .           .           .       CBMN3............
              .           .           .           .
              .           .           .           .
176           .           .           .           .        BMN2
              .           .           .           .           V
              .           .           .           .           V
181           .           .           .           .       RBMN2
              .           .           .           .           .
              .           .           .           .           .
183           .           .           .           .           .        BMN4
              .           .           .           .           .           .
              .           .           .           .           .           .
188           .           .           .           .       CBMN4............
              .           .           .           .           .
              .           .           .           .           .
190           .           .           .      CBMN34............
              .           .           .           V
              .           .           .           V
192           .           .           .     RCBMN34
              .           .           .           .
              .           .           .           .
194           .           .           .           .        BMN5
              .           .           .           .           .
              .           .           .           .           .
199           .           .           .           .           .        BMN6
              .           .           .           .           .           .
              .           .           .           .           .           .
204           .           .           .      CBMN56........................
              .           .           .           V
              .           .           .           V
206           .           .           .     RCBMN56
              .           .           .           .
              .           .           .           .
208           .           .           .           .        BMN7
              .           .           .           .           .
              .           .           .           .           .
213           .           .           .       CBMN7............
              .           .           .           V
              .           .           .           V
215           .           .           .      DBFGLS
              .           .           .           V
              .           .           .           V
228           .           .           .     RDBFGLS
              .           .           .           .
              .           .           .           .
230           .           .           .           .       FGDB1
```

```
              .           .           .           .           V
              .           .           .           .           V
235           .           .           .           .       DETBN
              .           .           .           .           .
              .           .           .           .           .
245           .           .           .      CFGDB1............
              .           .           .           V
              .           .           .           V
247           .           .           .     RCFGDB1
              .           .           .           .
              .           .           .           .
249           .           .           .           .        FGDB
              .           .           .           .           V
              .           .           .           .           V
254           .           .           .           .      DBFGWS
              .           .           .           .           V
              .           .           .           .           V
269           .           .           .           .     RDBFGWS
              .           .           .           .           .
              .           .           .           .           .
271           .           .           .           .           .       FGDB2
              .           .           .           .           .           .
              .           .           .           .           .           .
276           .           .           .           .    CRDBFGWS............
              .           .           .           .           .
              .           .           .           .           .
278           .           .           .      CFGDB2............
              .           .           .           V
              .           .           .           V
280           .           .           .     RCFGDB2
              .           .           .           .
              .           .           .           .
282           .           .           .           .      EWASH5
              .           .           .           .           .
              .           .           .           .           .
287           .           .           .     CEWASH5............
              .           .           .           .
              .           .           .           .
289        CMR1....................................
              V
              V
291       RCMR1
              .
              .
293           .        EWDB
              .           V
              .           V
298           .      DBEWGA
              .           V
              .           V
308           .     RDBEWGA
              .           .
              .           .
310           .           .      EWASH4
              .           .           .
              .           .           .
315           .     CEWASH4............
              .           .
              .           .
317           .           .      LWASH1
              .           .           .
              .           .           .
322           .           .           .      LWASH2
              .           .           .           .
              .           .           .           .
327           .           .     CLWASH1............
              .           .           V
              .           .           V
329           .           .    RCLWASH1
              .           .           .
              .           .           .
331           .           .           .      LWASH3
              .           .           .           .
              .           .           .           .
336           .           .     CLWASH3............
              .           .           V
              .           .           V
338           .           .    RCLWASH3
              .           .           .
              .           .           .
340           .           .           .      WWASH5
              .           .           .           V
              .           .           .           V
345           .           .           .     RWWASH5
              .           .           .           .
              .           .           .           .
347           .           .           .           .        LOG1
              .           .           .           .           .
              .           .           .           .           .
352        CMR2................................................
              V
              V
354       RCMR2
              .
              .
```

```
356           .      EWASH3
              .           .
              .           .
361           .           .        LOG3
              .           .           .
              .           .           .
366        CMR3........................
              V
              V
368       RCMR3
              .
              .
370           .        LOG2
              .           .
              .           .
375        CMR4............
              V
              V
377       RCMR4
              .
              .
379           .      EWASH2
              .           .
              .           .
384        CMR5............
              V
              V
386       RCMR5
              .
              .
388           .        OVR1
              .           .
              .           .
393        CMR6............
              V
              V
395       RCMR6
              .
              .
397           .     WWASH4A
              .           .
              .           .
402           .           .      WWASH4
              .           .           .
              .           .           .
407           .     CWWASH4............
              .           V
              .           V
409           .      DBWWWT
              .           V
              .           V
419           .    RCWWASH4
              .           .
              .           .
421           .           .     WWASH3A
              .           .           .
              .           .           .
426           .    CWWASH3A............
              .           .
              .           .
428           .           .      WWASH3
              .           .           V
              .           .           V
433           .           .      DBWWDA
              .           .           .
              .           .           .
443           .     CWWASH3............
              .           V
              .           V
445           .    RCWWASH3
              .           .
              .           .
447           .           .     WWASH2A
              .           .           .
              .           .           .
452           .    CWWASH2A............
              .           .
              .           .
454           .           .      WWASH2
              .           .           V
              .           .           V
459           .           .      DBWWCA
              .           .           V
              .           .           V
469           .           .     RDBWWCA
              .           .           .
              .           .           .
471           .     CWWASH2............
              .           V
              .           V
473           .    RCWWASH2
              .           .
              .           .
475           .           .      WIWASH
              .           .           V
```

```
              .           .           V
480           .           .      DBWWWI
              .           .           .
              .           .           .
490           .     CWIWASH............
              .           V
              .           V
492           .    RCWIWASH
              .           .
              .           .
494           .           .     WWASH1B
              .           .           V
              .           .           V
499           .           .      DBWWWA
              .           .           .
              .           .           .
509           .    CWWASH1B............
              .           V
              .           V
511           .    RCWWAS1B
              .           .
              .           .
513           .           .     WWASH1A
              .           .           V
              .           .           V
518           .           .      DBWWIA
              .           .           .
              .           .           .
528           .    CWWASH1A............
              .           V
              .           V
530           .    RCWWAS1A
              .           .
              .           .
532           .           .      OWASHS
              .           .           .
              .           .           .
537           .           .           .      OWASHN
              .           .           .           .
              .           .           .           .
542           .           .     COWASHS............
              .           .           V
              .           .           V
544           .           .    RCOWASHS
              .           .           .
              .           .           .
546           .           .           .      OWASH1
              .           .           .           .
              .           .           .           .
551           .           .     COWASH1............
              .           .           V
              .           .           V
553           .           .      RORIDG
              .           .           V
              .           .           V
559           .           .    RCOWASH1
              .           .           .
              .           .           .
561           .           .           .      OWASH2
              .           .           .           .
              .           .           .           .
566           .           .    CCOWASH2............
              .           .           V
              .           .           V
568           .           .      DBWWPA
              .           .           .
              .           .           .
578           .     COWASH2............
              .           V
              .           V
580           .    RCOWASH2
              .           .
              .           .
582           .           .      OWASH3
              .           .           .
              .           .           .
587           .     COWASH3............
              .           V
              .           V
589           .    RCOWASH3
              .           .
              .           .
591           .           .         OVR2
              .           .           .
              .           .           .
596           .       COVR2............
              .           .
              .           .
598        CMR7............
              V
              V
600       RCMR7
              .
              .
602           .         OVR3
```

```
              .           .
              .           .
 607       CMR8............
              V
              V
 609      RCMR8
              .
              .
 611          .      EWASH1
              .           .
              .           .
 616       CMR9............
              V
              V
 618      RCMR9
              .
              .
 620          .       MAGW1
              .           V
              .           V
 625          .      RMAGW1
              .           .
              .           .
 627          .           .       MAGW2
              .           .           .
              .           .           .
 632          .      CMAGW2............
              .           .
              .           .
 634      CMR10............
              .
              .
 636          .        BMN8
              .           .
              .           .
 641          .           .      BOWMAN
              .           .           .
              .           .           .
 646          .     CBOWMAN............

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
 *                                        *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
 *              JUN   1998                *
 *           VERSION 4.1                  *
 *                                        *
 *  RUN DATE   03MAY16  TIME  11:44:09    *
 *                                        *
 ******************************************

 ***************************************
 *                                     *
 *    U.S. ARMY CORPS OF ENGINEERS     *
 *    HYDROLOGIC ENGINEERING CENTER    *
 *          609 SECOND STREET          *
 *       DAVIS, CALIFORNIA 95616       *
 *           (916) 756-1104            *
 *                                     *
 ***************************************
```

```
                          2016 FLOOD CONTROL MASTER PLAN UPDATE
                          MUDDY RIVER AND TRIBUTARY WASHES
                          INPUT FILE = MRMPU5.DAT
                          INPUT FILE DATE = APR, 2016
                          DESIGN STORM = 100-YEAR 6-HR STORM
                          STORM DISTRIBUTION = SDN #5
                          MODELED BY ATKINS (HONGYU DENG, E.I.T, CFM)
                          CHECKED BY ATKINS (BRIAN ROWLEY, P.E. , CFM)
                          STORM CENTERING = ENTIRE WATERSHED

                          JR CARDS CONTAIN DARFS BASED ON THE FOLLOWING VALUES:

                                  AREA    DARF
                                  SQ.MI.
                                          SDN 3   SDN 4   SDN 5
                                  0 - 0.5 0.99
                                  0.5 - 1 0.975
                                  1 - 2   0.95
                                  2 - 3   0.925
                                  3 - 4   0.915
                                  4 - 5   0.908
                                  5 - 6   0.903
                                  6 - 7   0.895
                                  7 - 8   0.885
                                  8 - 9           0.875
                                  9 - 10          0.865
                                  10 - 11         0.857
                                  11 - 12         0.85
                                  12 - 16                 0.832
                                  16 - 20                 0.804
                                  20 - 30                 0.765
                                  30 - 40                 0.725
                                  40 - 50                 0.695
                                  50 - 100                0.64
                                  100 - 150               0.58
                                  150 - 200               0.53
                                  200 - 300               0.49

 40 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      1    0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2    0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE   24.92 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

     JP         MULTI-PLAN OPTION
                    NPLAN          1  NUMBER OF PLANS

     JR         MULTI-RATIO OPTION
                  RATIOS OF PRECIPITATION
                   .83       .80       .76       .73       .69       .64       .58       .53       .49


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


            **************
            *            *
 215 KK     *   DBFGLS   *
            *            *
            **************

 220 KO         OUTPUT CONTROL VARIABLES
                    IPRNT          3  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

 221 RS         STORAGE ROUTING
                    NSTPS          1  NUMBER OF SUBREACHES
                     ITYP       STOR  TYPE OF INITIAL CONDITION
                   RSVRIC        .00  INITIAL CONDITION
                        X        .00 WORKING R AND D COEFFICIENT

 222 SV           STORAGE         .0        .0        .0      10.6      91.1     184.3     279.7     377.1     476.4     577.7
                               681.0     786.2     893.5     947.9    1002.7    1058.1    1113.8    1169.9    1226.3    1282.0

 224 SE         ELEVATION    1474.00   1476.00   1478.00   1480.00   1482.00   1484.00   1486.00   1488.00   1490.00   1492.00
                             1494.00   1496.00   1498.00   1499.00   1500.00   1501.00   1502.00   1503.00   1504.00   1505.00

 226 SQ         DISCHARGE         0.       25.       75.      103.      125.      144.      161.      176.      189.      202.
                                214.      226.      237.      242.      247.      252.      257.      262.      267.      271.

                                                                              ***

*** WARNING *** MODIFIED PULS ROUTING MAY BE NUMERICALLY UNSTABLE FOR OUTFLOWS BETWEEN        0. TO       25.
                THE ROUTED HYDROGRAPH SHOULD BE EXAMINED FOR OSCILLATIONS OR OUTFLOWS GREATER THAN PEAK INFLOWS.
                THIS CAN BE CORRECTED BY DECREASING THE TIME INTERVAL OR INCREASING STORAGE (USE A LONGER REACH.)

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

                      HYDROGRAPH AT STATION   DBFGLS
                        FOR PLAN 1, RATIO =  .83

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     269.      8.50               267.        227.        219.         219.
                        (INCHES)   .104        .353        .353         .353
                         (AC-FT)   132.        450.        450.         450.

PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
    1261.       8.50              1228.        915.        881.         881.

 PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1504.62      8.50            1504.04     1497.87     1496.99      1496.99

                       CUMULATIVE AREA =   23.89 SQ MI
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      ***            ***            ***             ***            ***

                       HYDROGRAPH AT STATION   DBFGLS
                         FOR PLAN 1, RATIO =  .80

   PEAK FLOW    TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+     263.      8.50                   261.        221.        213.         213.
                       (INCHES)        .101        .344        .344         .344
                        (AC-FT)        129.        439.        439.         439.

  PEAK STORAGE  TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1185.      8.50                  1154.        855.        824.         824.

   PEAK STAGE   TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1503.28      8.50                1502.71     1496.77     1495.93      1495.93

                      CUMULATIVE AREA =   23.89 SQ MI


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

                       HYDROGRAPH AT STATION   DBFGLS
                         FOR PLAN 1, RATIO =  .76

   PEAK FLOW    TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+     254.      8.50                   251.        213.        205.         205.
                       (INCHES)        .098        .331        .331         .331
                        (AC-FT)        125.        422.        422.         422.

  PEAK STORAGE  TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1082.      8.50                  1051.        774.        746.         746.

   PEAK STAGE   TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1501.43      8.50                1500.88     1495.25     1494.47      1494.47

                      CUMULATIVE AREA =   23.89 SQ MI


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

                       HYDROGRAPH AT STATION   DBFGLS
                         FOR PLAN 1, RATIO =  .73

   PEAK FLOW    TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+     245.      8.50                   242.        204.        197.         197.
                       (INCHES)        .094        .318        .318         .318
                        (AC-FT)        120.        405.        405.         405.

  PEAK STORAGE  TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      978.      8.50                   949.        693.        667.         667.

   PEAK STAGE   TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1499.56      8.50                1499.02     1493.71     1492.98      1492.98

                      CUMULATIVE AREA =   23.89 SQ MI


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

                       HYDROGRAPH AT STATION   DBFGLS
                         FOR PLAN 1, RATIO =  .69

   PEAK FLOW    TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+     238.      8.42                   235.        197.        190.         190.
                       (INCHES)        .091        .307        .307         .307
                        (AC-FT)        117.        391.        391.         391.

  PEAK STORAGE  TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
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     902.     8.42               874.       633.       610.        610.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                 6-HR      24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1498.16      8.42          1497.63    1492.56    1491.88     1491.88

                        CUMULATIVE AREA =   23.89 SQ MI


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

                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .64

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                 6-HR      24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     224.      8.42             221.       184.       178.        178.
                        (INCHES)     .086       .287       .287        .287
                         (AC-FT)     109.       366.       366.        366.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                 6-HR      24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
      767.      8.42             740.       529.       509.        509.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                 6-HR      24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1495.64      8.42          1495.12    1490.50    1489.89     1489.89

                        CUMULATIVE AREA =   23.89 SQ MI


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

                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .58

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                 6-HR      24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     208.      8.33             205.       170.       164.        164.
                        (INCHES)     .080       .264       .264        .264
                         (AC-FT)     102.       337.       337.        337.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                 6-HR      24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
      626.      8.33             601.       420.       405.        405.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                 6-HR      24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1492.94      8.33          1492.45    1488.31    1487.78     1487.78

                        CUMULATIVE AREA =   23.89 SQ MI


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

                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .53

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                 6-HR      24-HR      72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     194.      8.25             191.       157.       152.        152.
                        (INCHES)     .074       .245       .245        .245
                         (AC-FT)      95.       312.       312.        312.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                 6-HR      24-HR      72-HR     24.92-HR
+  (AC-FT)      (HR)
      515.      8.25             492.       335.       323.        323.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                 6-HR      24-HR      72-HR     24.92-HR
+   (FEET)      (HR)
   1490.76      8.25          1490.30    1486.55    1486.09     1486.09

                        CUMULATIVE AREA =   23.89 SQ MI


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

                         HYDROGRAPH AT STATION   DBFGLS
                           FOR PLAN 1, RATIO =  .49

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                 6-HR      24-HR      72-HR     24.92-HR
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+   (CFS)       (HR)
                           (CFS)
+     183.      8.25                  180.        147.        142.         142.
                        (INCHES)      .070        .229        .229         .229
                         (AC-FT)       89.        292.        292.         292.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      431.      8.25                  409.        271.        261.         261.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1489.08      8.25               1488.64     1485.20     1484.79      1484.79

                         CUMULATIVE AREA =   23.89 SQ MI



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

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             *            *
  254 KK     *    DBFGWS  *
             *            *
             **************

  261 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

  262 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        STOR  TYPE OF INITIAL CONDITION
                       RSVRIC         .00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  263 SV            STORAGE          .0       2.6       6.3      10.9      16.5      23.2      31.1      40.3      50.6      62.2
                                   75.1      89.3     104.8     121.7     140.1     160.2     182.0     205.8     231.5     259.2

  265 SE          ELEVATION     1469.00   1481.00   1482.00   1483.00   1484.00   1485.00   1486.00   1487.00   1488.00   1489.00
                                1490.00   1491.00   1492.00   1493.00   1494.00   1495.00   1496.00   1497.00   1498.00   1499.00

  267 SQ          DISCHARGE          0.       31.       32.       34.       35.       36.       37.       38.       39.       40.
                                    41.       42.       43.       44.       45.      215.     1934.     4604.     7959.    11878.

                                                                              ***

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

                           HYDROGRAPH AT STATION   DBFGWS
                             FOR PLAN 1, RATIO =  .83

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      42.      6.33                   41.         37.         36.          36.
                        (INCHES)      .201        .724        .724         .724
                         (AC-FT)       21.         74.         74.          74.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       88.      6.33                   82.         53.         51.          51.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1490.92      6.33               1490.47     1487.20     1486.53      1486.53

                         CUMULATIVE AREA =    1.92 SQ MI


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

                           HYDROGRAPH AT STATION   DBFGWS
                             FOR PLAN 1, RATIO =  .80

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      42.      6.33                   41.         37.         35.          35.
                        (INCHES)      .199        .713        .713         .713
                         (AC-FT)       20.         73.         73.          73.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
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+  (AC-FT)      (HR)
       82.      6.33                   76.         48.         46.          46.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1490.52      6.33                1490.06     1486.73     1486.07      1486.07

                        CUMULATIVE AREA =    1.92 SQ MI


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

                         HYDROGRAPH AT STATION   DBFGWS
                           FOR PLAN 1, RATIO =  .76

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      41.      6.25                   41.         36.         35.          35.
                        (INCHES)      .197        .697        .697         .697
                         (AC-FT)       20.         71.         71.          71.

 PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       75.      6.33                   68.         41.         40.          40.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1489.97      6.33                1489.48     1486.02     1485.40      1485.40

                        CUMULATIVE AREA =    1.92 SQ MI


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

                         HYDROGRAPH AT STATION   DBFGWS
                           FOR PLAN 1, RATIO =  .73

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      41.      6.25                   40.         35.         34.          34.
                        (INCHES)      .195        .679        .679         .679
                         (AC-FT)       20.         70.         70.          70.

 PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       67.      6.25                   61.         35.         34.          34.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1489.36      6.25                1488.86     1485.26     1484.66      1484.66

                        CUMULATIVE AREA =    1.92 SQ MI


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

                         HYDROGRAPH AT STATION   DBFGWS
                           FOR PLAN 1, RATIO =  .69

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+      40.      6.25                   40.         34.         33.          33.
                        (INCHES)      .193        .664        .664         .664
                         (AC-FT)       20.         68.         68.          68.

 PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       61.      6.25                   55.         30.         29.          29.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1488.92      6.25                1488.38     1484.65     1484.07      1484.07

                        CUMULATIVE AREA =    1.92 SQ MI


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

                         HYDROGRAPH AT STATION   DBFGWS
                           FOR PLAN 1, RATIO =  .64

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
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                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                             (CFS)
+      39.      6.17                        39.         31.         30.          30.
                            (INCHES)       .188        .605        .605         .605
                             (AC-FT)        19.         62.         62.          62.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       51.      6.17                        45.         23.         22.          22.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1488.05      6.17                    1487.48     1482.91     1482.40      1482.40

                            CUMULATIVE AREA =    1.92 SQ MI


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

                             HYDROGRAPH AT STATION   DBFGWS
                               FOR PLAN 1, RATIO =  .58

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                             (CFS)
+      38.      6.08                        38.         26.         25.          25.
                            (INCHES)       .182        .497        .497         .497
                             (AC-FT)        19.         51.         51.          51.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       41.      6.17                        35.         15.         15.          15.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1487.04      6.17                    1486.42     1480.21     1479.79      1479.79

                            CUMULATIVE AREA =    1.92 SQ MI


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

                             HYDROGRAPH AT STATION   DBFGWS
                               FOR PLAN 1, RATIO =  .53

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                             (CFS)
+      37.      6.00                        37.         21.         20.          20.
                            (INCHES)       .177        .409        .409         .409
                             (AC-FT)        18.         42.         42.          42.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       33.      6.08                        27.         10.         10.          10.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1486.15      6.08                    1485.48     1478.07     1477.74      1477.74

                            CUMULATIVE AREA =    1.92 SQ MI


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

                             HYDROGRAPH AT STATION   DBFGWS
                               FOR PLAN 1, RATIO =  .49

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                             (CFS)
+      36.      6.00                        36.         18.         17.          17.
                            (INCHES)       .172        .343        .343         .343
                             (AC-FT)        18.         35.         35.          35.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       26.      6.00                        21.          7.          7.           7.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1485.40      6.00                    1484.68     1476.49     1476.22      1476.22
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                        CUMULATIVE AREA =    1.92 SQ MI


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

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             *            *
  298 KK     *    DBEWGA  *
             *            *
             **************

  303 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

  304 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC       -1.00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  305 SA               AREA         1.0       5.0      10.0      20.0      22.0

  306 SE          ELEVATION     1472.00   1476.00   1480.00   1484.00   1488.00

  307 SQ          DISCHARGE          0.       42.       67.       84.       98.

                                                                 ***

                                                        COMPUTED STORAGE-ELEVATION DATA

             STORAGE        .00     10.98     40.41     99.27    183.23
           ELEVATION    1472.00   1476.00   1480.00   1484.00   1488.00

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

                         HYDROGRAPH AT STATION   DBEWGA
                           FOR PLAN 1, RATIO =  .83

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      83.      6.08                     79.         57.         55.          55.
                        (INCHES)       .390       1.116       1.116        1.116
                         (AC-FT)        39.        112.        112.         112.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       95.      6.08                     83.         42.         40.          40.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1483.70      6.08                 1482.90     1478.95     1478.69      1478.69

                        CUMULATIVE AREA =    1.89 SQ MI


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

                         HYDROGRAPH AT STATION   DBEWGA
                           FOR PLAN 1, RATIO =  .80

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      81.      6.00                     78.         54.         52.          52.
                        (INCHES)       .382       1.062       1.062        1.062
                         (AC-FT)        39.        107.        107.         107.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       89.      6.00                     78.         38.         36.          36.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1483.31      6.00                 1482.53     1478.53     1478.29      1478.29

                        CUMULATIVE AREA =    1.89 SQ MI


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

                         HYDROGRAPH AT STATION   DBEWGA
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                              FOR PLAN 1, RATIO =  .76

    PEAK FLOW     TIME                                 MAXIMUM AVERAGE FLOW
                                                6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      79.      6.00                           76.         50.         48.          48.
                            (INCHES)           .372        .984        .984         .984
                             (AC-FT)            37.         99.         99.          99.

   PEAK STORAGE   TIME                                MAXIMUM AVERAGE STORAGE
                                                6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
        81.      6.00                           70.         33.         32.          32.

    PEAK STAGE    TIME                                 MAXIMUM AVERAGE STAGE
                                                6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
     1482.78     6.00                        1482.02     1477.95     1477.73      1477.73

                            CUMULATIVE AREA =    1.89 SQ MI


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

                             HYDROGRAPH AT STATION   DBEWGA
                               FOR PLAN 1, RATIO =  .73

    PEAK FLOW     TIME                                 MAXIMUM AVERAGE FLOW
                                                6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      77.      6.00                           73.         46.         44.          44.
                            (INCHES)           .361        .902        .902         .902
                             (AC-FT)            36.         91.         91.          91.

   PEAK STORAGE   TIME                                MAXIMUM AVERAGE STORAGE
                                                6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
        73.      6.00                           63.         28.         27.          27.

    PEAK STAGE    TIME                                 MAXIMUM AVERAGE STAGE
                                                6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
     1482.24     6.00                        1481.51     1477.36     1477.16      1477.16

                            CUMULATIVE AREA =    1.89 SQ MI


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

                             HYDROGRAPH AT STATION   DBEWGA
                               FOR PLAN 1, RATIO =  .69

    PEAK FLOW     TIME                                 MAXIMUM AVERAGE FLOW
                                                6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      75.      5.92                           72.         43.         41.          41.
                            (INCHES)           .353        .840        .840         .840
                             (AC-FT)            36.         85.         85.          85.

   PEAK STORAGE   TIME                                MAXIMUM AVERAGE STORAGE
                                                6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
        68.      5.92                           57.         25.         24.          24.

    PEAK STAGE    TIME                                 MAXIMUM AVERAGE STAGE
                                                6-HR       24-HR       72-HR     24.92-HR
 +   (FEET)      (HR)
     1481.84     5.92                        1481.14     1476.93     1476.74      1476.74

                            CUMULATIVE AREA =    1.89 SQ MI


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

                             HYDROGRAPH AT STATION   DBEWGA
                               FOR PLAN 1, RATIO =  .64

    PEAK FLOW     TIME                                 MAXIMUM AVERAGE FLOW
                                                6-HR       24-HR       72-HR     24.92-HR
 +   (CFS)       (HR)
                              (CFS)
 +      72.      5.92                           69.         37.         36.          36.
                            (INCHES)           .338        .727        .727         .727
                             (AC-FT)            34.         73.         73.          73.

   PEAK STORAGE   TIME                                MAXIMUM AVERAGE STORAGE
                                                6-HR       24-HR       72-HR     24.92-HR
 +  (AC-FT)      (HR)
        57.      5.92                           47.         19.         19.          19.

    PEAK STAGE    TIME                                 MAXIMUM AVERAGE STAGE
                                                6-HR       24-HR       72-HR     24.92-HR
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+   (FEET)       (HR)
   1481.14      5.92              1480.43     1476.16     1476.00      1476.00

                         CUMULATIVE AREA =    1.89 SQ MI


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

                          HYDROGRAPH AT STATION   DBEWGA
                            FOR PLAN 1, RATIO =  .58

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+       69.     5.83                       64.         31.         30.          30.
                         (INCHES)         .313        .606        .606         .606
                          (AC-FT)          32.         61.         61.          61.

 PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        47.     5.83                       37.         14.         14.          14.

  PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1480.41      5.83              1479.49     1475.37     1475.24      1475.24

                         CUMULATIVE AREA =    1.89 SQ MI


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

                          HYDROGRAPH AT STATION   DBEWGA
                            FOR PLAN 1, RATIO =  .53

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+       65.     5.83                       58.         26.         25.          25.
                         (INCHES)         .286        .509        .509         .509
                          (AC-FT)          29.         51.         51.          51.

 PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        38.     5.83                       30.         11.         10.          10.

  PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1479.70      5.83              1478.58     1474.75     1474.65      1474.65

                         CUMULATIVE AREA =    1.89 SQ MI


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

                          HYDROGRAPH AT STATION   DBEWGA
                            FOR PLAN 1, RATIO =  .49

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+       60.     5.75                       53.         22.         21.          21.
                         (INCHES)         .263        .434        .434         .434
                          (AC-FT)          27.         44.         44.          44.

 PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        32.     5.75                       25.          9.          8.           8.

  PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1478.85      5.75              1477.84     1474.30     1474.21      1474.21

                         CUMULATIVE AREA =    1.89 SQ MI


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             *            *
  409 KK     *    DBWWWT  *
             *            *
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  414 KO         OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  415 RS         STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC       -1.00  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

  416 SA              AREA         5.0       6.0       7.0       8.0

  417 SE         ELEVATION     1365.00   1370.00   1375.00   1380.00

  418 SQ         DISCHARGE          0.       19.       28.       35.

                                                               ***

                                               COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     27.46     59.93     97.40
          ELEVATION    1365.00   1370.00   1375.00   1380.00

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

                         HYDROGRAPH AT STATION   DBWWWT
                           FOR PLAN 1, RATIO =  .83

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+    (CFS)       (HR)
                          (CFS)
+      28.      6.08                    27.         21.         20.          20.
                        (INCHES)       .279        .869        .869         .869
                         (AC-FT)        13.         41.         41.          41.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       59.      6.17                    55.         38.         36.          36.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1374.90      6.17                1374.26     1371.51     1371.27      1371.27

                        CUMULATIVE AREA =      .89 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWT
                           FOR PLAN 1, RATIO =  .80

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+    (CFS)       (HR)
                          (CFS)
+      27.      6.08                    26.         20.         19.          19.
                        (INCHES)       .270        .838        .838         .838
                         (AC-FT)        13.         40.         40.          40.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       56.      6.08                    52.         35.         34.          34.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1374.43      6.08                1373.80     1371.15     1370.93      1370.93

                        CUMULATIVE AREA =      .89 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWT
                           FOR PLAN 1, RATIO =  .76

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+    (CFS)       (HR)
                          (CFS)
+      26.      6.08                    25.         19.         18.          18.
                        (INCHES)       .258        .792        .792         .792
                         (AC-FT)        12.         38.         38.          38.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       52.      6.08                    48.         32.         31.          31.
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  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1373.78      6.08              1373.18     1370.66     1370.45      1370.45

                         CUMULATIVE AREA =     .89 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWWT
                            FOR PLAN 1, RATIO =  .73

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+       25.     6.08                  24.         18.         17.          17.
                        (INCHES)     .246        .742        .742         .742
                         (AC-FT)      12.         35.         35.          35.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        48.     6.08                  44.         29.         28.          28.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1373.12      6.08              1372.55     1370.16     1369.97      1369.97

                         CUMULATIVE AREA =     .89 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWWT
                            FOR PLAN 1, RATIO =  .69

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+       24.     6.08                  23.         17.         16.          16.
                        (INCHES)     .238        .703        .703         .703
                         (AC-FT)      11.         33.         33.          33.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        45.     6.08                  41.         27.         26.          26.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1372.63      6.08              1372.08     1369.79     1369.61      1369.61

                         CUMULATIVE AREA =     .89 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWWT
                            FOR PLAN 1, RATIO =  .64

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+       22.     6.08                  21.         15.         14.          14.
                        (INCHES)     .222        .628        .628         .628
                         (AC-FT)      11.         30.         30.          30.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        39.     6.08                  36.         23.         22.          22.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1371.76      6.08              1371.25     1369.13     1368.98      1368.98

                         CUMULATIVE AREA =     .89 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWWT
                            FOR PLAN 1, RATIO =  .58

  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
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                         (CFS)
+      20.      6.00                   20.          13.          12.           12.
                       (INCHES)       .205         .541         .541          .541
                        (AC-FT)        10.          26.          26.           26.

  PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                      6-HR        24-HR        72-HR      24.92-HR
+  (AC-FT)      (HR)
       33.      6.00                   30.          19.          18.           18.

    PEAK STAGE   TIME                              MAXIMUM AVERAGE STAGE
                                      6-HR        24-HR        72-HR      24.92-HR
+   (FEET)      (HR)
   1370.83      6.00              1370.36      1368.46      1368.33       1368.33

                       CUMULATIVE AREA =      .89 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWWT
                          FOR PLAN 1, RATIO =  .53

    PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR      24.92-HR
+   (CFS)       (HR)
                         (CFS)
+      19.      6.00                   17.          11.          11.           11.
                       (INCHES)       .183         .466         .466          .466
                        (AC-FT)         9.          22.          22.           22.

  PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                      6-HR        24-HR        72-HR      24.92-HR
+  (AC-FT)      (HR)
       28.      6.00                   25.          16.          16.           16.

    PEAK STAGE   TIME                              MAXIMUM AVERAGE STAGE
                                      6-HR        24-HR        72-HR      24.92-HR
+   (FEET)      (HR)
   1370.10      6.00              1369.61      1367.94      1367.83       1367.83

                       CUMULATIVE AREA =      .89 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWWT
                          FOR PLAN 1, RATIO =  .49

    PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                      6-HR        24-HR        72-HR      24.92-HR
+   (CFS)       (HR)
                         (CFS)
+      17.      6.00                   15.          10.           9.            9.
                       (INCHES)       .159         .405         .405          .405
                        (AC-FT)         8.          19.          19.           19.

  PEAK STORAGE   TIME                             MAXIMUM AVERAGE STORAGE
                                      6-HR        24-HR        72-HR      24.92-HR
+  (AC-FT)      (HR)
       24.      6.00                   22.          14.          14.           14.

    PEAK STAGE   TIME                              MAXIMUM AVERAGE STAGE
                                      6-HR        24-HR        72-HR      24.92-HR
+   (FEET)      (HR)
   1369.45      6.00              1369.02      1367.55      1367.46       1367.46

                       CUMULATIVE AREA =      .89 SQ MI



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             *            *
   433 KK    *    DBWWDA  *
             *            *
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   438 KO         OUTPUT CONTROL VARIABLES
                        IPRNT          3  PRINT CONTROL
                        IPLOT          0  PLOT CONTROL
                        QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

   439 RS         STORAGE ROUTING
                        NSTPS          1  NUMBER OF SUBREACHES
                         ITYP       ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC      -1.00  INITIAL CONDITION
                            X        .00 WORKING R AND D COEFFICIENT

   440 SA             AREA         1.0       4.0       6.0       7.0       8.0
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  441 SE          ELEVATION     1335.00   1337.00   1340.00   1342.00   1345.00

  442 SQ          DISCHARGE          0.       10.       19.       23.       28.

                                                                   ***

                                                    COMPUTED STORAGE-ELEVATION DATA

             STORAGE        .00      4.67     19.57     32.55     55.04
           ELEVATION    1335.00   1337.00   1340.00   1342.00   1345.00

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                         HYDROGRAPH AT STATION   DBWWDA
                           FOR PLAN 1, RATIO =  .83

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+      22.      5.42                     21.         15.         14.          14.
                        (INCHES)        .428       1.240       1.241        1.241
                         (AC-FT)         10.         30.         30.          30.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       28.      5.42                     25.         14.         14.          14.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1341.37      5.42                 1340.86     1338.81     1338.67      1338.67

                        CUMULATIVE AREA =      .45 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWDA
                           FOR PLAN 1, RATIO =  .80

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+      21.      5.42                     20.         14.         14.          14.
                        (INCHES)        .419       1.193       1.194        1.194
                         (AC-FT)         10.         29.         29.          29.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       27.      5.42                     24.         13.         13.          13.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1341.14      5.42                 1340.64     1338.61     1338.48      1338.48

                        CUMULATIVE AREA =      .45 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWDA
                           FOR PLAN 1, RATIO =  .76

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                         (CFS)
+      21.      5.33                     20.         14.         13.          13.
                        (INCHES)        .406       1.124       1.125        1.125
                         (AC-FT)         10.         27.         27.          27.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       25.      5.42                     22.         12.         11.          11.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1340.82      5.42                 1340.33     1338.34     1338.22      1338.22

                        CUMULATIVE AREA =      .45 SQ MI


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                         HYDROGRAPH AT STATION   DBWWDA
                           FOR PLAN 1, RATIO =  .73
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  PEAK FLOW    TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+       20.     5.33                    19.        13.         12.          12.
                          (INCHES)      .389      1.049       1.050        1.050
                           (AC-FT)       9.        25.         25.          25.

 PEAK STORAGE  TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       23.      5.33                    20.        11.         10.          10.

  PEAK STAGE   TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1340.50      5.33                 1340.00     1338.06     1337.95      1337.95

                         CUMULATIVE AREA =     .45 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWDA
                            FOR PLAN 1, RATIO =  .69

  PEAK FLOW    TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+       20.     5.33                    18.        12.         12.          12.
                          (INCHES)      .376       .991        .991         .991
                           (AC-FT)       9.        24.         24.          24.

 PEAK STORAGE  TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       21.      5.33                    18.        10.          9.           9.

  PEAK STAGE   TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1340.27      5.33                 1339.75     1337.85     1337.74      1337.74

                         CUMULATIVE AREA =     .45 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWDA
                            FOR PLAN 1, RATIO =  .64

  PEAK FLOW    TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+       18.     5.33                    17.        11.         10.          10.
                          (INCHES)      .347       .880        .880         .880
                           (AC-FT)       8.        21.         21.          21.

 PEAK STORAGE  TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       19.      5.33                    16.         8.          8.           8.

  PEAK STAGE   TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1339.80      5.33                 1339.27     1337.47     1337.38      1337.38

                         CUMULATIVE AREA =     .45 SQ MI


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

                          HYDROGRAPH AT STATION   DBWWDA
                            FOR PLAN 1, RATIO =  .58

  PEAK FLOW    TIME                             MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+       17.     5.33                    15.         9.          9.           9.
                          (INCHES)      .314       .758        .758         .758
                           (AC-FT)       8.        18.         18.          18.

 PEAK STORAGE  TIME                            MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       16.      5.33                    13.         6.          6.           6.

  PEAK STAGE   TIME                             MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1339.22      5.33                 1338.74     1337.07     1337.00      1337.00
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                    CUMULATIVE AREA =     .45 SQ MI


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

                     HYDROGRAPH AT STATION   DBWWDA
                       FOR PLAN 1, RATIO =  .53

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      15.      5.33                   14.          8.          8.           8.
                        (INCHES)      .288        .655        .655         .655
                         (AC-FT)        7.         16.         16.          16.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       13.      5.33                   11.          5.          5.           5.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1338.75      5.33               1338.31     1336.75     1336.68      1336.68

                    CUMULATIVE AREA =     .45 SQ MI


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

                     HYDROGRAPH AT STATION   DBWWDA
                       FOR PLAN 1, RATIO =  .49

  PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      14.      5.33                   13.          7.          7.           7.
                        (INCHES)      .267        .574        .574         .574
                         (AC-FT)        6.         14.         14.          14.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       12.      5.33                   10.          4.          4.           4.

  PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1338.38      5.33               1337.98     1336.50     1336.45      1336.45

                    CUMULATIVE AREA =     .45 SQ MI



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            *            *
  459 KK    *    DBWWCA  *
            *            *
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  464 KO         OUTPUT CONTROL VARIABLES
                       IPRNT           3  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  465 RS         STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC       -1.00  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

  466 SA              AREA         1.0       3.0       6.0       8.0       9.0      10.0

  467 SE         ELEVATION     1365.00   1370.00   1375.00   1380.00   1385.00   1390.00

  468 SQ         DISCHARGE          0.       50.       76.       95.      111.      125.

                                                                         ***

                                                         COMPUTED STORAGE-ELEVATION DATA

              STORAGE        .00      9.55     31.62     66.50    108.98    156.46
            ELEVATION    1365.00   1370.00   1375.00   1380.00   1385.00   1390.00

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                        HYDROGRAPH AT STATION   DBWWCA
                          FOR PLAN 1, RATIO =  .83

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                             (CFS)
+     108.      6.17                      103.         66.         64.          64.
                           (INCHES)       .504       1.295       1.295        1.295
                            (AC-FT)        51.        131.        131.         131.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       102.     6.17                       88.         40.         38.          38.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
    1384.19     6.17                   1382.48     1374.64     1374.28      1374.28

                         CUMULATIVE AREA =    1.90 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWCA
                          FOR PLAN 1, RATIO =  .80

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                             (CFS)
+     106.      6.08                      101.         63.         61.          61.
                           (INCHES)       .493       1.230       1.230        1.230
                            (AC-FT)        50.        125.        125.         125.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        96.     6.08                       82.         36.         35.          35.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
    1383.50     6.08                   1381.83     1374.03     1373.70      1373.70

                         CUMULATIVE AREA =    1.90 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWCA
                          FOR PLAN 1, RATIO =  .76

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                             (CFS)
+     103.      6.08                       98.         58.         56.          56.
                           (INCHES)       .479       1.139       1.139        1.139
                            (AC-FT)        48.        115.        115.         115.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        88.     6.08                       74.         32.         31.          31.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
    1382.55     6.08                   1380.91     1373.20     1372.90      1372.90

                         CUMULATIVE AREA =    1.90 SQ MI


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

                        HYDROGRAPH AT STATION   DBWWCA
                          FOR PLAN 1, RATIO =  .73

   PEAK FLOW     TIME                             MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                             (CFS)
+     100.      6.08                       94.         53.         51.          51.
                           (INCHES)       .462       1.046       1.046        1.046
                            (AC-FT)        47.        106.        106.         106.

  PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        80.     6.08                       67.         27.         26.          26.

   PEAK STAGE    TIME                             MAXIMUM AVERAGE STAGE
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                                            6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1381.59      6.08                     1379.95     1372.38     1372.10      1372.10

                              CUMULATIVE AREA =    1.90 SQ MI


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

                               HYDROGRAPH AT STATION   DBWWCA
                                 FOR PLAN 1, RATIO =  .69

  PEAK FLOW     TIME                                   MAXIMUM AVERAGE FLOW
                                            6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                (CFS)
+      98.      6.08                          92.         50.         48.          48.
                              (INCHES)      .450        .977        .977         .977
                               (AC-FT)       46.         99.         99.          99.

 PEAK STORAGE   TIME                                  MAXIMUM AVERAGE STORAGE
                                            6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       74.      6.08                          61.         24.         24.          24.

  PEAK STAGE    TIME                                   MAXIMUM AVERAGE STAGE
                                            6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1380.89      6.08                     1379.22     1371.78     1371.53      1371.53

                              CUMULATIVE AREA =    1.90 SQ MI


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

                               HYDROGRAPH AT STATION   DBWWCA
                                 FOR PLAN 1, RATIO =  .64

  PEAK FLOW     TIME                                   MAXIMUM AVERAGE FLOW
                                            6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                (CFS)
+      93.      6.00                          87.         44.         42.          42.
                              (INCHES)      .425        .852        .852         .852
                               (AC-FT)       43.         86.         86.          86.

 PEAK STORAGE   TIME                                  MAXIMUM AVERAGE STORAGE
                                            6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       63.      6.00                          52.         19.         19.          19.

  PEAK STAGE    TIME                                   MAXIMUM AVERAGE STAGE
                                            6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1379.56      6.00                     1377.86     1370.72     1370.51      1370.51

                              CUMULATIVE AREA =    1.90 SQ MI


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

                               HYDROGRAPH AT STATION   DBWWCA
                                 FOR PLAN 1, RATIO =  .58

  PEAK FLOW     TIME                                   MAXIMUM AVERAGE FLOW
                                            6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                (CFS)
+      87.      6.00                          81.         37.         35.          35.
                              (INCHES)      .397        .719        .719         .719
                               (AC-FT)       40.         73.         73.          73.

 PEAK STORAGE   TIME                                  MAXIMUM AVERAGE STORAGE
                                            6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       52.      6.00                          41.         15.         14.          14.

  PEAK STAGE    TIME                                   MAXIMUM AVERAGE STAGE
                                            6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1377.95      6.00                     1376.37     1369.65     1369.48      1369.48

                              CUMULATIVE AREA =    1.90 SQ MI


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

                               HYDROGRAPH AT STATION   DBWWCA
                                 FOR PLAN 1, RATIO =  .53

  PEAK FLOW     TIME                                   MAXIMUM AVERAGE FLOW
                                            6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                (CFS)
+      82.      5.92                          75.         31.         30.          30.
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                    (INCHES)      .369        .612        .612         .612
                     (AC-FT)       37.         62.         62.          62.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      43.       5.92                33.         11.         11.          11.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1376.68      5.92            1375.05     1368.82     1368.68      1368.68

                     CUMULATIVE AREA =    1.90 SQ MI


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

                      HYDROGRAPH AT STATION   DBWWCA
                        FOR PLAN 1, RATIO =  .49

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                      (CFS)
+      79.      5.92                70.         27.         26.          26.
                    (INCHES)      .344        .529        .529         .529
                     (AC-FT)       35.         54.         54.          54.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      37.       5.92                27.          9.          8.           8.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1375.71      5.92            1373.95     1368.21     1368.09      1368.09

                     CUMULATIVE AREA =    1.90 SQ MI



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            *            *
  480 KK    *    DBWWWI  *
            *            *
            **************

  485 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  486 RS         STORAGE ROUTING
                       NSTPS          1  NUMBER OF SUBREACHES
                        ITYP       ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC      -1.00  INITIAL CONDITION
                           X        .00 WORKING R AND D COEFFICIENT

  487 SA              AREA         3.0       4.0       6.0       8.0      10.0

  488 SE         ELEVATION     1325.00   1332.00   1340.00   1347.00   1355.00

  489 SQ         DISCHARGE          0.       61.       95.      117.      137.

                                                                 ***

                                                  COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     24.42     64.15    112.98    184.83
          ELEVATION    1325.00   1332.00   1340.00   1347.00   1355.00

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

                      HYDROGRAPH AT STATION   DBWWWI
                        FOR PLAN 1, RATIO =  .83

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                      (CFS)
+     121.      6.92               116.         75.         72.          72.
                    (INCHES)      .307        .797        .797         .797
                     (AC-FT)       57.        149.        149.         149.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
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      126.      6.92                111.         56.         53.          53.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1348.48      6.92             1346.64     1337.08     1336.63      1336.63

                        CUMULATIVE AREA =    3.50 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .80

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                        (CFS)
+     118.      6.92                112.         71.         68.          68.
                       (INCHES)     .298        .752        .752         .752
                        (AC-FT)      56.        140.        140.         140.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      117.      6.92                103.         50.         48.          48.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1347.48      6.92             1345.53     1336.14     1335.73      1335.73

                        CUMULATIVE AREA =    3.50 SQ MI


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                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .76

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                        (CFS)
+     113.      6.92                107.         65.         62.          62.
                       (INCHES)     .285        .687        .687         .687
                        (AC-FT)      53.        128.        128.         128.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      105.      6.92                 91.         43.         42.          42.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1345.88      6.92             1343.92     1334.87     1334.51      1334.51

                        CUMULATIVE AREA =    3.50 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .73

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                        (CFS)
+     108.      6.83                102.         58.         56.          56.
                       (INCHES)     .271        .621        .621         .621
                        (AC-FT)      51.        116.        116.         116.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       93.      6.83                 80.         37.         35.          35.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1344.16      6.83             1342.29     1333.62     1333.31      1333.31

                        CUMULATIVE AREA =    3.50 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .69

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR     24.92-HR
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+   (CFS)       (HR)
                          (CFS)
+     104.      6.83                   98.         54.         52.          52.
                       (INCHES)      .260        .571        .571         .571
                        (AC-FT)       49.        107.        107.         107.

  PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       84.      6.83                   72.         32.         31.          31.

   PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1342.91      6.83               1341.06     1332.73     1332.45      1332.45

                        CUMULATIVE AREA =    3.50 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .64

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      97.      6.75                   89.         45.         44.          44.
                       (INCHES)      .237        .481        .481         .481
                        (AC-FT)       44.         90.         90.          90.

  PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       69.      6.75                   58.         25.         24.          24.

   PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1340.73      6.75               1338.69     1331.21     1330.98      1330.98

                        CUMULATIVE AREA =    3.50 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .58

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      86.      6.75                   78.         36.         35.          35.
                       (INCHES)      .207        .387        .387         .387
                        (AC-FT)       39.         72.         72.          72.

  PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       54.      6.75                   44.         18.         17.          17.

   PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1337.99      6.75               1336.02     1329.72     1329.55      1329.55

                        CUMULATIVE AREA =    3.50 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .53

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      77.      6.67                   69.         29.         28.          28.
                       (INCHES)      .184        .313        .313         .313
                        (AC-FT)       34.         58.         58.          58.

  PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       43.      6.67                   34.         13.         13.          13.

   PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1335.67      6.67               1333.94     1328.63     1328.50      1328.50

                        CUMULATIVE AREA =    3.50 SQ MI
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      ***             ***             ***             ***             ***

                         HYDROGRAPH AT STATION   DBWWWI
                           FOR PLAN 1, RATIO =  .49

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+      69.      6.67                   61.         24.         23.          23.
                       (INCHES)      .161        .257        .257         .257
                        (AC-FT)       30.         48.         48.          48.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       34.      6.67                   27.         10.         10.          10.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1333.98      6.67                1332.33     1327.88     1327.77      1327.77

                        CUMULATIVE AREA =    3.50 SQ MI



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  499 KK    *    DBWWWA  *
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  504 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

                HYDROGRAPH ROUTING DATA

  505 RS         STORAGE ROUTING
                       NSTPS          1  NUMBER OF SUBREACHES
                        ITYP       ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC      -1.00  INITIAL CONDITION
                           X        .00 WORKING R AND D COEFFICIENT

  506 SA              AREA         2.0      11.0      20.0      26.0      30.0

  507 SE         ELEVATION     1300.00   1303.00   1307.00   1311.00   1315.00

  508 SQ         DISCHARGE          0.       45.       86.      114.      135.

                                                                   ***

                                                      COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     17.69     78.80    170.54    282.44
          ELEVATION    1300.00   1303.00   1307.00   1311.00   1315.00

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

                         HYDROGRAPH AT STATION   DBWWWA
                           FOR PLAN 1, RATIO =  .83

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     109.      6.08                  104.         78.         75.          75.
                       (INCHES)      .368       1.104       1.104        1.104
                        (AC-FT)       52.        155.        155.         155.

 PEAK STORAGE   TIME                           MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      154.      6.08                  139.         80.         77.          77.

  PEAK STAGE    TIME                            MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1310.29      6.08                1309.60     1306.57     1306.33      1306.33

                        CUMULATIVE AREA =    2.63 SQ MI


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                         HYDROGRAPH AT STATION   DBWWWA
                           FOR PLAN 1, RATIO =  .80
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PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 106.	6.08		102.	75.	73.	73.
		(INCHES)	.360	1.065	1.065	1.065
		(AC-FT)	50.	149.	149.	149.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
146.	6.08	130.	74.	72.	72.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1309.92	6.08	1309.25	1306.26	1306.03	1306.03

CUMULATIVE AREA = 2.63 SQ MI

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HYDROGRAPH AT STATION DBWWWA
FOR PLAN 1, RATIO = .76

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 103.	6.08		98.	71.	69.	69.
		(INCHES)	.348	1.010	1.010	1.010
		(AC-FT)	49.	142.	142.	142.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
134.	6.08	119.	66.	64.	64.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1309.41	6.08	1308.76	1305.82	1305.61	1305.61

CUMULATIVE AREA = 2.63 SQ MI

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

HYDROGRAPH AT STATION DBWWWA
FOR PLAN 1, RATIO = .73

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 99.	6.08		95.	67.	65.	65.
		(INCHES)	.336	.950	.950	.950
		(AC-FT)	47.	133.	133.	133.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
122.	6.08	108.	59.	56.	56.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1308.89	6.08	1308.27	1305.37	1305.17	1305.17

CUMULATIVE AREA = 2.63 SQ MI

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

HYDROGRAPH AT STATION DBWWWA
FOR PLAN 1, RATIO = .69

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 97.	6.08		92.	64.	61.	61.
		(INCHES)	.327	.900	.900	.900
		(AC-FT)	46.	126.	126.	126.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
114.	6.08	100.	53.	51.	51.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				

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  1308.51      6.08             1307.91     1305.02     1304.83     1304.83

                      CUMULATIVE AREA =    2.63 SQ MI


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

                       HYDROGRAPH AT STATION   DBWWWA
                         FOR PLAN 1, RATIO =  .64

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+      92.      6.00                       87.         57.         55.          55.
                         (INCHES)         .308        .801        .801         .801
                          (AC-FT)          43.        112.        112.         112.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       98.      6.00                       85.         43.         41.          41.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
  1307.83      6.00             1307.23     1304.36     1304.20     1304.20

                      CUMULATIVE AREA =    2.63 SQ MI


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

                       HYDROGRAPH AT STATION   DBWWWA
                         FOR PLAN 1, RATIO =  .58

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+      87.      5.92                       80.         49.         47.          47.
                         (INCHES)         .282        .687        .687         .687
                          (AC-FT)          40.         96.         96.          96.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       82.      6.00                       70.         34.         32.          32.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
  1307.12      6.00             1306.40     1303.65     1303.51     1303.51

                      CUMULATIVE AREA =    2.63 SQ MI


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

                       HYDROGRAPH AT STATION   DBWWWA
                         FOR PLAN 1, RATIO =  .53

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+      79.      5.92                       72.         42.         40.          40.
                         (INCHES)         .255        .590        .590         .590
                          (AC-FT)          36.         83.         83.          83.

 PEAK STORAGE   TIME                            MAXIMUM AVERAGE STORAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       69.      5.92                       58.         27.         26.          26.

  PEAK STAGE    TIME                              MAXIMUM AVERAGE STAGE
                                          6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
  1306.34      5.92             1305.64     1303.07     1302.96     1302.96

                      CUMULATIVE AREA =    2.63 SQ MI


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

                       HYDROGRAPH AT STATION   DBWWWA
                         FOR PLAN 1, RATIO =  .49

  PEAK FLOW     TIME                              MAXIMUM AVERAGE FLOW
                                          6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                            (CFS)
+      73.      5.92                       66.         36.         35.          35.
                         (INCHES)         .234        .514        .514         .514
                          (AC-FT)          33.         72.         72.          72.
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 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       59.      5.92                   49.         22.         21.          21.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1305.69      5.92               1305.06     1302.63     1302.53      1302.53

                          CUMULATIVE AREA =    2.63 SQ MI


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  518 KK     *    DBWWIA  *
             *            *
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  523 KO          OUTPUT CONTROL VARIABLES
                        IPRNT           3  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  524 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC       -1.00  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  525 SA              AREA         1.0       6.0      11.0      14.0

  526 SE          ELEVATION     1295.00  1300.00  1305.00  1310.00

  527 SQ          DISCHARGE          0.       50.       76.       95.

                                                                 ***

                                                   COMPUTED STORAGE-ELEVATION DATA

             STORAGE        .00     15.75     57.62    119.97
           ELEVATION    1295.00   1300.00   1305.00   1310.00

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

                            HYDROGRAPH AT STATION   DBWWIA
                              FOR PLAN 1, RATIO =  .83

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+       79.     5.67                   74.         42.         41.          41.
                         (INCHES)     .551       1.264       1.265        1.265
                          (AC-FT)      37.         84.         84.          84.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       67.      5.67                   56.         24.         23.          23.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1305.73      5.67               1304.69     1300.01     1299.83      1299.83

                          CUMULATIVE AREA =    1.25 SQ MI


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

                            HYDROGRAPH AT STATION   DBWWIA
                              FOR PLAN 1, RATIO =  .80

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                           (CFS)
+       78.     5.67                   72.         40.         39.          39.
                         (INCHES)     .538       1.200       1.200        1.200
                          (AC-FT)      36.         80.         80.          80.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       63.      5.67                   52.         22.         21.          21.
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  PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1305.42      5.67                    1304.33     1299.71     1299.54      1299.54

                                   CUMULATIVE AREA =    1.25 SQ MI


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                                    HYDROGRAPH AT STATION   DBWWIA
                                      FOR PLAN 1, RATIO =  .76

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                 (CFS)
+       76.     5.67                         70.         37.         36.          36.
                               (INCHES)     .519       1.111       1.111        1.111
                                (AC-FT)      35.         74.         74.          74.

 PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        58.     5.67                         48.         20.         19.          19.

  PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1305.01      5.67                    1303.80     1299.30     1299.14      1299.14

                                   CUMULATIVE AREA =    1.25 SQ MI


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

                                    HYDROGRAPH AT STATION   DBWWIA
                                      FOR PLAN 1, RATIO =  .73

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                 (CFS)
+       73.     5.67                         67.         34.         33.          33.
                               (INCHES)     .497       1.019       1.020        1.020
                                (AC-FT)      33.         68.         68.          68.

 PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        52.     5.67                         43.         17.         17.          17.

  PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1304.38      5.67                    1303.23     1298.88     1298.74      1298.74

                                   CUMULATIVE AREA =    1.25 SQ MI


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

                                    HYDROGRAPH AT STATION   DBWWIA
                                      FOR PLAN 1, RATIO =  .69

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                 (CFS)
+       70.     5.67                         65.         32.         31.          31.
                               (INCHES)     .481        .952        .952         .952
                                (AC-FT)      32.         63.         63.          63.

 PEAK STORAGE   TIME                              MAXIMUM AVERAGE STORAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
        49.     5.67                         39.         15.         15.          15.

  PEAK STAGE    TIME                               MAXIMUM AVERAGE STAGE
                                           6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1303.92      5.67                    1302.81     1298.58     1298.45      1298.45

                                   CUMULATIVE AREA =    1.25 SQ MI


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

                                    HYDROGRAPH AT STATION   DBWWIA
                                      FOR PLAN 1, RATIO =  .64

  PEAK FLOW     TIME                               MAXIMUM AVERAGE FLOW
                                           6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                                 (CFS)
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+      66.      5.58                    61.          28.          27.           27.
                            (INCHES)   .452         .829         .829          .829
                             (AC-FT)    30.          55.          55.           55.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       42.      5.58                    33.          12.          12.           12.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1303.09      5.58                 1302.06     1298.05     1297.94      1297.94

                             CUMULATIVE AREA =    1.25 SQ MI


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

                              HYDROGRAPH AT STATION   DBWWIA
                                FOR PLAN 1, RATIO =  .58

   PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                              (CFS)
+      62.      5.58                    57.          23.          23.           23.
                            (INCHES)   .421         .699         .699          .699
                             (AC-FT)    28.          47.          47.           47.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       34.      5.58                    26.          10.           9.            9.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1302.21      5.58                 1301.27     1297.50     1297.41      1297.41

                             CUMULATIVE AREA =    1.25 SQ MI


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

                              HYDROGRAPH AT STATION   DBWWIA
                                FOR PLAN 1, RATIO =  .53

   PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                              (CFS)
+      58.      5.58                    53.          20.          19.           19.
                            (INCHES)   .391         .594         .594          .594
                             (AC-FT)    26.          40.          40.           40.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       28.      5.58                    21.           7.           7.            7.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1301.51      5.58                 1300.58     1297.08     1297.00      1297.00

                             CUMULATIVE AREA =    1.25 SQ MI


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

                              HYDROGRAPH AT STATION   DBWWIA
                                FOR PLAN 1, RATIO =  .49

   PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                              (CFS)
+      55.      5.50                    48.          17.          17.           17.
                            (INCHES)   .356         .513         .513          .513
                             (AC-FT)    24.          34.          34.           34.

  PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
       24.      5.50                    17.           6.           6.            6.

   PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                        6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1300.98      5.50                 1299.95     1296.76     1296.70      1296.70

                             CUMULATIVE AREA =    1.25 SQ MI
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            *            *
  568 KK    *   DBWWPA   *
            *            *
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  573 KO         OUTPUT CONTROL VARIABLES
                       IPRNT          3  PRINT CONTROL
                       IPLOT          0  PLOT CONTROL
                       QSCAL         0.  HYDROGRAPH PLOT SCALE

               HYDROGRAPH ROUTING DATA

  574 RS         STORAGE ROUTING
                       NSTPS          1  NUMBER OF SUBREACHES
                        ITYP       ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC      -1.00  INITIAL CONDITION
                           X        .00 WORKING R AND D COEFFICIENT

  575 SA              AREA        1.0       12.0       32.0       49.0       56.0

  576 SE         ELEVATION     1290.00    1300.00    1308.00    1315.00    1325.00

  577 SQ         DISCHARGE          0.       144.       202.       242.       289.

                                                                  ***

                                                     COMPUTED STORAGE-ELEVATION DATA

            STORAGE        .00     54.88    224.47    505.86   1030.48
          ELEVATION    1290.00   1300.00   1308.00   1315.00   1325.00

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

                         HYDROGRAPH AT STATION   DBWWPA
                           FOR PLAN 1, RATIO =  .83

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     287.      8.25                   284.        236.        227.         227.
                        (INCHES)       .119        .395        .395         .395
                         (AC-FT)       141.        468.        468.         468.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
     1012.      8.25                   975.        700.        674.         674.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1324.65      8.25                1323.94     1316.79     1315.80      1315.80

                        CUMULATIVE AREA =   22.25 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWPA
                           FOR PLAN 1, RATIO =  .80

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
                                       6-HR       24-HR       72-HR     24.92-HR
+   (CFS)       (HR)
                          (CFS)
+     281.      8.25                   278.        231.        222.         222.
                        (INCHES)       .116        .386        .386         .386
                         (AC-FT)       138.        458.        458.         458.

 PEAK STORAGE   TIME                          MAXIMUM AVERAGE STORAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+  (AC-FT)      (HR)
      945.      8.25                   909.        647.        623.         623.

  PEAK STAGE    TIME                           MAXIMUM AVERAGE STAGE
                                       6-HR       24-HR       72-HR     24.92-HR
+   (FEET)      (HR)
   1323.37      8.25                1322.68     1315.74     1314.80      1314.80

                        CUMULATIVE AREA =   22.25 SQ MI


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                         HYDROGRAPH AT STATION   DBWWPA
                           FOR PLAN 1, RATIO =  .76

  PEAK FLOW     TIME                           MAXIMUM AVERAGE FLOW
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                                            6-HR      24-HR      72-HR    24.92-HR
+   (CFS)        (HR)
                         (CFS)
+     273.       8.25                       270.       224.       215.        215.
                       (INCHES)             .113       .374       .374        .374
                        (AC-FT)             134.       443.       443.        443.

 PEAK STORAGE   TIME                               MAXIMUM AVERAGE STORAGE
                                            6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
      854.       8.25                       819.       576.       554.        554.

  PEAK STAGE    TIME                                MAXIMUM AVERAGE STAGE
                                            6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1321.63       8.25                    1320.96    1314.31    1313.42     1313.42

                        CUMULATIVE AREA =   22.25 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWPA
                           FOR PLAN 1, RATIO =  .73

  PEAK FLOW     TIME                                MAXIMUM AVERAGE FLOW
                                            6-HR      24-HR      72-HR    24.92-HR
+   (CFS)        (HR)
                         (CFS)
+     265.       8.17                       262.       216.       208.        208.
                       (INCHES)             .109       .361       .361        .361
                        (AC-FT)             130.       428.       428.        428.

 PEAK STORAGE   TIME                               MAXIMUM AVERAGE STORAGE
                                            6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
      763.       8.17                       729.       504.       485.        485.

  PEAK STAGE    TIME                                MAXIMUM AVERAGE STAGE
                                            6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1319.89       8.17                    1319.25    1312.85    1312.01     1312.01

                        CUMULATIVE AREA =   22.25 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWPA
                           FOR PLAN 1, RATIO =  .69

  PEAK FLOW     TIME                                MAXIMUM AVERAGE FLOW
                                            6-HR      24-HR      72-HR    24.92-HR
+   (CFS)        (HR)
                         (CFS)
+     259.       8.17                       256.       210.       202.        202.
                       (INCHES)             .107       .351       .351        .351
                        (AC-FT)             127.       416.       416.        416.

 PEAK STORAGE   TIME                               MAXIMUM AVERAGE STORAGE
                                            6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
      696.       8.17                       663.       452.       435.        435.

  PEAK STAGE    TIME                                MAXIMUM AVERAGE STAGE
                                            6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1318.62       8.17                    1317.99    1311.72    1310.92     1310.92

                        CUMULATIVE AREA =   22.25 SQ MI


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

                         HYDROGRAPH AT STATION   DBWWPA
                           FOR PLAN 1, RATIO =  .64

  PEAK FLOW     TIME                                MAXIMUM AVERAGE FLOW
                                            6-HR      24-HR      72-HR    24.92-HR
+   (CFS)        (HR)
                         (CFS)
+     248.       8.08                       246.       198.       191.        191.
                       (INCHES)             .103       .331       .331        .331
                        (AC-FT)             122.       393.       393.        393.

 PEAK STORAGE   TIME                               MAXIMUM AVERAGE STORAGE
                                            6-HR      24-HR      72-HR    24.92-HR
+  (AC-FT)      (HR)
      578.       8.08                       547.       361.       347.        347.

  PEAK STAGE    TIME                                MAXIMUM AVERAGE STAGE
                                            6-HR      24-HR      72-HR    24.92-HR
+   (FEET)      (HR)
   1316.38       8.08                    1315.78    1309.62    1308.90     1308.90
```

CUMULATIVE AREA = 22.25 SQ MI

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

HYDROGRAPH AT STATION DBWWPA
FOR PLAN 1, RATIO = .58

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 235.	8.08		231.	184.	177.	177.
		(INCHES)	.096	.307	.307	.307
		(AC-FT)	115.	364.	364.	364.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
458.	8.08	428.	269.	259.	259.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1313.80	8.08	1313.06	1307.22	1306.59	1306.59

CUMULATIVE AREA = 22.25 SQ MI

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

HYDROGRAPH AT STATION DBWWPA
FOR PLAN 1, RATIO = .53

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 222.	8.00		218.	169.	163.	163.
		(INCHES)	.091	.282	.282	.282
		(AC-FT)	108.	335.	335.	335.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
364.	8.00	336.	198.	191.	191.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1311.47	8.00	1310.78	1304.97	1304.42	1304.42

CUMULATIVE AREA = 22.25 SQ MI

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

HYDROGRAPH AT STATION DBWWPA
FOR PLAN 1, RATIO = .49

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.92-HR
+ (CFS)	(HR)					
		(CFS)				
+ 212.	7.92		208.	155.	150.	150.
		(INCHES)	.087	.260	.260	.260
		(AC-FT)	103.	308.	308.	308.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (AC-FT)	(HR)				
294.	7.92	268.	148.	142.	142.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	24.92-HR
+ (FEET)	(HR)				
1309.74	7.92	1309.08	1303.06	1302.58	1302.58

CUMULATIVE AREA = 22.25 SQ MI

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION								
					RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
					.83	.80	.76	.73	.69	.64	.58	.53	.49
HYDROGRAPH AT													
+	MRIV2	18.37	1	FLOW	4032.	3814.	3513.	3210.	2986.	2583.	2155.	1812.	1549.
				TIME	5.58	5.58	5.58	5.67	5.67	5.67	5.67	5.75	5.75

HYDROGRAPH AT													
+	MRIV1	22.91	1	FLOW	3870.	3644.	3333.	3020.	2788.	2377.	1946.	1604.	1344.
				TIME	6.08	6.08	6.08	6.08	6.08	6.17	6.17	6.17	6.25
2 COMBINED AT													
+	CMRIV1	41.28	1	FLOW	7767.	7328.	6727.	6119.	5671.	4866.	4019.	3346.	2829.
				TIME	5.75	5.75	5.83	5.83	5.83	5.83	5.92	5.92	5.92
ROUTED TO													
+	RCMRIV1	41.28	1	FLOW	7736.	7299.	6695.	6091.	5643.	4841.	3998.	3325.	2810.
				TIME	6.42	6.42	6.42	6.50	6.50	6.58	6.67	6.75	6.75
HYDROGRAPH AT													
+	MRIV3	21.99	1	FLOW	3761.	3540.	3236.	2929.	2703.	2300.	1880.	1546.	1293.
				TIME	6.00	6.00	6.00	6.00	6.00	6.08	6.08	6.08	6.17
2 COMBINED AT													
+	CMRIV3	63.27	1	FLOW	11350.	10691.	9785.	8876.	8203.	7001.	5739.	4738.	3977.
				TIME	6.25	6.25	6.33	6.33	6.33	6.42	6.50	6.50	6.58
ROUTED TO													
+	RCMRIV3	63.27	1	FLOW	11324.	10670.	9766.	8854.	8185.	6983.	5725.	4726.	3965.
				TIME	6.50	6.50	6.50	6.58	6.58	6.67	6.75	6.83	6.92
HYDROGRAPH AT													
+	MRIV4	10.45	1	FLOW	2486.	2361.	2189.	2015.	1885.	1651.	1400.	1197.	1039.
				TIME	5.58	5.58	5.67	5.67	5.67	5.67	5.75	5.75	5.75
HYDROGRAPH AT													
+	MDW	19.44	1	FLOW	4469.	4198.	3826.	3450.	3174.	2687.	2176.	1776.	1510.
				TIME	4.58	4.58	4.58	4.58	4.67	4.67	4.67	5.42	5.42
HYDROGRAPH AT													
+	MRIV5	3.26	1	FLOW	1072.	1014.	934.	853.	793.	684.	569.	476.	405.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
4 COMBINED AT													
+	CMRIV5	96.42	1	FLOW	16463.	15474.	14127.	12765.	11756.	9965.	8089.	6603.	5475.
				TIME	5.92	5.92	6.00	6.00	6.00	6.08	6.17	6.25	6.33
ROUTED TO													
+	RCMRIV5	96.42	1	FLOW	16370.	15394.	14043.	12689.	11688.	9903.	8033.	6555.	5433.
				TIME	6.25	6.25	6.25	6.33	6.33	6.42	6.50	6.67	6.75
HYDROGRAPH AT													
+	MRIV6	2.17	1	FLOW	539.	510.	470.	430.	400.	347.	291.	247.	212.
				TIME	4.92	5.00	5.00	5.00	5.00	5.17	5.25	5.25	5.33
HYDROGRAPH AT													
+	MRIV7	12.41	1	FLOW	3386.	3209.	2965.	2717.	2533.	2201.	1850.	1566.	1348.
				TIME	4.75	4.75	4.75	4.75	4.75	4.75	4.83	4.83	4.92
HYDROGRAPH AT													
+	WSWASH	61.31	1	FLOW	13663.	12952.	11968.	10970.	10229.	8895.	7482.	6339.	5452.
				TIME	5.67	5.67	5.67	5.67	5.67	5.75	5.75	5.75	5.75
4 COMBINED AT													
+	CMRIV7	172.31	1	FLOW	32154.	30295.	27722.	25126.	23212.	19736.	16053.	13080.	10777.
				TIME	5.92	5.92	5.92	6.00	6.00	6.08	6.17	6.25	6.33
ROUTED TO													
+	RCMRIV7	172.31	1	FLOW	31893.	30054.	27498.	24905.	22996.	19544.	15883.	12941.	10685.
				TIME	6.25	6.25	6.25	6.33	6.33	6.42	6.50	6.67	6.75
HYDROGRAPH AT													
+	EWASH8	3.47	1	FLOW	654.	613.	557.	501.	460.	389.	315.	257.	214.
				TIME	5.08	5.08	5.17	5.17	5.25	5.33	5.42	5.50	5.50
HYDROGRAPH AT													
+	AWASH1	4.57	1	FLOW	1535.	1453.	1339.	1224.	1139.	985.	821.	689.	587.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
ROUTED TO													
+	RAWASH1	4.57	1	FLOW	1506.	1425.	1313.	1199.	1115.	963.	802.	672.	573.
				TIME	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.50
HYDROGRAPH AT													
+	AWASH2	1.63	1	FLOW	710.	673.	622.	570.	531.	461.	387.	327.	280.
				TIME	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92
2 COMBINED AT													
+	CAWASH2	6.20	1	FLOW	1976.	1870.	1723.	1575.	1465.	1266.	1055.	885.	755.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.33
ROUTED TO													
+	RCAWASH2	6.20	1	FLOW	1897.	1795.	1655.	1513.	1408.	1219.	1018.	855.	730.
				TIME	4.83	4.83	4.92	4.92	4.92	4.92	4.92	4.92	4.92
HYDROGRAPH AT													
+	AWASH3	5.03	1	FLOW	1573.	1492.	1380.	1266.	1182.	1029.	867.	736.	634.
				TIME	4.42	4.42	4.42	4.42	4.42	4.42	4.50	4.50	4.50
2 COMBINED AT													
+	CAWASH3	11.23	1	FLOW	3330.	3156.	2915.	2671.	2490.	2162.	1815.	1535.	1318.
				TIME	4.75	4.75	4.75	4.75	4.75	4.75	4.83	4.83	4.83

3 COMBINED AT													
+	CMR0	187.01	1	FLOW	34371.	32371.	29591.	26771.	24693.	20935.	16951.	13763.	11406.
				TIME	6.17	6.17	6.17	6.25	6.25	6.33	6.42	6.50	6.25
ROUTED TO													
+	RCMR0	187.01	1	FLOW	34362.	32338.	29562.	26746.	24664.	20903.	16946.	13762.	11405.
				TIME	6.17	6.17	6.25	6.25	6.33	6.42	6.50	6.58	6.33
HYDROGRAPH AT													
+	WWASH6	1.20	1	FLOW	645.	613.	569.	524.	491.	430.	365.	312.	271.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
HYDROGRAPH AT													
+	EWASH7	6.39	1	FLOW	1336.	1234.	1095.	957.	856.	683.	523.	424.	349.
				TIME	4.08	4.08	4.08	4.08	4.08	4.17	5.25	5.25	5.25
ROUTED TO													
+	REWASH7	6.39	1	FLOW	1257.	1162.	1032.	903.	810.	645.	496.	402.	330.
				TIME	4.50	4.58	4.58	4.58	4.58	4.58	5.67	5.67	5.67
HYDROGRAPH AT													
+	EWASH6	.78	1	FLOW	203.	189.	171.	153.	139.	116.	91.	72.	57.
				TIME	4.08	4.08	4.17	4.17	4.17	4.17	4.17	4.17	4.17
2 COMBINED AT													
+	CEWASH6	7.17	1	FLOW	1416.	1309.	1164.	1019.	914.	733.	559.	453.	372.
				TIME	4.50	4.50	4.50	4.50	4.58	4.58	5.58	5.58	5.58
HYDROGRAPH AT													
+	BMN1	3.72	1	FLOW	1205.	1131.	1030.	928.	853.	719.	579.	468.	384.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.08
ROUTED TO													
+	RBMN1	3.72	1	FLOW	1119.	1051.	957.	863.	793.	669.	539.	436.	357.
				TIME	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58	4.58
HYDROGRAPH AT													
+	BMN3	5.12	1	FLOW	1265.	1195.	1097.	999.	926.	796.	659.	552.	471.
				TIME	4.75	4.75	4.75	4.75	4.83	4.83	4.92	5.08	5.17
2 COMBINED AT													
+	CBMN3	8.84	1	FLOW	2367.	2228.	2036.	1843.	1700.	1445.	1181.	970.	809.
				TIME	4.58	4.58	4.58	4.58	4.58	4.67	4.67	4.67	4.67
HYDROGRAPH AT													
+	BMN2	4.08	1	FLOW	1492.	1415.	1307.	1198.	1117.	971.	815.	688.	590.
				TIME	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17
ROUTED TO													
+	RBMN2	4.08	1	FLOW	1384.	1312.	1211.	1110.	1035.	900.	755.	638.	548.
				TIME	4.92	4.92	5.00	5.00	5.00	5.00	5.00	5.00	5.00
HYDROGRAPH AT													
+	BMN4	6.98	1	FLOW	1746.	1653.	1525.	1396.	1300.	1128.	948.	804.	692.
				TIME	5.00	5.00	5.00	5.00	5.08	5.17	5.25	5.25	5.33
2 COMBINED AT													
+	CBMN4	11.06	1	FLOW	3129.	2964.	2737.	2506.	2335.	2026.	1697.	1431.	1226.
				TIME	4.92	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.08
2 COMBINED AT													
+	CBMN34	19.90	1	FLOW	5319.	5027.	4624.	4216.	3914.	3370.	2795.	2339.	1987.
				TIME	4.83	4.83	4.83	4.83	4.83	4.83	4.92	4.92	4.92
ROUTED TO													
+	RCBMN34	19.90	1	FLOW	5274.	4983.	4584.	4181.	3883.	3345.	2776.	2324.	1976.
				TIME	5.00	5.00	5.08	5.08	5.08	5.08	5.08	5.17	5.17
HYDROGRAPH AT													
+	BMN5	1.48	1	FLOW	276.	254.	224.	194.	173.	137.	109.	87.	71.
				TIME	4.08	4.17	4.17	4.17	4.17	5.25	5.25	5.25	5.25
HYDROGRAPH AT													
+	BMN6	2.06	1	FLOW	538.	508.	465.	423.	391.	335.	276.	229.	192.
				TIME	4.50	4.50	4.50	4.50	4.58	4.58	4.58	4.58	4.58
3 COMBINED AT													
+	CBMN56	23.44	1	FLOW	5980.	5649.	5196.	4737.	4398.	3787.	3140.	2628.	2232.
				TIME	5.00	5.08	5.08	5.08	5.08	5.08	5.17	5.17	5.17
ROUTED TO													
+	RCBMN56	23.44	1	FLOW	5969.	5638.	5183.	4727.	4388.	3780.	3135.	2623.	2229.
				TIME	5.08	5.08	5.17	5.17	5.17	5.17	5.17	5.25	5.25
HYDROGRAPH AT													
+	BMN7	.45	1	FLOW	167.	156.	141.	127.	116.	96.	76.	61.	49.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
2 COMBINED AT													
+	CBMN7	23.89	1	FLOW	6074.	5738.	5274.	4804.	4458.	3840.	3186.	2660.	2260.
				TIME	5.08	5.08	5.08	5.08	5.17	5.17	5.17	5.17	5.25
ROUTED TO													
+	DBFGLS	23.89	1	FLOW	269.	263.	254.	245.	238.	224.	208.	194.	183.

				TIME	8.50	8.50	8.50	8.50	8.42	8.42	8.33	8.25	8.25
			** PEAK STAGES IN FEET **										
			1	STAGE	1504.62	1503.28	1501.43	1499.56	1498.16	1495.64	1492.94	1490.76	1489.08
				TIME	8.50	8.50	8.50	8.50	8.42	8.42	8.33	8.25	8.25
ROUTED TO													
+	RDBFGLS	23.89	1	FLOW	269.	263.	254.	245.	238.	224.	208.	194.	183.
				TIME	8.67	8.58	8.58	8.58	8.50	8.50	8.42	8.42	8.33
HYDROGRAPH AT													
+	FGDB1	.39	1	FLOW	110.	101.	90.	79.	71.	56.	42.	33.	27.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.83	5.00	5.00
ROUTED TO													
+	DETBN	.39	1	FLOW	46.	44.	41.	38.	36.	32.	27.	24.	20.
				TIME	5.33	5.33	5.33	5.33	5.33	5.25	5.25	5.25	5.25
			** PEAK STAGES IN FEET **										
			1	STAGE	1418.42	1418.03	1417.48	1416.96	1416.57	1415.92	1415.28	1414.91	1414.51
				TIME	5.33	5.33	5.33	5.33	5.33	5.25	5.25	5.25	5.25
2 COMBINED AT													
+	CFGDB1	24.28	1	FLOW	291.	282.	270.	257.	246.	224.	208.	194.	183.
				TIME	7.17	7.17	6.92	6.75	6.58	6.58	8.42	8.42	8.33
ROUTED TO													
+	RCFGDB1	24.28	1	FLOW	291.	282.	270.	257.	246.	224.	208.	194.	183.
				TIME	7.17	7.17	6.92	6.75	6.58	6.58	8.50	8.42	8.33
HYDROGRAPH AT													
+	FGDB	1.92	1	FLOW	758.	713.	652.	590.	544.	462.	376.	308.	255.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
ROUTED TO													
+	DBFGWS	1.92	1	FLOW	42.	42.	41.	41.	40.	39.	38.	37.	36.
				TIME	6.33	6.33	6.25	6.25	6.25	6.17	6.08	6.00	6.00
			** PEAK STAGES IN FEET **										
			1	STAGE	1490.92	1490.52	1489.97	1489.36	1488.92	1488.05	1487.04	1486.15	1485.40
				TIME	6.33	6.33	6.33	6.25	6.25	6.17	6.17	6.08	6.00
ROUTED TO													
+	RDBFGWS	1.92	1	FLOW	42.	42.	41.	41.	40.	39.	38.	37.	36.
				TIME	6.42	6.42	6.42	6.33	6.33	6.25	6.17	6.17	6.08
HYDROGRAPH AT													
+	FGDB2	.46	1	FLOW	102.	93.	81.	69.	60.	48.	38.	30.	24.
				TIME	3.75	3.75	3.75	3.75	3.75	5.00	5.00	5.00	5.00
2 COMBINED AT													
+	CRDBFGWS	2.38	1	FLOW	137.	128.	115.	103.	96.	86.	75.	66.	59.
				TIME	3.75	3.75	3.75	3.75	5.00	5.00	5.00	5.00	5.00
2 COMBINED AT													
+	CFGDB2	26.66	1	FLOW	344.	333.	317.	301.	288.	266.	245.	231.	219.
				TIME	5.00	5.08	5.08	5.08	5.08	6.25	8.33	8.25	8.17
ROUTED TO													
+	RCFGDB2	26.66	1	FLOW	344.	333.	317.	300.	287.	266.	245.	231.	219.
				TIME	5.08	5.08	5.08	5.08	5.08	6.25	8.42	8.33	8.25
HYDROGRAPH AT													
+	EWASH5	.58	1	FLOW	82.	74.	65.	57.	52.	43.	33.	25.	20.
				TIME	4.25	4.25	5.25	5.25	5.25	5.33	5.33	5.33	5.33
2 COMBINED AT													
+	CEWASH5	27.24	1	FLOW	418.	401.	378.	355.	338.	306.	272.	247.	225.
				TIME	5.08	5.08	5.17	5.17	5.17	5.17	5.17	5.25	5.25
4 COMBINED AT													
+	CMR1	222.62	1	FLOW	35429.	33353.	30446.	27546.	25372.	21499.	17397.	14137.	11839.
				TIME	6.17	6.17	6.17	6.25	6.25	6.33	6.50	6.50	6.17
ROUTED TO													
+	RCMR1	222.62	1	FLOW	35390.	33311.	30407.	27512.	25337.	21463.	17383.	14130.	11832.
				TIME	6.25	6.25	6.25	6.33	6.42	6.42	6.58	6.67	6.33
HYDROGRAPH AT													
+	EWDB	1.89	1	FLOW	848.	802.	739.	675.	628.	542.	451.	378.	321.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
ROUTED TO													
+	DBEWGA	1.89	1	FLOW	83.	81.	79.	77.	75.	72.	69.	65.	60.
				TIME	6.08	6.00	6.00	6.00	5.92	5.92	5.83	5.83	5.75
			** PEAK STAGES IN FEET **										
			1	STAGE	1483.70	1483.31	1482.78	1482.24	1481.84	1481.14	1480.41	1479.70	1478.85
				TIME	6.08	6.00	6.00	6.00	5.92	5.92	5.83	5.83	5.75
ROUTED TO													
+	RDBEWGA	1.89	1	FLOW	83.	81.	79.	77.	75.	72.	69.	65.	60.
				TIME	6.25	6.17	6.17	6.17	6.08	6.08	6.00	6.00	6.00
HYDROGRAPH AT													

Operation	Station	Area	Plan		Ratio 1	Ratio 2	Ratio 3	Ratio 4	Ratio 5	Ratio 6	Ratio 7	Ratio 8	Ratio 9
+	EWASH4	2.03	1	FLOW	449.	416.	371.	326.	293.	235.	177.	143.	118.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.17	5.17	5.25
2 COMBINED AT +	CEWASH4	3.92	1	FLOW	516.	481.	432.	384.	349.	289.	241.	203.	174.
				TIME	4.08	4.08	4.08	4.08	4.08	4.17	5.25	5.25	5.25
HYDROGRAPH AT +	LWASH1	4.03	1	FLOW	888.	824.	738.	651.	588.	478.	367.	293.	244.
				TIME	4.17	4.17	4.17	4.17	4.17	4.25	4.25	5.25	5.25
HYDROGRAPH AT +	LWASH2	.70	1	FLOW	242.	227.	207.	186.	171.	144.	116.	94.	77.
				TIME	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	4.00
2 COMBINED AT +	CLWASH1	4.73	1	FLOW	1098.	1021.	916.	812.	736.	603.	465.	365.	305.
				TIME	4.08	4.08	4.08	4.17	4.17	4.17	4.17	5.25	5.25
ROUTED TO +	RCLWASH1	4.73	1	FLOW	1067.	992.	891.	790.	717.	587.	453.	355.	297.
				TIME	4.33	4.33	4.42	4.42	4.42	4.42	4.42	5.50	5.50
HYDROGRAPH AT +	LWASH3	1.17	1	FLOW	596.	567.	527.	486.	455.	399.	339.	291.	253.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
2 COMBINED AT +	CLWASH3	5.90	1	FLOW	1409.	1317.	1192.	1067.	975.	812.	643.	512.	420.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.17	5.17
ROUTED TO +	RCLWASH3	5.90	1	FLOW	1409.	1317.	1192.	1067.	975.	812.	643.	512.	419.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	5.25
HYDROGRAPH AT +	WWASH5	1.61	1	FLOW	875.	832.	774.	714.	669.	588.	501.	430.	374.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO +	RWWASH5	1.61	1	FLOW	822.	783.	728.	672.	630.	554.	473.	406.	354.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
HYDROGRAPH AT +	LOG1	.41	1	FLOW	132.	123.	112.	100.	92.	77.	61.	49.	40.
				TIME	3.92	3.92	3.92	3.92	3.92	3.92	3.92	4.00	4.00
5 COMBINED AT +	CMR2	234.46	1	FLOW	36112.	33953.	31004.	28003.	25793.	21827.	17642.	14341.	12109.
				TIME	6.17	6.25	6.25	6.33	6.33	6.42	6.50	6.50	6.25
ROUTED TO +	RCMR2	234.46	1	FLOW	35937.	33788.	30839.	27842.	25654.	21708.	17572.	14330.	12056.
				TIME	6.33	6.33	6.42	6.42	6.50	6.58	6.67	6.67	6.50
HYDROGRAPH AT +	EWASH3	1.77	1	FLOW	270.	247.	217.	189.	172.	142.	112.	88.	70.
				TIME	4.33	4.33	4.33	5.33	5.33	5.33	5.33	5.33	5.42
HYDROGRAPH AT +	LOG3	.51	1	FLOW	157.	148.	136.	123.	114.	97.	80.	66.	55.
				TIME	4.17	4.17	4.17	4.17	4.17	4.25	4.25	4.25	4.25
3 COMBINED AT +	CMR3	236.74	1	FLOW	36061.	33904.	30933.	27927.	25724.	21760.	17609.	14360.	12089.
				TIME	6.33	6.33	6.42	6.42	6.50	6.58	6.67	6.67	6.50
ROUTED TO +	RCMR3	236.74	1	FLOW	35969.	33821.	30853.	27856.	25657.	21705.	17576.	14351.	12061.
				TIME	6.42	6.42	6.50	6.50	6.58	6.67	6.75	6.75	6.58
HYDROGRAPH AT +	LOG2	1.62	1	FLOW	541.	510.	468.	425.	393.	336.	276.	228.	192.
				TIME	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.17	4.17
2 COMBINED AT +	CMR4	238.36	1	FLOW	36045.	33893.	30911.	27910.	25700.	21738.	17599.	14371.	12086.
				TIME	6.42	6.42	6.50	6.50	6.58	6.67	6.75	6.75	6.58
ROUTED TO +	RCMR4	238.36	1	FLOW	36018.	33851.	30895.	27894.	25675.	21716.	17597.	14370.	12084.
				TIME	6.42	6.50	6.50	6.58	6.67	6.75	6.83	6.83	6.67
HYDROGRAPH AT +	EWASH2	4.80	1	FLOW	1190.	1118.	1018.	918.	844.	712.	574.	466.	384.
				TIME	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.50	4.50
2 COMBINED AT +	CMR5	243.16	1	FLOW	36407.	34211.	31202.	28147.	25911.	21889.	17720.	14486.	12199.
				TIME	6.42	6.42	6.50	6.58	6.58	6.67	6.83	6.67	6.67
ROUTED TO +	RCMR5	243.16	1	FLOW	36381.	34188.	31177.	28125.	25891.	21871.	17713.	14485.	12192.
				TIME	6.50	6.50	6.58	6.67	6.67	6.75	6.92	6.83	6.75

HYDROGRAPH AT													
+	OVR1	1.88	1	FLOW	668.	630.	578.	525.	486.	416.	342.	284.	239.
				TIME	4.00	4.00	4.00	4.00	4.00	4.00	4.08	4.08	4.08
2 COMBINED AT													
+	CMR6	245.04	1	FLOW	36443.	34247.	31224.	28161.	25924.	21896.	17726.	14499.	12208.
				TIME	6.50	6.50	6.58	6.67	6.67	6.75	6.92	6.83	6.75
ROUTED TO													
+	RCMR6	245.04	1	FLOW	36410.	34212.	31181.	28149.	25899.	21894.	17721.	14498.	12206.
				TIME	6.50	6.58	6.58	6.67	6.75	6.83	6.92	6.83	6.83
HYDROGRAPH AT													
+	WWASH4A	.31	1	FLOW	215.	205.	190.	176.	165.	146.	125.	107.	94.
				TIME	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.67
HYDROGRAPH AT													
+	WWASH4	.58	1	FLOW	323.	308.	286.	264.	248.	218.	186.	159.	139.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
2 COMBINED AT													
+	CWWASH4	.89	1	FLOW	521.	496.	461.	426.	399.	351.	300.	258.	225.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
ROUTED TO													
+	DBWWWT	.89	1	FLOW	28.	27.	26.	25.	24.	22.	20.	19.	17.
				TIME	6.08	6.08	6.08	6.08	6.08	6.08	6.00	6.00	6.00
			** PEAK STAGES IN FEET **										
			1	STAGE	1374.90	1374.43	1373.78	1373.12	1372.63	1371.76	1370.83	1370.10	1369.45
				TIME	6.17	6.08	6.08	6.08	6.08	6.08	6.00	6.00	6.00
ROUTED TO													
+	RCWWASH4	.89	1	FLOW	28.	27.	26.	25.	24.	22.	21.	19.	17.
				TIME	6.33	6.33	6.33	6.33	6.33	6.33	6.25	6.33	6.25
HYDROGRAPH AT													
+	WWASH3A	.49	1	FLOW	297.	282.	263.	243.	227.	200.	171.	147.	128.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
2 COMBINED AT													
+	CWWASH3A	1.38	1	FLOW	305.	290.	269.	248.	232.	204.	174.	149.	129.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
HYDROGRAPH AT													
+	WWASH3	.45	1	FLOW	367.	350.	326.	302.	284.	252.	216.	187.	165.
				TIME	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58	3.58
ROUTED TO													
+	DBWWDA	.45	1	FLOW	22.	21.	21.	20.	20.	18.	17.	15.	14.
				TIME	5.42	5.42	5.33	5.33	5.33	5.33	5.33	5.33	5.33
			** PEAK STAGES IN FEET **										
			1	STAGE	1341.37	1341.14	1340.82	1340.50	1340.27	1339.80	1339.22	1338.75	1338.38
				TIME	5.42	5.42	5.42	5.33	5.33	5.33	5.33	5.33	5.33
2 COMBINED AT													
+	CWWASH3	1.83	1	FLOW	322.	306.	285.	263.	247.	217.	186.	160.	140.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
ROUTED TO													
+	RCWWASH3	1.83	1	FLOW	322.	307.	286.	264.	248.	219.	187.	162.	142.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
HYDROGRAPH AT													
+	WWASH2A	.39	1	FLOW	184.	174.	160.	146.	135.	116.	96.	80.	68.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
2 COMBINED AT													
+	CWWASH2A	2.22	1	FLOW	499.	474.	440.	405.	379.	332.	281.	240.	208.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
HYDROGRAPH AT													
+	WWASH2	1.90	1	FLOW	854.	811.	751.	691.	646.	564.	477.	406.	351.
				TIME	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92
ROUTED TO													
+	DBWWCA	1.90	1	FLOW	108.	106.	103.	100.	98.	93.	87.	82.	79.
				TIME	6.17	6.08	6.08	6.08	6.08	6.00	6.00	5.92	5.92
			** PEAK STAGES IN FEET **										
			1	STAGE	1384.19	1383.50	1382.55	1381.59	1380.89	1379.56	1377.95	1376.68	1375.71
				TIME	6.17	6.08	6.08	6.08	6.08	6.00	6.00	5.92	5.92
ROUTED TO													
+	RDBWWCA	1.90	1	FLOW	108.	106.	103.	100.	98.	93.	87.	82.	79.
				TIME	6.17	6.17	6.17	6.08	6.08	6.08	6.00	6.00	5.92
2 COMBINED AT													
+	CWWASH2	4.12	1	FLOW	573.	547.	509.	471.	443.	392.	337.	293.	257.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
ROUTED TO													
+	RCWWASH2	4.12	1	FLOW	569.	542.	504.	465.	437.	386.	333.	289.	256.
				TIME	3.83	3.83	3.83	3.83	3.83	3.92	3.92	3.92	3.92

HYDROGRAPH AT													
+	WIWASH	3.50	1	FLOW	783.	732.	662.	592.	541.	450.	355.	285.	239.
				TIME	4.42	4.42	4.42	4.42	4.42	4.42	4.42	5.33	5.33
ROUTED TO													
+	DBWWWI	3.50	1	FLOW	121.	118.	113.	108.	104.	97.	86.	77.	69.
				TIME	6.92	6.92	6.92	6.83	6.83	6.75	6.75	6.67	6.67
			** PEAK STAGES IN FEET **										
			1	STAGE	1348.48	1347.48	1345.88	1344.16	1342.91	1340.73	1337.99	1335.67	1333.98
				TIME	6.92	6.92	6.92	6.83	6.83	6.75	6.75	6.67	6.67
2 COMBINED AT													
+	CWIWASH	7.62	1	FLOW	607.	576.	534.	491.	460.	405.	347.	309.	277.
				TIME	3.83	3.83	3.92	3.92	3.92	3.92	3.92	5.17	5.17
ROUTED TO													
+	RCWIWASH	7.62	1	FLOW	608.	577.	534.	491.	461.	405.	346.	309.	275.
				TIME	3.92	3.92	4.00	4.00	4.00	4.00	4.00	5.25	5.25
HYDROGRAPH AT													
+	WWASH1B	2.63	1	FLOW	1314.	1249.	1158.	1066.	997.	872.	739.	630.	545.
				TIME	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83	3.83
ROUTED TO													
+	DBWWWA	2.63	1	FLOW	109.	106.	103.	99.	97.	92.	87.	79.	73.
				TIME	6.08	6.08	6.08	6.08	6.08	6.00	5.92	5.92	5.92
			** PEAK STAGES IN FEET **										
			1	STAGE	1310.29	1309.92	1309.41	1308.89	1308.51	1307.83	1307.12	1306.34	1305.69
				TIME	6.08	6.08	6.08	6.08	6.08	6.00	6.00	5.92	5.92
2 COMBINED AT													
+	CWWASH1B	10.25	1	FLOW	688.	656.	612.	565.	531.	474.	426.	384.	346.
				TIME	4.00	4.00	4.00	4.00	4.00	5.25	5.25	5.25	5.33
ROUTED TO													
+	RCWWAS1B	10.25	1	FLOW	688.	655.	610.	562.	528.	472.	423.	382.	345.
				TIME	4.00	4.00	4.00	4.00	4.00	5.25	5.25	5.33	5.33
HYDROGRAPH AT													
+	WWASH1A	1.25	1	FLOW	684.	650.	602.	554.	518.	453.	383.	326.	282.
				TIME	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75	3.75
ROUTED TO													
+	DBWWIA	1.25	1	FLOW	79.	78.	76.	73.	70.	66.	62.	58.	55.
				TIME	5.67	5.67	5.67	5.67	5.67	5.58	5.58	5.58	5.50
			** PEAK STAGES IN FEET **										
			1	STAGE	1305.73	1305.42	1305.01	1304.38	1303.92	1303.09	1302.21	1301.51	1300.98
				TIME	5.67	5.67	5.67	5.67	5.67	5.58	5.58	5.58	5.50
2 COMBINED AT													
+	CWWASH1A	11.50	1	FLOW	753.	718.	672.	622.	586.	537.	484.	440.	400.
				TIME	4.00	4.00	4.00	4.00	4.00	5.25	5.25	5.33	5.33
ROUTED TO													
+	RCWWAS1A	11.50	1	FLOW	746.	712.	668.	620.	583.	535.	484.	438.	399.
				TIME	4.08	4.08	4.08	4.08	4.08	5.33	5.33	5.33	5.42
HYDROGRAPH AT													
+	OWASHS	11.43	1	FLOW	3072.	2877.	2610.	2341.	2144.	1792.	1430.	1146.	931.
				TIME	4.25	4.25	4.25	4.25	4.25	4.25	4.33	4.33	4.33
HYDROGRAPH AT													
+	OWASHN	5.95	1	FLOW	1662.	1565.	1431.	1297.	1197.	1019.	831.	684.	571.
				TIME	4.33	4.33	4.33	4.33	4.33	4.33	4.42	4.42	4.42
2 COMBINED AT													
+	COWASHS	17.38	1	FLOW	4721.	4429.	4027.	3623.	3331.	2808.	2261.	1828.	1498.
				TIME	4.25	4.25	4.25	4.25	4.33	4.33	4.33	4.33	4.33
ROUTED TO													
+	RCOWASHS	17.38	1	FLOW	4611.	4326.	3935.	3542.	3252.	2738.	2206.	1785.	1464.
				TIME	4.58	4.58	4.58	4.58	4.58	4.67	4.67	4.67	4.67
HYDROGRAPH AT													
+	OWASH1	2.44	1	FLOW	453.	418.	371.	325.	292.	233.	187.	151.	123.
				TIME	4.25	4.25	4.33	4.33	4.33	5.33	5.33	5.33	5.33
2 COMBINED AT													
+	COWASH1	19.82	1	FLOW	5015.	4701.	4271.	3838.	3519.	2952.	2366.	1907.	1559.
				TIME	4.58	4.58	4.58	4.58	4.58	4.58	4.67	4.67	4.67
ROUTED TO													
+	RORIDG	19.82	1	FLOW	4723.	4434.	4040.	3655.	3362.	2821.	2254.	1810.	1517.
				TIME	4.83	4.83	4.83	4.83	4.83	4.83	4.92	4.92	5.67
ROUTED TO													
+	RCOWASH1	19.82	1	FLOW	4675.	4390.	4002.	3620.	3326.	2793.	2233.	1795.	1509.
				TIME	5.08	5.08	5.08	5.08	5.08	5.08	5.17	5.17	5.92
HYDROGRAPH AT													
+	OWASH2	2.43	1	FLOW	830.	782.	716.	648.	599.	510.	418.	345.	288.

				TIME	4.00	4.00	4.00	4.00	4.00	4.08	4.08	4.08	4.08
2 COMBINED AT													
+	CCOWASH2	22.25	1	FLOW	5231.	4919.	4492.	4071.	3748.	3162.	2553.	2069.	1698.
				TIME	5.08	5.08	5.08	5.08	5.08	5.08	5.17	5.17	5.25
ROUTED TO													
+	DBWWPA	22.25	1	FLOW	287.	281.	273.	265.	259.	248.	235.	222.	212.
				TIME	8.25	8.25	8.25	8.17	8.17	8.08	8.08	8.00	7.92
			** PEAK STAGES IN FEET **										
			1	STAGE	1324.65	1323.37	1321.63	1319.89	1318.62	1316.38	1313.80	1311.47	1309.74
				TIME	8.25	8.25	8.25	8.17	8.17	8.08	8.08	8.00	7.92
2 COMBINED AT													
+	COWASH2	33.75	1	FLOW	926.	902.	865.	826.	798.	743.	680.	618.	567.
				TIME	5.33	5.33	5.33	5.33	5.33	5.33	5.42	5.42	5.42
ROUTED TO													
+	RCOWASH2	33.75	1	FLOW	923.	898.	861.	824.	795.	741.	677.	616.	566.
				TIME	5.33	5.33	5.33	5.42	5.42	5.42	5.42	5.42	5.50
HYDROGRAPH AT													
+	OWASH3	.32	1	FLOW	197.	188.	174.	160.	150.	132.	112.	96.	83.
				TIME	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67
2 COMBINED AT													
+	COWASH3	34.07	1	FLOW	992.	949.	897.	855.	824.	766.	697.	632.	578.
				TIME	4.08	4.08	5.33	5.33	5.33	5.33	5.42	5.42	5.50
ROUTED TO													
+	RCOWASH3	34.07	1	FLOW	992.	949.	896.	854.	824.	765.	696.	632.	578.
				TIME	4.17	4.17	5.42	5.42	5.42	5.42	5.50	5.50	5.58
HYDROGRAPH AT													
+	OVR2	.47	1	FLOW	156.	146.	132.	119.	108.	91.	72.	58.	47.
				TIME	3.83	3.83	3.83	3.83	3.83	3.92	3.92	3.92	3.92
2 COMBINED AT													
+	COVR2	34.54	1	FLOW	1121.	1066.	994.	916.	880.	812.	731.	659.	600.
				TIME	4.08	4.17	4.17	5.33	5.33	5.33	5.42	5.42	5.50
2 COMBINED AT													
+	CMR7	279.58	1	FLOW	37188.	34969.	31913.	28851.	26579.	22536.	18315.	15052.	12726.
				TIME	6.50	6.58	6.58	6.67	6.75	6.83	6.92	6.83	6.83
ROUTED TO													
+	RCMR7	279.58	1	FLOW	37174.	34955.	31909.	28837.	26564.	22521.	18312.	15050.	12720.
				TIME	6.58	6.58	6.67	6.75	6.75	6.92	7.00	6.92	6.92
HYDROGRAPH AT													
+	OVR3	.45	1	FLOW	115.	107.	95.	83.	75.	60.	45.	36.	30.
				TIME	3.83	3.83	3.83	3.92	3.92	3.92	3.92	5.08	5.08
2 COMBINED AT													
+	CMR8	280.03	1	FLOW	37178.	34959.	31912.	28839.	26566.	22522.	18313.	15051.	12721.
				TIME	6.58	6.58	6.67	6.75	6.75	6.92	7.00	6.92	6.92
ROUTED TO													
+	RCMR8	280.03	1	FLOW	37163.	34937.	31889.	28824.	26554.	22517.	18304.	15047.	12716.
				TIME	6.58	6.67	6.67	6.75	6.83	6.92	7.00	7.00	6.92
HYDROGRAPH AT													
+	EWASH1	6.33	1	FLOW	1221.	1143.	1037.	932.	856.	723.	586.	480.	401.
				TIME	4.83	4.92	4.92	5.08	5.17	5.25	5.33	5.42	5.50
2 COMBINED AT													
+	CMR9	286.36	1	FLOW	37750.	35476.	32354.	29209.	26886.	22772.	18497.	15223.	12866.
				TIME	6.58	6.58	6.67	6.75	6.75	6.92	7.00	6.92	6.92
ROUTED TO													
+	RCMR9	286.36	1	FLOW	37736.	35454.	32332.	29194.	26883.	22763.	18490.	15223.	12859.
				TIME	6.58	6.67	6.67	6.75	6.83	6.92	7.00	6.92	7.00
HYDROGRAPH AT													
+	MAGW1	5.52	1	FLOW	788.	732.	657.	583.	529.	435.	339.	266.	212.
				TIME	5.33	5.33	5.42	5.42	5.50	5.50	5.58	5.58	5.67
ROUTED TO													
+	RMAGW1	5.52	1	FLOW	782.	726.	652.	577.	523.	429.	334.	261.	208.
				TIME	5.83	5.83	5.92	5.92	6.00	6.00	6.08	6.17	6.17
HYDROGRAPH AT													
+	MAGW2	4.81	1	FLOW	1041.	975.	885.	795.	728.	610.	489.	404.	340.
				TIME	4.58	4.58	4.58	4.58	4.58	4.67	4.67	5.42	5.42
2 COMBINED AT													
+	CMAGW2	10.33	1	FLOW	1688.	1578.	1427.	1277.	1168.	974.	776.	622.	507.
				TIME	5.42	5.42	5.42	5.50	5.50	5.50	5.58	5.58	5.67
2 COMBINED AT													
+	CMR10	296.69	1	FLOW	38760.	36402.	33153.	29885.	27482.	23227.	18847.	15537.	13106.
				TIME	6.58	6.58	6.67	6.75	6.75	6.83	6.92	6.83	6.92
HYDROGRAPH AT													

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+                   BMN8      1.27     1  FLOW         142.     131.     115.     100.      89.      70.      51.      36.      25.
                                          TIME         5.17     5.17     5.17     5.17     5.17     5.17     5.17     5.17     5.17

 HYDROGRAPH AT
+                 BOWMAN       .30     1  FLOW           0.       0.       0.       0.       0.       0.       0.       0.       0.
                                          TIME          .00      .00      .00      .00      .00      .00      .00      .00      .00

  2 COMBINED AT
+                CBOWMAN      1.57     1  FLOW         142.     131.     115.     100.      89.      70.      51.      36.      25.
                                          TIME         5.17     5.17     5.17     5.17     5.17     5.17     5.17     5.17     5.17
1

 *** NORMAL END OF HEC-1 ***
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Appendix A-5

HEC-1 Results

HEC-1 MODELING RESULTS

			SDN3									SDN4				SDN5								
			0	0.5	1	2	3	4	5	6	7	8	9	10	11	12	16	20	30	40	50	100	150	200
Node Name	Tributary Area (mi^2)	Peak Flow (cfs)	0.99	0.975	0.95	0.925	0.915	0.908	0.903	0.895	0.885	0.875	0.865	0.857	0.85	0.832	0.804	0.765	0.725	0.695	0.64	0.58	0.53	0.49
MRIV2	18.37	3814	6057	5913	5675	5438	5343	5277	5230	5155	5061	4667	4581	4512	4453	4032	3814	3513	3210	2986	2583	2155	1812	1549
MRIV1	22.91	3333	5658	5514	5276	5039	4946	4881	4834	4760	4667	4403	4316	4246	4185	3870	3644	3333	3020	2788	2377	1946	1604	1344
CMRIV1	41.28	5671	11470	11189	10722	10258	10074	9945	9853	9706	9523	8904	8734	8597	8479	7767	7328	6727	6119	5671	4866	4019	3346	2829
RCMRIV1	41.28	5643	11425	11146	10682	10220	10036	9907	9815	9668	9485	8866	8695	8559	8442	7736	7299	6695	6091	5643	4841	3998	3325	2810
MRIV3	21.99	3236	5539	5397	5162	4929	4836	4771	4725	4651	4560	4290	4204	4136	4077	3761	3540	3236	2929	2703	2300	1880	1546	1293
CMRIV3	63.27	7001	16814	16391	15693	15003	14728	14536	14399	14181	13908	13024	12769	12565	12387	11350	10691	9785	8876	8203	7001	5739	4738	3977
RCMRIV3	63.27	6983	16780	16361	15667	14975	14699	14507	14370	14150	13876	12997	12741	12537	12358	11324	10670	9766	8854	8185	6983	5725	4726	3965
MRIV4	10.45	2779	3668	3587	3454	3320	3267	3230	3204	3161	3108	2867	2818	2779	2745	2486	2361	2189	2015	1885	1651	1400	1197	1039
MDW	19.44	4198	7584	7389	7067	6746	6619	6530	6467	6365	6239	5526	5414	5324	5246	4469	4198	3826	3450	3174	2687	2176	1776	1510
MRIV5	3.26	1629	1841	1799	1728	1657	1629	1609	1595	1573	1545	1345	1321	1301	1284	1072	1014	934	853	793	684	569	476	405
CMRIV5	96.42	9965	23983	23371	22354	21342	20939	20658	20457	20136	19742	18722	18346	18047	17785	16463	15474	14127	12765	11756	9965	8089	6603	5475
RCMRIV5	96.42	9903	23842	23232	22217	21206	20803	20524	20327	20012	19620	18611	18235	17934	17672	16370	15394	14043	12689	11688	9903	8033	6555	5433
MRIV6	2.17	773	858	838	805	773	760	750	744	734	721	648	636	627	619	539	510	470	430	400	347	291	247	212
MRIV7	12.41	3386	5459	5337	5134	4932	4851	4795	4754	4690	4610	4107	4035	3978	3928	3386	3209	2965	2717	2533	2201	1850	1566	1348
WSWASH	61.31	8895	20270	19806	19036	18269	17963	17749	17597	17353	17049	15757	15476	15252	15057	13663	12952	11968	10970	10229	8895	7482	6339	5452
CMRIV7	172.31	13080	46418	45245	43295	41351	40590	40059	39679	39072	38315	36367	35648	35074	34572	32154	30295	27722	25126	23212	19736	16053	13080	10777
RCMRIV7	172.31	12941	46104	44926	42989	41077	40313	39778	39393	38782	38018	36088	35378	34811	34315	31893	30054	27498	24905	22996	19544	15883	12941	10685
EWASH8	3.47	950	1099	1069	1019	970	950	936	927	911	892	799	781	767	755	654	613	557	501	460	389	315	257	214
AWASH1	4.57	2303	2632	2571	2471	2371	2331	2303	2283	2252	2212	1925	1891	1863	1839	1535	1453	1339	1224	1139	985	821	689	587
RAWASH1	4.57	2237	2554	2495	2399	2302	2263	2237	2217	2187	2148	1876	1842	1815	1791	1506	1425	1313	1199	1115	963	802	672	573
AWASH2	1.63	1187	1263	1235	1187	1140	1122	1108	1099	1084	1066	911	895	882	871	710	673	622	570	531	461	387	327	280
CAWASH2	6.2	2831	3305	3230	3105	2980	2930	2895	2870	2831	2781	2439	2395	2360	2330	1976	1870	1723	1575	1465	1266	1055	885	755
RCAWASH2	6.2	2709	3163	3091	2971	2852	2804	2771	2747	2709	2662	2342	2300	2266	2237	1897	1795	1655	1513	1408	1219	1018	855	730
AWASH3	5.03	2262	2591	2534	2439	2345	2308	2281	2262	2232	2195	1931	1897	1871	1848	1573	1492	1380	1266	1182	1029	867	736	634
CAWASH3	11.23	3896	5452	5330	5127	4924	4843	4787	4746	4682	4602	4075	4003	3946	3896	3330	3156	2915	2671	2490	2162	1815	1535	1318
CMR0	187.01	13763	49436	48159	46060	43987	43158	42579	42158	41495	40667	38757	37987	37371	36832	34371	32371	29591	26771	24693	20935	16951	13763	11406
RCMR0	187.01	13762	49404	48138	46044	43934	43104	42534	42113	41464	40633	38727	37938	37323	36797	34362	32338	29562	26746	24664	20903	16946	13762	11405
WWASH6	1.2	1097	1162	1137	1097	1056	1040	1028	1020	1007	991	829	815	804	795	645	613	569	524	491	430	365	312	271
EWASH7	6.39	2072	2576	2495	2361	2228	2176	2139	2113	2072	2022	1746	1702	1666	1635	1336	1234	1095	957	856	683	523	424	349
REWASH7	6.39	1931	2395	2321	2197	2075	2027	1993	1969	1931	1884	1633	1591	1559	1530	1257	1162	1032	903	810	645	496	402	330
EWASH6	0.78	362	372	362	345	328	322	317	314	308	302	261	255	250	246	203	189	171	153	139	116	91	72	57
CEWASH6	7.17	2097	2655	2573	2439	2306	2254	2217	2191	2149	2097	1822	1776	1740	1708	1416	1309	1164	1019	914	733	559	453	372
BMN1	3.72	1930	2215	2158	2062	1968	1930	1904	1885	1855	1818	1559	1527	1502	1480	1205	1131	1030	928	853	719	579	468	384
RBMN1	3.72	1758	2017	1965	1878	1792	1758	1734	1717	1690	1657	1432	1403	1379	1359	1119	1051	957	863	793	669	539	436	357
BMN3	5.12	1788	2072	2023	1941	1859	1827	1804	1788	1762	1730	1542	1513	1490	1470	1265	1195	1097	999	926	796	659	552	471
CBMN3	8.84	2948	4054	3954	3787	3622	3556	3511	3478	3425	3360	2948	2890	2843	2803	2367	2228	2036	1843	1700	1445	1181	970	809
BMN2	4.08	2258	2571	2514	2418	2323	2285	2258	2239	2209	2171	1881	1848	1821	1798	1492	1415	1307	1198	1117	971	815	688	590
RBMN2	4.08	2055	2339	2287	2200	2113	2079	2055	2038	2010	1976	1724	1694	1670	1649	1384	1312	1211	1110	1035	900	755	638	548
BMN4	6.98	2371	2770	2706	2601	2496	2454	2425	2404	2371	2329	2095	2057	2027	2001	1746	1653	1525	1396	1300	1128	948	804	692
CBMN4	11.06	3646	5092	4977	4786	4596	4520	4467	4430	4369	4294	3814	3746	3693	3646	3129	2964	2737	2506	2335	2026	1697	1431	1226
CBMN34	19.9	5027	8791	8585	8242	7901	7765	7670	7602	7494	7359	6522	6401	6305	6221	5319	5027	4624	4216	3914	3370	2795	2339	1987
RCBMN34	19.9	4983	8678	8475	8137	7802	7668	7574	7508	7401	7268	6449	6331	6236	6153	5274	4983	4584	4181	3883	3345	2776	2324	1976
BMN5	1.48	495	541	524	495	466	455	447	441	432	421	363	353	346	339	276	254	224	194	173	137	109	87	71
BMN6	2.06	808	901	879	843	808	794	784	776	765	751	663	650	640	632	538	508	465	423	391	335	276	229	192
CBMN56	23.44	5196	9734	9503	9120	8739	8587	8480	8405	8284	8133	7265	7130	7022	6927	5980	5649	5196	4737	4398	3787	3140	2628	2232
RCBMN56	23.44	5183	9704	9474	9093	8713	8562	8456	8381	8260	8110	7248	7113	7005	6911	5969	5638	5183	4727	4388	3780	3135	2623	2229
BMN7	0.45	320	320	311	297	283	278	274	271	266	261	218	213	209	206	167	156	141	127	116	96	76	61	49
CBMN7	23.89	5274	9800	9568	9183	8800	8647	8540	8464	8343	8191	7344	7208	7099	7004	6074	5738	5274	4804	4458	3840	3186	2660	2260
DBFGLS	23.89	254	302	299	294	289	287	285	284	283	281	278	276	275	273	269	263	254	245	238	224	208	194	183
RDBFGLS	23.89	254	302	299	294	289	287	285	284	283	281	278	276	275	273	269	263	254	245	238	224	208	194	183
FGDB1	0.39	222	222	215	204	193	188	185	183	179	175	146	142	139	137	110	101	90	79	71	56	42	33	27
DETBN	0.39	58	58	57	55	54	53	53	52	52	51	50	49	48	48	46	44	41	38	36	32	27	24	20
CFGDB1	24.28	270	336	332	326	319	316	314	313	311	308	304	302	300	298	291	282	270	257	246	224	208	194	183

HEC-1 MODELING RESULTS

			SDN3									SDN4				SDN5								
			0	0.5	1	2	3	4	5	6	7	8	9	10	11	12	16	20	30	40	50	100	150	200
Node Name	**Tributary Area (mi^2)**	**Peak Flow (cfs)**	0.99	0.975	0.95	0.925	0.915	0.908	0.903	0.895	0.885	0.875	0.865	0.857	0.85	0.832	0.804	0.765	0.725	0.695	0.64	0.58	0.53	0.49
RCFGDB1	24.28	270	336	332	326	319	316	314	313	311	308	304	302	300	298	291	282	270	257	246	224	208	194	183
FGDB	1.92	1318	1413	1377	1318	1259	1236	1220	1208	1190	1166	992	972	956	943	758	713	652	590	544	462	376	308	255
DBFGWS	1.92	44	45	44	44	43	43	43	43	43	43	43	42	42	42	42	42	41	41	40	39	38	37	36
RDBFGWS	1.92	44	45	44	44	43	43	43	43	43	43	43	42	42	42	42	42	41	41	40	39	38	37	36
FGDB2	0.46	216	216	209	197	185	180	177	174	170	166	139	135	132	129	102	93	81	69	60	48	38	30	24
CRDBFGWS	2.38	221	253	245	233	221	216	212	210	206	201	174	170	166	163	137	128	115	103	96	86	75	66	59
CFGDB2	26.66	317	405	396	381	367	361	358	356	354	351	349	345	342	340	344	333	317	301	288	266	245	231	219
RCFGDB2	26.66	317	401	392	377	364	360	358	356	354	351	348	344	342	340	344	333	317	300	287	266	245	231	219
EWASH5	0.58	158	163	158	148	138	135	132	130	127	124	107	104	102	99	82	74	65	57	52	43	33	25	20
CEWASH5	27.24	378	520	507	486	465	457	451	447	440	432	429	423	419	415	418	401	378	355	338	306	272	247	225
CMR1	222.62	11839	50829	49506	47342	45185	44335	43725	43289	42611	41749	39888	39075	38450	37875	35429	33353	30446	27546	25372	21499	17397	14137	11839
RCMR1	222.62	11832	50786	49465	47292	45146	44289	43688	43249	42567	41707	39844	39042	38404	37842	35390	33311	30407	27512	25337	21463	17383	14130	11832
EWDB	1.89	1447	1542	1507	1447	1388	1364	1348	1336	1317	1294	1100	1080	1064	1050	848	802	739	675	628	542	451	378	321
DBEWGA	1.89	88	90	89	88	87	87	87	86	86	86	85	85	84	84	83	81	79	77	75	72	69	65	60
RDBEWGA	1.89	88	90	89	88	87	87	87	86	86	86	85	85	84	84	83	81	79	77	75	72	69	65	60
EWASH4	2.03	750	864	837	793	750	733	721	712	699	682	588	573	562	552	449	416	371	326	293	235	177	143	118
CEWASH4	3.92	802	935	908	864	820	802	790	781	767	750	656	640	628	618	516	481	432	384	349	289	241	203	174
LWASH1	4.03	1387	1648	1599	1519	1440	1409	1387	1371	1346	1316	1142	1114	1093	1074	888	824	738	651	588	478	367	293	244
LWASH2	0.7	435	447	435	417	398	390	385	381	376	368	314	307	302	298	242	227	207	186	171	144	116	94	77
CLWASH1	4.73	1718	2034	1975	1878	1782	1744	1718	1699	1669	1631	1411	1379	1353	1330	1098	1021	916	812	736	603	465	365	305
RCLWASH1	4.73	1660	1965	1909	1815	1722	1685	1660	1641	1612	1576	1369	1337	1312	1290	1067	992	891	790	717	587	453	355	297
LWASH3	1.17	999	1059	1036	999	963	948	938	930	919	904	768	755	745	736	596	567	527	486	455	399	339	291	253
CLWASH3	5.9	2108	2497	2429	2317	2205	2161	2130	2108	2073	2029	1778	1740	1709	1682	1409	1317	1192	1067	975	812	643	512	420
RCLWASH3	5.9	2100	2488	2421	2308	2198	2153	2123	2100	2066	2022	1772	1734	1703	1677	1409	1317	1192	1067	975	812	643	512	419
WWASH5	1.61	1485	1572	1539	1485	1431	1409	1394	1383	1366	1344	1127	1109	1094	1081	875	832	774	714	669	588	501	430	374
RWWASH5	1.61	1374	1455	1424	1374	1323	1303	1289	1279	1263	1242	1057	1040	1026	1014	822	783	728	672	630	554	473	406	354
LOG1	0.41	246	246	239	228	218	213	211	208	205	201	170	167	164	161	132	123	112	100	92	77	61	49	40
CMR2	234.46	12109	51773	50431	48198	45970	45078	44464	44019	43327	42456	40609	39778	39119	38548	36112	33953	31004	28003	25793	21827	17642	14341	12109
RCMR2	234.46	12056	51604	50255	48011	45814	44937	44325	43869	43170	42295	40442	39621	38963	38389	35937	33788	30839	27842	25654	21708	17572	14330	12056
EWASH3	1.77	474	520	503	474	445	434	426	420	412	401	350	340	332	326	270	247	217	189	172	142	112	88	70
LOG3	0.51	268	274	268	257	246	241	238	236	232	228	198	194	191	189	157	148	136	123	114	97	80	66	55
CMR3	236.74	12089	51797	50442	48191	45965	45086	44472	44014	43313	42435	40578	39755	39094	38519	36061	33904	30933	27927	25724	21760	17609	14360	12089
RCMR3	236.74	12061	51699	50354	48118	45887	44997	44388	43933	43237	42366	40486	39667	39010	38439	35969	33821	30853	27856	25657	21705	17576	14351	12061
LOG2	1.62	893	954	931	893	855	840	830	822	810	795	686	673	662	653	541	510	468	425	393	336	276	228	192
CMR4	238.36	12086	51811	50464	48224	45989	45097	44476	44020	43323	42450	40569	39749	39091	38518	36045	33893	30911	27910	25700	21738	17599	14371	12086
RCMR4	238.36	12084	51795	50436	48188	45972	45083	44467	43999	43298	42423	40551	39729	39065	38482	36018	33851	30895	27894	25675	21716	17597	14370	12084
EWASH2	4.8	1766	2052	2000	1912	1825	1790	1766	1749	1721	1687	1485	1454	1430	1409	1190	1118	1018	918	844	712	574	466	384
CMR5	243.16	12199	52388	51016	48730	46458	45559	44935	44463	43755	42872	40983	40153	39483	38889	36407	34211	31202	28147	25911	21889	17720	14486	12199
RCMR5	243.16	12192	52362	50980	48710	46444	45543	44910	44432	43727	42844	40955	40124	39454	38869	36381	34188	31177	28125	25891	21871	17713	14485	12192
OVR1	1.88	1115	1191	1162	1115	1068	1049	1036	1027	1012	993	851	835	822	811	668	630	578	525	486	416	342	284	239
CMR6	245.04	12208	52471	51080	48799	46531	45628	44994	44514	43798	42914	41027	40191	39521	38935	36443	34247	31224	28161	25924	21896	17726	14499	12208
RCMR6	245.04	12206	52442	51061	48772	46498	45597	44982	44495	43792	42895	41014	40176	39487	38903	36410	34212	31181	28149	25899	21894	17721	14498	12206
WWASH4A	0.31	395	395	387	374	360	355	351	349	344	339	281	277	273	270	215	205	190	176	165	146	125	107	94
WWASH4	0.58	567	579	567	547	528	520	514	510	504	496	415	408	403	398	323	308	286	264	248	218	186	159	139
CWWASH4	0.89	909	928	909	877	845	833	824	817	807	794	661	651	642	635	521	496	461	426	399	351	300	258	225
DBWWWT	0.89	31	31	31	30	30	30	30	29	29	29	29	29	28	28	28	27	26	25	24	22	20	19	17
RCWWASH4	0.89	31	31	31	30	30	30	30	29	29	29	29	29	28	28	28	27	26	25	24	22	21	19	17
WWASH3A	0.49	539	539	528	510	491	484	479	475	469	462	384	378	373	369	297	282	263	243	227	200	171	147	128
CWWASH3A	1.38	516	547	535	516	497	490	485	481	475	467	393	386	381	377	305	290	269	248	232	204	174	149	129
WWASH3	0.45	674	674	660	638	615	606	600	595	588	579	483	476	470	464	367	350	326	302	284	252	216	187	165
DBWWDA	0.45	24	24	24	24	23	23	23	23	23	23	23	22	22	22	22	21	21	20	20	18	17	15	14
CWWASH3	1.83	536	567	556	536	517	510	504	500	494	486	411	405	400	395	322	306	285	263	247	217	186	160	140
RCWWASH3	1.83	536	567	556	536	517	509	504	500	494	486	413	406	401	396	322	307	286	264	248	219	187	162	142

HEC-1 MODELING RESULTS

			SDN3									SDN4				SDN5							
			0	0.5	1	2	3	4	5	6	7	8	9	10	11	12	16	20	30	40	50	100	150	200
Node Name	Tributary Area (mi^2)	Peak Flow (cfs)	0.99	0.975	0.95	0.925	0.915	0.908	0.903	0.895	0.885	0.875	0.865	0.857	0.85	0.832	0.804	0.765	0.725	0.695	0.64	0.58	0.53	0.49
WWASH2A	0.39	338	338	331	317	304	299	296	293	289	284	238	233	230	227	184	174	160	146	135	116	96	80	68
CWWASH2A	2.22	821	906	886	854	821	809	799	793	783	770	649	638	629	622	499	474	440	405	379	332	281	240	208
WWASH2	1.9	1417	1503	1471	1417	1364	1342	1327	1317	1300	1278	1086	1067	1053	1040	854	811	751	691	646	564	477	406	351
DBWWCA	1.9	118	121	120	118	116	116	115	115	114	114	112	112	111	111	108	106	103	100	98	93	87	82	79
RDBWWCA	1.9	118	121	120	118	116	116	115	115	114	114	112	112	111	111	108	106	103	100	98	93	87	82	79
CWWASH2	4.12	873	983	963	929	896	882	873	866	855	842	723	712	703	695	573	547	509	471	443	392	337	293	257
RCWWASH2	4.12	855	962	945	912	879	866	855	850	841	826	711	698	688	681	569	542	504	465	437	386	333	289	256
WIWASH	3.5	1196	1383	1345	1282	1220	1196	1178	1166	1147	1122	985	964	947	932	783	732	662	592	541	450	355	285	239
DBWWWI	3.5	129	137	135	133	130	129	129	128	127	126	125	124	123	123	121	118	113	108	104	97	86	77	69
CWIWASH	7.62	863	1011	993	957	921	907	895	889	879	863	752	738	729	721	607	576	534	491	460	405	347	309	277
RCWIWASH	7.62	856	990	976	938	913	894	879	871	863	856	749	735	727	719	608	577	534	491	461	405	346	309	275
WWASH1B	2.63	2140	2361	2310	2225	2140	2107	2083	2066	2039	2005	1701	1673	1650	1630	1314	1249	1158	1066	997	872	739	630	545
DBWWWA	2.63	117	121	120	119	117	117	116	116	115	115	114	113	112	111	109	106	103	99	97	92	87	79	73
CWWASH1B	10.25	814	1084	1070	1030	1004	984	968	961	952	945	837	822	814	806	688	656	612	565	531	474	426	384	346
RCWWAS1B	10.25	811	1081	1068	1025	1001	979	964	955	946	941	835	821	811	803	688	655	610	562	528	472	423	382	345
WWASH1A	1.25	1184	1257	1230	1184	1139	1121	1108	1099	1085	1067	897	882	870	859	684	650	602	554	518	453	383	326	282
DBWWIA	1.25	85	87	86	85	84	83	83	83	82	82	81	81	80	80	79	78	76	73	70	66	62	58	55
CWWASH1A	11.5	870	1157	1143	1099	1073	1051	1035	1026	1016	1011	903	888	878	870	753	718	672	622	586	537	484	440	400
RCWWAS1A	11.5	862	1144	1129	1089	1058	1042	1028	1016	1006	1000	896	879	869	862	746	712	668	620	583	535	484	438	399
OWASHS	11.43	3675	5442	5296	5055	4817	4723	4657	4611	4536	4443	3880	3798	3732	3675	3072	2877	2610	2341	2144	1792	1430	1146	931
OWASHN	5.95	2444	2848	2777	2660	2545	2499	2467	2444	2407	2362	2072	2031	1999	1971	1662	1565	1431	1297	1197	1019	831	684	571
COWASHS	17.38	4429	8282	8068	7713	7360	7220	7122	7052	6940	6801	5937	5815	5718	5633	4721	4429	4027	3623	3331	2808	2261	1828	1498
RCOWASHS	17.38	4326	8034	7827	7483	7142	7006	6911	6843	6736	6601	5772	5652	5558	5475	4611	4326	3935	3542	3252	2738	2206	1785	1464
OWASH1	2.44	735	848	822	778	735	718	707	698	685	668	582	567	556	546	453	418	371	325	292	233	187	151	123
COWASH1	19.82	4701	8762	8530	8147	7766	7614	7509	7433	7313	7163	6290	6158	6053	5961	5015	4701	4271	3838	3519	2952	2366	1907	1559
RORIDG	19.82	4434	8106	7895	7546	7196	7057	6960	6891	6780	6642	5868	5747	5650	5565	4723	4434	4040	3655	3362	2821	2254	1810	1517
RCOWASH1	19.82	4390	8003	7795	7450	7106	6969	6874	6806	6697	6561	5801	5681	5586	5503	4675	4390	4002	3620	3326	2793	2233	1795	1509
OWASH2	2.43	1333	1490	1454	1393	1333	1309	1293	1281	1262	1238	1061	1041	1024	1010	830	782	716	648	599	510	418	345	288
CCOWASH2	22.25	4492	8634	8413	8046	7679	7533	7432	7359	7243	7099	6366	6237	6134	6044	5231	4919	4492	4071	3748	3162	2553	2069	1698
DBWWPA	22.25	273	324	320	314	309	306	305	304	302	300	297	295	293	292	287	281	273	265	259	248	235	222	212
COWASH2	33.75	826	1297	1281	1239	1207	1190	1175	1162	1153	1146	1046	1028	1017	1010	926	902	865	826	798	743	680	618	567
RCOWASH2	33.75	824	1292	1271	1227	1201	1174	1161	1151	1140	1131	1037	1021	1009	999	923	898	861	824	795	741	677	616	566
OWASH3	0.32	356	356	348	335	323	318	314	312	308	302	256	252	248	246	197	188	174	160	150	132	112	96	83
COWASH3	34.07	855	1462	1438	1388	1356	1327	1308	1297	1283	1272	1163	1144	1131	1120	992	949	897	855	824	766	697	632	578
RCOWASH3	34.07	854	1442	1419	1373	1337	1322	1296	1282	1267	1258	1155	1131	1117	1108	992	949	896	854	824	765	696	632	578
OVR2	0.47	297	297	289	275	262	257	254	251	247	242	205	200	197	194	156	146	132	119	108	91	72	58	47
COVR2	34.54	916	1706	1676	1604	1556	1532	1499	1483	1465	1452	1319	1292	1275	1263	1121	1066	994	916	880	812	731	659	600
CMR7	279.58	12726	53319	51929	49627	47333	46426	45807	45317	44610	43707	41819	40975	40282	39693	37188	34969	31913	28851	26579	22536	18315	15052	12726
RCMR7	279.58	12720	53306	51910	49604	47330	46421	45795	45302	44588	43686	41797	40947	40262	39688	37174	34955	31909	28837	26564	22521	18312	15050	12720
OVR3	0.45	231	231	224	212	200	196	193	190	187	182	154	150	147	145	115	107	95	83	75	60	45	36	30
CMR8	280.03	12721	53316	51919	49612	47337	46428	45803	45309	44595	43693	41803	40952	40267	39693	37178	34959	31912	28839	26566	22522	18313	15051	12721
RCMR8	280.03	12716	53285	51898	49607	47318	46404	45773	45292	44580	43686	41792	40947	40259	39676	37163	34937	31889	28824	26554	22517	18304	15047	12716
EWASH1	6.33	1715	2067	2010	1917	1825	1788	1762	1744	1715	1678	1499	1467	1441	1419	1221	1143	1037	932	856	723	586	480	401
CMR9	286.36	12866	54239	52814	50444	48109	47181	46541	46038	45305	44388	42470	41595	40891	40299	37750	35476	32354	29209	26886	22772	18497	15223	12866
RCMR9	286.36	12859	54217	52784	50435	48099	47169	46522	46019	45286	44374	42452	41587	40886	40284	37736	35454	32332	29194	26883	22763	18490	15223	12859
MAGW1	5.52	1093	1331	1289	1220	1152	1125	1106	1093	1072	1046	945	922	903	887	788	732	657	583	529	435	339	266	212
RMAGW1	5.52	1077	1309	1268	1201	1134	1108	1090	1077	1056	1030	935	912	894	878	782	726	652	577	523	429	334	261	208
MAGW2	4.81	1533	1791	1743	1664	1586	1555	1533	1518	1493	1462	1294	1266	1244	1225	1041	975	885	795	728	610	489	404	340
CMAGW2	10.33	1893	2703	2625	2497	2370	2320	2285	2260	2220	2171	1974	1929	1893	1862	1688	1578	1427	1277	1168	974	776	622	507
CMR10	296.69	13106	55880	54391	51942	49514	48551	47878	47354	46590	45639	43645	42738	42016	41377	38760	36402	33153	29885	27482	23227	18847	15537	13106
BMN8	1.27	267	301	288	267	246	238	232	228	222	214	181	174	169	164	142	131	115	100	89	70	51	36	25
BOWMAN	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CBOWMAN	1.57	267	301	288	267	246	238	232	228	222	214	181	174	169	164	142	131	115	100	89	70	51	36	25

Appendix B

Hydraulic Analysis and Facility Sizing

- Appendix B-1: Facility Sizing Spreadsheets
- Appendix B-2: Detention Basin Stage-Area-Discharge Tables

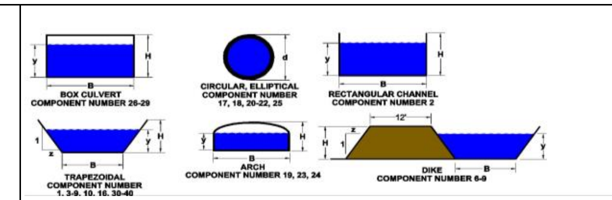
Appendix B-1

Facility Sizing Spreadsheets

MUDDY RIVER MPU Facility Sizing Tool - Version a

Input data in yellow columns. You may cut and paste any data.

Normal Depth:
To calculate the proposed facility height (H or d) required to convey the HEC-1 flow, press <control d> or highlight a cell in the correct line and pick the "Calculate Height" button. Not required for existing facilities.
28
p



ID	MILE	Facility Description	Status	Recommended Status	HEC-1 Q (cfs)	Spillway Q (cfs)	Capacity Q (cfs)	Facility Length L (ft)	HEC-1 Model	HEC-1 Node	Tributary Area (Mi^2)	Manning's Roughness n	Channel Slope S (ft/ft)	Component Number	Facility Component	Side Slope z	Width B (ft)	# of Pipes or Boxes in Parallel N	Flow Depth/Full Pipe Diameter y (ft)	Flow Velocity/ Full Pipe Velocity u (ft/s)	Froude # Fr	Minimum Freeboard Required Fb (ft)	Channel Depth/ Pipe Diameter H or d (ft)	Channel ROW (ft)	GIS Code	Comment	Storage Volume	Bridge Span
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)		
EWGA	0000	10'X5' RCB	P1		802			3155	MRMPU3	CEWASH4	3.92	0.015	0.012	26	RCB Stormdrain	0.0	10	1	4.2	18.88797764		0	5		19	NORMAL DEPTH		
EWGA	0060	48" RCP	P1		88			7035	MRMPU3	DBEWGA	1.89	0.013	0.012	17	RCP Stormdrain Circular	0.0	0	1	3.2	10.82848425		0	4		20	NORMAL DEPTH		
EWGA	0194	30" RCP OUTLET PIPE	P1		88			70	MRMPU3	DBEWGA	1.89	0.013	0.005	17	RCP Stormdrain Circular	0.0	0	1							20	ORIFICE EQUATION		
EWGA	0195	14,470 CFS SPILLWAY	P1		14470	14470			MRMPU3	EWDB	1.89	0	0.000	15	Spillway	0.0	0								10	PMF SPILLWAY		
EWGA	0196	157 ACRE-FEET DETENTION BASIN	P1		1447				MRMPU3	EWDB	1.89	0	0.000	11	Detention Basin										34	DETENTION BASIN	157	
FGLS	0000	72" RCP	P1		270			2625	MRMPU5	CFGDB1	24.28	0.013	0.009	17	RCP Stormdrain Circular	0.0	0	1	5.2	12.86577389		0	6		20	NORMAL DEPTH		
FGLS	0050	72" RCP	P1		254			6070	MRMPU5	DBFGLS	23.89	0.013	0.007	17	RCP Stormdrain Circular	0.0	0	1	5.3	11.53119935		0	6		20	NORMAL DEPTH		
FGLS	0165	42" RCP OUTLET PIPE	P1		254			70	MRMPU5	DBFGLS	23.89	0.013	0.005	17	RCP Stormdrain Circular	0.0	0	1	p						20	ORIFICE EQUATION		
FGLS	0166	52,740 CFS SPILLWAY	P1		52740	52740			MRMPU5	CBMN7	23.89	0	0.000	15	Spillway	0.0	0								10	PMF SPILLWAY		
FGLS	0167	1,247 ACRE-FEET DETENTION BASIN	P1		5274				MRMPU5	CBMN7	23.89	0	0.000	11	Detention Basin										34	DETENTION BASIN	1247	
FGWS	0000	7'X5' RCB	P2		378			3975	MRMPU5	CEWASH5	27.24	0.015	0.010	26	RCB Stormdrain	0.0	7	1	3.7	14.63763635		0	5		19	NORMAL DEPTH		
FGWS	0075	54" RCP^	P2		221			1580	MRMPU3	CRDBFGWS	2.38	0.013	0.014	17	RCP Stormdrain Circular	0.0	0	1	4.4	14.44274914		0	5		20	NORMAL DEPTH		
FGWS	0105	48" RCP^	P2		44			1200	MRMPU3	DBFGWS	1.92	0.013	0.018	17	RCP Stormdrain Circular	0.0	0	1	2.3	10.60093727		0	3		20	NORMAL DEPTH		
FGWS	0128	36" RCP	P2		44			2645	MRMPU3	DBFGWS	1.92	0.013	0.010	17	RCP Stormdrain Circular	0.0	0	1	2.6	8.503894223		0	3		20	NORMAL DEPTH		
FGWS	0164	18" RCP OUTLET PIPE	P2		44			70	MRMPU3	DBFGWS	1.92	0.013	0.005	17	RCP Stormdrain Circular	0.0	0	1							20	ORIFICE EQUATION		
FGWS	0165	16,000 CFS SPILLWAY^	P2		13180	16000			MRMPU3	FGDB	1.92	0	0.000	15	Spillway	0.0	0								10	PMF SPILLWAY		
FGWS	0166	139 ACRE-FEET DETENTION BASIN^	P2		1318				MRMPU3	FGDB	1.92	0	0.000	11	Detention Basin										34	DETENTION BASIN	147	

* The HEC-1 node shown identifies the controlling concentration point for the associated facility and is located upstream of this facility due to decreasing peak flow with increasing tributary area caused by storm distribution transitions, depth area reduction factors, or attenuation of flow from routing.

MUDDY RIVER MPU Facility Sizing Tool - Version a

Input data in yellow columns. You may cut and paste any data.

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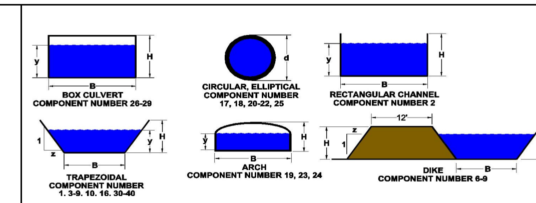

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

ID	MILE	Facility Description	Status	Recommended Status	HEC-1 Q (cfs)	Spillway Q (cfs)	Capacity Q (cfs)	Facility Length L (ft)	HEC-1 Model	HEC-1 Node	Tributary Area (Mi^2)	Manning's Roughness n	Channel Slope S (ft/ft)	Component Number	Facility Component	Side Slope z	Width B (ft)	# of Pipes or Boxes in Parallel N	Flow Depth/Full Pipe Diameter y (ft)	Flow Velocity/ Full Pipe Velocity u (ft/s)	Froude # Fr	Minimum Freeboard Required Fb (ft)	Channel Depth/ Pipe Diameter H or d (ft)	Channel ROW (ft)	GIS Code	Comment	Storage Volume	Bridge Span
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)		
GASD	0000	20' X 8' TRANSITION CHNL	E2		2108		3029.77834	220	MRMPU3	CLWASH3	5.9	0.015	0.005	1	Concrete Channel Trapezoidal	0	20						8		3	NORMAL DEPTH		
GASD	0005	2: 10' RCP	E2		2108		2338.69365	1400	MRMPU3	CLWASH3	5.9	0.013	0.005	17	RCP Stormdrain Circular	0	0	2					10		20	NORMAL DEPTH		
GASD	0030	2: 10'X8' RCB	E2		2108		3516.85909	1600	MRMPU3	CLWASH3	5.9	0.015	0.011	26	RCB Stormdrain	0	10	2					8		19	NORMAL DEPTH		
GASD	0058	GANN AVENUE DEBRIS BASIN	E2		2108				MRMPU3	CLWASH3	5.9			14	Debris Basin										35	DEBRIS BASIN		
MRLL	0001	CONCRETE DIKE	P3		21400			675	NA	NA	NA	0.033	0.009	7	Concrete Dike	2	150		8.1	15.94484547		3	26		11	NORMAL DEPTH		
MRLL	0013	CONCRETE DIKE	P3		21400			1325	NA	NA	NA	0.033	0.012	7	Concrete Dike	2	150		7.4	17.49294383		3	25		11	NORMAL DEPTH		
MRLL	0038	CONCRETE DIKE	P3		21400			925	NA	NA	NA	0.031	0.017	7	Concrete Dike	2	150		6.5	20.35583257		3	24.5		11	NORMAL DEPTH		
MRLV	0142	EARTHEN LEVEE	P1		21400			2230	NA	NA	NA	0.0275	0.003	16	Unlined Levee	3	1500		2.6	5.528491691	0.60959	1	4	1545	13	NORMAL DEPTH		
MRLV	0184	STABILIZED EARTHEN CHNL W/ RIPRAP-LINED BANK 600'W 6.5'D 3:1 SS	P1		21400			750	NA	NA	NA	0.025	0.002	31	Earth Channel	3	600		4.7	7.365601035	0.60366	1.34242358	6.5	660	2	NORMAL DEPTH		
MRLV	0198	STABILIZED EARTHEN CHNL W/ RIPRAP-LINED BANK 600'W 6.5'D 3:1 SS	P2		21400			2872	NA	NA	NA	0.025	0.002	31	Earth Channel	3	600		4.7	7.365601035	0.60366	1.34242358	6.5	660	2	NORMAL DEPTH		
MRLV	0240	STABILIZED EARTHEN CHNL W/ RIPRAP-LINED BANK 600'W 6.5'D 3:1 SS	P2		21400			376	NA	NA	NA	0.025	0.002	31	Earth Channel	3	600		4.7	7.365601035	0.60366	1.34242358	6.5	660	2	NORMAL DEPTH		
MRLV	0268	STABILIZED EARTHEN CHNL W/ RIPRAP-LINED BANK 400'W 8'D 3:1 SS	P2		21400			450	NA	NA	NA	0.025	0.003	31	Earth Channel	3	400		5.3	9.657787382	0.75146	1.94833629	7.5	466	2	NORMAL DEPTH		
MRLV	0276	STABILIZED EARTHEN CHNL W/ RIPRAP-LINED BANK 400'W 8'D 3:1 SS	P2		21400			3005	NA	NA	NA	0.025	0.003	31	Earth Channel	3	400		5.3	9.657787382	0.75146	1.94833629	7.5	466	2	NORMAL DEPTH		
MRLV	0343	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 9.5'D 3:1 SS	E1		21400		29079.091	600	NA	NA	NA	0.025	0.003	31	Earth Channel	3	200						9.5		2	NORMAL DEPTH		
MRLV	0350	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 11'D 3:1 SS	E1		21400		43242.2866	630	NA	NA	NA	0.025	0.004	31	Earth Channel	3	200						11		2	NORMAL DEPTH		
MRLV	0357	CONC CHNL 200'W 11'D 2:1 SS	E1		21400		70066.2989	818	NA	NA	NA	0.015	0.004	1	Concrete Channel Trapezoidal	2	200						11		3	NORMAL DEPTH		
MRLV	0375	COOPER STREET BRIDGE	E1		21400			290	NA	NA	NA	0.015	0.004	10	Bridge													
MRLV	0377	CONC CHNL 180'W 13.6'D 2.5:1 SS	E1		21400		92866.5168	375	NA	NA	NA	0.015	0.004	1	Concrete Channel Trapezoidal	2.5	180						13.6		3	NORMAL DEPTH		
MRLV	0388	GABION CHNL 200'W 11.5'D 3:1 SS	E1		21400		33024.5673	386	NA	NA	NA	0.025	0.002	4	Gabion Channel	3	200						11.5		5	NORMAL DEPTH		
MRLV	0395	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 11.5'D 3:1 SS	P2		21400			673	NA	NA	NA	0.025	0.002	31	Earth Channel	3	200		8.9	10.5498689	0.65744	2.22825674	11.5	290	2	NORMAL DEPTH		
MRLV	0423	GRADE CONTROL STRUCTURE	P2		21400									33		0	0											
MRLV	0424	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			1720	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0442	GRADE CONTROL STRUCTURE	P2		21400																							
MRLV	0443	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			723	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0458	GRADE CONTROL STRUCTURE	P2		21400																							
MRLV	0459	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			2549	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0507	GRADE CONTROL STRUCTURE	P2		21400																							
MRLV	0508	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			1395	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0534	EARTH CHNL W/ GABION SIDE SLOPES	E2		21400			135	NA	NA	NA																	
MRLV	0536	YAMASHITA STREET BRIDGE	E2		21400			36	NA	NA	NA																	
MRLV	0537	EARTH CHNL W/ GABION SIDE SLOPES	E2		21400			100	NA	NA	NA																	
MRLV	0539	GRADE CONTROL STRUCTURE	P2		21400																							
MRLV	0540	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			345	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0547	GRADE CONTROL STRUCTURE	P2		21400																							
MRLV	0548	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			698	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0561	GRADE CONTROL STRUCTURE	P2		21400																							
MRLV	0562	EARTHEN CHNL W' RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			1016	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0583	GRADE CONTROL STRUCTURE	P2		21400																							
MRLV	0584	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			2297	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0629	GRADE CONTROL STRUCTURE	P2		21400																							
MRLV	0630	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			464	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0637	GRADE CONTROL STRUCTURE	P2		21400								0															
MRLV	0638	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			885	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0654	GRADE CONTROL STRUCTURE	P2		21400								0															
MRLV	0655	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			744	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0669	GRADE CONTROL STRUCTURE	P2		21400								0															
MRLV	0670	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			2115	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0709	GRADE CONTROL STRUCTURE	P2		21400				NA				0															
MRLV	0710	EARTHEN CHNL W/ RIPRAP-LINED BANK 200'W 13'D 3:1 SS	P2		21400			625	NA	NA	NA	0.025	0.001	31	Earth Channel	3	200		10.9	8.406396452	0.47852	1.59732145	13	299	2	NORMAL DEPTH		
MRLV	0725	GUBLER AVENUE BRIDGE	E2		21400			50	NA	NA	NA	0.015	0.004	10	Bridge													
MRWC	0000	CONC CHNL 10'W 6'D 3:1 SS	P1		1115			2964	MRMPU3	OVR1	1.88	0.015	0.003	1	Concrete Channel Trapezoidal	3	10		4.5	10.62182649	1.10941	1.4375029	6	67	3	NORMAL DEPTH		
MRWC	0065	2:12' X 9' RCBC @ COOPER STREET	P1		1115			60	MRMPU3	OVR1	1.88	0.015	0.001	28	RCB Culvert	0	12	2	6.8	6.796307786		2	9		19	NORMAL DEPTH		

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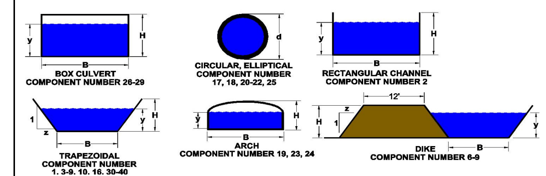

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

ID	MILE	Facility Description	Status	Recommended Status	HEC-1 Q (cfs)	Spillway Q (cfs)	Capacity Q (cfs)	Facility Length L (ft)	HEC-1 Model	HEC-1 Node	Tributary Area (Mi^2)	Manning's Roughness n	Channel Slope S (ft/ft)	Component Number
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
LWAW	0000	EARTHEN DIVERSION CHNL 45'W 3:1 SS	E2		2303			1675	MRMPU3	AWASH1	4.57	0.025	0.005	3
WWCA	0000	60" RCP	P1		118			2550	MRMPU3	DBWWCA	1.9	0.013	0.005	17
WWCA	0048	30" RCP OUTLET PIPE	P1		118			70	MRMPU3	DBWWCA	1.9	0.013	0.005	17
WWCA	0049	14,170 CFS SPILLWAY	P1		14170	14170			MRMPU3	WWASH2	1.9			15
WWCA	0050	156 ACRE-FEET DETENTION BASIN	P1		1417				MRMPU3	WWASH2	1.9			11
WWDA	0000	36" RCP	P1		24			750	MRMPU3	DBWWDA	0.45	0.013	0.005	17
WWDA	0007	18" OUTLET PIPE	P1		24			70	MRMPU3	DBWWDA	0.45	0.013	0.005	17
WWDA	0008	6,740 CFS SPILLWAY	P1		6740	6740			MRMPU3	WWASH3	0.45		0	15
WWDA	0009	49 ACRE-FEET DETENTION BASIN	P1		674				MRMPU3	WWASH3	0.45			11
WWIA	0000	48" RCP	P1		85			760	MRMPU3	DBWWIA	1.25	0.013	0.010	17
WWIA	0014	30" RCP OUTLET PIPE	P1		85			70	MRMPU3	DBWWIA	1.25	0.013	0.005	17
WWIA	0015	11,840 CFS SPILLWAY	P1		11840	11840			MRMPU3	WWASH1A	1.25		0	15
WWIA	0016	108 ACRE-FEET DETENTION BASIN	P1		1184				MRMPU3	WWASH1A	1.25			11
WWPA	0000	6' X 6' RCB	P1		273			840	MRMPU5	DBWWPA	22.25	0.015	0.005	26
WWPA	0016	42" RCP OUTLET PIPE	P1		273			70	MRMPU5	DBWWPA	22.25	0.013	0.005	17
WWPA	0017	44,920 CFS SPILLWAY	P1		44920	44920			MRMPU5	CCOWASH2	22.25		0	15
WWPA	0018	992 ACRE-FEET DETENTION BASIN	P1		4492				MRMPU5	CCOWASH2	22.25			11
WWRR	0000	CONC CHNL 12'W 5.5'D 2:1 SS	P1		916			4030	MRMPU5	COVR2	34.54	0.015	0.004	1
WWRR	0077	14' X 7' RCBC @ STATE ROUTE 169	P1		873			100	MRMPU3	CWWASH2*	4.12	0.015	0.005	28
WWRR	0079	CONC CHNL 12'W 5.5D 2:1 SS	P1		873			515	MRMPU3	CWWASH2*	4.12	0.015	0.005	1
WWRR	0083	CONC CHNL 12'W 5.5'D 2:1 SS	P1		873			2500	MRMPU3	CWWASH2*	4.12	0.015	0.004	1
WWRR	0139	14' X 7' RCBC @ ACCESS ROAD	P1		873			60	MRMPU3	CWWASH2*	4.12	0.015	0.004	28
WWRR	0141	CONC CHNL 12'W 5.5'D 2:1 SS	P1		873			725	MRMPU3	CWWASH2*	4.12	0.015	0.004	1
WWRR	0157	14' X 7' RCBC @ ACCESS ROAD	P1		873			60	MRMPU3	CWWASH2*	4.12	0.015	0.004	28
WWRR	0159	CONC CHNL 12'W 5.5'D 2:1 SS	P1		873			2310	MRMPU3	CWWASH2*	4.12	0.015	0.004	1
WWRR	0204	14' X 7' RCBC @ ACCESS ROAD	P1		873			60	MRMPU3	CWWASH2*	4.12	0.015	0.004	28
WWRR	0206	CONC CHNL 12'W 5.5'D 2:1 SS	P1		873			1620	MRMPU3	CWWASH2*	4.12	0.015	0.004	1
WWRR	0236	14' X 7' RCBC @ ACCESS ROAD	P1		873			60	MRMPU3	CWWASH2*	4.12	0.015	0.004	28
WWRR	0238	CONC CHNL 12'W 5.5'D 2:1 SS	P1		873			1900	MRMPU3	CWWASH2*	4.12	0.015	0.004	1
WWRR	0274	14' X 7' RCBC @ ACCESS ROAD	P1		873			60	MRMPU3	CWWASH2*	4.12	0.015	0.004	28
WWRR	0276	CONC CHNL 12'W 5.5'D 2:1 SS	P1		873			2035	MRMPU3	CWWASH2*	4.12	0.015	0.004	1
WWRR	0305	CONC CHNL 12'W 5.5'D 2:1 SS	P1		873			2350	MRMPU3	CWWASH2	4.12	0.015	0.004	1
WWRR	0359	14' X 7' RCBC @ ACCESS ROAD	P1		873			60	MRMPU3	CWWASH2	4.12	0.015	0.004	28
WWRR	0361	CONC CHNL 12'W 5.5'D 2:1 SS	P1		821			4525	MRMPU3	CWWASH2A	2.22	0.015	0.004	1
WWRR	0441	CONC CHNL 12'W 4.5'D 2:1 SS	P1		539			2050	MRMPU3	WWASH3A	1.38	0.015	0.005	1
WWRR	0480	ACCESS ROAD BRIDGE 12' X 6' RCB	P1		539			60	MRMPU3	WWASH3A	1.38	0.015	0.005	28
WWRR	0482	CONC CHNL 12'W 4.5'D 2:1 SS	P1		539			3565	MRMPU3	WWASH3A	1.38	0.015	0.005	1
WWRR	0550	CONC CHNL 12'W 4'D 2:1 SS	P1		395			2250	MRMPU3	WWASH4A	0.31	0.015	0.005	1
WWWA	0000	36" RCP OUTLET PIPE	P1		117			70	MRMPU3	DBWWWA	2.63	0.013	0.005	17
WWWA	0016	21,400 CFS SPILLWAY	P1		21400	21400			MRMPU3	WWASH1B	2.63		0	15
WWWA	0017	235 ACRE-FEET DETENTION BASIN	P1		2140				MRMPU3	WWASH1B	2.63			11
WWWI	0000	60" RCP	P1		129			1010	MRMPU3	DBWWWI	3.5	0.013	0.005	17
WWWI	0025	30" RCP OUTLET PIPE	P1		129			70	MRMPU3	DBWWWI	3.5	0.013	0.005	17
WWWI	0026	11,960 CFS SPILLWAY	P1		11960	11960			MRMPU3	WIWASH	3.5		0	15
WWWI	0027	182 ACRE-FEET DETENTION BASIN	P1		1196				MRMPU3	WIWASH	3.5			11
WWWT	0000	18" RCP OUTLET PIPE	P1		31			70	MRMPU3	DBWWWT	0.89	0.013	0.005	17
WWWT	0003	9,090 CFS SPILLWAY	P1		9090	9090			MRMPU3	CWWASH4	0.89		0	15
WWWT	0004	91 ACRE-FEET DETENTION BASIN	P1		909				MRMPU3	CWWASH4	0.89			11

ID	MILE	Facility Component	Side Slope z	Width B (ft)	# of Pipes or Boxes in Parallel N	Flow Depth/Full Pipe Diameter y (ft)	Flow Velocity/ Full Pipe Velocity u (ft/s)	Froude # Fr	Minimum Freeboard Required Fb (ft)	Channel Depth/ Pipe Diameter H or d (ft)	Channel ROW (ft)	GIS Code	Comment	Storage Volume	Bridge Span
(1)	(2)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)		
LWAW	0000	Riprap Channel	3.0	45		4.2	9.483747088	0.89909	1.8966065	6.5	105	4	NORMAL DEPTH		
WWCA	0000	RCP Stormdrain Circular	0.0	0	1	4.2	8.391471533		0	5		20	NORMAL DEPTH		
WWCA	0048	RCP Stormdrain Circular	0	0	1							20	ORIFICE EQUATION		
WWCA	0049	Spillway	0	0								10	PMF SPILLWAY		
WWCA	0050	Detention Basin										34	DETENTION BASIN	156	
WWDA	0000	RCP Stormdrain Circular	0.0	0	1	2.3	5.635344264		0	3		20	NORMAL DEPTH		
WWDA	0007	RCP Stormdrain Circular	0.0	0	1							20	NORMAL DEPTH		
WWDA	0008	Spillway	0	0								10	PMF SPILLWAY		
WWDA	0009	Detention Basin										34	DETENTION BASIN	49	
WWIA	0000	RCP Stormdrain Circular	0.0	0	1	3.3	10.0255675		0	4		20	NORMAL DEPTH		
WWIA	0014	RCP Stormdrain Circular	0	0	1							20	ORIFICE EQUATION		
WWIA	0015	Spillway	0	0								10	PMF SPILLWAY		
WWIA	0016	Detention Basin										34	DETENTION BASIN	108	
WWPA	0000	RCB Stormdrain	0.0	6	1	4.4	10.31124178		0	6		19	NORMAL DEPTH		
WWPA	0016	RCP Stormdrain Circular	0	0	1							20	ORIFICE EQUATION		
WWPA	0017	Spillway	0	0								10	PMF SPILLWAY		
WWPA	0018	Detention Basin										34	DETENTION BASIN	992	
WWRR	0000	Concrete Channel Trapezoidal	2.0	12		3.9	11.90123902	1.2551	1.46775222	5.5	55	3	NORMAL DEPTH		
WWRR	0077	RCB Culvert	0.0	14	1	4.5	13.75490633		2	7		19	NORMAL DEPTH		
WWRR	0079	Concrete Channel Trapezoidal	2.0	12		3.6	12.72695803	1.3893	1.48653082	5.5	55	3	NORMAL DEPTH		
WWRR	0083	Concrete Channel Trapezoidal	2.0	12		3.8	11.74342625	1.25134	1.45772636	5.5	55	3	NORMAL DEPTH		
WWRR	0139	RCB Culvert	0.0	14	1	4.9	12.6999873		2	7		19	NORMAL DEPTH		
WWRR	0141	Concrete Channel Trapezoidal	2.0	12		3.8	11.74342625	1.25134	1.45772636	5.5	55	3	NORMAL DEPTH		
WWRR	0157	RCB Culvert	0.0	14	1	4.9	12.6999873		2	7		19	NORMAL DEPTH		
WWRR	0159	Concrete Channel Trapezoidal	2.0	12		3.8	11.74342625	1.25134	1.45772636	5.5	55	3	NORMAL DEPTH		
WWRR	0204	RCB Culvert	0.0	14	1	4.9	12.6999873		2	7		19	NORMAL DEPTH		
WWRR	0206	Concrete Channel Trapezoidal	2.0	12		3.8	11.74342625	1.25134	1.45772636	5.5	55	3	NORMAL DEPTH		
WWRR	0236	RCB Culvert	0.0	14	1	4.9	12.6999873		2	7		19	NORMAL DEPTH		
WWRR	0238	Concrete Channel Trapezoidal	2.0	12		3.8	11.74342625	1.25134	1.45772636	5.5	55	3	NORMAL DEPTH		
WWRR	0274	RCB Culvert	0.0	14	1	4.9	12.6999873		2	7		19	NORMAL DEPTH		
WWRR	0276	Concrete Channel Trapezoidal	2.0	12		3.8	11.74342625	1.25134	1.45772636	5.5	55	3	NORMAL DEPTH		
WWRR	0305	Concrete Channel Trapezoidal	2.0	12		3.8	11.74342625	1.25134	1.45772636	5.5	55	3	NORMAL DEPTH		
WWRR	0359	RCB Culvert	0.0	14	1	4.9	12.6999873		2	7		19	NORMAL DEPTH		
WWRR	0361	Concrete Channel Trapezoidal	2.0	12		3.7	11.54417385	1.24655	1.44518825	5.5	55	3	NORMAL DEPTH		
WWRR	0441	Concrete Channel Trapezoidal	2.0	12		2.8	11.09179665	1.34714	1.38932051	4.5	51	3	NORMAL DEPTH		
WWRR	0480	RCB Culvert	0.0	12	1	3.7	12.1580099		2	6		19	NORMAL DEPTH		
WWRR	0482	Concrete Channel Trapezoidal	2.0	12		2.8	11.09179665	1.34714	1.38932051	4.5	51	3	NORMAL DEPTH		
WWRR	0550	Concrete Channel Trapezoidal	2.0	12		2.3	10.12284107	1.3198	1.33586196	4	49	3	NORMAL DEPTH		
WWWA	0000	RCP Stormdrain Circular	0	0								20	ORIFICE EQUATION		
WWWA	0016	Spillway	0	0								10	PMF SPILLWAY		
WWWA	0017	Detention Basin										34	DETENTION BASIN	235	
WWWI	0000	RCP Stormdrain Circular	0.0	0	1	4.4	8.580547689		0	5		20	NORMAL DEPTH		
WWWI	0025	RCP Stormdrain Circular	0	0	1							20	ORIFICE EQUATION		
WWWI	0026	Spillway	0	0								10	PMF SPILLWAY		
WWWI	0027	Detention Basin										34	DETENTION BASIN	182	
WWWT	0000	RCP Stormdrain Circular	0	0	1							20	ORIFICE EQUATION		
WWWT	0003	Spillway	0	0								10	PMF SPILLWAY		
WWWT	0004	Detention Basin										34	DETENTION BASIN	91	

* The HEC-1 node shown identifies the controlling concentration point for the associated facility and is located upstream of this facility due to decreasing peak flow with increasing tributary area caused by storm distribution transitions, depth area reduction factors, or attenuation of flow from routing.

Appendix B-2

Detention Basin Stage-Area-Discharge Tables

2016 Muddy River and Tributary Washes Flood Control Master Plan Update
Detention Basin

DETENTION BASIN NODE	HEC-1 CARD	HEC-1 INPUTS						PEAK STORAGE (AC-FT)	PEAK STAGE (FT)	PEAK FLOW (CFS)	W/ SEDIMENT (10%)	REQ STAGE (FT)	FREEBOARD (1FT)	2016 DESIGN STORAGE (AC-FT)	2010 MPU STORAGE (AC-FT)
DBEWGA	SA	1	5	10	20	22		124	1485.16	88	136.4	1485.77	1486.77	157	NEW
	SE	1472	1476	1480	1484	1488									
	SQ	0	42	67	84	98									
	SV - HEC-1	0	10.98	40.41	99.27	183.23									
DBFGWS	SV	0	104.8	121.7	140.1	160.2	259.2	116	1492.66	44				139*	130
	SE	1469	1492	1493	1494	1495	1499								
	SQ	0	43	44	45	215	11878								
DBFGLS	SV	0	1058.1	1113.8	1169.9	1226.3	1282	1082	1501.43	254	1190.2	1503.36	1504.36	1247	NEW
	SE	1474	1501	1502	1503	1504	1505								
	SQ	0	252	257	262	267	271								
DBWWWT	SA	5	6	7	8			76	1377.17	31	83.6	1378.16	1379.16	91	76
	SE	1365	1370	1375	1380										
	SQ	0	19	28	35										
	SV - HEC-1	0	27.46	59.93	97.4										
DBWWDA	SA	1	4	6	7	8		38	1342.74	24	41.8	1343.23	1344.23	49	46
	SE	1335	1337	1340	1342	1345									
	SQ	0	10	19	23	28									
	SV - HEC-1	0	4.67	19.57	32.55	55.04									
DBWWCA	SA	1	3	6	8	9	10	133	1387.48	118	146.3	1388.93	1389.93	156	146
	SE	1365	1370	1375	1380	1385	1390								
	SQ	0	50	76	95	111	125								
	SV - HEC-1	0	9.55	31.62	66.5	108.98	156.46								
DBWWWI	SA	3	4	6	8	10		157	1351.88	129	172.7	1353.65	1354.65	182	244
	SE	1325	1332	1340	1347	1355									
	SQ	0	61	95	117	137									
	SV - HEC-1	0	24.42	64.15	112.98	184.83									
DBWWPA	SA	1	12	32	49	56		854	1321.64	273	939.4	1323.26	1324.26	992	1179
	SE	1290	1300	1308	1315	1325									
	SQ	0	144	202	242	289									
	SV - HEC-1	0	54.88	224.47	505.86	1030.48									
DBWWIA	SA	1	6	11	14			87	1307.33	85	95.7	1308.05	1309.05	108	NEW
	SE	1295	1300	1305	1310										
	SQ	0	50	76	95										
	SV - HEC-1	0	15.75	57.62	119.97										
DBWWWA	SA	2	11	20	26	30		188	1311.61	117	206.8	1312.30	1313.30	235	229
	SE	1300	1303	1307	1311	1315									
	SQ	0	45	86	114	135									
	SV - HEC-1	0	17.69	78.8	170.54	282.44									

NOTE:
* Storage volume from Louis Berger Fairgrounds Detention Basin Preliminary Design.

Appendix C

Gage Analysis

```
1
  Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.000.000
  Ver. 5.2            Annual peak flow frequency analysis      Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines       05/22/2015 15:56

                         --- PROCESSING OPTIONS ---

                      Plot option         = Graphics device
                      Basin char output   = None
                      Print option        = Yes
                      Debug print         = No
                      Input peaks listing = Long
                      Input peaks format  = WATSTORE peak file

                      Input files used:
                         peaks (ascii)  - X:\WATER RESOURCES
NEVADA\FERRIN\RFP\MUDDYRIVER\PKFQ\MOAPAVALLEY.TXT
                         specifications - PKFQWPSF.TMP

                      Output file(s):
                         main - X:\WATER RESOURCES
NEVADA\FERRIN\RFP\MUDDYRIVER\PKFQ\MOAPAVALLEY.PRT

1


  Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.001.001
  Ver. 5.2            Annual peak flow frequency analysis      Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines       05/22/2015 15:56

                   Station - 09416000  MUDDY RV NR MOAPA, NV


                     I N P U T   D A T A   S U M M A R Y

                Number of peaks in record           =       76
                Peaks not used in analysis          =        0
                Systematic peaks in analysis        =       76
                Historic peaks in analysis          =        0
                Years of historic record            =        0
                Generalized skew                    =    0.000
                     Standard error                 =    0.550
                     Mean Square error              =    0.303
                Skew option                         =   WEIGHTED
                Gage base discharge                 =      0.0
                User supplied high outlier threshold =   --
                User supplied low outlier criterion  =   --
                Plotting position parameter         =     0.00


  *********  NOTICE  --  Preliminary machine computations.        *********
  *********  User responsible for assessment and interpretation.  *********

    WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                    0.0
    WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.       8140.1
    WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION.               5.1
1

  Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.001.002
  Ver. 5.2            Annual peak flow frequency analysis      Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines       05/22/2015 15:56
```

Station - 09416000 MUDDY RV NR MOAPA, NV

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	2.3078	0.5485	0.999
BULL.17B ESTIMATE	0.0	1.0000	2.3078	0.5485	0.666

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	84-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.9950	17.2	24.8	16.3	13.2	21.6
0.9900	20.1	27.3	19.2	15.6	25.1
0.9500	33.2	38.5	32.3	26.6	40.3
0.9000	45.2	48.9	44.4	37.0	54.1
0.8000	68.8	69.3	68.1	57.7	80.9
0.6667	106.5	102.3	106.0	90.9	123.7
0.5000	176.7	165.2	176.7	152.7	204.1
0.4292	221.3	206.0	221.7	191.6	255.9
0.2000	553.3	528.9	561.7	471.7	657.7
0.1000	1092.0	1104.0	1128.0	904.5	1348.0
0.0400	2407.0	2681.0	2565.0	1908.0	3137.0
0.0200	4160.0	5036.0	4571.0	3189.0	5650.0
0.0100	6980.0	9238.0	7953.0	5172.0	9872.0
0.0050	11450.0	16640.0	13610.0	8204.0	16850.0
0.0020	21430.0	35470.0	27210.0	14710.0	33210.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.003
Ver. 5.2 Annual peak flow frequency analysis Run Date / Time
11/01/2007 following Bulletin 17-B Guidelines 05/22/2015 15:56

Station - 09416000 MUDDY RV NR MOAPA, NV

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1913	85.0		1977	428.0	
1914	205.0		1978	311.0	
1915	88.0		1979	4860.0	
1916	68.0		1980	101.0	
1917	62.0		1981	361.0	
1918	53.0		1982	130.0	
1945	1310.0		1983	234.0	
1946	290.0		1984	1700.0	
1947	162.0		1985	447.0	
1948	82.0		1986	94.0	
1949	61.0		1987	62.0	

1950	173.0	1988	260.0
1951	93.0	1989	49.0
1952	132.0	1990	5760.0
1953	82.0	1991	718.0
1954	98.0	1992	145.0
1955	104.0	1993	1600.0
1956	59.0	1994	81.0
1957	356.0	1995	68.0
1958	280.0	1996	53.0
1959	120.0	1997	110.0
1960	260.0	1998	401.0
1961	1100.0	1999	154.0
1962	76.0	2000	195.0
1963	76.0	2001	50.0
1964	92.0	2002	47.0
1965	124.0	2003	53.0
1966	931.0	2004	49.0
1967	5100.0	2005	157.0
1968	335.0	2006	81.0
1969	855.0	2007	75.0
1970	294.0	2008	43.0
1971	847.0	2009	59.0
1972	698.0	2010	68.0
1973	803.0	2011	150.0
1974	78.0	2012	147.0
1975	177.0	2013	1720.0
1976	1990.0	2014	3320.0

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Program PeakFq — U. S. GEOLOGICAL SURVEY — Seq.001.004
Ver. 5.2 — Annual peak flow frequency analysis — Run Date / Time
11/01/2007 — following Bulletin 17-B Guidelines — 05/22/2015 15:56

Station - 09416000 MUDDY RV NR MOAPA, NV

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
1990	5760.0	0.0130	0.0130

1967	5100.0	0.0260	0.0260
1979	4860.0	0.0390	0.0390
2014	3320.0	0.0519	0.0519
1976	1990.0	0.0649	0.0649
2013	1720.0	0.0779	0.0779
1984	1700.0	0.0909	0.0909
1993	1600.0	0.1039	0.1039
1945	1310.0	0.1169	0.1169
1961	1100.0	0.1299	0.1299
1966	931.0	0.1429	0.1429
1969	855.0	0.1558	0.1558
1971	847.0	0.1688	0.1688
1973	803.0	0.1818	0.1818
1991	718.0	0.1948	0.1948
1972	698.0	0.2078	0.2078
1985	447.0	0.2208	0.2208
1977	428.0	0.2338	0.2338
1998	401.0	0.2468	0.2468
1981	361.0	0.2597	0.2597
1957	356.0	0.2727	0.2727
1968	335.0	0.2857	0.2857
1978	311.0	0.2987	0.2987
1970	294.0	0.3117	0.3117
1946	290.0	0.3247	0.3247
1958	280.0	0.3377	0.3377
1960	260.0	0.3506	0.3506
1988	260.0	0.3636	0.3636
1983	234.0	0.3766	0.3766
1914	205.0	0.3896	0.3896
2000	195.0	0.4026	0.4026
1975	177.0	0.4156	0.4156
1950	173.0	0.4286	0.4286
1947	162.0	0.4416	0.4416
2005	157.0	0.4545	0.4545
1999	154.0	0.4675	0.4675
2011	150.0	0.4805	0.4805
2012	147.0	0.4935	0.4935
1992	145.0	0.5065	0.5065
1952	132.0	0.5195	0.5195
1982	130.0	0.5325	0.5325
1965	124.0	0.5455	0.5455
1959	120.0	0.5584	0.5584
1997	110.0	0.5714	0.5714
1955	104.0	0.5844	0.5844
1980	101.0	0.5974	0.5974
1954	98.0	0.6104	0.6104
1986	94.0	0.6234	0.6234
1951	93.0	0.6364	0.6364
1964	92.0	0.6494	0.6494
1915	88.0	0.6623	0.6623
1913	85.0	0.6753	0.6753
1948	82.0	0.6883	0.6883
1953	82.0	0.7013	0.7013
1994	81.0	0.7143	0.7143
2006	81.0	0.7273	0.7273
1974	78.0	0.7403	0.7403
1962	76.0	0.7532	0.7532
1963	76.0	0.7662	0.7662
2007	75.0	0.7792	0.7792
1916	68.0	0.7922	0.7922
1995	68.0	0.8052	0.8052
2010	68.0	0.8182	0.8182
1917	62.0	0.8312	0.8312

1987	62.0	0.8442	0.8442
1949	61.0	0.8571	0.8571
1956	59.0	0.8701	0.8701
2009	59.0	0.8831	0.8831
1918	53.0	0.8961	0.8961
1996	53.0	0.9091	0.9091
2003	53.0	0.9221	0.9221
2001	50.0	0.9351	0.9351
1989	49.0	0.9481	0.9481
2004	49.0	0.9610	0.9610
2002	47.0	0.9740	0.9740
2008	43.0	0.9870	0.9870

1

```
 Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.002.001
 Ver. 5.2             Annual peak flow frequency analysis      Run Date / Time
 11/01/2007           following Bulletin 17-B Guidelines       05/22/2015 15:56

             Station - 09417300  CALIFORNIA WASH NR MOAPA, NEVADA


                    I N P U T   D A T A   S U M M A R Y

               Number of peaks in record            =       29
               Peaks not used in analysis           =        1
               Systematic peaks in analysis         =       28
               Historic peaks in analysis           =        0
               Years of historic record             =        0
               Generalized skew                     =    0.000
                    Standard error                  =    0.550
                    Mean Square error               =    0.303
               Skew option                          =   WEIGHTED
               Gage base discharge                  =      0.0
               User supplied high outlier threshold =   --
               User supplied low outlier criterion  =   --
               Plotting position parameter          =     0.00


 *********  NOTICE  --  Preliminary machine computations.        *********
 *********  User responsible for assessment and interpretation.  *********

 **WCF109W-PEAKS WITH MINUS-FLAGGED DISCHARGES WERE BYPASSED.       1
 **WCF113W-NUMBER OF SYSTEMATIC PEAKS HAS BEEN REDUCED TO NSYS =   28
   WCF133I-SYSTEMATIC PEAKS BELOW GAGE BASE WERE NOTED.         5       0.0
   WCF198I-LOW OUTLIERS BELOW FLOOD BASE WERE DROPPED.      1           2.5
   WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.     14692.4
   WCF002J-CALCS COMPLETED.  RETURN CODE =  2
```

1

```
 Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.002.002
 Ver. 5.2             Annual peak flow frequency analysis      Run Date / Time
 11/01/2007           following Bulletin 17-B Guidelines       05/22/2015 15:56

             Station - 09417300  CALIFORNIA WASH NR MOAPA, NEVADA


          ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                      FLOOD BASE                    LOGARITHMIC
                 ----------------------  -------------------------------
```

	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	0.8214	2.1550	1.0731	-1.066
BULL.17B ESTIMATE	2.5	0.7857	2.2998	0.7999	-0.073

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	84-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.8000	--	22.4	--	--	--
0.6667	91.9	74.1	89.9	62.9	130.5
0.5000	204.0	219.9	204.0	143.9	289.4
0.4292	283.1	328.8	285.5	200.3	405.5
0.2000	945.8	1165.0	995.6	646.2	1467.0
0.1000	2082.0	2242.0	2299.0	1352.0	3502.0
0.0400	4786.0	3899.0	5718.0	2900.0	8893.0
0.0200	8150.0	5194.0	10460.0	4701.0	16230.0
0.0100	13110.0	6444.0	18250.0	7221.0	27830.0
0.0050	20200.0	7606.0	30770.0	10650.0	45510.0
0.0020	33980.0	8969.0	59120.0	16980.0	82390.0

1

Program PeakFq   U. S. GEOLOGICAL SURVEY   Seq.002.003
Ver. 5.2   Annual peak flow frequency analysis   Run Date / Time
11/01/2007   following Bulletin 17-B Guidelines   05/22/2015 15:56

Station - 09417300 CALIFORNIA WASH NR MOAPA, NEVADA

I N P U T   D A T A   L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1981	-30600.0	H	2001	100.0	
1987	0.0		2002	0.0	
1988	200.0		2003	360.0	
1989	60.0		2004	1.0	
1990	1400.0		2005	800.0	
1991	770.0		2006	100.0	
1992	100.0		2007	1800.0	
1993	100.0		2008	93.0	
1994	0.0		2009	800.0	
1995	0.0		2010	0.0	
1996	400.0		2011	25.0	
1997	75.0		2012	3100.0	
1998	4400.0		2013	3230.0	
1999	100.0		2014	2360.0	
2000	500.0				

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly

```
         G        8    Discharge greater than stated value
         X       3+8   Both of the above
         L        4    Discharge less than stated value
         K      6 OR C  Known effect of regulation or urbanization
         H        7    Historic peak

         -  Minus-flagged discharge -- Not used in computation
               -8888.0 -- No discharge value given
         -  Minus-flagged water year -- Historic peak used in computation
```

1

```
  Program PeakFq          U. S. GEOLOGICAL SURVEY              Seq.002.004
  Ver. 5.2              Annual peak flow frequency analysis    Run Date / Time
  11/01/2007            following Bulletin 17-B Guidelines     05/22/2015 15:56

           Station - 09417300  CALIFORNIA WASH NR MOAPA, NEVADA
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EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
1998	4400.0	0.0345	0.0345
2013	3230.0	0.0690	0.0690
2012	3100.0	0.1034	0.1034
2014	2360.0	0.1379	0.1379
2007	1800.0	0.1724	0.1724
1990	1400.0	0.2069	0.2069
2005	800.0	0.2414	0.2414
2009	800.0	0.2759	0.2759
1991	770.0	0.3103	0.3103
2000	500.0	0.3448	0.3448
1996	400.0	0.3793	0.3793
2003	360.0	0.4138	0.4138
1988	200.0	0.4483	0.4483
1992	100.0	0.4828	0.4828
1993	100.0	0.5172	0.5172
1999	100.0	0.5517	0.5517
2001	100.0	0.5862	0.5862
2006	100.0	0.6207	0.6207
2008	93.0	0.6552	0.6552
1997	75.0	0.6897	0.6897
1989	60.0	0.7241	0.7241
2011	25.0	0.7586	0.7586
2004	1.0	0.7931	0.7931
1987	0.0	--	--
1994	0.0	--	--
1995	0.0	--	--
2002	0.0	--	--
2010	0.0	--	--
1981	-30600.0	--	--

1

```
  Program PeakFq          U. S. GEOLOGICAL SURVEY              Seq.003.001
  Ver. 5.2              Annual peak flow frequency analysis    Run Date / Time
  11/01/2007            following Bulletin 17-B Guidelines     05/22/2015 15:56
```

Station - 09418700 MEADOW VALLEY WASH NR ROX, NV

I N P U T   D A T A   S U M M A R Y

Number of peaks in record	=	10
Peaks not used in analysis	=	0
Systematic peaks in analysis	=	10
Historic peaks in analysis	=	0
Years of historic record	=	0
Generalized skew	=	0.000
Standard error	=	0.550
Mean Square error	=	0.303
Skew option	=	WEIGHTED
Gage base discharge	=	0.0
User supplied high outlier threshold	=	--
User supplied low outlier criterion	=	--
Plotting position parameter	=	0.00

********* NOTICE -- Preliminary machine computations. *********
********* User responsible for assessment and interpretation. *********

WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.	0.0
WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION.	0.2
WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.	7911.7

1

Program PeakFq   U. S. GEOLOGICAL SURVEY   Seq.003.002
Ver. 5.2   Annual peak flow frequency analysis   Run Date / Time
11/01/2007   following Bulletin 17-B Guidelines   05/22/2015 15:56

Station - 09418700 MEADOW VALLEY WASH NR ROX, NV

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	1.6149	1.1215	-0.107
BULL.17B ESTIMATE	0.0	1.0000	1.6149	1.1215	-0.042

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	84-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.9950	0.0	0.0	0.0	0.0	0.2
0.9900	0.1	0.1	0.0	0.0	0.4
0.9500	0.6	0.5	0.3	0.1	1.7
0.9000	1.5	1.5	1.0	0.4	4.0
0.8000	4.7	4.8	3.8	1.5	11.2
0.6667	13.7	14.1	12.5	5.4	31.0
0.5000	41.9	43.1	41.9	18.2	96.8
0.4292	66.5	68.3	68.9	29.4	158.9

0.2000	363.9	366.6	451.7	152.7	1117.0
0.1000	1115.0	1093.0	1711.0	419.4	4346.0
0.0400	3649.0	3437.0	8132.0	1178.0	19030.0
0.0200	7817.0	7129.0	24850.0	2260.0	49770.0
0.0100	15470.0	13640.0	74840.0	4025.0	118500.0
0.0050	28830.0	24570.0	226900.0	6789.0	262200.0
0.0020	61110.0	49760.0	1020000.0	12720.0	686500.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.003.003
Ver. 5.2 Annual peak flow frequency analysis Run Date / Time
11/01/2007 following Bulletin 17-B Guidelines 05/22/2015 15:56

Station - 09418700 MEADOW VALLEY WASH NR ROX, NV

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1988	111.0		1993	1620.0	
1989	3.0		1994	2.9	
1990	550.0		2002	2.5	
1991	145.0		2003	83.0	
1992	340.0		2004	1.6	

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.003.004
Ver. 5.2 Annual peak flow frequency analysis Run Date / Time
11/01/2007 following Bulletin 17-B Guidelines 05/22/2015 15:56

Station - 09418700 MEADOW VALLEY WASH NR ROX, NV

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
1993	1620.0	0.0909	0.0909

```
      1990           550.0          0.1818          0.1818
      1992           340.0          0.2727          0.2727
      1991           145.0          0.3636          0.3636
      1988           111.0          0.4545          0.4545
      2003            83.0          0.5455          0.5455
      1989             3.0          0.6364          0.6364
      1994             2.9          0.7273          0.7273
      2002             2.5          0.8182          0.8182
      2004             1.6          0.9091          0.9091
1

  Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.004.001
  Ver. 5.2            Annual peak flow frequency analysis      Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines       05/22/2015 15:56

               Station - 09418990  WEISER WASH NR GLENDALE, NV


                    I N P U T   D A T A   S U M M A R Y

               Number of peaks in record           =       35
               Peaks not used in analysis          =        0
               Systematic peaks in analysis        =       35
               Historic peaks in analysis          =        0
               Years of historic record            =        0
               Generalized skew                    =    0.000
                    Standard error                 =    0.550
                    Mean Square error              =    0.303
               Skew option                         =   WEIGHTED
               Gage base discharge                 =      0.0
               User supplied high outlier threshold =   --
               User supplied low outlier criterion  =   --
               Plotting position parameter         =     0.00


  *********  NOTICE  --  Preliminary machine computations.        *********
  *********  User responsible for assessment and interpretation.  *********

    WCF133I-SYSTEMATIC PEAKS BELOW GAGE BASE WERE NOTED.        11      0.0
    WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION.              0.1
  **WCF199W-NUMBER OF PEAKS BELOW FLOOD BASE EXCEEDS 17B SPEC.  11      0.0    8
    WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.     18691.4
    WCF002J-CALCS COMPLETED.  RETURN CODE =  2
1

  Program PeakFq           U. S. GEOLOGICAL SURVEY            Seq.004.002
  Ver. 5.2            Annual peak flow frequency analysis      Run Date / Time
  11/01/2007          following Bulletin 17-B Guidelines       05/22/2015 15:56

               Station - 09418990  WEISER WASH NR GLENDALE, NV


          ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

                          FLOOD BASE                 LOGARITHMIC
                    ----------------------  -------------------------------
                               EXCEEDANCE                STANDARD
                     DISCHARGE PROBABILITY     MEAN     DEVIATION     SKEW
                    -------------------------------------------------------
 SYSTEMATIC RECORD        0.0      0.6857     0.9762       1.4709    -0.348
```

BULL.17B ESTIMATE	0.0	0.6857	0.9762	1.4709	-0.222

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	84-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.6667	2.4	2.6	2.4	1.3	4.4
0.5000	10.7	11.5	10.7	6.1	19.1
0.4292	19.5	20.9	19.8	11.0	35.3
0.2000	168.8	170.8	181.3	89.8	345.3
0.1000	665.1	628.1	761.3	326.5	1536.0
0.0400	2727.0	2328.0	3450.0	1206.0	7288.0
0.0200	6598.0	5201.0	9111.0	2713.0	19460.0
0.0100	14340.0	10430.0	21810.0	5513.0	46290.0
0.0050	28740.0	19260.0	48560.0	10380.0	100800.0
0.0020	65470.0	39380.0	128500.0	21920.0	253800.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.004.003
Ver. 5.2 Annual peak flow frequency analysis Run Date / Time
11/01/2007 following Bulletin 17-B Guidelines 05/22/2015 15:56

Station - 09418990 WEISER WASH NR GLENDALE, NV

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1966	300.0		1998	180.0	
1967	100.0		1999	1.0	
1968	2.0		2000	6100.0	
1969	0.0		2001	0.0	
1970	0.0		2002	0.0	
1971	0.0		2003	8.0	
1972	584.0		2004	0.0	
1973	150.0		2005	29.0	
1974	0.0		2006	0.0	
1975	25.0		2007	700.0	
1976	0.0		2008	25.0	
1977	47.0		2009	4.0	
1978	1.0		2010	7.5	
1979	14.0		2011	22.7	
1980	4.3		2012	718.0	
1981	100.0		2013	0.0	
1984	833.0		2014	0.0	
1990	1200.0				

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above

```
L        4    Discharge less than stated value
K      6 OR C  Known effect of regulation or urbanization
H        7    Historic peak

-  Minus-flagged discharge -- Not used in computation
      -8888.0 -- No discharge value given
-  Minus-flagged water year -- Historic peak used in computation
```

1

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Program PeakFq          U. S. GEOLOGICAL SURVEY              Seq.004.004
Ver. 5.2             Annual peak flow frequency analysis     Run Date / Time
11/01/2007           following Bulletin 17-B Guidelines      05/22/2015 15:56

             Station - 09418990  WEISER WASH NR GLENDALE, NV
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EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
2000	6100.0	0.0278	0.0278
1990	1200.0	0.0556	0.0556
1984	833.0	0.0833	0.0833
2012	718.0	0.1111	0.1111
2007	700.0	0.1389	0.1389
1972	584.0	0.1667	0.1667
1966	300.0	0.1944	0.1944
1998	180.0	0.2222	0.2222
1973	150.0	0.2500	0.2500
1967	100.0	0.2778	0.2778
1981	100.0	0.3056	0.3056
1977	47.0	0.3333	0.3333
2005	29.0	0.3611	0.3611
1975	25.0	0.3889	0.3889
2008	25.0	0.4167	0.4167
2011	22.7	0.4444	0.4444
1979	14.0	0.4722	0.4722
2003	8.0	0.5000	0.5000
2010	7.5	0.5278	0.5278
1980	4.3	0.5556	0.5556
2009	4.0	0.5833	0.5833
1968	2.0	0.6111	0.6111
1978	1.0	0.6389	0.6389
1999	1.0	0.6667	0.6667
1969	0.0	--	--
1970	0.0	--	--
1971	0.0	--	--
1974	0.0	--	--
1976	0.0	--	--
2001	0.0	--	--
2002	0.0	--	--
2004	0.0	--	--
2006	0.0	--	--
2013	0.0	--	--
2014	0.0	--	--

1

Program PeakFq   U. S. GEOLOGICAL SURVEY   Seq.005.001
Ver. 5.2   Annual peak flow frequency analysis   Run Date / Time
11/01/2007   following Bulletin 17-B Guidelines   05/22/2015 15:56

Station - 09419000 MUDDY RV NR GLENDALE, NV

I N P U T   D A T A   S U M M A R Y

Number of peaks in record	=	65
Peaks not used in analysis	=	0
Systematic peaks in analysis	=	65
Historic peaks in analysis	=	0
Years of historic record	=	0
Generalized skew	=	0.000
Standard error	=	0.550
Mean Square error	=	0.303
Skew option	=	WEIGHTED
Gage base discharge	=	0.0
User supplied high outlier threshold	=	--
User supplied low outlier criterion	=	--
Plotting position parameter	=	0.00

********* NOTICE -- Preliminary machine computations. *********
********* User responsible for assessment and interpretation. *********

WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.	0.0
WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION.	8.8
WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.	43441.4

1

Program PeakFq   U. S. GEOLOGICAL SURVEY   Seq.005.002
Ver. 5.2   Annual peak flow frequency analysis   Run Date / Time
11/01/2007   following Bulletin 17-B Guidelines   05/22/2015 15:56

Station - 09419000 MUDDY RV NR GLENDALE, NV

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	2.7914	0.6443	0.142
BULL.17B ESTIMATE	0.0	1.0000	2.7914	0.6443	0.110

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	84-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.9950	15.8	16.5	13.8	10.6	22.3
0.9900	22.1	22.9	19.9	15.2	30.5
0.9500	56.5	57.3	53.6	41.9	73.4
0.9000	94.1	94.6	91.0	72.4	118.9

0.8000	176.2	175.9	173.2	140.8	216.3
0.6667	319.4	317.5	317.2	262.1	385.4
0.5000	602.0	597.3	602.0	500.9	723.3
0.4292	785.0	778.9	787.1	653.7	946.2
0.2000	2138.0	2132.0	2177.0	1742.0	2673.0
0.1000	4210.0	4229.0	4366.0	3327.0	5488.0
0.0400	8775.0	8915.0	9381.0	6648.0	12070.0
0.0200	14190.0	14550.0	15600.0	10430.0	20290.0
0.0100	21970.0	22750.0	24940.0	15670.0	32570.0
0.0050	32900.0	34400.0	38700.0	22810.0	50470.0
0.0020	53900.0	57120.0	66890.0	36080.0	86330.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.005.003
Ver. 5.2 Annual peak flow frequency analysis Run Date / Time
11/01/2007 following Bulletin 17-B Guidelines 05/22/2015 15:56

Station - 09419000 MUDDY RV NR GLENDALE, NV

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1950	253.0		1983	5100.0	
1951	879.0		1984	5830.0	
1952	621.0		1985	326.0	
1953	205.0		1986	576.0	
1954	351.0		1987	81.0	
1955	1460.0		1988	587.0	
1956	398.0		1989	87.0	
1957	986.0		1990	2290.0	
1958	870.0		1991	1150.0	
1959	130.0		1992	849.0	
1960	136.0		1993	2200.0	
1961	7380.0		1994	55.0	
1962	534.0		1995	48.0	
1963	439.0		1996	75.0	
1964	267.0		1997	220.0	
1965	546.0		1998	6400.0	
1966	1110.0		1999	61.0	
1967	1200.0		2000	3270.0	
1968	1880.0		2001	101.0	
1969	1190.0		2002	48.0	
1970	1220.0		2003	90.0	
1971	524.0		2004	402.0	
1972	1860.0		2005	8600.0	
1973	616.0		2006	129.0	
1974	113.0		2007	1590.0	
1975	489.0		2008	78.0	
1976	282.0		2009	828.0	
1977	1030.0		2010	65.0	
1978	1850.0		2011	4770.0	
1979	856.0		2012	3000.0	
1980	885.0		2013	1510.0	
1981	16400.0		2014	17300.0	
1982	505.0				

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

```
Program PeakFq            U. S. GEOLOGICAL SURVEY            Seq.005.004
Ver. 5.2             Annual peak flow frequency analysis      Run Date / Time
11/01/2007           following Bulletin 17-B Guidelines       05/22/2015 15:56
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Station - 09419000 MUDDY RV NR GLENDALE, NV

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
2014	17300.0	0.0152	0.0152
1981	16400.0	0.0303	0.0303
2005	8600.0	0.0455	0.0455
1961	7380.0	0.0606	0.0606
1998	6400.0	0.0758	0.0758
1984	5830.0	0.0909	0.0909
1983	5100.0	0.1061	0.1061
2011	4770.0	0.1212	0.1212
2000	3270.0	0.1364	0.1364
2012	3000.0	0.1515	0.1515
1990	2290.0	0.1667	0.1667
1993	2200.0	0.1818	0.1818
1968	1880.0	0.1970	0.1970
1972	1860.0	0.2121	0.2121
1978	1850.0	0.2273	0.2273
2007	1590.0	0.2424	0.2424
2013	1510.0	0.2576	0.2576
1955	1460.0	0.2727	0.2727
1970	1220.0	0.2879	0.2879
1967	1200.0	0.3030	0.3030
1969	1190.0	0.3182	0.3182
1991	1150.0	0.3333	0.3333
1966	1110.0	0.3485	0.3485
1977	1030.0	0.3636	0.3636
1957	986.0	0.3788	0.3788
1980	885.0	0.3939	0.3939
1951	879.0	0.4091	0.4091
1958	870.0	0.4242	0.4242
1979	856.0	0.4394	0.4394
1992	849.0	0.4545	0.4545
2009	828.0	0.4697	0.4697
1952	621.0	0.4848	0.4848

1973	616.0	0.5000	0.5000
1988	587.0	0.5152	0.5152
1986	576.0	0.5303	0.5303
1965	546.0	0.5455	0.5455
1962	534.0	0.5606	0.5606
1971	524.0	0.5758	0.5758
1982	505.0	0.5909	0.5909
1975	489.0	0.6061	0.6061
1963	439.0	0.6212	0.6212
2004	402.0	0.6364	0.6364
1956	398.0	0.6515	0.6515
1954	351.0	0.6667	0.6667
1985	326.0	0.6818	0.6818
1976	282.0	0.6970	0.6970
1964	267.0	0.7121	0.7121
1950	253.0	0.7273	0.7273
1997	220.0	0.7424	0.7424
1953	205.0	0.7576	0.7576
1960	136.0	0.7727	0.7727
1959	130.0	0.7879	0.7879
2006	129.0	0.8030	0.8030
1974	113.0	0.8182	0.8182
2001	101.0	0.8333	0.8333
2003	90.0	0.8485	0.8485
1989	87.0	0.8636	0.8636
1987	81.0	0.8788	0.8788
2008	78.0	0.8939	0.8939
1996	75.0	0.9091	0.9091
2010	65.0	0.9242	0.9242
1999	61.0	0.9394	0.9394
1994	55.0	0.9545	0.9545
1995	48.0	0.9697	0.9697
2002	48.0	0.9848	0.9848

1

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Program PeakFq            U. S. GEOLOGICAL SURVEY            Seq.006.001
Ver. 5.2             Annual peak flow frequency analysis      Run Date / Time
11/01/2007           following Bulletin 17-B Guidelines       05/22/2015 15:56
```

Station - 09419507 MUDDY RV AT LEWIS AVENUE AT OVERTON, NV

I N P U T   D A T A   S U M M A R Y

```
Number of peaks in record            =       17
Peaks not used in analysis           =        0
Systematic peaks in analysis         =       17
Historic peaks in analysis           =        0
Years of historic record             =        0
Generalized skew                     =    0.000
     Standard error                  =    0.550
     Mean Square error               =    0.303
Skew option                          =   WEIGHTED
Gage base discharge                  =      0.0
User supplied high outlier threshold =   --
User supplied low outlier criterion  =   --
Plotting position parameter          =     0.00
```

```
*********  NOTICE  --  Preliminary machine computations.        *********
*********  User responsible for assessment and interpretation.  *********
```

WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE. 0.0
WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE. 18747.4
WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION. 3.6

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.006.002
Ver. 5.2 Annual peak flow frequency analysis Run Date / Time
11/01/2007 following Bulletin 17-B Guidelines 05/22/2015 15:56

Station - 09419507 MUDDY RV AT LEWIS AVENUE AT OVERTON, NV

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	2.4123	0.8058	0.770
BULL.17B ESTIMATE	0.0	1.0000	2.4123	0.8058	0.350

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	'EXPECTED PROBABILITY' ESTIMATE	84-PCT CONFIDENCE LIMITS FOR BULL. 17B ESTIMATES LOWER	UPPER
0.9950	4.0	8.2	2.3	1.4	8.4
0.9900	5.6	10.0	3.6	2.2	11.3
0.9500	14.8	19.3	11.8	6.8	27.0
0.9000	26.0	29.4	22.4	13.0	44.7
0.8000	53.0	52.7	48.9	29.4	86.2
0.6667	106.9	98.1	103.2	64.2	168.3
0.5000	232.0	204.1	232.0	146.7	364.4
0.4292	323.5	283.6	328.2	206.4	514.2
0.2000	1184.0	1105.0	1305.0	730.0	2115.0
0.1000	2954.0	3079.0	3614.0	1694.0	6019.0
0.0400	8225.0	10280.0	12160.0	4231.0	19940.0
0.0200	16370.0	23880.0	29150.0	7758.0	45020.0
0.0100	30980.0	53210.0	69060.0	13540.0	96150.0
0.0050	56380.0	114900.0	164000.0	22790.0	196600.0
0.0020	118800.0	306200.0	525000.0	43460.0	480500.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.006.003
Ver. 5.2 Annual peak flow frequency analysis Run Date / Time
11/01/2007 following Bulletin 17-B Guidelines 05/22/2015 15:56

Station - 09419507 MUDDY RV AT LEWIS AVENUE AT OVERTON, NV

I N P U T D A T A L I S T I N G

WATER YEAR	DISCHARGE	CODES	WATER YEAR	DISCHARGE	CODES
1998	1300.0	K	2007	960.0	K

1999	51.0	K	2008	66.0	K
2000	444.0	K	2009	105.0	K
2001	37.0	K	2010	83.0	K
2002	223.0	K	2011	690.0	K
2003	40.0	K	2012	2000.0	K
2004	30.0	K	2013	109.0	K
2005	4000.0	K	2014	15500.0	K
2006	68.0	K			

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Program PeakFq　　U. S. GEOLOGICAL SURVEY　　Seq.006.004
Ver. 5.2　　Annual peak flow frequency analysis　　Run Date / Time
11/01/2007　　following Bulletin 17-B Guidelines　　05/22/2015 15:56

Station - 09419507 MUDDY RV AT LEWIS AVENUE AT OVERTON, NV

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	BULL.17B ESTIMATE
2014	15500.0	0.0556	0.0556
2005	4000.0	0.1111	0.1111
2012	2000.0	0.1667	0.1667
1998	1300.0	0.2222	0.2222
2007	960.0	0.2778	0.2778
2011	690.0	0.3333	0.3333
2000	444.0	0.3889	0.3889
2002	223.0	0.4444	0.4444
2013	109.0	0.5000	0.5000
2009	105.0	0.5556	0.5556
2010	83.0	0.6111	0.6111
2006	68.0	0.6667	0.6667
2008	66.0	0.7222	0.7222
1999	51.0	0.7778	0.7778
2003	40.0	0.8333	0.8333
2001	37.0	0.8889	0.8889
2004	30.0	0.9444	0.9444

1

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 End PeakFQ analysis.
   Stations processed :       6
   Number of errors   :       0
   Stations skipped   :       0
   Station years      :     232

Data records may have been ignored for the stations listed below.
(Card type must be Y, Z, N, H, I, 2, 3, 4,  or *.)
(2, 4, and * records are ignored.)

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  09416000       USGS MUDDY RV NR MOAPA, NV


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  09417300       USGS CALIFORNIA WASH NR MOAPA, NEV


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  09418700       USGS MEADOW VALLEY WASH NR ROX, NV


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  09418990       USGS WEISER WASH NR GLENDALE, NV


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  09419000       USGS MUDDY RV NR GLENDALE, NV


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  09419507       USGS MUDDY RV AT LEWIS AVENUE AT O


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:
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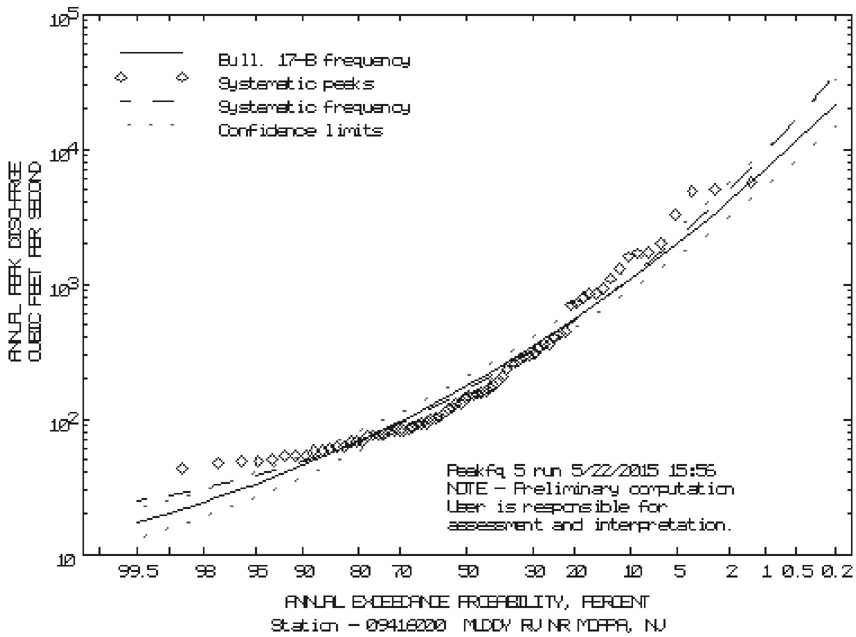
Bull. 17-B frequency
Systematic peaks
Systematic frequency
Confidence limits
ANNUAL PEAK DISCHARGE
CUBIC FEET PER SECOND
Peakfq 5 run 5/22/2015 15:56
NOTE - Preliminary computation
User is responsible for
assessment and interpretation.
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ANNUAL EXCEEDANCE PROBABILITY, PERCENT
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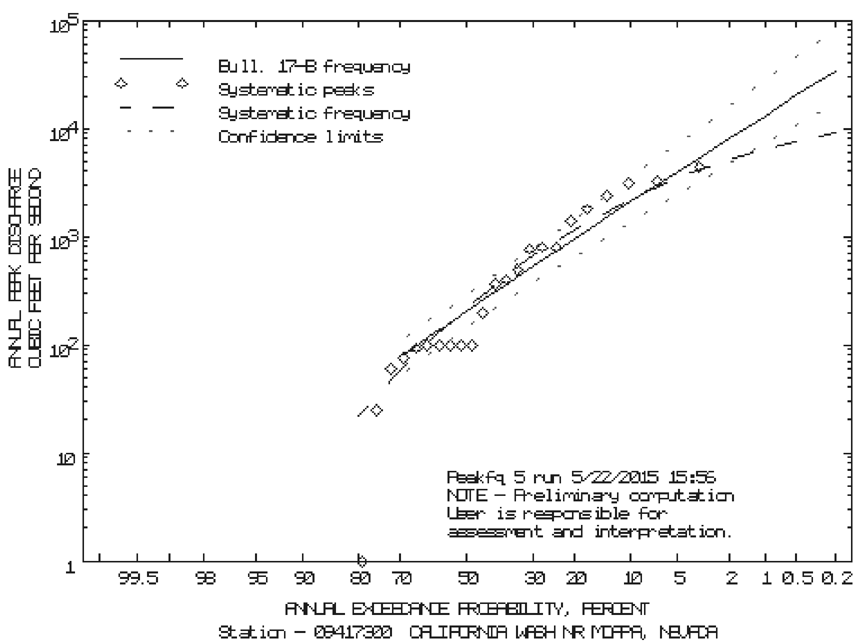
Bull. 17-B frequency
Systematic peaks
Systematic frequency
Confidence limits
ANNUAL PEAK DISCHARGE
CUBIC FEET PER SECOND
Peakfq 5 run 5/22/2015 15:56
NOTE - Preliminary computation
User is responsible for
assessment and interpretation.
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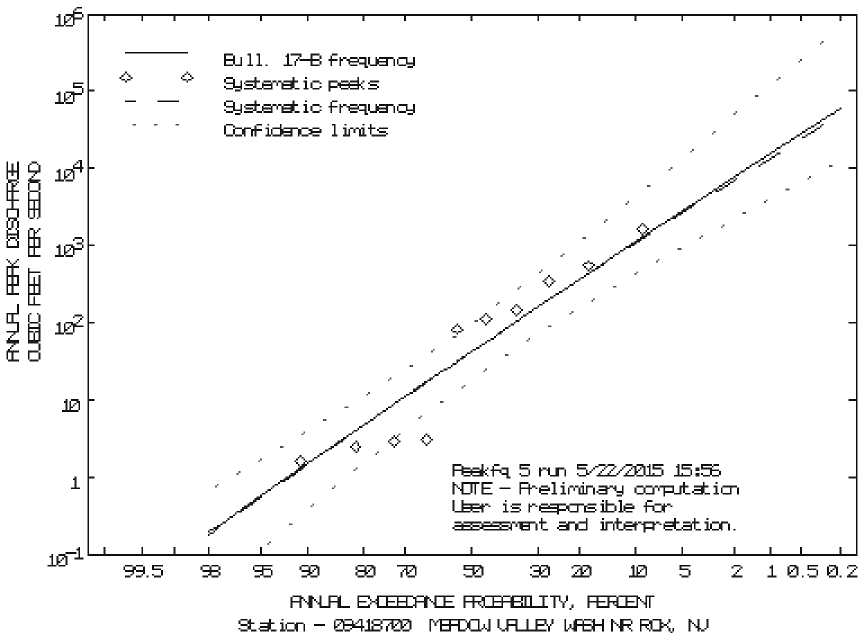
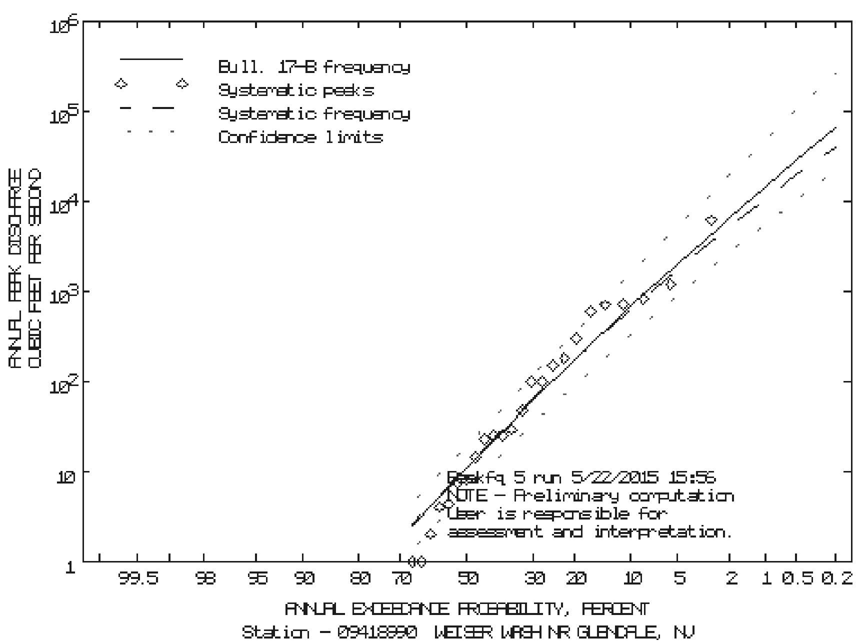
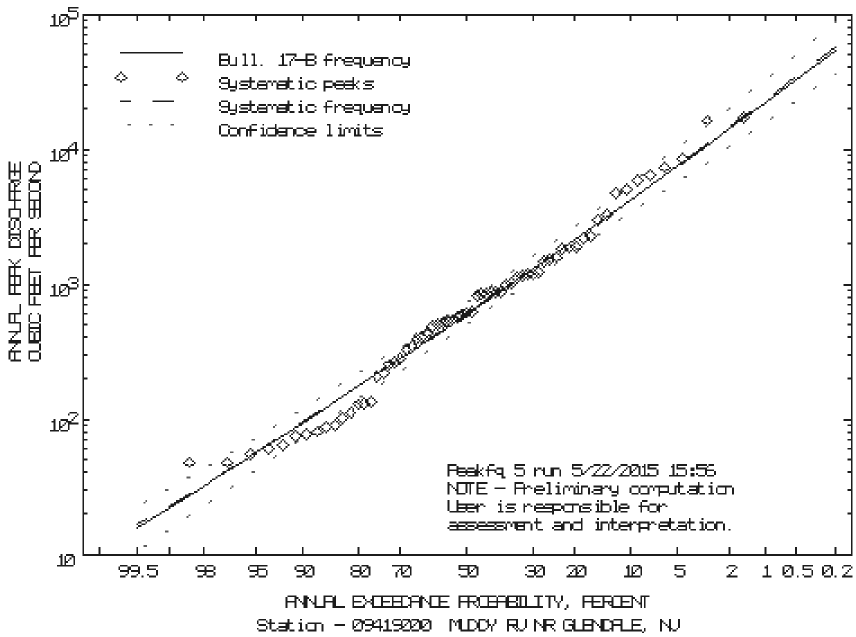
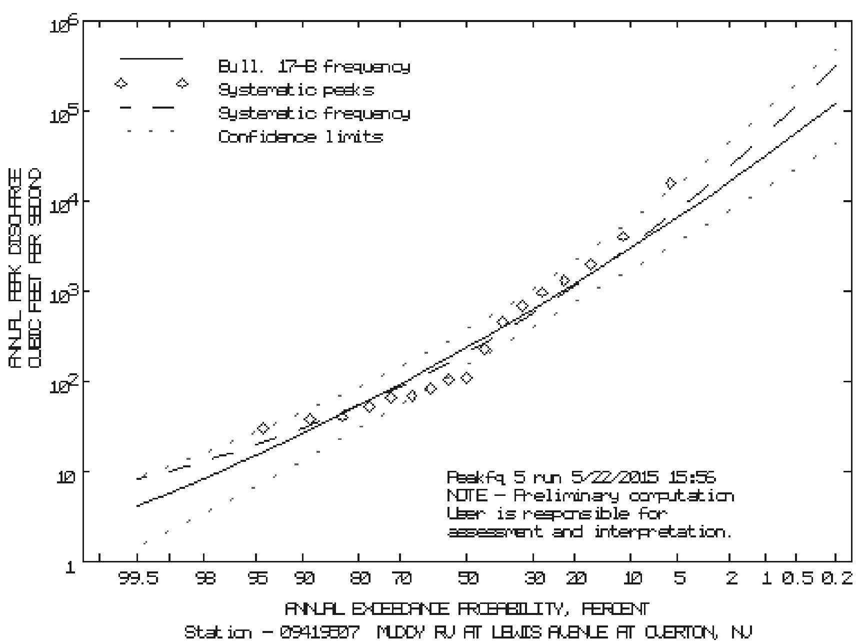

Bull. 17-B frequency
Systematic peaks
Systematic frequency
Confidence limits
ANNUAL PEAK DISCHARGE
CUBIC FEET PER SECOND
Peakfq 5 run 5/22/2015 15:56
NOTE - Preliminary computation
User is responsible for
assessment and interpretation.
ANNUAL EXCEEDANCE PROBABILITY, PERCENT
Station - 09418700 MEADOW VALLEY WASH NR ROX, NV


Bull. 17-B frequency
Systematic peaks
Systematic frequency
Confidence limits
ANNUAL PEAK DISCHARGE
CUBIC FEET PER SECOND
Peakfq 5 run 5/22/2015 15:56
NOTE - Preliminary computation
User is responsible for
assessment and interpretation.
ANNUAL EXCEEDANCE PROBABILITY, PERCENT
Station - 09418890 WEISER WASH NR GLENDALE, NV


Bull. 17-B frequency
Systematic peaks
Systematic frequency
Confidence limits
Peakfq 5 run 5/22/2015 15:56
NOTE - Preliminary computation
User is responsible for
assessment and interpretation.
ANNUAL PEAK DISCHARGE
CUBIC FEET PER SECOND
ANNUAL EXCEEDANCE PROBABILITY, PERCENT
Station - 09419000 MUDDY RV NR GLENDALE, NV


Bull. 17-B frequency
Systematic peaks
Systematic frequency
Confidence limits
Peakfq 5 run 5/22/2015 15:56
NOTE - Preliminary computation
User is responsible for
assessment and interpretation.
ANNUAL PEAK DISCHARGE
CUBIC FEET PER SECOND
ANNUAL EXCEEDANCE PROBABILITY, PERCENT
Station - 09419507 MUDDY RV AT LEWIS AVENUE AT OVERTON, NV

Appendix D

Flood History and Master Plan History

- Appendix D-1: Historical Storms and Town Advisory Board History
- Appendix D-2: History of the Flood Control Master Plan
- Appendix D-3: Progress Meeting Minutes and Town Advisory Board Meeting Minutes

Appendix D-1

Historical Storms and Town Advisory Board History

HISTORICAL STORMS AND TOWN ADVISORY BOARD HISTORY

HISTORIC STORMS

Historical accounts of flooding and storms are included in this report to provide a qualitative analysis of the flooding conditions in the Moapa Valley. Reports of flooding in the Upper and Lower regions of the Moapa Valley date back nearly one hundred years. The following historical accounts of major storms/floods have been recorded concerning the Moapa Valley.

Year	Description
1906	"Medium to large flood on March 25 caused considerable damage to the Union Pacific Railroad. Peak discharge was estimated at 8,850 cubic feet per second (cfs) near the "Narrows" on the Muddy River (River Mile 18)." (Reference 24)
1907	"Medium to large flood on February 23 and March 5 caused greater damage to Union Pacific Railroad than 1906 flood. Flow estimated to be 9,000 cfs at Glendale." (Reference 21)
1908	"Minor washout occurred on Union Pacific Railroad." (Reference 24)
1910	"Largest general flood known prior to 1910 occurred on January 1 and almost completely destroyed 84 miles of railroad along Clover Creek and Meadow Valley Wash and severely damaged agricultural property in the Lower Moapa Valley and in the Panaca Valley. Peak discharges were estimated at 11,000 cfs at Caliente on Meadow Valley Wash (Stream Mile 73), and at 7,000 cfs at the Wells Siding Dam site on the Muddy River (River Mile 15)." (Reference 24)
1911	"Small floods occurred on January 25 and March 9 and damaged about 8 miles of railroad along Meadow Valley Wash and agricultural property in the Lower Moapa Valley." (Reference 24)
1912	"Small flood damaged farm property and crops in the Lower Moapa Valley. . . .Flow estimated to be 3,500 cfs at Glendale." (Reference 24)
1913	"Minor flood damaged farm property and crops in the Lower Moapa Valley. . . .Flow estimated to be 2,900 cfs at Glendale." (Reference 24)
1914	"Flood of February 22 was recorded as a destructive flood. Extensive damage to

Year	Description
	agricultural property occurred throughout the Meadow Valley Wash basin and the Lower Moapa Valley. Peak discharge was estimated at 6,500 cfs near St. Thomas, now submerged by Lake Mead. Flow estimated by USGS to be 9,100 cfs at Glendale." (Reference 24)
1919	"Minor flash floods of the cloudburst type occurred on July 18 and 28 and damaged the railroad in the vicinity of Rox on Meadow Valley Wash (Stream Mile 18)." (Reference 24)
1922	"Medium flood on January 2 damaged roads, railroads, and agricultural property along Clover Creek, Meadow Valley Wash and the Lower Muddy River. Peak discharge was estimated at 8,110 cfs at Wells Siding Dam site on the Muddy River (River Mile 15)." (Reference 24)
1922	"On August 17, 1922, a large flood damaged much of the Moapa Valley. The flood came through Arrow Canyon into the upper end of the valley and was augmented by flow from side washes emptying into the valley. Roads and bridges were washed out, the drugstore and many houses were flooded in Overton. The estimated discharge for the lower Moapa area was 8,110 cfs." (Reference 21)
1923	"Small flood caused some damage to the Lower Moapa Valley. Flow estimated to be 4,300 cfs at Glendale." (Reference 21)
1924	"Minor flood caused slight damage in the Lower Moapa Valley. Flows estimated to be 3,600 cfs at Glendale." (Reference 21)
1925	"Medium to large flood on September 18 caused damage throughout the Muddy River basin. Peak discharges were estimated at 1,500 cfs at Arrowhead Canyon Dam on the Muddy River and 10,200 cfs at spreading grounds on Meadow Valley Wash (Stream Mile 7). Flow estimated by Nevada State Engineer's Office to be 11,100 cfs at Glendale." (Reference 21)
1926	"Flood on July 27 caused damage on the Upper Muddy River. No record of magnitude of flood or extent of damage is available." (Reference 24)
1928	"Largest known flood on the Upper Muddy River occurred." (Reference 24)
1934	"Second largest known flood on the Upper Muddy River occurred." (Reference 24)

Year	Description
1937	"Small flood caused slight damage to roads, bridges, and farmland in the Lower Moapa Valley. Flow estimated to be 2,500 cfs at Glendale." (Reference 21)
1938	"Largest general flood in the history of the Muddy River Basin occurred on March 3. The flood severely damaged the railroad; inundated a large residential section of Caliente on Meadow Valley Wash (Stream Mile 73) and stores and homes in Logandale on the Muddy River (River Mile 12); and severely damaged irrigation works, crops, roads, bridges, farmland, and dwellings in the Lower Moapa Valley, in the Panaca Valley, and between Joseco and Rox, a distance of 77 miles. Peak discharges were estimated at 15,000 cfs at Caliente, 3,500 cfs at Wells Siding Dam site on the Muddy River (River Mile 15)." (Reference 24)
1939	"Flash flood occurred in the Upper Moapa Valley in September and caused the most severe damage to the Moapa Indian Reservation. Peak discharge was estimated at 1,700 cfs at Arrowhead Dam on the Muddy River." (Reference 24)
1941	"Flood, which originated in a small wash near Panaca, occurred on July 24. The flood damaged much farmland and destroyed part of the highway and railroad in the Panaca Valley, and washed out the Union Pacific Railroad main line near Farrier. Peak discharge was estimated at 2,000 cfs near Panaca on Meadow Valley Wash (Stream Mile 88)." (Reference 24)
1941	"Intense short-duration storm occurred on August 11 in the Lower Muddy River Basin and resulted in largest estimated peak flow prior to 1981 known on California Wash and the lower Muddy River. The flood severely damaged the town of Overton by floodwaters from Overton Creek and also damaged agricultural and railroad property. Peak discharges were estimated at 10,000 cfs in California Wash near mouth and at 12,000 cfs in the Muddy River channel in the Lower Moapa Valley." (Reference 21) "On August 11, 1941, the largest flood recorded at that point in time in the Lower Moapa Valley occurred. An intense short-duration storm over the Lower Moapa Valley and California Wash produced estimated discharges of 10,000 cfs at California Wash and 12,000 cfs at Glendale." (Reference 24)
1945	"Small to medium flood occurred in July and caused considerable damage in the lower Muddy River Basin, especially in the town of Overton. The flood washed out

Year	Description
	part of the main line of the Union Pacific Railroad along lower Meadow Valley Wash, delaying trains for several hours." (Reference 24).
1946	"Medium to large flood occurred on October 28 and caused extensive damage to the Union Pacific Railroad, agricultural property, and highways in the Meadow Valley Wash and the lower Muddy River Basins. Peak discharge was estimated at 8,400 cfs in Meadow Valley Wash near mouth." (Reference 24)
1955	"A flash flood on August 26 caused residents to sandbag property in the Logandale area and attempt to divert a flood in which six feet of water ran down the Meadow Valley Wash." (Reference 21)
1960	"Flood of November 6 was reported to have a major disaster in the Moapa Valley area. The *Las Vegas Sun* issue of November 7, 1960, reported that the Muddy River spilled its banks to a distance of one-half mile in both directions, unleashed a torrent of destruction, drove people from their homes, and put highways and farmlands under more than two feet of water in many places. The *Las Vegas Sun* correspondent, Lois Perkins, reported that the Muddy River around Overton was tumbling big trees end over end and was making its own channel in many places. The *Las Vegas Review-Journal* indicated that local farmers saw their year's work destroyed when the raging floods covered fields of growing vegetables. The Union Pacific Railroad reported that service on its Moapa Valley branch was at a standstill because of a large amount of washouts." (Reference 21) "Flow was estimated to be 7,400 cfs in Glendale." (Reference 24)
1981	"The main rainfall on August 10 occurred over the North Muddy Mountains and flowed from there to the north and east, thus involving Overton in a flood advance from two directions. Extensive damage occurred in California Wash and the Upper Moapa Valley downstream. Seven hundred twenty-five milk cows drowned in the Hidden Valley area. The U.S. Geological Survey (USGS) estimated that the flow from California Wash into the Muddy River, immediately upstream from the Glendale bridge, was 50,000 cfs. In computing figures from the FEMA maps, the U.S. Army Corps of Engineers previously estimated the 100-year flood flow at Glendale to be 21,000 cfs and the Probable Maximum Flood (standard project flood) flow to be 47,000 cfs. This water continued down the course of the Muddy River into the Lower Moapa Valley where it flooded several locations including the low-lying area east of

Year	Description
	Overton. At the same time, the rainfall was also filling Overton Wash, which sent a flash flood directly from the west, causing extensive damage to the levee and a mobile home park." (Reference 21)
1981	"The 1981 event was the result of a severe thunderstorm that occurred on August 10, 1981, moving from north to south across southeastern Nevada. Heaviest rainfall was reported over the Moapa Valley with at least one inch of rain falling over approximately 280 square miles. In the area of greatest intensity, 6.5 inches of rain was estimated to fall in less than one hour." (Reference 21)
1983	"A large flood hit Meadow Valley Wash and Lower Moapa Valley on March 3, 1983. The estimated discharge was 10,000 cfs for Meadow Valley Wash. The flow at Glendale is estimated to be 5,100 cfs." (Reference 21)
1984	"A series of thunderstorms swept through Southern Nevada in July and August 1984 and caused flooding in the Las Vegas Valley, the Moapa Valley, and the City of Boulder City. The total storm depth at the City of Boulder City was 3.25 inches in a 2.5-hour period." (Reference 21) "The flow at Glendale is estimated to be 5,830 cfs." (Reference 24)
1990	"Intense rainfall began at Valley of Fire State Park at approximately 8:00 p.m. on June 9. A Regional Flood Control District Warning System rain gauge at the park reported 0.67 inches between 8:00 and 10:30 p.m. There have been no reports of damage resulting from this event other than minor debris deposits on roads " (Reference 25) "On June 10, very significant stream flow in California Wash at Glendale was reported by USGS personnel the following day. The Wash was reported to have risen very quickly to an estimated maximum depth of twelve (12) feet. This estimate was confirmed by Mr. Jack Tuls, Jr. (Hidden Valley Dairy). Mr. Tuls estimated the flow as being twelve feet deep and 200 feet wide." (Reference 25)
1990	"Intense, localized thunderstorms, typical of the summer "monsoon" season in the southwest, moved across eastern Clark County in the early morning of July 8, 1990. These storms caused localized flooding in the Moapa Valley. There were no reports of damages to public facilities. Fill under the Union Pacific Railroad tracks was washed out at many points, including immediately south of the Amber and Lake Mead

Year	Description
	railroad sidings in Moapa Valley.
	"A total of 1.02 inches was recorded at a gauge west of Logandale for a 3-hour period, while another gauge southwest of Overton recorded 0.67 inches. Valley of Fire State Park reported 1.09 inches of rainfall.
	"Sediment laden flow from the Overton Wash across SR 169 closed that highway for an unknown length of time. At its peak, flow in the Overton Wash was approximately 6 feet deep. No damage resulting from this flow has been reported." (Reference 25)
1990	"A thunderstorm caused flooding across the North Shore Road at a number of locations in the Overton Beach area in the early evening on July 13. No significant damage to either private or public property has been reported as being attributed to these flows. A CCRFCD station located at the Valley of Fire State Park recorded 0.55 inches of rainfall in a 75-minute period. The station also recorded a 36-degree fall in the temperature in a 2-hour period, accompanied by winds in excess of 35 mph." (Reference 25)
1990	"During this August 15 event, a total of 2.48 inches of rainfall was recorded in a 90-minute period at the CCRFCD gauge west of Logandale; 2.20 inches of this rain was within a 45-minute period.
	"A CCRFCD/USGS gauge on Warm Springs Road at the Muddy River recorded 1.97 inches of rainfall. The CCRFCD gauge north of the Valley of Fire Visitors Center reported 1.30 inches, and 1.60 inches was reported at the Visitors Center. Other rain gauges in the area reported only moderate rainfall amounts. The NWS has characterized this storm as a mesoscale convective complex similar in nature to the severe storm in the same area in 1981.
	"Major stream flow in the Muddy River as well as in many normally dry washes resulted from this rainfall. The Muddy River was 4-5 feet deep over the Warm Springs Road bridge of Glendale. The USGS has preliminarily estimated the flow at this location to have been 4,000 cfs. Pahranagat Wash, a major tributary to the Muddy River, has been preliminarily estimated to have had a peak flow of 4,000 - 5,000 cfs. USGS staff advise that this is the largest peak flow recorded for that Wash.

Year	Description
	"Major flows were also experienced along Meadow Valley Wash and Weiser Wash, both tributary to the Muddy River. However, while the Gubler Avenue and Cooper Avenue crossings over the Muddy River were closed due to water flowing over the roadway, the flow in the Muddy River through Logandale and Overton was within the channel's capacity at other locations. The Gubler Avenue crossing suffered some damages as a result of this flow. "With the exception of the Gubler Avenue crossing, the flood waters which caused damage to the Lower Moapa Valley appear to have originated from the many washes flowing into the Valley from the west. Logan (Benson) Wash was the source of damaging flows impacting Logandale. Flow from this and other washes caused a reported $250,000 in damages to the UPRR tracks on the western edge of the Valley. Overton Wash was flowing approximately 5 feet deep over SR 169; no damages have been attributed to flow in Overton Wash. "Flow in California Wash north of I-15 removed the pavement at the Hidden Valley Road dip-section. This flow also caused minor damage to the Hidden Valley Dairy. "The current estimate of damages to public facilities in the Moapa Valley as a result of this event is $100,000. No estimate of private property damage is available at this time." (Reference 25)
1990	"September 18, 1990: The most intense rain was recorded at a CCRFCD gauge located approximately 7 miles southwest of Glendale. A total of 1.97 inches of rain was recorded over a one-hour period at this location. Other CCRFCD gauges in the Moapa Valley recorded 0.04-0.12 inches of rain. "As a result of this rainfall, a few normally dry washes experienced some flow. The USGS has a preliminary estimate of 500-600 cfs (2-2.25 feet deep) in California Wash at Hidden Valley Road. NDOT has reported that Overton Wash was flowing up to 8 feet deep across SR 169 and deposited nearly 3 feet of mud in the roadway. According to Clark County Public Works, Wieber Wash did not experience any flow, but minor flow did occur in Logan (Benson) Wash. Neither the Gubler Avenue nor Cooper Avenue crossings of the Muddy River were over-topped." (Reference 25)

Year	Description
1991	"July 6-8, 1991: A moist unstable air mass typical of the monsoonal flow spawned numerous thunderstorms in Southern Nevada over the period of July 6-8, 1991. The most rainfall recorded at any of the District's remotely located gauges was 0.87 inches at Meadow Valley Wash, 11 miles north of Glendale. Most of this rainfall occurred within a one-hour period." (Reference 25)
1992	"February 12, 1992: A very wet weather system from the Pacific Ocean moved through southern California and into Clark County on the evening of February 12, 1992, dropping an unseasonably large amount of rainfall throughout the area. Rainfall in the Clark County area began shortly after 4:00 p.m. and continued intermittently until 1:30 a.m. Rain gauges in the vicinity of the Glendale recorded between 0.91 inches and 1.46 inches of rain." (Reference 25)
1992	"October 24, 1992: The rainfall for this storm was associated with a low pressure system which moved inland from the Pacific Ocean on October 22. The National Weather Service issued a Flash Flood Watch at 3:30 a.m. on October 24 and let the watch expire at 9:00 p.m. Rain gauges in the vicinity of Overton, Logandale, and Glendale recorded between 0.248 inches and 2.09 inches of rain." (Reference 25)
1993	"February 8, 1993: A powerful Pacific Ocean storm system moved through the Southern California area and into Clark County on February 8, 1993, dropping an unseasonably large amount of rainfall throughout the area. The Clark County Public Works Department (CCPW) reported that extended above-normal flow in the Muddy River caused the loss of some pavement at the Gubler Avenue crossing in Logandale and resulted in the closing of that road for a few hours until repairs were affected. Rain gauges in the vicinity of Overton, Logandale, and Glendale recorded between 0.91 inches and 2.09 inches of rain." (Reference 25)
1996	"July 28, 1996: The Overton Wash experienced flow to a depth of 6 feet where it crosses State Route 168 south of Overton. Rain gauges in the vicinity of the Overton, Logandale, and Glendale areas recorded between 0.00 and 0.63 inches of rain."
1998	"Severe weather moved through the Las Vegas Valley and northeast Clark County beginning late in the morning on September 11, 1998, causing wide-spread drainage problems and other damages. While the rainfall intensities and depths recorded in many parts of the County were not atypical of warm season convective storms in the

Year	Description

region, perhaps the most notable feature of this storm system was the size of the area which was impacted. Based on weather radar images it is estimated that 40 percent of the County may have received up to one inch of rainfall or more.

"The rainfall depths recorded in the California Wash and Muddy River drainages were far more impressive than those recorded in the Las Vegas Valley. For the twelve-hour period ending at midnight on September 11, four CCRFCD rain gauges in that area recorded in excess of two inches of rainfall, and one of those recorded more than three inches of rain. The resulting runoff in the California Wash at the Hidden Valley Road may have been up to 10,000 cfs. This flow combined with flow in the Muddy River above Glendale and overtopped SR 168 at Glendale, washed out the Gubler Avenue crossing of the Muddy River in Logandale and caused some residential flooding in Overton.

"The storm system moved generally from the southwest to the northeast across the southern and eastern portions of the Las Vegas Valley before moving into the California Wash and Muddy River drainage areas. In the Las Vegas Valley, rainfall began to move into the south end of the Valley between 11:30 a.m. and noon. At approximately 11:30 a.m., the National Weather Service (NWS) office issued a Severe Thunderstorm Warning for Northeast Clark County, including the Moapa Valley, Mesquite, and Bunkerville.

"While the rainfall in the Las Vegas Valley generally took place within a two-hour period, in the drainages impacting the Moapa Valley intense cells appear to have built and re-built a few times throughout the afternoon and evening. Four CCRFCD rain gauges recorded more than 2 inches of rainfall, and one of those recorded over 3 inches. Each of these gauges recorded rainfall rates of 1.15 inches per hour or more. This rainfall generated flows in the California Wash which washed out 150 feet of the paved road east of the Byron exit from I-15. At some time during this storm, runoff was flowing over I-15 in the vicinity of the rest area south of the Glendale/Moapa exit. Flows in the California Wash at Hidden Valley Road may have been in the 7,000-10,000 cfs range (the 100-year flow rate for the California Wash in this area is 14,600 cfs). (Reference 25)

"Flows in the Muddy River overtopped the SR 168 bridge in Glendale and washed out

Year	Description
	the low level crossing at Gubler Avenue in Logandale. According to the damage assessment prepared by the American Red Cross, thirteen homes in the Overton area suffered major damages and two mobile homes in the Glendale/Moapa area were destroyed by flooding. The preliminary USGS estimate of the Muddy River flows two miles below Glendale is 6,500 cfs." (Reference 25)
1999	"July 8, 1999: Torrential rains deluged the Las Vegas Valley the morning of July 8, 1999, causing wide-spread drainage problems and damages to public and private properties. "The National Weather Service issued the first weather advisory at 3:45 a.m., based on heavy rainfall in northern Clark County and southern Lincoln County. Rain in the northern part of the County caused flooding in the Pahranagat Wash, which resulted in the closure of US 93 near SR 168. Throughout the remainder of the day there was concern that this flow would impact the communities of Moapa and Glendale. However, no significant flows reached those areas." (Reference 25)
2004	"The rain Tuesday and Wednesday was enough to make this the wettest December since record keeping began in 1937. Already the fourth wettest year on record, 2004 is on pace to surpass 1965, and its almost 8 inches of precipitation, for third on the list. The two wettest years on record are 1992 with 9.9 inches and 1941 with 10.7 inches." (Las Vegas Review – Journal, December 30) "The total of 7.76 inches of rain for 2004 put it as the fourth wettest year in local weather records kept since 1934." (Las Vegas Sun, August 25)
2005	"With a weak El Nino this winter, weather scientists believe the western United States may be in for a Madden-Julian oscillation, also known as an intraseasonal oscillation. "The Oscillation features a week to 10 days of rainfall, that can bring flooding. The weather service issued a flood watch for Southern Nevada until 9 p.m. Monday. "The "pineapple express" last arrived in California during the winter of 1996-97, according to the National Climate Prediction Center. "The Madden-Julian oscillation is so rare that there has been only three of them in the past century, Redmond said." (Las Vegas Sun, January 4)

Year	Description

"In the Moapa Valley, approximately 250 people were evacuated from their homes in Overton as historic flows in the Meadow Valley Wash swelled the Muddy River. The Meadow Valley Wash flood waters undercut and washed out the UPRR tracks in at least two locations between Moapa and Caliente. Twenty-one freight cars that were parked on this rail line were pulled from the tracks into the flood flows. On January 13, 2005 Governor Kenny Guinn declared a State of Emergency for Clark County because of the flooding."

"The U.S. Geological Survey estimated that flows in the... Meadow Valley Wash (8,600 cfs) [was] the largest [flow] on record... despite the high volume of runoff and large scale damage to property, there were no serious injuries reported as a result of this flooding." (Regional Flood Control District Annual Report 2004/05)

The following information was provided from The Clark County Regional Flood Control District Rain Gages that are in conjunction with the United States Geological Service. Weiser Wash (NE of Glendale) measured 2.01" in approximately 90 minutes. Meadow Valley wash north of Glendale recorded 2.52" between 11PM and 12:30AM - just over 0.90" of that was in 15 minutes. (CCRFCD Flood Threat Recognition System Web site, August 1, 2005)

Based on current information provided by the U.S. Geological Survey, flows from January 2005 storms are as follows: Muddy River near Glendale = 8,500 cfs; Meadow Valley Wash near Rox = 7,500 cfs; and California Wash near Moapa = 830 cfs. (E-mail correspondence from USGS representative Roslyn Ryan, November 22, 2005)

SUMMARY OF PREVIOUS FLOOD CONTROL MASTER PLANS

In 1986, the CCRFCD completed a county-wide Flood Control Master Plan (1986 CCMP, Reference 32) which included the Moapa Valley (both upper and lower portions). The Nevada Revised Statutes (NRS) 543.596 requires that updates to the Master Plan be made on at least a five-year interval. The CCRFCD has updated the Upper and Lower Moapa Valley portion of the 1986 CCMP in 1988 (1988 MPU), 1994 (1994 MPU), and 2001 (2001 MPU). The following paragraphs summarize the evolution of the Flood Control Master Plan in the Moapa Valley.

The 1986 CCMP recommended structural flood control improvements on the Lower Muddy River, Logan Wash, Wieber Wash, and the Overton Wash. The 1988 MPU expanded the recommended facilities to include two other washes on the west side of the Lower Moapa Valley. These were referred to as West Wash 1 and West Wash 2, which are situated adjacent to Wieber Wash, on the south and north sides, respectively.

The 1994 MPU modified the recommended plan within the Lower Moapa Valley to combine West Wash 1, West Wash 2, Overton Wash, and Wieber Wash into a collection channel (West Wash Facility) that runs along the west side of the UPRR tracks and discharges flows to the Muddy River via the Overton Wash. The updated 1994 MPU also called for a "High Water Mark Channel" within the Muddy River and for Flood Insurance Study (FIS) mapping.

The 2001 MPU kept the Muddy River "High Water Mark" Channel and the West Wash Facility that runs along the west side of the UPRR tracks. New to the Flood Control Master Plan, the 2001 MPU recommended facilities at the Clark County Fairgrounds.

DETAILED HISTORY OF MPU PROCESS IN THE MOAPA VALLEY

The following information provides a detailed history of the Master Plan process in the Moapa Valley since the original Master Plan was created in 1986.

ACTIONS BETWEEN 1988 MPU AND 1994 MPU

Several flood control projects were proposed within the Moapa Valley area during this time period. However, a general lack of consensus within the community delayed implementation and, in one case, caused the abandonment of a designed facility. Progress of Moapa Valley flood control projects during the period of 1988 to 1994 is listed in detail in the following portion of the report. This information was compiled from meeting minutes and reports.

1989 CCRFCD Board Meetings

- *Benson/Logan Wash Diversion and Channel*: scope of services prepared.
- *Muddy River (West) Levee*: Engineering services negotiated with The Mark Group.

1990 CCRFCD Board Meetings

- *Muddy River (West) Levee*: Contract with The Mark Group for engineering services signed (February 1990). Estimated design cost was $240,000.
- *Muddy River (West) Levee*: Reported that the survey, some right-of-way and geotechnical work completed (March 1990).
- *Benson/Logan Wash Diversion and Channel*: Contract awarded to Dames and Moore for engineering services (May 1990).
- *Benson/Logan Wash Diversion and Channel*: Contract negotiations completed with engineering firm. Design fee was $235,000.
- *Cooper Avenue Crossing at the Muddy River*: Progressive Contracting given notice to proceed (June 1990).
- *Cooper Avenue Crossing at the Muddy River*: Pre-construction conference with contractor (July 1990).
- *Benson/Logan Wash Diversion and Channel*: It was reported that right-of-way acquisition could cause delay since a significant number of parcels were required (November 1990).
- *Benson/Logan Wash Diversion and Channel*: The Moapa Valley Town Advisory Board passed resolution for underground piping extending from the railroad culvert to the Muddy River. This alignment, not addressed in the Master Plan, was adopted by the Moapa Valley (December 1990).
- *Cooper Avenue Crossing at the Muddy River*: Waiting for commission approval of Change Order #1 before beginning closeout of project (December 1990).

1990 Moapa Valley Town Advisory Board (TAB)

During the June 7, 1990, meeting, the Moapa Valley TAB discussed several flood control issues. A request was made by one of the members of the TAB to consider a bicycle/equestrian route along the Muddy River Flood Control Channel. Both the TAB and the audience agreed that the idea should be presented to the County for inclusion in the Muddy River Flood Control Channel project. Another flood control issue discussed at this meeting involved the White Grow Gypsum Mine. The general manager of the mine requested that something be done to the Logan Wash to protect the mine. He was willing to donate men, equipment, and materials for the construction of a diversion dam upstream of the mine. The TAB secretary was instructed to write a letter requesting CCRFCD to meet with representatives of the mine.

The flood control issues addressed at the July 26, 1990, TAB meeting concerned the Logan Wash project and the Muddy River Flood Control Channel. Gale Fraser of CCRFCD and Dennis Cederburg of CCPW presented four alternatives for flood control channels to handle floodwater from the Logan Wash. The final channel would lie between Gubler and Cappalappa in the area of the railroad tracks and extend to the Muddy River Channel. All four alternatives were designed to handle the 100-year design storm. In conjunction with this project, a diversion dam was proposed to divert floodwater from the Logan Wash to the Anderson Wash.

The TAB questioned the CCRFCD about the status of the river maintenance project planned for the Muddy River. The County had been unable to reach an agreement with one of the property owners along the river concerning an easement. Subsequently, funds for the river maintenance project had been diverted to the Cooper Avenue Crossing project.

As of the August 2, 1990, TAB meeting, no resolution to the easement to allow the maintenance of the Muddy River Channel had been reached. The TAB chairman had researched the floods of 1981 and 1984 that had impacted the Cooper Avenue Crossing. His conclusion was that, if an individual builds within the "floodplain," he assumes liability. If the County builds flood control improvements and alters the natural flow path and/or characteristics, then the County assumes liability for damage to impacted properties. Both the TAB and the ad-hoc committee expressed hostility towards the County, and the TAB chairman suggested that the best way to get action was to take the County to court.

William C. Brandt from CCPW was present at the September 13, 1990, TAB meeting to present the four alternatives for routing the Logan Wash flows through town. Members of the audience, as well as the TAB, expressed the opinion that a channel was not the best way to handle the flows. Objections concerning the channel were as follows:

- The open channel would not be maintained.
- Flows would not be confined within the channel due to the several 90-degree turns that it would have to make.
- The area that the channel was located in had not flooded before.
- The new channel would devalue adjacent properties.

One member of the audience suggested that the storm flows should be routed underground down Gann Avenue and across Wayne Newton's property. A motion was put forward and carried by the TAB to reject the four channel alternatives and recommend that the County study an underground pipe.

A revised plan for the Logan Wash project, incorporating an underground facility, was presented to the TAB at the December 6, 1990, meeting. Design completion date was estimated to be May 1991. The TAB and the audience voiced unanimous approval for the revised project. Concern was expressed that the upstream diversion dam be completed as soon as possible.

1991 CCRFCD Board Meetings

- *Benson/Logan Wash Diversion and Channel*: Recommended approval of the inter-local agreement for the acquisition of right-of-way. Clark County Public Works began right-of-way acquisition (September 1991).
- *Muddy River (West) Levee*: Identification and acquisition of right-of-way and easements involving forty plus property owners was anticipated to be extremely lengthy (November 1991).

1991 Moapa Valley Town Advisory Board

The design engineer for the Muddy River West Levee project gave a brief overview of the proposed plans for the project at the January 17, 1991, TAB meeting. The TAB and members of the audience concurred with the plans as they were presented.

Several flood control projects were at issue at the September 26, 1991, TAB meeting. It was reported to the TAB that the Muddy River Flood Control Channel had been cleared to the boundary line of the Hidden Valley Dairy Farm. Without an easement from the property owner, however, progress on the clearing would be stopped.

The Overton Wash presented problems with regard to easements and access for County maintenance workers. The Overton Wash at the train trestle was in need of clearing. However, the railroad would not allow County workers on the property.

William C. Brandt from CCPW was present at the September 26, 1991, TAB meeting to provide the TAB with a progress report on the Benson/Logan Wash Diversion and Storm Drain. The design work was at 95 percent complete with construction expected to begin in May of 1992. The County was acquiring the necessary land. The TAB questioned the delay of the project from a start date of November 1991 to May of 1992, and requested a time accounting for work done and an explanation of the delay.

It was also reported at the September 26 meeting that the Muddy River (West) Levee was expected to go to bid in the spring of 1992. There would be a substantial number of easements to be obtained, and the TAB might be requested to help in the acquisition. A suggestion was made to include a bridle path in the design plans.

1992 CCRFCD Board Meetings

- *Benson/Logan Wash Diversion and Storm Drain*: CCRFCD staff recommended acceptance of the bid from the contractor (May 1992).
- *Moapa Valley Master Plan Update*: CCRFCD staff requested proposals from engineering firms (May 1992).
- *Moapa Valley Master Plan Update*: Contract negotiated with James Montgomery, Consulting Engineers, Inc. for engineering services (August 1992). Contract in the amount of $120,000 for engineering services.
- *Benson/Logan Wash Diversion System*: Construction Contract awarded to Ron Williams in the amount of $500,000 (November 3 1992)

1992 Moapa Valley Town Advisory Board

The TAB was informed on July 2, 1992, that construction of the culvert below Gann Avenue was scheduled to begin on July 13, 1992. Expected project completion date was December 1992.

Gale Fraser from CCRFCD and Lonnie Roy of James Montgomery, Consulting Engineers, Inc. were present at the October 15, 1992, TAB meeting to discuss the Master Plan Update for the Moapa Valley. Questions concerning flooding at the fairgrounds were raised. Mr. Fraser assured the TAB that there would be an open meeting before anything was decided concerning the fairgrounds. Mr. Roy assured the TAB that they would be reviewing previous flood control facility recommendations and, also, addressing flooding from the east washes.

William C. Brandt from CCPW was also present at the October 15 meeting. The issue of the Muddy River Flood Control Channel easements was raised again. Board members noted that the channel was congested with weeds and debris and in need of cleaning. It was stated by Board members that the channel crosses private property and that right-of-way was required.

The flood control issues addressed at the November 19, 1992, TAB meeting included the Muddy River Flood Control Channel clearing, the Muddy River West Levee, and the Benson/Logan Wash Diversion and Flood Control Project. A memo read by the TAB chairman stated that the Muddy River Pilot Channel was built from the fish and game area to the Hidden Valley Dairy Farm. However, an easement could not be obtained from the dairy farm and the project had ceased. The TAB had been asked to help in this matter, but was also unsuccessful in obtaining the necessary easement.

Right-of-way research for the Muddy River (West) Levee identified 73 parcels that would require easements. Construction was estimated to be completed in 1993 or 1994. The design for the levee was at 70 percent, and the Benson/Logan Wash project was progressing. The lower portion of the Benson/Logan Wash project was currently under construction, and the contract for the diversion dam would be awarded soon.

1993 CCRFCD Board Meetings

- *Benson/Logan Wash Diversion Channel Area 2*: The project status report noted that there were some delays to the project caused by rain and the acquisition of right-of-way across Wayne Newton's property. In-house design and change order for two 10-foot diameter cast-in-place pipes were approved. Change order amount was $200,000. Work to be completed that month involved project close out (June 1993).
- *Muddy River (West) Levee*: It was reported that the project schedule and dates would be revised once project problems were resolved. Right-of-way acquisition from 60 plus owners would be extremely lengthy. Right-of-way issue ongoing (July 1993).
- *Moapa Valley Master Plan Update*: It was reported that the Master Plan Update was 70 percent completed waiting for comments from CCPW (August, 1993).
- *Moapa Valley Master Plan Update*: It was reported that a revised draft based on review comments was being prepared (September 1993).

1993 Moapa Valley Town Advisory Board

Mr. Lonnie Roy of James Montgomery, Consulting Engineers, Inc., the engineer for the MPU, was present at the January 7, 1993, TAB meeting to present the initial alternatives for the update. He asked for input from the community so that cost estimates could be done for the next meeting. The three alternatives presented were:

- Levee on the Muddy River.
- Channel above the existing Muddy River high water mark.
- Total Channelization of the Muddy River.

Chairman Perkins of the TAB was updated on the progress of two of the flood control jobs under construction at that time by a letter from the CCPW dated January 14, 1993. Earthwork was underway for the Benson/Logan Wash Area I (Diversion Dam). The pipeline for the Benson/Logan Wash Area II (Railroad to Muddy River) was completed and the contractor was finishing the inlet and outlet structures for the underground pipe.

The consultant developing the MPU was on hand at the February 18, 1993 TAB meeting to give the cost estimates for the MPU alternatives. The projects and their associated costs were as follows:

- Muddy River Levee (on either side), $7.3 million.
- Total Channelization, $17 million.
- Channel above the high water mark, $8.8 million.

All three of the alternatives have a bridge replacement at Cooper Avenue Crossing. There were no decisions at this meeting as to the preferred option. The consultant also had cost estimates for the flood control projects at the west washes. The projects and associated costs were as follows:

- Channel along the west side of the UPRR tracks, $5.2 million.
- Individual channels for the Overton and Wieber Washes, $7.4 million.

1994 CCRFCD Board Meetings

- *Benson/Logan Wash Diversion Channel*: CCRFCD funds allocated for environmental mitigation (January 1994).
- *Muddy River (West) Levee*: Project engineering services contract termination discussed. Project delayed until resolved (January 1994).
- *Moapa Valley Master Plan Update*: Reported that the draft was being revised per review comments (January 1994).
- *Muddy River Flood Insurance Study Restudy*: G. C. Wallace, Inc. selected as consultant (July 1994). Estimated cost of project was $224,000.
- *Muddy River (West) Levee*: Awaiting adoption of Master Plan Update. Scope change in Master Plan Update (December 1994).

1994 Moapa Valley Town Advisory Board

Flood control issues for the Moapa Valley generally centered around the Muddy River. Although several issues were discussed during the 1994 TAB meetings, the clearing of the Muddy River channel was the most prominent flood control issue during 1994.

Citizens disagreed with County engineers on what should be done to alleviate flooding in the Moapa Valley. The view was expressed that the focus of the ongoing Master Plan Update did not coincide with what the citizens of Moapa Valley wanted. The "Dike or Levee" option for the Muddy River that had been presented was strongly opposed by the community due to the numerous side washes and the Cooper Avenue Crossing. Some interest was expressed in a detention basin option. Commissioner Bruce Woodbury noted that this alternative had been studied in the original Master Plan, but had not been considered a viable alternative. Commissioner Woodbury assured the TAB that the County would never implement a flood control alternative without community approval.

During the TAB meeting on April 7, 1994, the consultant developing the MPU proposed three alternatives to the Muddy River flooding issue. These three alternatives were part of the draft Master Plan Update report. The three alternatives presented were:

1. Construction of levees on both sides of the river channel. The proposed levees would be approximately 8 feet to 10 feet in height and would include a bridge at Cooper Avenue Crossing.
2. Total channelization of the river.
3. Channelization of the river above the high water mark only.

The TAB members noted the need for an interim solution for the flooding of the Muddy River involving the clearing of the channel. Residents felt that full and permanent protection from the 100-year event ultimately would be necessary. However, a more immediate solution was required. Several members had also proposed several alternative solutions of their own. These included (1) cutting a channel all the way to the lake and (2) cleaning out and sloping the channel.

The consultant also presented two alternatives for the Western Washes. These alternatives were:

1. Take flow from each of the washes straight through town in individual channels to the West Branch of the Muddy River.

2. Construct a channel along the west side of the railroad tracks and route the storm runoff to the Overton Wash and then to the Muddy River. Because this option involves only one crossing of the valley floor, it would be the most cost effective.

Funds in the amount of $1.8 million for right-of-way acquisition had been allocated in the 1994 - 1995 budget, and Commissioner Woodbury stated that funding for construction would be available within the next two years. Right-of-way acquisition would affect approximately 32 property owners along the channel. Per TAB meeting minutes from March 13, 1985, $265,000 had been allocated to clear the flood control channel. However, the money had never been used, and the TAB wanted an itemized account of the money and any interest that had accrued.

The 1994 Master Plan Update for the Moapa Valley presented by the CCRFCD and Montgomery Watson was well received by the TAB. The citizens in attendance were pleased by the recommended plan for flood control, and the TAB unanimously accepted the plan.

ACTIONS BETWEEN 1994 MPU AND 2001 MPU

The following information was compiled from meeting minutes and reports on record between the 1994 MPU and the 2001 MPU. Following the adoption of the 1994 MPU, several projects for the recommended facilities were started. A predesign report for the Muddy River Riverine Enhancement was developed for the "Normal High Water Mark" Channel Alternative. A Flood Insurance Study Restudy was also developed for the populated areas of both the Upper and Lower Moapa Valley.

1995 CCRFCD Board Meetings

- *Moapa Valley Master Plan Update*: CCRFCD adopted the *1994 Master Plan Update for Moapa Valley* (January 1995).
- *Muddy River Flood Insurance Study Restudy*: On schedule except for a one-month delay due to complications with topographic mapping (November 1995).

1995 Moapa Valley Town Advisory Board

The two issues that were predominately discussed during the 1995 TAB meetings concerned the Yamashita Bridge and the Muddy River clearing projects.

Funding was an issue for the Yamashita Bridge project. Some money was located for the project, but it fell short of the estimated $1,360,000 needed to complete the work.

Based on conversations with the County Manager's Office, as of March 16, 1995, no funds had been found to make up the difference in the funding shortfall. The TAB recognized the need for an all-weather crossing in the valley, but was concerned about the high cost of such a structure. While research was done to find additional funds for the Yamashita Bridge, lower cost alternatives were requested from Clark County.

It was reported on January 19, 1995, that the project to clean and straighten the Muddy River channel could begin in eight to twelve months. The channel would be approximately 200 feet wide and would extend from the Ozaki-Marshall Farm area to the Fish and Game Reserve. Community interest centered on the idea of protecting potentially endangered species and the development of multiple-uses (i.e. recreational uses) for the flood control facility. Suggested uses included a bridle path, hiking trails, biking trails, and wetland use. Concern was expressed for the Cooper Avenue crossing on the Muddy River, noting that the roadway at that location washed out every time there was a flood on the Muddy River. It was pointed out in the April 20, 1995, meeting that according to the current Flood Control Master Plan, the crossing at that location would be replaced with an all-weather crossing. An interim measure to provide erosion control was suggested at the May 18, 1995, TAB meeting.

1996 CCRFCD Board Meetings

- *Muddy River (West) Levee*: Continued analysis of right-of-way (January 1996).
- *Muddy River Flood Insurance Study Restudy*: FEMA review (February 1996).

1996 Moapa Valley Town Advisory Board

Very little information on flood control projects was included in the TAB meeting minutes throughout the year of 1996. However, members of the TAB met with representatives from the Clark County Habitat Conservation Project to discuss funding for multiple uses of the Muddy River. Funding that had been acquired through Desert Tortoise fees was available for programs that would be of a "conservation" nature, such as the Muddy River habitat. Some suggestions involved using the money to create rock kiosks along the river to describe the natural features in the area. Other suggestions included constructing bird-watching facilities and providing maintenance for the road to the Valley of Fire.

1997 CCRFCD Board Meetings

- *Muddy River*: Problems resolving overlapping title reports in Moapa Valley (December 1997).

1997 Moapa Valley Town Advisory Board

Very little information was included in the meeting minutes for the year 1997. Concern was expressed at the October 16, 1997, meeting regarding the groundbreaking ceremony for the Yamashita Bridge. Right-of-way acquisition had delayed the project. The groundbreaking event was rescheduled for December 1, 1997.

1998 CCRFCD Board Meetings

- *Muddy River*: Project was placed on hold pending resolution of issues (June 1998).
- *Muddy River*: Owners of affected property reacted negatively to the proposed design and offered several alternative suggestions (September 1998).

1998 Moapa Valley Town Advisory Board Meetings

April 16, 1998, TAB Meeting:

The Board was informed that the land acquisition process for the Muddy River Channel Project would take approximately two years; construction could begin as early as 2002. There was opposition expressed by property owners to the clearing of the vegetation and the acquisition of land along the Muddy River as outlined in the project. Some of the property owners felt that the dam at the Overton Wildlife Management Area should also be removed as part of the project.

Based on the concerns expressed at the TAB, a meeting to discuss the proposed project and project impacts was scheduled for May 7 prior to the regularly scheduled TAB meeting.

May 7, 1998, Moapa Valley-Muddy River Meeting: The meeting was attended by Commissioner Bruce Woodbury who committed to those present that the County would not force a project that did not have the support of the local residents. Gale Fraser and Kevin Eubanks from CCRFCD outlined the Flood Control planning and implementation history in the Lower Moapa Valley and, specifically, for the Muddy River. There was a large contingent of local residents attending the meeting. A number of local residents spoke both for and against the Muddy River Channel Project. However, the majority of those in attendance were opposed to the project. As a result, it was decided to obtain the services of a facilitator and form a Moapa Valley Flood Control Advisory Committee to evaluate the project options, constraints, and impacts to the community in order to provide community direction and support. The Advisory Committee would be made up of representatives from all interested parties, i.e., those who are for the project, those who are against the project, those property owners that are involved in takes as part of the project, those property owners whose properties are enhanced by the project, and the community at large.

October 1, 1998 TAB Meeting: Commissioner Bruce Woodbury and the Flood Control District met with the Town Advisory Board and interested citizens. The TAB was notified that the Flood Control District had hired a facilitator and possible names were discussed for inclusion on the Moapa Valley Flood Control Advisory Committee.

1998 Moapa Valley Flood Control Advisory Committee Meetings

Meeting #1 Moapa Valley Flood Control Advisory Committee, November 19, 1998: On November 19, 1998, the first Moapa Valley Flood Control Advisory Committee meeting was held. Jason Associates was hired by CCRFCD at a cost not to exceed $24,950 to act as a facilitator for the meetings. The facilitator's role was mainly to serve in an administrative capacity: to give all committee members an equal opportunity to speak and to ensure that all perspectives were heard, valued, and recognized. Principles of participation provided a set of ground rules to which the committee agreed in order to gain a common understanding of what the committee was trying to accomplish.

Committee members voiced concerns for numerous aspects of the flooding problem in the Moapa Valley. One committee member stated the opinion that Moapa Valley had not had fair representation from the CCRFCD, but had taken a "second seat" to other communities in the area (Reference 29). Since the early 1980s, Moapa Valley had suffered about one-fifth of the damage incurred by flooding in Clark County. However, while flood bonds had been passed for approximately $7 million, Moapa Valley had only received $300,000.

Concern for the tributary washes was also an issue at this meeting. Many of the committee members felt the flooding problems in the area stemmed from the surrounding washes. "We can't start implementing solutions from the top down. We found out from past flood control projects, people were being flooded in areas that hadn't been flooded before" (Reference 29).

One member objected to the County telling the committee what it could and could not do. Members asked that topographical maps and flood maps, with the washes identified, be provided. Members were informed that staff from G. C. Wallace, Inc. would present flood control information at the next meeting.

Representatives of the CCRFCD were present at the meeting to inform committee members about CCRFCD planning and funding policies. The goal of the CCRFCD is to implement flood control in a logical and systematic way. Everything in the Master Plan would be implemented. The total Moapa Valley Master Plan implementation was estimated at $22 million; a total of $55,983,935 had been identified for all the outlying areas of Clark County. Due to the fact that projects for the Upper Moapa Valley had not been environmentally and economically feasible, no structural solutions had been proposed in the past for this area. However, if solutions could be identified for the Upper Muddy River, they would be included in the plan. Given that the Muddy River is the main artery for storm runoff for the entire watershed, the current flood control plan was to start with the Muddy River and to then radiate outward. The Moapa Valley Flood Control Master Plan was last updated in 1994; it is required by law to be updated every five years.

According to Mr. Fraser of the CCRFCD, a large project requiring a significant amount of money may require phasing over time to accommodate financial resources (Reference 29). Projects are funded on a first-come, first-serve basis. However, if funds are allocated to a program and not used, they get reprogrammed to a different project. The 10-year program adopted for the Muddy River for FY 98-99 is listed in Table 2.4.

Table 2.4
98-99 Yearly Funding Allocation for the Muddy River

Year	Funding Amount (in Millions)
1	$1.7
2	$0.5
3	$0.5
4	$4.7
5	$1.7
6	$2.8
7	$1.2
8	$2.0
9	$5.2

Meeting #2 Moapa Valley Flood Control Advisory Committee, December 22, 1998: The general focus of this meeting was to inform committee members about flood control methods. Representatives from both G. C. Wallace, Inc. and CCRFCD were present to help the committee better understand the drainage situation in the Moapa

Valley so that the committee could develop a consensus on flooding concerns and priorities. Reaching a consensus, the committee could map out their objectives. Maps requested at the previous meeting were presented to the committee.

The discussion focused on standard hydrologic and hydraulic modeling procedures employed in flood studies. The hydrologic model was described as a statistical model that determines rainfall/runoff relationships in a mathematical way. The hydraulic model establishes water surface elevations based on the river cross sections. Both models approximate the 100-year event, which is a nationally used benchmark for flood control. The 100-year storm event conforms to federal regulations and guidelines and is the accepted standard for FEMA.

Clark County has studied weather patterns in the Moapa Valley and the hydrologic modeling was based on historical rainfall depths. The hydrologic models provide 100-year peak flow rates exclusively for the Muddy River stream system and only for the portion of the river upstream of the fish and wildlife dam. Several different peak flow rate values have been calculated for the Muddy River through the Moapa Valley; however, the accepted value for the 100-year storm event is 21,500 cfs. It was pointed out to the committee that there have been many instances of 100-year flood events. The 1981 flood event washed out the stream gauge. However, the peak flow rate in the Muddy River was estimated at 50,000 cfs.

One member of the committee brought a draft of a Muddy River Flood Control Channel Resolution. The resolution called for committee agreement and subsequent updating of the Master Plan for the washes in the rest of the watershed. The resolution defined the Lower Muddy River as an area that extends from Lake Mead to some point upstream of the Cooper Avenue Crossing. In addition to the resolution, he stated that he had a petition with 120 signatures supporting his solution. Questions concerning the use of the models and the reasoning behind using the 100-year event for the modeling were also posed.

In keeping with the planned focus of the meeting, the committee expressed their opinions on the critical flood issues for the Muddy River Area. The following list provides a brief summary of the questions, comments, and answers provided.

Question #1: "If the proposed resolution was accurate, is there funding available for the Muddy River Project from the Lake to the Cooper Avenue Crossing?"

Response #1: "The Master Plan does not provide money for the area below the wildlife dam. The option must already be in the plan for money to be made available."

Question #2: "Has a model been done that shows the scenario of a retaining basin?"

Response #2: "No."

Question #3: "Are there models like this one for other areas behind the river that experience a lot of flooding?"

Response #3: "No, we just looked at the river."

Question #4: "Is the model strictly upstream of the dam?"

Response #4: "Yes."

Question #5: "Were other tributaries included on this map?"

Response #5: "No." The facilitator then explained that: "The purpose of the presentation is to show the Committee how these models work. You can then apply this model to potential solutions to see their impacts on flood control and then do a cost-benefit analysis."

Question #6: "Is there a feasible way to put in a retention basin?"

Response #6: "Yes, we can look at that, but we have to consider what happens downstream of the retention basin."

1999 CCRFCD Board Meetings

- *Muddy River Master Plan Update*: Muddy River Master Plan Update project has met with considerable opposition. In an effort to pursue a flood control solution for the Muddy River, a Moapa Valley Flood Control Advisory Committee was formed and the District hired a facilitator to work with the group on reaching a consensus of flood control needs for the area. It was agreed that a Master Plan Update would not commence until clear direction was given to the District on a preferred flood control solution (November, 1999).

- *Muddy River (West) Levee*: TAB adopted flood-proofing option (November, 1999).

1999 Moapa Valley Town Advisory Board Meetings Due to a lack of consensus concerning the direction the TAB should take towards flood control, three alternatives were presented to the board in the February meeting. The alternatives were as follows:

1. A relocation plan (individual flood protection)
2. The engineered, or structural, solution (Muddy River Riverine Enhancement project).
3. No action plan (Status Quo).

The relocation plan would involve elevating homes or moving them out of the floodplain altogether. This plan might also require homeowners to provide an easement across their property. It was noted that this approach to flood control would protect individual structures, but does not address flood protection of roadways or utilities.

In addition to offering the TAB the three options of floodplain management, the County had begun a survey of the residents who would be impacted by the Muddy River Riverine Enhancement project to see how many of them would accept the engineered solution (Alternative 2). The TAB was unable to reach a final consensus before the end of the year.

The TAB meeting on September 16, 1999, included discussion and possible action on the CCRFCD presentation and recommendation made by Moapa Valley Flood Control Committee regarding flood control on the Muddy River. The following was reproduced from the meeting minutes (September 16, 1999):

> *Discussion and possible action on Regional Flood Control District presentation and recommendation made by Moapa Valley Flood Control Committee regarding flood control on the Muddy River.*
>
> *Board members decided that they review all of the information provided to them by Regional Flood Control officials and engineers before they make a recommendation to Clark County regarding flood control on the Muddy River. Terry (Tony) opened the item to public input and limited each speaker to three minutes, which brought objections from many in*

the audience. Those speaking against the proposed structural solution on the Lower Muddy River between Gubler and Lewis Streets were Flood Control Committee members Ann Schreiber, Bob Behmer, Melbourne Perkins, Michael Kwiatowski, Roxanne LaBeau, Connie Mortenson, Deborah Hardy, B. R. Behmer, and Floyd Behmer, most of whom said a detention basin on the California Wash near Moapa would do more good and help more people. Two other Committee members spoke - Val Smith who asked why the Committee's decision after all the work it had done was being questioned, and Margaret Humes who said she is confused because she is now hearing that the Committee had been given erroneous information by Regional Flood Control officials. Also speaking were Dennis Westwood, Brian Seely, and Leonard and Karen Dejoria, all of whom urged the Board to look at more options, perhaps a combination of solutions, and not just accept what the County has thrown out. Ray Robison told the Board he had lived here longer than anyone present at the meeting has seen many floods, and that the tamarack needs to be cleaned out of the river or there won't be a river before long. Terry told the group that he had received a call from the County saying that Board Member Patricia Behmer should not vote on the issue because of a conflict of interest, which could result in sanctions and fines for violating ethics rules. Behmer said she does not own any property in the valley, but it was pointed out that her husband does. Marilyn Perkins, Nancy Perkins, Laura Bledsoe, Floyd Behmer, and Fred Christensen expressed their displeasure in hearing that Behmer should not vote on the issue because she is their representative. It was suggested that perhaps the County Commission could appoint someone who has no conflict to sit in for her on that vote. Behmer told the group if she is not allowed to vote, she wants them to remember that engineers are not God as proven by a recent article she read regarding a flood control project constructed by the government on the Mississippi River that resulted in more damage during a flood than before the project was built. Kwiatkowski also asked Board members if they'd like to see a video of the damage done at the Hidden Valley Dairy during the September 1998 flood, and he was asked to come to a future meeting to be scheduled just to discuss the flood control issue to show it. Board members decided to meet with members of the flood control

> *Committee for a workshop on the issue September 30 and then ask Flood Control District officials to an additional meeting to answer questions before voting on the matter.* (Reference 28)
>
> Motion to Conduct a Workshop with the Town Advisory Board and the Flood Control Advisory Committee at 5:30 p.m., September 30, in the Moapa Valley Community Center by Briggs, Second by Metz. Carried Unanimously. (Reference 28)

Several of the board members were dissatisfied with the options that had been presented by the County, and there was also some confusion as to the results of the survey presented to property owners in the valley. A fourth alternative was presented to the board at the September 30, 1999, meeting that was not listed on the original survey, but still received a total of 19 votes. The new unofficial option involved a detention basin at the California Wash and would leave the Muddy River in its natural state. However, as pointed out in the past, the County is obligated by law to provide for the most cost effective plan; the $52 million dollar cost estimate for the detention basin alternative determined by the Muddy River Flood Control Committee did not meet this criteria.

Several issues surrounding the structural solution, or Muddy River Riverine Enhancement project, were discussed at this meeting. Most notable of these issues were the land acquisition and the $23 million cost. Concern was expressed about the total price of the facility and its per acre cost impact on the valley. It was noted that the structural solution would require approximately 200 acres to build and would remove approximately 1,000 acres from the floodplain. Maintenance of the channel was also a predominant issue. Because of the unavailability of the right-of-way, the County had not been maintaining the existing channel. Flood Control Committee members informed the TAB that clearing the channel where portions of right-of-way were established and leaving the balance of the channel in its natural state could create a worse flooding problem.

Concern was expressed that the Board needed to make a decision concerning the Muddy River Riverine Enhancement project. The 1994 Master Plan Update recommended this structural solution and the Board had adopted that plan. However, a number of the board members wanted to revise the plan for a new alternative. There was some concern by other members of the Committee that a new alternative would require a revision in the Master Plan and re-acquisition of project funding. The Muddy River Flood Control

Committee noted that the money for the structural solution had already been allocated and that choosing another alternative could not be done without updating the *Master Plan*. It was also pointed out that this would entail starting over to design, develop, and obtain funding for the new alternative. Once the new alternative was drafted, the town would have to compete with other communities for project funding.

One option posed by the TAB as an alternative was to dig the Muddy River channel deeper. The TAB was informed that this alternative would require the lowering of the channel approximately twenty-five feet to get the necessary slope; this would place the channel lower than the water elevation at Lake Mead. The TAB was also informed that "the channel could only be dug deeper if there is no other option," and that the permit for this excavation would have to come from the COE.

> *Questions and comments from the audience included complaints that only two options were available to property owners since most of the homes along the river are already flood proofed; complaints that there are other alternatives but the Committee did not look into them; a concern that some of the Committee members aren't all that concerned with the issue because all of them did not attend the meetings; comments that all residents, regardless of whether or not they live along the river, should have a say in what is going to be done; comments that the town should not be forced to take what is being offered but should consider a combination of projects to control flooding in both the upper and lower valleys; comments that it will take 10 years for the proposed project to be completed; a question regarding the difference in cost and intrusion on private property for a lesser than a 100-year flood control project; a comment that the Fish and Wildlife Dam and the sewer crossing hold the water back causing flooding in Overton; a comment that the project is too obtrusive and some owners will fight to the bitter end; a question asking why the channel can't be changed to go around the Fish and Wildlife Dam; a comment that if the project was going to be done in Logandale, the group would have a different attitude towards it because they'd have to look at the monstrosity everyday; and a comment that it's easy for Committee and board members to sit at the table and make the decision because it's not their land involved.* (Reference 28)

Responses from the Board and the Committee members stated, "*because of the law, only three options were available.*" The audience was then informed that (1) the County was instructed by the District Attorney's Office that nothing less than a 100-year facility should be constructed and (2) that "if the plan were amended for a 25-year flood, the cost and intrusion into property would be 90 percent of what is projected for the 100-year floodplain." The Flood Control Committee also stated that "even if property owners fight condemnation, the project would go forward because there would be no question of ownership, only price, and the project could get underway while the condemnation proceedings are being handled in court" (Reference 28). Several of the other issues concerning the river flooding and the structural solutions that where discussed with the audience included:

- Engineers had explained (at least to one member of the Committee's satisfaction) that the Fish and Wildlife Dam is not an obstacle in the river and that "the facts show that the water does not even back up to the Tres Lobos subdivision in Overton."
- The cost of changing the channel to go around the Fish and Wildlife Dam is prohibitive.
- The aesthetics of the project were never discussed.
- The Sanitation District has stated that if the sewer crossing at the Muddy River is causing a problem, they will work with the community and the Flood Control District to resolve the problem.
- The fact that "if the County does a project and it isn't done right and flooding occurs, it can be sued, but if the County walks away and does nothing, it cannot be sued."

Members of the Committee were asked if the County had been "heavy handed" in its dealing with the community. The Committee's response was to state, "The County has bent over backwards to present all aspects of the issue," and that although "the choice made is not the perfect solution, it is the best of all the solutions offered." At this point the Committee was of the opinion the structural solution was the right solution. "It is the right solution to control flooding on the Lower Muddy River and protect the most people and property, but not the right solution for the people whose property will be affected." The point was also made that the votes were not easy and that members of the Committee agonized over this issue. The question was also asked "if the project wasn't just a way for the County to get land along the river for roads and paths" to which the Committee responded "no" (September 30, 1999).

In the October TAB meeting, discussion of flood control centered on the clearing of the Muddy River Channel. The TAB was presented with ten letters from property owners refusing easement unless the structural solution is implemented. The Board was reminded that Commissioner Woodbury had previously stated that 100 percent of the residents along the river must agree to the easements because they could not be obtained by court order. A resident commented "that it isn't fair that the Board picked an option considered and rejected by the Flood Control Committee, made up of local residents who studied the issue over several months." It was also pointed out to the board that clearing the channel would only allow for 1,000 cfs, not the design flow rate of 21,000 cfs. No action was taken on this item; however, it was asked that an item to reconsider the board's previous decision on flood control be placed on the December 29 agenda (October 27, 1999).

1999 Moapa Valley Flood Control Advisory Committee Meetings The following is a reproduction of the Moapa Valley Flood Control Committee Progress Report dated January 6, 1999, by Lewis Michaelson, the Neutral Facilitator, from Jason and Associates Corporation hired by the County to assist the community in coming to some consensus on flood control issues:

> **Summary of Activities**
>
> October 1998 - With the assistance of Sue Baker, a list of individuals was identified that could provide a representative cross-section of concerns and perspectives on the issue of flooding and flood control in the Moapa Valley. All of these individuals are residents of Overton or Logandale and almost half of them were affected by the flood that occurred in September. They were invited to participate and all agreed to serve.
>
> November 1998 - The kick-off meeting was held at the Overton Community Center on November 19. The primary objectives of this meeting were to obtain concurrence from the Committee members on the mission and ground rules for the group and to make clear that Clark County Regional Flood Control District had an open mind with regard to letting the community explore potential flood control solutions. These objectives were achieved. As a part of the group's operating principles, the Committee agreed that before they would be able to achieve

community consensus on a solution, it was necessary to come to agreement on a common definition of the problem and their objectives in resolving it. However, it was apparent that several of the Committee members wanted the process to produce rapid, if not immediate, results and that they were anxious to discuss solutions.

December 1998 - The second meeting of the Committee was held on December 22. The primary purpose of this meeting was to present the 100-year flood estimate and hydraulic model used by the CCRFCD to determine the need for and effectiveness of flood control measures for Moapa Valley. It was critical for the Committee to understand and accept the model, since it is the standard, accepted tool for evaluating potential flood control solutions. This objective was achieved. However, some members appeared to presume that they already had identified an alternative solution that would work and that the model would bear them out. Further, one Committee member introduced a resolution that assumed everyone would agree to that solution at the next meeting, even though he had not formally laid out that solution to the Committee yet. Other Committee members indicated they thought a rush to judgment was not appropriate until the Committee had enough time to examine its options and evaluate them using the model. The agenda for the third meeting was agreed to as an opportunity to look at the modeling results of various flood control options as well as the practical/legal/regulatory feasibility of their implementation.

Progress Assessment

The desire for quick action is understandable, given the many years of previous efforts to identify a flood control solution, the fresh memory of recent flooding, and the concern that another flood can strike at any time. Every previous solution, however, has been opposed by a significant segment of the community that has made implementation virtually impossible. It is this lack of community consensus and acceptance that the Moapa Valley Flood Control Advisory Committee is meant to address and a majority of its members understand its importance. Unfortunately, the desire by a fraction of the Committee's members to proceed directly to adoption of an alternative solution without sufficient Committee discussion of and agreement on the nature of the problem and community consensus regarding their flood control objectives poses a significant challenge to the Committee's ability to succeed.

If the Committee can stick to a logical, orderly examination of the issues for at least one more meeting, it is believed it will become apparent there is no perfect solution - only different options, each with its own relative tradeoffs. Implicit in the Committee's discussions to date is a community desire for meeting four objectives:

1. The preferred solution should impact private property minimally, if at all.
2. The preferred solution should be capable of immediate initiation and implementation.
3. The preferred solution should be capable of protecting against a 100-year flood.
4. The preferred solution should not create new problems (e.g., erosion; new areas of flooding).

What the community has not yet faced is the prospect, if not the inevitability, that all of these objectives cannot be achieved simultaneously by the same solution and that some hard choices, i.e., tradeoffs, must ultimately be accepted. This is the crux of the issue and until the community has taken the time to understand this and deal with it, true community consensus cannot emerge. It is believed the CCRFCD has taken the absolutely essential step of using the Committee to place this decision-making dilemma in the hands of the community, because history has shown that no matter which set of tradeoffs CCRFCD would choose, some segment of the community would again oppose it, because it was being imposed from outside the community. It is believed that if the Committee can overcome the impatience of a few, that within two or three meetings the basis for community consensus will emerge, based on a true understanding of the feasibility and tradeoffs of various options. In fact, I (Lewis Michaelson) know of no other way to get there (Reference 29).

Meeting #3 Moapa Valley Flood Control Advisory Committee, January 26, 1999: The Committee was asked to identify the primary flooding problems in the Moapa Valley watershed. The following list resulted from the exercise:

1. Flooding around the dairy and behind it (in the California Wash).
2. Residences around Meadow Valley Wash - Meadow Street/Lawson Street/Henry Street.
3. Just below Wells Siding (in big floods).
4. Elementary School / Fairgrounds on Whipple Lane / Lyman Street.
5. Mills Wash floods upper Logandale.
6. Cooper Avenue Crossing area.
7. Pony Wash.
8. Overton Wash.
9. Magnesite Wash area.
10. Lewis Street (behind Dan's store).
11. The Gubler Dip.

Several members of CCRFCD were at the meeting to give a presentation defining the Master Plan concept and objectives. In short, the *Master Plan* is intended to identify the most effective way to protect life and property from the impacts of flooding. This can be accomplished by either keeping floods away from people or by keeping people away from floods. A brief summary of the issues discussed at the meeting is as follows:

Gale Fraser of the CCRFCD was present to explain the "Master Plan" concept to the Committee. The Master Plan requires that the structural or regulatory method used to provide protection be the most cost effective. The document is flexible and can be revised through "Amendments" or "Changes." The "Amendment" process is accomplished through the public hearings. The item must be presented to the Board and governing entity where the amendment is proposed. An example of an amendment would be to change from a detention/conveyance alternative to an all-conveyance alternative. A "Change" to the Master Plan does not require a public meeting, but it does require a two-thirds vote of approval by the governing Board. A "Change" must be consistent with the general principles of the Master Plan and have no adverse impact on the implementation of the master plan. An example of a "Change" to the Master Plan would be changing the lining of a channel from rock to concrete.

Members of CCRFCD stated that in order to participate in the National Flood Insurance Program (NFIP) and receive federal emergency assistance, the current Master Plan must promote sound floodplain management. The current Master Plan for the Moapa Valley was developed to handle 21,500 cfs for the Muddy River. At present, the design for the Muddy River structural solution involves building a flood control channel above the normal high water mark. Discussions with the U. S. Army Corp of Engineers (COE) have revealed that, due to environmental impacts, the COE would probably not permit a project to dig the channel deeper than its present course.

Other Master Plan issues concerned the Clark County Fairgrounds and the Western Washes. At present there is no facility proposed for the protection of the fairgrounds; however, flood control for the Western Washes area could be accomplished with a collection channel along the west side of the railroad tracks. At least one member of the Committee did not believe that the Muddy River channel could not be dug deeper and would not accept this answer unless he heard it from the governor.

In order to clearly identify objectives, the Committee was asked to identify the preferred solution objectives and the goals for flood control in the area. The purpose of this list was to establish which of those projects are complementary and mutually achievable as well as objectives that may be contradictory and/or mutually exclusive. The objectives of the Committee were as follows:

1. Protect the most people.
2. Minimize impacts on private property.
3. Cost-effective.
4. Capable of immediate initiation/implementation.
5. Protection against the 100-year flood.
6. Does not create new problems.

Calvin Black of G. C. Wallace, Inc presented several flood models, as previously requested, at this meeting. The first of these models showed little impact on the existing floodplain by removing the wildlife dam due to flatness of the channel slope, insufficient channel capacity, and the fact that, in the lower reaches of the river by the wildlife dam, the land outside the channel banks is lower than the banks.

The second of these models showed the impact of the 100-year event on the Muddy River with the channel cleared of brush and debris (but at the same size). Except at the lower end of the valley where the river is very flat, there was a reduction in the floodplain. However, although brush clogs the river and reduces capacity, it does help prevent the channel from eroding. If the channel were cleared out, the channel would quickly erode during a flood.

The Committee identified several solutions that needed to be considered, as follows:

1. Structural solution for a 100-year flood.
2. Structural solution for a less than 100-year flood.
3. Channel maintenance.
4. Sound floodplain management.
5. Detention basins (California Wash, Meadow Valley Wash, Arrow Canyon Wash).

Open questions presented by the Committee to be answered at the next meeting were:

1. "Can the channel be deepened below the normal high water mark or not?"
2. "What is the impact on flooding from building a detention basin on the California Wash?"
3. "Can the County work on land it doesn't own?"
4. "Can you modify County obstructions (Cooper Avenue Crossing and sewer crossing)?"
5. "Can you remove the Fish and Game Dam?"
6. "Why can't the channel be taken farther down than the Fish and Game Dam?"
7. "Is a 50-year flood okay to build and what does it do for channel size and floodplain?"

Meeting #4 Moapa Valley Flood Control Advisory Committee, February 23, 1999: Gale Fraser of CCRFCD reiterated that he and his colleagues have no vested interest in the outcome of the flood control decisions made by the Committee or the community. The CCRFCD has recognized the potential hazard of flooding to some in the community and has tried to develop solutions to mitigate those hazards. He indicated that they had tried to answer the Committee's questions as best they could at previous meetings and would continue to do so at future meetings (Reference 28).

Chris Figgins of the District Attorney's Office of Clark County was at the meeting to address several of the questions that had been posed at the previous meeting. In reference to the question, "Can the County work on land it doesn't own," he responded by saying he requires right-of-way to be granted before he will advise the initiation of a project. There are two ways that right-of-way can be granted. An "Easement" granting unlimited access to the property is one of those; the owner could stipulate certain restrictions, but the County would have to agree to them. A "Fee Simple" would involve turning ownership of the land over to the County. A combination of easement types could also be done, but the County needs access to make the project work.

Nancy Kang from the United States Army Corps of Engineers (COE) was also present to address the question: "Can the channel be deepened below the normal high water mark?" The COE regulates the Muddy River, which is a waterway of the U.S. The COE is responsible for implementing the Clean Water Act and regulating water below the ordinary high water and adjacent wetlands. She stated that a permit would be required, "If excavation is conducted and fill is necessary. If fill is not necessary, a permit is not needed." She also stated "a permit would be required if the channel were straightened or if culverts, bridges, etc. were rebuilt. An alternative analysis would be required, and only the least environmentally damaging alternative is permitted." In her opinion, the impacts to the environment and the wetlands would pose a problem to lowering the channel.

Ms. Kang also helped address the question: "Can you remove the Fish and Wildlife Dam?" From the COE perspective the dam backs up water that creates wetlands. If the dam were to be removed, the wetland area would have to be compensated someplace else (i.e., another wetland created). Roy Horsley, Nevada Division of Wildlife, was also present to help address this issue. He stated: "Due to the community's concerns, a study was conducted for the Wildlife Department by an independent agency, the Desert Research Institute." The study determined that the dam influenced the river only 700 to 1,200 feet above the dam. However, the dam was not found to create flooding conditions for the 50- or 100-year flood because the land was so flat and the banks would overflow prior to reaching the floodplain at Lewis Avenue. The community had previously expressed concern over this issue, and a second floodgate was installed two feet below the first gate in 1978. In addition, the gates are opened once a month to wash out sediment buildup that occurs behind the dam. Mike Rickersham, Regional Director of the Nevada Wildlife Division, was also present. He added that the dam was built as an irrigation diversion to maintain wetlands and fields, and it is not intended to be a flood control device. In response to the question concerning the deepening of the channel, Mr. Rickersham stated that there is a point of diminishing returns when deepening the channel as it reaches Lake Mead. There is less than a 20-foot difference between the dam and Lake Mead.

Marty Flint from the Sanitation District was present to help address the question concerning the modification of the sewer crossing and Cooper Avenue Crossing. He stated that if there were another access to the sewage pond, he would be willing to look at it. Gale Fraser also stated that he didn't believe the sewer crossing presented a problem, but that the sediment issue had not been looked at. He also stated that the Cooper Avenue Crossing could be modified if it is shown to be causing a problem.

Chris Figgins, Deputy District Attorney, addressed the question concerning the project design for the 50-year flood. He was concerned about designing a flood control project to a standard less than the 100-year storm. Calvin Black of G. C. Wallace, Inc. added that a model for the 50-year event had not been done; however, the 50-year storm event is typically 85 percent to 90 percent of the 100-year storm event.

Mr. Black addressed the question concerning the flood reduction impact that detention basins in the Upper Moapa Valley would have. A map was displayed showing the potential locations for detention basins on the California Wash, the Muddy River, and the Meadows Valley Wash. The possible location of the detention basin on the Muddy River was in question because there is no public land available, and there could be backwater impacts to the Moapa Indian Reservation. Although there had not been any flooding recently, the Muddy River basin did present potential for 6,500 cfs. Even with the three detention basins in place, there is a 161-square mile watershed downstream of the possible detention basin sites. This watershed represents a continued potential for flooding along the Muddy River in the Overton/Logandale areas. The cost to build the three detention basins would be approximately $52 million. The COE had estimated that the detention basin on the California Wash would be $26 million.

Gale Fraser presented a potential alternative to the structural flood control solutions at this meeting. A Flood Proofing Assistance Program was introduced whereby an individual in the floodplain could either elevate their home or relocate outside of the floodplain (whichever proved to be the most cost effective). Those individuals located in the floodway would only be able to relocate. This program would offer financial assistance in the form of grant money to the individual owner. Although the County currently does not have a policy for public/private funding, it was believed that the funding should be more public than private (10 percent private to 90 percent public). It was noted that the County would have to seek statutory change in order to implement this program. The program was discussed with Commissioners Woodbury and Kincaid who then proposed three alternatives to be offered to the community:

1. The proposal in the Master Plan.
2. Flood Proofing Assistance and channel maintenance.
3. Status Quo.

Mr. Fraser then went on to remind the Committee that the County does not have any liability for the current flooding because it is an existing natural hazard. The County can walk away if the community cannot agree on an alternative. He said that the County wants to help, but it cannot keep coming back to the same issues. CCRFCD plans on sending a survey to the property owners along the river that would be impacted by the proposal in the Master Plan to assess support for the three alternatives.

The following is a reproduction of the Moapa Valley Flood Control Committee Progress Report dated March 8, 1999, by Lewis Michaelson, the neutral facilitator, from Jason and Associates Corporation:

> **Summary of Activities**
> Overton Community Center on January 26, 1999 - The three primary purposes for this meeting were to:
>
> 1. Clarify which projects are included in the current Master Plan for the watershed;
> 2. Present flood modeling results prepared by the consultant G. C. Wallace, Inc. in response to flood control solutions suggested by Committee members; and
> 3. Identify the community's objectives for flood control in the Moapa Valley.
>
> The presentation by Calvin Black, G. C. Wallace, Inc., demonstrated that structural solutions proposed by various Committee members for areas downstream from Overton were costly and still did not address the 100-year flood. He also demonstrated that a deeper excavated channel in the Muddy River through the Moapa Valley would impact almost as many parcels as the proposed project that was rejected. Another Committee member asked that an upstream solution involving detention basins be looked at instead. It was clear from their suggestions that Committee members were looking for structural solutions that protected

the Moapa Valley without having to build anything that would impact property owners along the river.

The discussion of the community objectives for flood control revealed a number of potentially conflicting objectives that indicated no single solution could meet all of the objectives. In particular, the group's desire for quick action was at odds with the desire to reject the current Master Plan project, and the rejection of any property taking within the Moapa Valley was at odds with the ability of any solution to protect against a 100-year flood. By the end of the meeting, it was clear that much of the critical information provided by the CCRFCD and its consultants was not taken at face value by some of the Committee members and that they wanted independent corroboration. The desire for independent verification was particularly true as it related to what other county, state, and federal units of government would permit or allow to be implemented as flood control solutions. The CCRFCD committed to inviting representatives of these organizations to the next meeting to answer the Committee's questions.

February 1999 - After the meeting in January, the CCRFCD continued to look at innovative solutions in light of the Committee's competing objectives. Gale Fraser developed the concept for a Flood Proofing Assistance Program as a way for individuals to protect themselves from flooding that did not require community consensus on a structural solution. In meetings with Commissioners Woodbury and Kincaid, Mr. Fraser sought their feedback on the Flood Proofing Program as well as how to work with property owners in Moapa Valley along the Muddy River that objected to any structural solution that affected their properties. Based on these discussions, CCRFCD decided to discuss the Flood Proofing Program with the Committee and to conduct a survey of the property owners that would have been affected by the project proposed in the current Master Plan.

The fourth Committee meeting was held at the Overton Community Center on February 23, 1999. During this meeting, the agency representatives invited by CCRFCD (Army Corps of Engineers, Nevada Wildlife Division, Clark County Sanitation District, and Clark County

District Attorney's Office) answered all of the outstanding questions posed by the Committee at the previous meeting, including those related to removal or modification of existing structures in the river, the feasibility of upstream detention basins, and the County's policy on building structural solutions to address less than a 100-year flood standard. Further Committee discussion led to the conclusion that the community is primarily stymied in reaching consensus on a solution by the conflict between those whose properties are affected by structural solutions (but not flooding) versus those who are affected by flooding but not structural solutions. Several Committee members expressed their frustration that some property owners along the river seemed unwilling to compromise in any way to accommodate a solution that was in the best interests of the community as a whole.

This discussion was followed by a presentation by Gale Fraser on a potential Individual Flood Proofing Assistance Program. The proposed program was generally well received by the Committee that seemed to recognize that in the absence of a structural solution, it was probably the best alternative. Mr. Fraser also stated CCRFCD's intention to survey property owners whose parcels would have been affected by the Master Plan proposed project to ascertain their preference for what CCRFCD considers the only three remaining viable options:

1. The originally proposed high water mark channel.
2. An Individual Flood Proofing Assistance Program with channel maintenance.
3. Or the status quo (sound floodplain management).

The Committee agreed that it made sense to wait until the results of the survey were known before meeting again.

<u>Progress Assessment</u>

The CCRFCD has worked diligently to establish its credibility with the members of the Committee. Despite these best efforts, until the meeting in February there were some members of the Committee who remain skeptical of CCRFCD's assessment of the feasibility of various flood control solutions. With the corroboration from representatives of other agencies at the February meeting, the overall attitude of the

Committee became markedly different, with most members giving CCRFCD credit for making an honest attempt to "tell it like it is." Instead of blaming CCRFCD for their predicament, it is believed most of the members began to realize it is a conflict of interests within the community itself that is the greatest impediment to achieving consensus on a workable solution. That is why a solution like the Individual Flood Proofing Assistance Program was embraced so readily, i.e., it does not require community consensus to implement.

The survey should be extremely helpful in sorting out the true extent of owner resistance to the originally proposed project. It will also be helpful that if these property owners want to seek out more information, they have a group of respected community members (the Committee) that, for the most part, can address why the three options being presented in the survey are the only feasible ones.

Meeting #5 Moapa Valley Flood Control Advisory Committee, August 6, 1999: The survey that had been conducted by CCRFCD was completed. The individuals surveyed were those who were identified as owning property within the proposed right-of-way of the structural solution. A letter was included with the 19 votes for the status quo with upstream detention basins option stating that those individuals felt that the structural solution was too intrusive and wished to have detention basins constructed in the California Wash and Meadow Valley Wash. It was pointed out by one Committee member that the detention basins were eliminated as an option because of the impracticality and cost. The results of the survey are summarized in the following table:

Table 2.5
Results of CCRFCD Survey

Response	Number of Parcels	Acres
Option 1 - Status Quo	21	41.52
Option 1 - Status Quo (with upstream detention basins) *	19	23 37
Option 2 - Structural Solution (Current Master Plan)	45	63.00
Option 1 or Option 2	1	0.36
Option #3 - Individual Flood Proofing Assistance Program with Channel Maintenance	4	5.04
None of the Above	1	0.96
No Response	30	57.34
Did not Receive	1	24.38
Total	**122**	**215.97**

* Added by respondents

At this point it was becoming apparent that there were two conflicts in the Committee's deliberations. One conflict involved the credibility of provided data/information (e.g., cost, effectiveness of detention basins, and impacts of downstream obstructions). For instance, the consultants and agency staff analyzed alternatives suggested by the Committee using accepted methodology and models. However, some of the Committee members accepted the results of the modeling, and some did not. The other conflict encountered by the Committee was the values attached to lifestyles and life choices (e.g., river front property held for generations).

2000 CCRFCD Board Meetings

- *Muddy River Watershed Master Plan Update*; the Board of Directors authorized the general manager to negotiate a professional contract with G. C. Wallace, Inc. to prepare a Master Plan Update for the Muddy River Watershed (Moapa Valley, Moapa, and Glendale) (February 2000).

2000 Moapa Valley Town Advisory Board Meetings There was a great deal of debate concerning the proposed structural solution during the January 26, 2000, meeting. Both residents and Board members were split on the issue. Numerous solutions for the flooding issue were proposed, and the Individual Flood Proofing alternative was mentioned.

A motion was made to "withdraw the Board's previous decision to obtain easements and clean out the river, seek legislation to provide individual homeowner flood proofing, work on preventing flooding from the Western Washes, and recommend that the County work towards implementation of the structural solution as soon as possible along with providing help that Commissioner Woodbury has promised in assisting land owners in keeping the most beneficial use of their property and providing assistance in the aesthetics of the project." The motion was seconded and the vote was two in favor, one against, and one abstention.

A CCRFCD representative was present to update the TAB. The following list is a brief summary of the information presented at the April 29, 2000, meeting:

- G. C. Wallace, Inc. has been hired to update the Master Plan for the Moapa Valley.
- Regional Flood Control officials planned to develop an Individual Flood Proofing Plan that would work for parts of the river that are not included in the structural plan.

The structural solution that was approved earlier this year was still moving forward.

- The structural project would begin downstream and move upstream in phases.
- The property acquisition phase of the project would begin in about six months.

Table 2.6 lists the MPU facilities completed in the Moapa Valley by the year 2000.

Table 2.6
2000 Inventory of the Existing CCRFCD Facilities in the Moapa Valley

Project	Engineer/Contractor	Cost	Date Completed
Logan/Benson Wash Diversion and Storm Drain Design	Dames and Moore	$ 235,040.74	**
Benson/Logan Wash Diversion Dam	Ron Williams	$ 500,000.00*	04/93*
Logan Wash Storm Drain (Area II)	Meadow Valley	$ 3,269,540.00*	03/93*
Muddy River Crossing at Cooper Avenue	Progressive Contracting Inc.	$ 185,000.00	10/90

*Information taken from project status report of Board meeting on June 30. 1993.
**No information available.

2000 Individual Flood Proofing Assistance Committee Meetings The Individual Flood Proofing Assistance Committee (IFPAC) was informed during the September 14, 2000, meeting that the Muddy River Channel widening project for the Logandale/Overton area was progressing. The IFPAC members expressed doubt about whether the channel-widening project would ever be finished due to environmental constraints.

Committee members stated that a structural solution for the Upper Moapa Valley is the only way to solve the flooding issues in the area. The IFPAC stated that it is the businesses in the Upper Valley that suffer the most damage during flood events. Mr. Kevin Eubanks, in attendance at the meeting, pointed out that the project would need to meet criteria in terms of cost to be eligible for inclusion in the Master Plan. However, if the cost of the project were more than the cost of the property it would protect, it would make more sense to buy the land susceptible to flooding.

The issue of the Upper Valley detention basins was discussed again. Mr. Eubanks pointed out that these detention basins may solve the flooding problems in the Upper Valley, but there would still be a need for a channel-widening project, although reduced in size, for the Lower Valley. There is a drainage area in excess of 100-square miles between the proposed detention basin locations and the Logandale/Overton area. The example was given of flooding problems from the recent storm that impacted the

Weiser Wash. The Committee members expressed some disbelief that this area, downstream of the proposed detention basins, would produce substantial storm water runoff. Some members also expressed the opinion that the detention basins should meet a standard that is less than the 100-year design. There was some disagreement by the Committee as to whether the main flooding problem to the Lower Valley was generated by the upper basin watersheds or the Western Washes of the Lower Valley.

The Individual Flood Proofing Assistance (IFPA) Plan was then discussed. It was pointed out that the plan is meant as an alternative for the residents of the Upper and Lower Valley, but is not the only alternative for flood protection. The IFPAC felt that the plan should be left as an alternative, but that it should not be the only or even the primary alternative. Other points of the program that were discussed are as follows:

- IFPA is not a complete answer to the flooding issue. Some people may lose their homes.
- The plan itself would be very involved.
- The task of the Committee is to provide input to assist in the development of a framework for the plan, so that it can be included in the Master Plan.
- If legislation is passed that allows the County to fund private flood proofing projects, the program could be further developed.
- Funding for the IFPA Plan was suggested at 90 percent of the money coming from government sources and 10 percent from private participation.
- The draft IFPA Plan framework will be made available to the Committee.

The IFPAC then went on to address the issue of flood control at the Hidden Valley Dairy at the California Wash. According to the IFPAC there had been some dikes built, and there had also been some clearing of the salt cedar in the area. This had gone a long way to reducing the flooding problems in that area. The IFPAC also mentioned that the levees in the Muddy Mountains had been protecting residents for years, but that these structures had been torn down approximately 6 years ago. The IFPAC asked that members of GCW and CCRFCD accompany them on a field trip to see where the flooding problems are occurring. GCW and CCRFCD agreed, and a date and time for the field trip would be scheduled later.

On November 3, 2000, Calvin Black from G. C. Wallace, Inc. met with Charlie Hester, one of the IFPAC members, and visited the site of a dam located in the North Muddy Mountains approximately 3 ½ miles east of the Ute Interchange on Interstate 15 (I-15). Mr.

Hester thought that the Civilian Conservation Corps had constructed the dam in the early 1930's. The dam had a drainage area of approximately 5.4 square area miles and was removed to construct a road for access to mining operations located east of the site.

GCW also visited the site of a similar dam constructed in Arrow Canyon and the site of several earthen berms immediately upstream of Moapa Valley in the Meadow Valley Wash. The Arrow Canyon dam and berms upstream of Moapa Valley had been filled in with sediment.

ACTIONS BETWEEN 2001 AND 2005

The following information was compiled from meeting minutes and reports on record between the 2001 MPU and the 2005 MPU. Following the adoption of the 2001 MPU, right-of-way engineering began for the Muddy River (West) Levee project.

2001 CCRFCD Board Meetings

"The recommended structural improvements in the plan are similar to the previous plan with the exception of the addition of a debris basin and storm drain to protect the fairgrounds. The recommended plan for the Lower Muddy River is construction of a channel above the ordinary high water. The recommended plan for the Western Washes Tributary to the Muddy River continues to rely on debris basins with channel and storm drain conveyances collecting along the railroad. Due to the relatively sparse development in the Upper Muddy River floodplain (Moapa and Glendale), the plan continues to recommend sound flood proofing assistance program be developed for application in areas where no structural improvements are proposed. Recently approved legislation will support implementation of such a program."

The 1994 figure of $14,369,000 to construct the Moapa Valley MPU facilities was determined to be in error. The revised estimated cost for the Muddy River and Tributaries was $49,266,000 (July 12, 2001).

2001 Moapa Valley Town Advisory Board Kevin Eubanks of Regional Flood Control presented to the Board the proposed five-year update. He said the plan, scheduled for adoption in June, was the same as the previous five-year plan for the Muddy River and western washes, but included the addition of a debris basin to collect water at the fairgrounds and an underground drainage channel from the fairgrounds down Whipple to the river. The estimated costs for the proposed projects are $30,266,000 for the Muddy River structural plan from Gubler to Lewis, $16,856,000 for flood control in the western washes, and $2,144,000 for the fairgrounds/Whipple project. The plan calls for the Muddy River project to be implemented in Year 3 through Years 9 and 10; the fairgrounds/Whipple project would be implemented sometime after Year 10 since no funding was allocated for it at that time. Board members indicated that they would like to review the plan before making a recommendation and asked Mr. Eubanks if he would return for their May 30 meeting to answer any questions board members may have. He agreed to return (May 9, 2001).

Kevin Eubanks and G. C. Wallace representatives recapped the Muddy River Master Plan for the five-year update. Board members discussed and asked questions primarily about the structural plan on the Muddy River in the lower valley. Marilyn Perkins asked that Fetherston not be allowed to vote on the issue since she felt it was a conflict, but board members did not act on that request. The board members approved the five-year update (May 30, 2001).

> "Fetherston reported that he had received information regarding the flood control project on the Muddy River. He said it would be at least another 90 days before Regional Flood Control can start buying property for the project because an archaeological site has been found about 10-feet down along the river bank near where the Mortenson castle house was built and it must be dug up and checked which is estimated to cost about $250,000. There also was a problem with a blowfly on the river, but Fish and Game has taken care of that, he said. Baker told the board carbon dating of the archaeological site puts it somewhere between 300 BC and 200 AD, which makes it one of the oldest known sites in the area and could make it eligible for the National Register" (August 15, 2001).

2001 Moapa Town Advisory Board Kevin Eubanks and representatives from G. C. Wallace addressed the board. "Mr. Eubanks stated that they came to the board 6 months ago and will give updates every 5 years according to state law. The Master Plan is done. The plan has no affect on the Moapa area. The lower valley is estimated at $49,000,000 of improvements. Eubanks explained that individual flood proofing plan is currently being pursued by the legislators, which would be cheaper than building detention areas. Plan was accepted unanimously" (May 10, 2001).

2002 CCRFCD Board Meetings Reallocation of funds was discussed for the Muddy River (West) Levee project. A decrease of right-of-way was proposed which would increase engineering services yet mitigate environmental costs (September 12, 2002).

2002 Moapa Valley Town Advisory Board CCRFCD reported that all studies and paperwork had been submitted to the Army Corp of Engineers for review and comment. Once the review process has been completed and permits have been issued, right-of-way acquisition could be started. Permits should be issued in early fall and the acquisition would start shortly after. CCPW stated that the project timeline is 10-years divided into phases (May 15, 2002).

> "John Catanese of Clark County Public Works told board members the permit for the project is within 45 days to two months of being issued and the appraisal and acquisition of property should start shortly after that. Calvin Black of G. C. Wallace, Inc. said his company will be working on the final design and hopes to have public meetings for input as the design process moves along. Mr. Catanese also told the group the Regional Flood Control's budget shows construction on the project could begin in 2005 and that he believes the project probably will be done in phases over a 10-year period. He said the county also plans to contact the property owners willing to sell their property for the project and work with them first" (July 31, 2002).

2002 Moapa Town Advisory Board There was no mention of Regional Flood Control issues addressed at the TAB meetings for the year 2002.

2003 CCRFCD Board Meetings Commissioner Woodbury asked specifically about the Muddy River project in Moapa Valley at the CCRFCD Board of Directors meeting. Mr. Kevin Eubanks stated that the Muddy River project has no monies programmed in the first five years of the ten-year construction program. In Fiscal Year 2110 there is design and additional right-of-way funds identified. Commissioner Woodbury asked if this was a change in the original Ten-Year Construction program. Mr. Eubanks stated he thought that the project had been pushed back. Mr. Fraser stated that the District was willing to make amendments to this change. These amendments could be accommodated at any time (July 10, 2003).

2003 Moapa Valley Town Advisory Board "Sue Baker, Rural Town Manager, was asked to schedule a representative of Regional Flood Control District to present an update on the flood control project" (October 1, 2003).

"Sue Baker, Rural Town Manager, reported that she had not received confirmation from Clark County Public Works on when a representative could attend a town board meeting for an update on the flood control project" (October 15, 2003).

"Judith Metz, Chairman, reported receiving the Regional Flood Control's annual report and said she was upset because there was nothing about the Moapa Valley Project in it. After talking with Gale Fraser of Regional Flood Control, she said she learned that the money for the local project is still there but was not mentioned in the report because that is about money already expended and the local project is still in the future" (October 29, 2003).

"Sue Baker, Rural Town Manager, reported that she is meeting with Public works on December 1 to discuss a number of items including the flood control project and where the input meeting on the final design for that project will be held" (November 12, 2003).

2003 Moapa Town Advisory Board There was no mention of Regional Flood Control issues addressed at the TAB meetings for the year 2003.

2004 CCRFCD Board Meetings An action was issued to request for proposals, select a consultant, and negotiate a contract for professional services for the 2005 Muddy River Master Plan Update.

A request for reallocation of funds for the Muddy River (West) Levee was approved. The following is the summary of the reallocation of the funds from agenda item 10c:

	Current	**Proposed**
Design Engineering	$ 330,000	$ 435,000
Right-of-Way	$1,416,200	$1,304,200
Facilitation Services	$ 66,800	$ 66,800
Environmental Mitigation	$ 37,000	$ 44,000
Total	$1,850,000	$1,850,000

(November 10, 2004)

2004 Moapa Valley Town Advisory Board Sue Baker, Clark County Liaison, reported that the District Attorney's office has approved the agreement between the Corp of Engineers, SHIPCO, and the county regarding the flood control project in the valley; the agreement is currently awaiting signatures. She said the appraisal process should get under way by the end of the month and G. C. Wallace will be hired to begin work on the final design as soon as the agreement is signed (April 28, 2004).

"Sue Baker, Clark County Liaison, reported that the flood control agreement has been signed by the Corp of Engineers and will be signed shortly by SHIPCO" (May 12, 2004). The acquisition of property between Lewis and Cooper will take place mid summer to begin Phase 1 of the project. The acquisition of Cooper to Yamashita and Yamashita to Gubler will take place at a later date for Phase 2 and Phase 3 of the project (June 30, 2004).

"Sue Baker, Clark County Liaison, reported that Public Works has secured all the necessary permits from Fish and Wildlife and the Corp of Engineers to go forward with the flood control project and that Public Works and /or G. C. Wallace representatives will make a presentation to the board soon regarding strategy for the project" (October 27,2004).

2004 Moapa Town Advisory Board There was no mention of Regional Flood Control issues addressed at the TAB meetings for the year 2004.

2005 CCRFCD Board Meetings Open bidding for the Master Plan Update for the Muddy River was issued. After review of the bids, G.C. Wallace was chosen.

G. C. Wallace, Inc. signed a contract to prepare the Master Plan Update for the Muddy River and the Tributaries (January 13, 2005).

A supplemental interlocal contract was approved for the extension of the completion date to June 30, 2010 along with the reallocation of the funds as previously stated (March 10, 2005).

2005 Moapa Valley Town Advisory Board Denis Cederburg of Clark County Public Works Department addressed the board stating that the permits for the project had been obtained and the first two phases (1A and 1B) were already underway. Phases 1A and 1B of the project start at Lewis Street and follow the river to a point upstream of Cooper Street. Appraisals will be completed for Phase 1A in the next three to four months. As soon as right-of-way acquisition begins for Phase 1A, appraisals will be started for Phase 1B at Cooper Street. According to Mr. Cederburg, the cost of the first two phases is $8 million of the estimated $22 million total project cost. It will take an estimated 1 ½ years to acquire the property and then another 1 ½ years to complete the two phases. Mr. Cederburg noted it would be more than 10 years before the entire project ending at Gubler Street would be complete.

Concerns about washes in Logandale and expanding the Overton project south of Lewis Street were also discussed and Mr. Cederburg said those issues will be looked at but no plans were being made at that time. The issue was brought up of the dam below Lewis Street on the river and Mr. Cederburg told the group that the dam belongs to the Fish and Wildlife and his department can do nothing about it. It was suggested that perhaps a request for help from Gov. Kenny Guinn and U.S. Congressman Jon Porter would help. Mr. Cederburg was also asked to make regular updates to the board regarding the project. He agreed and will make his next update in September (January 26, 2005).

2005 Moapa Town Advisory Board Kevin Eubanks, CCRFCD, addressed the board stating that the 2001 Master Plan is in the process of being updated. The update is due for completion in September 2005. Mr. Eubanks also stated that he would come before the board in 3-6 months to present the updated plan (March 10, 2005).

Appendix D-2

History of the Flood Control Master Plan

II. HISTORY OF THE FLOOD CONTROL MASTER PLAN

INTRODUCTION

In 1986, the CCRFCD completed a countywide Flood Control Master Plan (1986 CCMP, Reference 32) that included the Moapa Valley (both upper and lower portions). The Nevada Revised Statutes (NRS) 543.596 requires that updates to the Master Plan be made on at least a five-year interval. The CCRFCD has updated the Upper and Lower Moapa Valley portion of the 1986 CCMP in 1988 (1988 MPU), 1994 (1994 MPU), and 2001 (2001 MPU). The following is a summary of the evolution of the Flood Control Master Plan in the Moapa Valley.

1986 MASTER PLAN

The 1986 Master Plan, by James W. Montgomery Consulting Engineers Inc., was developed to address the flood control needs for the entire Clark County area, including the Moapa Valley. In keeping with their mission to provide cost effective methods of flood control, the CCRFCD presented several alternatives to address flooding problems within the Moapa Valley. The following provides a summary of the alternatives analyzed in the 1986 Master Plan.

Lower Muddy River

Two flood control strategies were examined to address the flooding problems along the Muddy River, Overton Wash, Wieber Wash, and Benson (Logan) Wash. Alternatives were formulated in accordance with the generally accepted design criteria at that time. The first strategy was referred to as an all-conveyance alternative. Alternatives developed using this strategy were designed to pass the full design flow safely through the study area by improving the existing channel, storm drain, and bridge/culvert system. The second strategy was referred to as a detention/conveyance alternative. A detention/conveyance alternative incorporated detention and/or retention basins to reduce the peak flows to the downstream channel system improvements (see Reference 32).

The strategy of the all-conveyance alternative for the Lower Moapa Valley was to "make maximum use of the existing channel and associated right-of-way, and to confine flows to their natural flow paths as much as possible" (Reference 32). This alternative consisted of a series of channel improvements that would convey Muddy River flows from the Wells Siding Diversion Structure to the Nevada Department of Wildlife Refuge Dam, requiring full-channel improvement for the entire length of the Muddy River Channel. With the flows generated under fully developed conditions, essentially none of the elements of the then existing channel system (with the exception of the Highway 169 bridge structure) had adequate capacity to convey the 100-year peak flows.

A detention/conveyance alternative for the Lower Moapa Valley was also explored in the 1986 Master Plan. However, the 1986 Master Plan concluded that "the magnitude of the 100-year flood flows (24,400 cfs) and the volume of runoff made it nearly impossible to construct a detention basin of sufficient size to have any major effect on the downstream flow conditions." The 1986 Master Plan also concluded "even if a structure could be constructed, the cost would be prohibitively high."

A third alternative explored for the Lower Muddy River was an all-conveyance alternative that focused on the use of conveyance facilities other than concrete channel. However, the costs of this alternative were prohibitive.

Lower Moapa Valley Dry Washes

Two alternatives were developed to convey the 100-year flood flows from the western washes (Overton, Wieber, and Benson Washes) to the Muddy River. One of these alternatives is described as an all-conveyance alternative. With the all-conveyance alternative, every bridge and culvert over the Overton, Wieber, and Benson Washes would be either upgraded or replaced. Several aspects of this alternative would have been difficult to implement. First, keeping storm flows in the natural stream course, major flows were conveyed through already urbanized areas. Second, UPRR structures required upgrading or replacement. Work on these facilities would have been difficult to initiate, coordinate, and implement with the UPRR.

A detention/conveyance alternative was also analyzed for the Lower Moapa Valley dry washes. Site investigations for detention basin locations focused on sites, located partially or entirely on public lands. Under this alternative, the existing road crossing at Highway 169 and the Overton Wash needed to be replaced with a new bridge structure and the railroad structures on Wieber Wash and Benson Wash needed upgrading. This alternative did present the advantage of using a large portion of the existing drainage system without major modifications. However, the construction and operation of the detention basins required a significant outlay in resources and funds. The detention basins were located in fairly remote areas without existing access. Sediment control and debris removal required close monitoring and frequent maintenance.

Upper Moapa Valley

Two alternatives for the Upper Moapa Valley were analyzed: an all-conveyance and a detention/conveyance alternative. An all-conveyance alternative consisted of a series of channels to convey flow from the drainage areas of the Muddy River, Meadow Valley Wash, and the California Wash. According to the *1986 Master Plan*, "The all-conveyance alternative has aspects that would make implementation difficult. Because of the overall objective of keeping as much flow in the natural stream courses as possible, major flows must be conveyed through some currently developed areas."

The all-conveyance alternative presented for the Upper Moapa Valley System required a substantial investment in right-of-way purchase throughout the study area to handle the 100-year storm flows without major channel improvements. However, a flood control alternative using detention basins to reduce peak flows was assumed to be even more costly. Therefore, the detention/conveyance alternative was rejected with the 1986 Master Plan (Reference 32).

The *1986 Master Plan* concluded that because of the magnitude of the 100-year flood flows (24,400 cfs) and the sparse development conditions that existed then and were expected to exist in the future, "the definition of a complex, expensive flood control system did not seem to be warranted. Therefore, the recommendation for this area is to maintain the existing floodplains in a usable, non-encroached condition. In view of the tremendous size and depth of most of these floodplains, they would not likely be encroached upon in the future. Any existing structures that are located in the floodplain (such as the Hidden Valley Dairy Farm) have accepted the risks involved in building there." (Reference 32)

1986 Master Plan Recommended Flood Control Plan

The *1986 Master Plan* recommended floodplain management for the Upper Moapa Valley and the detention/conveyance alternative for the Lower Muddy River dry washes. Facilities for the plan are listed in Table 2.1.

Table 2.1 1986 Master Plan Recommended Facilities		
ID Number*	**Facility Description (Size, Materials)**	**Estimated Cost**
1	Diversion 70' wide x 10' high, lined	N/A
2	Levee 25' wide x 3' high, unlined	N/A
3	Floodway 200' wide 3' dikes	N/A
4	Bridge 1 200' wide x 25" deep, supported	N/A
5	Detention Basin 350-acre feet, 700-cfs outlet capacity	N/A
6	Levee 60' wide x 8' high, unlined	N/A
7	Bridge 100' wide trestle	N/A
8	Channel 20' wide x 9' deep, unlined	N/A
9	Bridge 100' wide x 10' deep, supported	N/A
10	Floodway 200' wide 3' dikes	N/A
11	Detention Basin 200acre-feet, 700-cfs outlet capacity	N/A
12	Levee 60' wide x 8' high, unlined	N/A
13	Bridge 100' wide trestle	N/A
14	Channel 20' wide x 9' deep, unlined	N/A
15	Bridge 100' wide x 10' deep, supported	N/A
16	Bridge 200' wide x 25' deep, supported	N/A
17	Floodway 200' wide 3' dikes	N/A
18	Detention Basin 450-acre ft, 1500-cfs outlet capacity	N/A
19	Levee 70' wide x 10' high, unlined	N/A
20	Bridge 50' wide x 10' deep, supported	N/A
21	Channel 15' wide x 7' deep, unlined	N/A
	Total	**$25,375,000**

* See Appendix H.

1988 MASTER PLAN UPDATE

In the 1988 MPU, developed by the Mark Group, three concepts were developed for the Upper Moapa Valley. The first of these evaluated detention on the Muddy River, the California Wash, and the Meadow Valley Wash. According to the 1988 MPU, these facilities would reduce peak flows to the Lower Moapa Valley Basins to about 3,000 cfs. However, this analysis did not take into account the storm flows generated downstream of the detention basins. Concept 2 was the implementation of a floodplain management plan. Concept 3 evaluated detention storage between the confluence of the Muddy River and the Meadow Valley Wash and the Lower Moapa Valley. Concept 3 did not provide protection to the population of Upper Moapa Valley because the recommended improvements were located downstream of Glendale.

For the Lower Muddy River, four alternatives were analyzed, each assuming that no facilities would be built in the Upper Moapa Valley. The first of these alternatives was the Muddy River Flood Control Channel, involving full improvement of the channel. The second alternative consisted of a system of levees parallel to the river leaving the floodway in its existing state. The third alternative proposed strategically located levees to protect high value properties in Logandale and Overton. The fourth alternative consisted of non-structural methods to prevent loss of life. Measures for the fourth alternative included installing rain gauges for an early warning system and restricting development in the floodplain area (Reference 22).

Three alternatives were evaluated for flood control at the Lower Moapa Valley Dry Washes (i.e., Western Washes). The first of these alternatives evaluated open channels that would convey the storm runoff across the valley to the Muddy River. The second alternative evaluated detention basins at each of the washes. Alternative 3 evaluated flow diversion to other washes for peak flow reduction. In the third alternative storm flows in the Logan Wash were diverted to the Anderson Wash.

Table 2.2 reflects the alternatives chosen for the 1988 MPU with their associated costs.

Table 2.2
1988 Master Plan Update Recommended Facilities

ID Number	Facility Description*	Estimated Cost
1	Cooper Street Crossing	$ 185,000
2	Muddy River (West) Levee	$ 1,570,000
3	Benson/Logan Wash Diversion and Channel	$ 21,557,000
4	Flood Warning System	$ 200,000
5	Overton Wash Channel	$ 1,798,000
6	Wieber Wash System (50-Year)	$ 3,546,000
7	Muddy River (East) Levee	$ 1,114,000
8	Floodplain Management Upper Moapa Valley	$ 4,521,000
9	Wells Siding Diversion Maintenance and Repair	$ 282,000
	Total	**$ 34,773,000**

* See Appendix H

1994 MASTER PLAN UPDATE

Several Master Plan projects were completed between 1988 and 1994: the Cooper Crossing at the Muddy River, the Anderson to Logan Wash Diversion, and the Gann Avenue Storm Drain.

Several options were suggested for flood control in the Upper Moapa Valley. The 1994 MPU, developed by James M. Montgomery, recommended that the dam at Arrow Canyon be rebuilt to meet current hydrology and dam safety standards. However, the dam is on the edge of a wilderness area, creating a constraint to construction.

Floodwaters from the California Wash pose a significant hazard to a dairy situated near the confluence of the Muddy River and the California Wash. Enlargements of the California Wash channel upstream and adjacent to the dairy would lessen the frequency of flooding in this area. However, the 1994 MPU concluded that, "Since the benefit of California Wash channelization would accrue solely to the dairy, and not a widespread area, it was determined that this project does not qualify as a Regional Flood Control project" (Reference 21). Another alternative for the Upper Moapa Valley area was a Flood Insurance Study and a Detailed Floodplain Management Plan. This would provide base flood elevations for future development.

Three alternatives for the Lower Muddy River were explored. The first of these alternatives was the previously adopted levee system. The second alternative was the total channelization of the Muddy River, consisting of a fully excavated channel, with the banks either lined with riprap gabions or left unlined. The third alternative was to excavate the over bank portions of the river above the ordinary high water mark. This third alternative was recommended for the Lower Muddy River System.

The recommended alternative for the Overton Wash enlarged the existing channel from the railroad to the Muddy River. Flow velocities calculated for the channel were approximately 17 fps. Consequently, the channel would need to be concrete-lined.

Two alternatives were evaluated for the Wieber Wash system, which consists of West Wash 1, West Wash 2, and Wieber Wash. The first of these alternatives routed the flows from West Wash 2 and Wieber Wash across the valley via a single gabion-lined channel to the West Branch of the Muddy River. This alternative required a new crossing at the UPRR and two new bridges. The second alternative conveyed flows from West Wash 1 and West Wash 2 along the western side of the UPRR railroad tracks via a gabion-lined channel to the Overton Wash. Flows in the Overton Wash would be conveyed to the Muddy River via concrete-lined channel.

The 1994 MPU was adopted by the Moapa Valley Town Advisory Board (TAB) in April 1994, the Glendale TAB in September 1994, and the Town of Moapa TAB in November 1994. The CCRFCD Board adopted the plan in January 1995. The facilities recommended in the 1994 Moapa Valley MPU are listed in Table 2.3.

Table 2.3
1994 Master Plan Update Recommended Facilities

ID Number	*Facility Description	Estimated Cost
1	Ordinary High Water Mark Channel Alternative (Lower Muddy River) Upper Muddy River Floodplain Mapping	$ 8,259,000 $ 80,000
2	Overton Wash Channel Upper Moapa Valley Channel Maintenance	$ 5,950,000 N/A
3	Railroad Channel Meadow Valley Wash Floodplain Mapping	$15,350,000 $ 80,000
4	FIS Mapping of the Lower Muddy River	$ 120,000
	Total	**$29,839,000**

*See Maps in Appendix H

2001 MASTER PLAN UPDATE

Several flood control options were suggested in the 2001 Muddy River Master Plan Update developed by G. C. Wallace, Inc. The alternatives analyzed included detention basins for the Western Washes, the Clark County Fairground, and the Upper Moapa Valley. The detention alternatives for these three areas were eliminated due to the high cost associated with these alternatives. Other alternatives included debris basins with concrete-lined conveyance facilities downstream. The selected alternatives included an ordinary high water mark channel for the Lower Muddy River through Logandale/Overton, a debris basin and channel system for the Western Washes along Logandale/Overton, and a debris basin and storm drain system to protect the Clark County Fairgrounds. The recommended flood control solution for the Upper Moapa Valley was floodplain management. The recommended facilities are listed in Table 2.4.

Table 2.4
2001 Master Plan Update Recommended Facilities

Priority	*Facility Description	Project Cost
1	Ordinary High Water Mark Channel Alternative (Lower Muddy River) Upper Moapa Valley Floodplain Management	$ 30,266,000 $0
2	Western Wash Channel System	$ 16,856,000
3	Clark County Fairgrounds Debris Basin and Storm Drain	$ 2,144,000
	Total	**$ 49,266,000**

*See Appendix H

The 2001 MPU was approved by the Moapa Town Advisory Board in May 2001, the Moapa Valley Town Advisory Board in May 2001, and the Regional Flood Control District in June 2001.

Additionally, an inventory of Regional Flood Control Facilities was established. The existing regional facilities as of 2000 are listed in Table 2.5.

Table 2.5
Year 2000 Inventory of the Existing CCRFCD Facilities in the Moapa Valley

Project	Engineer/Contractor	Cost	Date Completed
Gann Avenue Storm Drain Design	Dames and Moore	$ 235,040	**
Benson/Logan Wash Diversion	CCPW/Ron Williams	$ 500,000*	04/93*
Logan Wash Storm Drain (Area II)	Dames and Moore/Meadow Valley	$ 3,269,540*	03/93*
Muddy River Crossing at Cooper Street	CCPW/Progressive Contracting Inc.	$ 185,000	10/90

*Information taken from project status report of Board meeting June 1993.
**No information available.

Appendix D-3

Progress Meeting Minutes and Town Advisory Board Meeting Minutes

Meeting Minutes

ATKINS

Project:	Muddy River and Tributaries MPU		
Subject:	Meeting Minutes: Kick-off Meeting		
Date & Time:	Thursday, July 16, 2015	**Project #**	100045944
Meeting Place:	CCRFCD Conference Room	**Minutes By:**	Brian Rowley

Present:

Tim Sutko, CCRFCD
Joe Damiani, CCRFCD
Andrew Trelease, CCRFCD
Rodd Lighthouse, NDOW
Mike Zahradka, NDOW
Scott Millington, MVIC
Joe Davis, MVWD
Lon Dalley, MVWD
Janice Ridondo, Clark County
Harshal Desai, Atkins
Brian Rowley, Atkins

SUMMARY OF ACTION ITEMS:

Item	Description & Action	Responsible (Status)
1	Find out next available meeting dates for Moapa TAB and Moapa Valley TAB and coordinated with Atkins/CCRFCD to get the MPU Kick-off presentation on the meeting agendas	Janice Ridondo (pending)
2	Prepare draft MPU presentations for TAB meetings	Atkins (pending)
3	Send available hydraulic data and information (e.g., Kimley-Horn report) or other relevant documentation for the Overton WMA	NDOW (complete)
4	Follow up with the County and G.C. Wallace to obtain relevant topography data, hydraulic models, and plans from the following projects: • Cooper Street Bridge • Logandale Levee • Fairground Detention Basin • Gubler Bridge or Yamashita Bridge (if available)	Atkins with CCRFCD support as needed (pending)
5	Contact Clark County Development Review Group (Layne Weber) to obtain plans for any significant development that has occurred in the past 5 years	Atkins (pending)
6	Obtain survey data, review SNWA DEM data, and make recommendations regarding need for LiDAR data acquisition for this project	Atkins (to be discussed at next meeting)
8	Schedule future progress meetings	Atkins / CCRFCD (pending)

ATKINS

SUMMARY OF DISCUSSION:

- **Project Team.** The project team was introduced. Tim Sutko and Joe Damiani will be the primary points of contact for CCRFCD. Brian Rowley is the project manager for Atkins and Harshal Desai is the principal. Rodd Lighthouse and Mike Zahradka will be the contacts for NDOW. Janice Ridondo is a Clark County liaison to Moapa Town Advisory Board (TAB), Moapa Valley TAB, and Commissioner Tom Collins. Scott Millington from Muddy Valley Irrigation Company and Joe Davis from Moapa Valley Water will also provide input and are stakeholders on the project. A sign-in sheet was distributed and signed at the meeting and is attached to the end of these notes for reference.

- **Scope and Schedule.** The project scope and schedule was distributed. Tim stated that the project scope includes an update of the flood control master plan for the Muddy River and Tributaries, which will involve data collection, site visits, hydrologic/hydraulic analysis, plan formulation, cost estimates, and final document preparation and presentations. The schedule is aggressive with a goal of completing final documents by March 2016.

- **Town Advisory Board Presentations.** Atkins, CCRFCD, and/or County representatives will be conducting a kick-off presentation at the Moapa TAB Meeting and the Moapa Valley TAB Meeting. Janice Ridondo said she will look into next available meeting times and coordinate with Atkins/CCRFCD to get on the agendas. Meeting are typically Tuesday/Wednesday nights at 7 PM. Atkins stated that they will prepare a draft presentation that can be discussed at the next progress meeting. A decision regarding who will give the presentation will also be made at the next meeting.

- **Key Design Issues.** Atkins and those present at the meeting brought up the following key issues that will be considered during the master plan:

    - Overton WMA. Rodd stated that the Overton Wildlife Management Area (WMA) is National Park Service property that is managed by the Nevada Department of Wildlife (NDOW). Rodd indicated that they are glad that the area is being looked at as part of the master planning effort and will provide reports they have from Kimley-Horn and other information or a tour of the site as needed. They also requested that Mike Boyles from NPS be copied on future correspondence. They also suggested that US Fish and Wildlife be in the loop if needed. The operations and dam and topography of the site are all relevant for this project. Joe mentioned that the residents always feel like the dam on the WMA causes backwater and flooding.

    - Lower Muddy River. Atkins will be reviewing the Lower Muddy River corridor and proposed plan to evaluate alternatives and consider right-of-way acquisition, phasing, environmental concerns, 404 permit, jurisdiction, etc. A HEC-RAS model will be developed along the river corridor to help with the evaluation.

    - Lewis Crossing. The crossing/culvert at Lewis Avenue along the Muddy River should be reviewed to determine impacts. Joe stated that residents complain that this is a “choke point”.

    - Wells Siding. Scott mentioned that it may be worth reviewing the operation of Wells Siding Diversion and some extra capacity in Bowman Reservoir (potentially around 500 ac-ft). Scott said he was willing to provide some historical context and information about what has happened in the past.

- **Data Collection.** Atkins has obtained a lot of the previous MPU data and documentation from the website. CCRFCD also provided Atkins with a hard copy of the previous MPU at the meeting that will be returned by Atkins after the project. Other data Atkins requested at the meeting is listed below:

- Data from Logandale Levee, Cooper St, and Fairgrounds DB Projects. Atkins requested the latest topography, reports, HEC-RAS model, and available electronic data from the ongoing Logandale Levee project, the Cooper Street Bridge project, and the Fairgrounds Detention Basin project. Joe stated that he put in a request to G.C. Wallace for that information. Atkins has also made a request to the County. Atkins will follow up on these requests to obtain the data. Atkins will also check with the County to see if they have topography or model data from the Gubler Street Bridge or Yamashita Bridge Projects.

- Development Plans from Last 5 Years. CCRFCD suggested Atkins also contact Layne Weber at Clark County to see if there are relevant developments in the area from the past 5 years and to obtain plans if necessary.

- **Topography/ LiDAR Acquisition**. Atkins stated they received some DEM/topography data from SNWA from 2008. The data is essentially raw data that was not fully post-processed or cleaned. However, it is a decent dataset that is likely better than USGS data or some of the other older topography in the area. Atkins will be sending out a survey crew to get some points and channel cross sections. That survey data can then be used to review the DEM from SNWA in more detail.

  Atkins also coordinated with SNWA on their ongoing LiDAR plans. SNWA said they may or may not be flying the Muddy River study area for new LiDAR, but even if this happens it will likely be after the MPU project is complete so it will not be available for this project.

  Atkins obtained a quote of $15,000 to fly, obtain, and post process the LiDAR if desired. This can be discussed at the next meeting after Atkins has had a chance to review the surface in more detail.

- **Progress Meeting Schedule**. Atkins is targeting the third Thursday of the month at 2:30 PM for future progress meetings. Meeting invites will be sent out following the meeting. CCRFCD stated videoconferencing or conference calls are also available for future meetings.

--- End of Meeting Minutes ---

SIGN-IN SHEET

Master Plan Update for the Muddy River and Tributaries
Kickoff Meeting, July 16, 2015, 2:30 PM
Clark County Regional Flood Control District Conference Room

Name	Affiliation	Phone Number	Email Address	Initials	Attendance
Tim Sutko	CCRFCD	702-685-0000	tsutko@regionalflood.org	[signature]	☑
Joe Damiani	CCRFCD	702-685-0000	jdamiani@regionalflood.org	[signature]	☑
John Catanese	CCPW	702-455-6050	catanese@clarkcountynv.gov		☐
Joe Yatson	CCPW	702-455-6050	jyatson@clarkcountynv.gov		☐
Janice Ridondo	Clark County	702-455-3504	jridondo@clarkcountynv.gov	[signature]	☑
Angelo Santovito	Clark County		angelo@clarkcountynv.gov		☐
Dwayne Ako	Clark County		dako@clarkcountynv.gov		☐
Rodd Lighthouse	NDOW	775-688-1586	rlighthouse@ndow.org		☑
Tim Hunt	NDOW	775-688-1564	thunt@ndow.org		☐
Mike Zahradka	NDOW	775-688-1563	mzahradka@ndow.org	MZ	☑
Scott Millington	MVIC	702-281-7385	muddyvalley@mvdsl.com		☑
Brian Rowley	Atkins	702-551-0320	brian.rowley@atkinsglobal.com	BR	☑
Harshal Desai	Atkins	702-551-0349	harshal.desai@atkinsglobal.com	HBD	☑
Matt Baird	Atkins	702-990-7432	matt.baird@atkinsglobal.com		☐
* ~~Joseph Davis~~	~~MVWD~~	~~702-397-6893~~	~~joe@moapawater.com~~	[signature]	☑
Lon Dalley	MVWD	702-397-6893	lon@moapawater.com	LD	☑
Andrew Trelease	RFCD				☑
Rodd Lighthouse	NDOW	775.688.1586	RLighthouse@ndow.org		☑
Mike Zahradka	NDOW	775.688.1563	MZahradka@ndow.org		☑
					☐

Present at the meeting but did not sign in

REGIONAL FLOOD CONTROL DISTRICT

ATKINS

Meeting Minutes

Project:	Muddy River and Tributaries MPU		
Subject:	Meeting Minutes: Progress Meeting 01		
Date & Time:	Thursday, August 20, 2015	**Project #**	100045944
Meeting Place:	CCRFCD Conference Room	**Minutes By:**	Brian Rowley

Present:

Tim Sutko, CCRFCD
Joe Damiani, CCRFCD
John Catanese, CCPW
Joe Davis, MVWD
Hongyu Deng, Atkins
Lon Dalley, MVWD
Janice Ridondo, Clark County
Harshal Desai, Atkins
Brian Rowley, Atkins

SUMMARY OF ACTION ITEMS:

Item	Description & Action	Responsible (Status)
1	Revise TAB presentations and send to CCRFCD	Atkins
2	Prepare supplemental scope/fee for LiDAR acquisition for the study area. Submit to CCRFCD.	Atkins
3	Provide Atkins with USACE studies related to gage data/frequency analysis along the Muddy River	Clark County (John)

SUMMARY OF DISCUSSION:

The purpose of the meeting was to discuss progress since the previous meeting. Atkins stated they have completed the majority of the data collection, performed field visits, started the hydrologic analysis review, and commenced with field survey. A summary of key discussion points is below:

- **Town Advisory Board (TAB) Presentations.** Atkins went through the presentations for the Moapa and Moapa Valley TAB meetings. CCRFCD, the County, Janice, and Atkins agreed to a few revisions: (1) the stakeholders listed in the presentation will include Moapa and Moapa Valley and the Nevada Department of Wildlife, (2) the study area images will include a different image for Moapa and Moapa Valley, and (3) the schedule slide will be more generalized to just show the month as well as the date of the next TAB meeting presentation with final recommendations. Joe said he will give the presentation. Atkins informed CCRFCD that they need to bring computer and projector to the meeting. Atkins said they will try to send a representative to the meeting since Harshal and Brian will be out of town. CCRFCD said that would be good but not required.

- **LiDAR Acquisition.** Atkins said the DEM/topography data (2008) they received from SNWA is not fully post-processed and outdated and does not accurately reflect the current terrain. Atkins recommended acquiring new LiDAR data. Tim asked why that is necessary. Atkins explained that current elevation data will give them an accurate HEC-RAS model, especially since the area is so flat and the floodplain covers large overbank areas. Current topography will also give an accurate representation of the river corridor changes and the embankments in the Overton WMA. Also, since everything else is being updated for the MPU it makes sense to get current elevation. The cost of LiDAR acquisition compared to overall project costs will be relatively small (Atkins estimated around $15,000). CCRFCD agreed and asked Atkins to prepare a supplemental services scope/fee and send it to CCRFCD for authorization.

- **Survey.** Atkins stated their survey team went out to survey channel cross sections and bridges. The collected data will be post-processed and used for the HEC-RAS model and to verify other elevation data.

- **Field Visits.** Atkins performed two field visits on August 4th and 12th at existing and proposed regional flood control facilities in the study area. Joe Damiani was with Atkins for the first field visit. Atkins met with NDOW personnel (Rodd Lighthouse) at the Overton WMA as well as Scott Millington's staff from the MVIC to see the Logandale Levee area and Bowman Reservoir. Atkins presented an online GIS map showing the photographs taken during the field visits. CCRFCD asked if anything unexpected came out of the field visits. Atkins mentioned the earthen, man-made diversion that re-directs a natural wash to the Bowman Reservoir. There were also plugged culverts and roadway sections that have been damaged. The Overton WMA is in the process of lowering the embankments by the Honeybee Reservoir. Joe and Brian also mentioned that the area upstream of Wells Siding seemed like a potential location for a detention basin. All of these areas will be reviewed in more detail as the project progresses.

- **Data Collection.** Atkins stated they received data from the Logandale Levee, Cooper Street Bridge, and Fairgrounds Detention Basin projects. The County gave Atkins 3 CDs containing construction plans of Cooper St, Yamashita Bridge, and Logandale Levee during the meeting. The County also said they would send Atkins USACE studies related to the gage data and frequency analysis along the Muddy River. John suggested Atkins to search for Gubler Bridge data online. Atkins agreed.

- **Hydrology Review**. Atkins said they started reviewing the hydrologic analysis and HEC-1 models from the previous MPU. The following observations were discussed:

    - <u>Study Area</u>. Atkins displayed the total area tributary to the Lower Muddy River and the proposed HEC-1 hydrologic modelling area. Atkins plans to analyze the area downstream of I-15 with HEC-1 models to determine peak flows, while peak flows in the area upstream of I-15 and along the large washes will be determined using gage data and frequency analysis. Meeting attendants were informed that the 100-year flows from previous MPUs can potentially change when all of the analysis is updated. Those impacts will be explained and evaluated as needed in future progress meetings. Atkins will review the previous MPU in detail to understand how the flows and floodplains upstream of I-15 were determined. CCRFCD agreed with this approach.

    - <u>HEC-1 Models</u>. Atkins reviewed 2010 MPU HEC-1 models and concluded that there are many models that are redundant and not necessary. In addition, the soils data, rainfall, CN values, and subbasins all need to be revised to fix outdated information and errors. Atkins will not be perpetuating or simply updating the previous HEC-1 models; rather, Atkins will create new models with current information using best available data. If an older model is needed for some reason in the future, it can be re-created as necessary. CCRFCD agreed with this approach and send it is better to start fresh than spending time making lots of changes to the older models. Tim also mentioned that the current land use data from the County should be used in the analysis.

- Soils Data. Based on preliminary review of soils data, Atkins stated that most of the CN values are expected to decrease, resulting in lower peak flows. Atkins recommended that the current projects in the area, such as the Fairgrounds Detention Basin project, consider the updated soils information in their analysis and design to ensure the latest information is used.

Atkins stated that the hydrologic information and analysis described above is preliminary and a more detailed review of the hydrologic analysis and modeling and parameters will be presented at the next meeting.

The next progress meeting is scheduled for September 17th.

--- End of Meeting Minutes ---

SIGN-IN SHEET

Master Plan Update for the Muddy River and Tributaries
Kickoff Meeting, August 20, 2015, 2:30 PM
Clark County Regional Flood Control District Conference Room

Name	Affiliation	Phone Number	Email Address	Initials	Attendance
Tim Sutko	CCRFCD	702-685-0000	tsutko@regionalflood.org	[illegible]	☐
Joe Damiani	CCRFCD	702-685-0000	jdamiani@regionalflood.org	[illegible]	☒
Andrew Trelease	CCRFCD		atrelease@regionalflood.org		☐
John Catanese	CCPW	702-455-6050	catanese@clarkcountynv.gov	[illegible]	☑
Joe Yatson	CCPW	702-455-6050	jyatson@clarkcountynv.gov		☐
Janice Ridondo	Clark County	702-455-3504	jridondo@clarkcountynv.gov	[illegible]	☒
Angelo Santovito	Clark County		angelo@clarkcountynv.gov		☐
Dwayne Ako	Clark County		dako@clarkcountynv.gov		☐
Rodd Lighthouse	NDOW	775-688-1586	rlighthouse@ndow.org		☐
Tim Hunt	NDOW	775-688-1564	thunt@ndow.org		☐
Mike Zahradka	NDOW	775-688-1563	mzahradka@ndow.org		☐
Scott Millington	MVIC	702-281-7385	muddyvalley@mvdsl.com		☐
Brian Rowley	Atkins	702-551-0320	brian.rowley@atkinsglobal.com	[illegible]	☑
Harshal Desai	Atkins	702-551-0349	harshal.desai@atkinsglobal.com	HBD	☑
Matt Baird	Atkins	702-990-7432	matt.baird@atkinsglobal.com		☐
Joe Davis	MVWD	702-397-6893	joe@moapawater.com	[illegible]	☐
Lon Dalley	MVWD	702-397-6893	lon@moapawater.com	[illegible]	☒
Hongyu Deng	Atkins	702-551-0287	hongyu.deng@atkinsglobal.com	[illegible]	☒
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REGIONAL FLOOD CONTROL DISTRICT

ATKINS

Meeting Minutes

ATKINS

Project:	Muddy River and Tributaries MPU		
Subject:	Meeting Minutes: Progress Meeting 02		
Date & Time:	Thursday, September 17, 2015	**Project #**	100045944
Meeting Place:	CCRFCD Conference Room	**Minutes By:**	Hongyu Deng

Present:

Tim Sutko, CCRFCD
Joe Damiani, CCRFCD
Harshal Desai, Atkins
Hongyu Deng, Atkins
Andrew Trelease, CCRFCD
John Catanese, CCPW
Brian Rowley, Atkins

SUMMARY OF ACTION ITEMS:

Item	Description & Action	Responsible (Status)
1	Obtain LiDAR data and perform necessary post-processing analysis	Atkins (pending)
2	Prepare land use maps and categories for review	Atkins (pending)
3	Finalize hydrologic analysis and prepare a Hydrologic Summary Memo	Atkins (pending)
4	Get information about the state study that Commissioner Kirkpatrick mentioned at the Moapa TAB meeting	CCRFCD (Tim) pending
5	Check on available progress meeting times to better accommodate Joe Yatson's schedule	CCPW (John) done

SUMMARY OF DISCUSSION:

The purpose of the meeting was to discuss progress since the previous meeting. A summary of key discussion points is below:

- **Data Collection.** Atkins stated they are essentially done with the data collection phase and have the information needed at this phase. There may be future data needs as the project progresses.

- **LiDAR Acquisition.** Atkins estimated the LiDAR acquisition will be completed within two weeks. John asked if the LiDAR coverage can be shared with other projects, such as Logandale Levee. Atkins said yes and that final deliverables will include bare-earth DEMs and one foot contours, but development of the contours will not include processing of detailed breaklines. Atkins stated that the raw LiDAR data can be processed further in the future if necessary for other detailed information, such as polygons representing buildings in the area.

- **Survey.** Atkins stated their survey team completed surveying channel cross sections and bridges. The collected data will be post-processed and used for the HEC-RAS model.

- **Town Advisory Board (TAB) Presentations.** Atkins asked if there was any feedback to discuss from the Moapa and Moapa Valley TAB meetings. Tim said it went well. Atkins noticed that channel and facility maintenance was brought up several times as a concern and CCRFCD agreed. Atkins stated they will review the maintenance plan and activities as part of the non-structural portion of the MPU planning process at a later time. CCRFCD said to check on the easements related to maintenance. Atkins also asked about the "State Flood Study" that Commissioner Kirkpatrick mentioned, and CCRFCD said they will follow up with her assistant to get more information or see if it is relevant.

- **Hydrology Review**. Atkins made substantial progress on the hydrologic review and shared a presentation showing the results. The following topics were discussed:

    - Rainfall. Atkins displayed the 100-year and 6-hour rainfall depth map from the Design Manual that was used to create a raster and interpolate rainfall values at the centroid of each subbasin. These rainfall depths were reviewed and are generally consistent with previous MPU rainfall data so they will be used. CCRFCD agreed with this approach.

    - Soils. Atkins reviewed the latest available soils maps from NRCS, August 2014, and compared that information with the 1980 soils data used in previous MPUs. There are significant differences in the current data compared to the older data from 1980. In addition, the previous MPU methodology was based on using the predominant hydrologic soil group (HSG), rather than considering the composition and breakdown of minor HSGs and the rock outcrop within each soil map unit. In this particular study area, there is a significant amount of rock outcrop in the western washes area. Atkins also showed a map comparing the CN values that result from the different soil sources and methods Atkins recommended using the minor HSGs and rock outcrop breakdown in the analysis since it is best available data based on physical soil characteristics and will be consistent with MPU methodology used in other area. CCRFCD agreed with using the latest soils data and the detailed breakdown of minor HSGs and rock outcrop.

    - Land Use. Atkins reviewed 2010 MPU land use map and current county planned land use (PLU, 2012) GIS data. Atkins also talked to Clark County planning (Garret Terberg and Kevin Smedley) and concluded that current county PLU is the best available data to develop the ultimate condition land use map for study area. Atkins also reviewed the 2008 Las Vegas MPU land use categories and added three new categories that are appropriate for this study area: Agriculture, Right-of-Way and Residential Countryside (0.5 unit/acre). Atkins distributed a land use table showing the categories and the correlation between MPU land use categories for hydrologic purposes and current county PLU codes. Atkins is reviewing the land use data and validating it. Once complete, Atkins will distribute the land use tables and maps to Clark County, CCRFCD, Moapa Valley Water District, CCWRD, and other stakeholders to get any other feedback or input. CCRFCD told Atkins to state in the email that if we don't hear back by a certain time then we will assume it is final. Atkins also showed a curve number comparison based on using the different land use sources, and there are notable differences since the land use data has changed a lot during the past 20 years.

- Curve Number. Combining the data and proposed methods described above (2014 soils map, minor HSG methods, and land use map with new categories), Atkins presented a draft CN map and comparison for 2016 MPU. Compared with 2010 MPU CN values, the CNs generally go up in the western washes area and generally go down on the eastern side of the Muddy River.

- Subbasin Delineation. Atkins said they have completed a draft subbasin delineation map and are finalizing it, but overall changes do not look to be drastic and the watershed boundary is very similar. The subbasins are being reviewed using more accurate DEM data and aerial maps etc. Atkins will finalize these subbasin delineations prior to the next progress meeting.

Atkins stated that they will finalize the hydrologic parameterization and preliminary HEC-1 model prior to the next progress meeting. Atkins will also summarize the methodology in a hydrologic summary memo for review and feedback prior to moving on with facility planning. Atkins intends to send this out a week or so before the next meeting and then it can be discussed further in the meeting.

The next progress meeting is scheduled for 10:30 am, October 15, 2015.

--- End of Meeting Minutes ---

SIGN-IN SHEET

Master Plan Update for the Muddy River and Tributaries
Progress Meeting 02, September 17, 2015, 2:30 PM
Clark County Regional Flood Control District Conference Room

Name	Affiliation	Phone Number	Email Address	Initials	Attendance
Tim Sutko	CCRFCD	702-685-0000	tsutko@regionalflood.org	[signature]	☐
Joe Damiani	CCRFCD	702-685-0000	jdamiani@regionalflood.org	[signature]	☒
Andrew Trelease	CCRFCD		atrelease@regionalflood.org	AJT	☒
John Catanese	CCPW	702-455-6050	catanese@clarkcountynv.gov		☒
Joe Yatson	CCPW	702-455-6050	jyatson@clarkcountynv.gov	[signature]	☐
Garrett TerBerg	CCPW	702-455-5617	gtb@clarkcountynv.gov		☐
Janice Ridondo	Clark County	702-455-3504	jridondo@clarkcountynv.gov		☐
Angelo Santovito	Clark County		angelo@clarkcountynv.gov		☐
Dwayne Ako	Clark County		dako@clarkcountynv.gov		☐
Rodd Lighthouse	NDOW	775-688-1586	rlighthouse@ndow.org		☐
Tim Hunt	NDOW	775-688-1564	thunt@ndow.org		☐
Mike Zahradka	NDOW	775-688-1563	mzahradka@ndow.org		☐
Scott Millington	MVIC	702-281-7385	muddyvalley@mvdsl.com		☐
Brian Rowley	Atkins	702-551-0320	brian.rowley@atkinsglobal.com	[signature]	☑
Harshal Desai	Atkins	702-551-0349	harshal.desai@atkinsglobal.com	HBD	☑
Matt Baird	Atkins	702-990-7432	matt.baird@atkinsglobal.com		☐
Joe Davis	MVWD	702-397-6893	joe@moapawater.com		☐
Lon Dalley	MVWD	702-397-6893	lon@moapawater.com		☐
Hongyu Deng	Atkins	702-551-0287	hongyu.deng@atkinsglobal.com	[signature]	☑
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REGIONAL FLOOD CONTROL DISTRICT

ATKINS

Meeting Minutes

ATKINS

Project:	Muddy River and Tributaries MPU		
Subject:	Meeting Minutes: Progress Meeting 3		
Date & Time:	Thursday, October 15, 2015	**Project #**	100045944
Meeting Place:	CCRFCD Conference Room	**Minutes By:**	Brian Rowley

Present:

Tim Sutko, CCRFCD
Harshal Desai, Atkins
Brian Rowley, Atkins

Joe Davis, MVWD
Lon Dalley, MVWD
Garret TerBerg, CCCP

SUMMARY OF ACTION ITEMS:

Item	Description & Action	Responsible (Status)
1	Obtain and provide Atkins with any records or observations of where flooding occurred during the September 2014 flood events for use in the development of the hydraulic model	Joe Davis, MVWD (pending)
2	Contact MVIC to discuss the history of the berm that diverts flow into the Bowman Reservoir and determine if they are willing to accommodate these flows etc.	Atkins (pending)
3	Check if there is any documentation or history from previous MPUs regarding the man-made berm that diverts flow to Bowman Reservoir	Tim, CCRFCD (pending)
4	Check with CCPW on meeting time for next progress meeting	Tim, CCRFCD (complete)

SUMMARY OF DISCUSSION:

The purpose of the meeting was to discuss progress since the previous meeting. A summary of key discussion points is below:

- **Land Use.** Atkins reported that following the previous progress meeting, Atkins compiled land use maps and sent them out to CCRFCD, CCPW, CCCP, NPS, NDOW, MVIC, MVWD, and other stakeholders for review and approval. Atkins received some comments and coordinated with Kevin Smedley from Clark County Comp Planning to finalize the maps. No other comments were received and the land use data is considered final for hydrologic purposes at this point of the project.

- **LiDAR Acquisition.** Atkins received the LiDAR data and performed post processing and QC work to develop 1-ft contours and DEMs for the study area. The data is current and provides high-quality elevation data in the study area that will be used for hydraulic analysis and planning purposes. Atkins will provide this data to CCRFCD as part of the final project deliverables. Atkins showed the data on screen at the meeting to provide an overview of the coverage and resolution of the data. Atkins mentioned this data can be leveraged with FEMA on future floodplain studies.

- **Preliminary HEC-RAS Modeling.** Using the new LiDAR data, Atkins used a rapid floodplain delineation GIS tool to create some preliminary HEC-RAS models along the Muddy River in the study area using the 100-year flow of 21,400 cfs. The preliminary results showed that manning's n was a sensitive parameter and influenced the floodplain extents and inundation areas. The model also showed relative consistency with the FEMA flood zones in the area. Another run was performed using the flow from the September 2014 flood event to get an understanding of what the model predicts. Atkins asked Joe Davis (MVWD) if he had an idea of where the flooding occurred during the actual event because that information is helpful in validating and calibrating the model. Joe said he would check with the fire department and other individuals who were out in the area during the event to see what information and records they have available. Joe mentioned that the volunteer fire department marked and recorded which houses were supposed to evacuate so that might be useful information. Before the next progress meeting, Atkins will develop more detailed HEC-RAS models including the bridge structures for review and discussion.

- **Hydrologic Analysis Memorandum.** Atkins stated that since the previous meeting, they have spent time developing hydrologic parameters in accordance with discussion from previous progress meetings. Atkins has a preliminary hydrologic model running and compiled a memo to summarize the methodology and approach. Joe and Tim reviewed the memo, and Joe sent an email to Atkins concurring with assumption and methodology. Atkins shared some of the preliminary results at the meeting and will finalize the hydrologic analysis in the coming weeks.

- **Facility Analysis.** Atkins and CCRFCD and others at the meeting had a brief discussion about some of the main facilities and locations that will be reviewed and analyzed for master planning purposes. These locations include:

    - Lower Muddy River – HEC-RAS modeling will be performed for existing and proposed condition to analyze the proposed plan along the Muddy River corridor

    - Western Washes – The proposed regional detention basins and channel along the western side of UPRR will be reviewed and updated. The downstream of this channel and basin ties into the Muddy River floodplain so the relationship//impact/hazards associated with the interaction between these two floodplains will be considered to determine the best approach. Joe indicated that the flooding from the Western Washes generally seems to be more problematic than flooding from the Muddy River recently.

    - Wells Siding – Atkins will use the LiDAR data to investigate the feasibility of a peaking basin or detention basin in the vicinity of Wells Siding at the upstream end of town. Atkins will start by understanding if it is even feasible in terms of hydrology and storage volume capacity. If so, further discussion will be needed other stakeholders, such as MVIC, BLM, environmental entities, Clark County Desert Conservation Program, etc. For now, Atkins will do some preliminary work to determine if this is a viable option worth pursuing further.

    - Fairground Detention Basin – Atkins will review the design plans and analysis for the Fairground Detention Project (by Louis Berger) and ensure the MPU is consistent with what has been done.

- Non-Structural Solutions – Atkin will begin looking into non-structural solutions to get some ideas and options regarding floodplain management and acquiring/relocating properties in lieu of costly flood control improvements.

- Man-Made Berm Upstream of Bowman Reservoir – Atkins stated that during field investigations they observed a man-made berm that redirects flow from a large wash to the Bowman Reservoir, upstream of some residential areas in the northeast part of Logandale. The MVIC and MVWD and others are aware of this berm, but is currently not accounted for in the master plan and the downstream areas are not currently mapped in a flood zone. This area presents some hazards and there is evidence of the berm overtopping in previous flood events. Atkins will contact MVIC to understand the history and if they are willing to accept these flows from the diversion into the reservoir. This discussion will lead to further discussion and coordination to come up with a plan to address this issue in the master plan and potentially on the FEMA maps. Atkins mentioned that GC Wallace indicated this berm was discussed in previous master planning efforts, but there is nothing in the final reports. Tim stated he will check to see if he can find any documentation or history in relation to the berm.

Atkins stated that the project is on schedule. The hydrologic analysis is being finalized and the next couple months will be spent on the hydraulic model and facility planning and analysis.

The next progress meeting is scheduled for 2:30 PM, October 15, 2015. Tim will follow up with CCPW to confirm if this meeting time will work for them.

--- End of Meeting Minutes ---

SIGN-IN SHEET

Master Plan Update for the Muddy River and Tributaries
Progress Meeting 03, October 15, 2015, 10:30 AM
Clark County Regional Flood Control District Conference Room

Name	Affiliation	Phone Number	Email Address	Initials	Attendance
Tim Sutko	CCRFCD	702-685-0000	tsutko@regionalflood.org	[signature]	☒
Joe Damiani	CCRFCD	702-685-0000	jdamiani@regionalflood.org		☐
Andrew Trelease	CCRFCD		atrelease@regionalflood.org		☐
John Catanese	CCPW	702-455-6050	catanese@clarkcountynv.gov		☐
Joe Yatson	CCPW	702-455-6050	jyatson@clarkcountynv.gov		☐
Garrett TerBerg	~~CCPW~~ CCRFCD	702-455-5617	gtb@clarkcountynv.gov	GTB	☒
Janice Ridondo	Clark County	702-455-3504	jridondo@clarkcountynv.gov		☐
Angelo Santovito	Clark County		angelo@clarkcountynv.gov		☐
Dwayne Ako	Clark County		dako@clarkcountynv.gov		☐
Rodd Lighthouse	NDOW	775-688-1586	rlighthouse@ndow.org		☐
Tim Hunt	NDOW	775-688-1564	thunt@ndow.org		☐
Mike Zahradka	NDOW	775-688-1563	mzahradka@ndow.org		☐
Scott Millington	MVIC	702-281-7385	muddyvalley@mvdsl.com		☐
Brian Rowley	Atkins	702-551-0320	brian.rowley@atkinsglobal.com	[signature]	☑
Harshal Desai	Atkins	702-551-0349	harshal.desai@atkinsglobal.com	HBD	☑
Matt Baird	Atkins	702-990-7432	matt.baird@atkinsglobal.com		☐
Joe Davis	MVWD	702-397-6893	joe@moapawater.com	[signature]	☑
Lon Dalley	MVWD	702-397-6893	lon@moapawater.com	[signature]	☑
Hongyu Deng	Atkins	702-551-0287	hongyu.deng@atkinsglobal.com		☐
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REGIONAL FLOOD CONTROL DISTRICT

ATKINS

Meeting Minutes

ATKINS

Project:	Muddy River and Tributaries MPU		
Subject:	Coordination on hydrology and facility planning downstream of berm near Bowman Reservoir		
Date & Time:	Friday, November 6, 2015	**Project #**	100045944
Meeting Place:	CCPW Design Conference Room	**Minutes By:**	Brian Rowley

Present:

Tim Sutko, CCRFCD
Brian Rowley, Atkins
Jeff Douglas, Louis Berger

Roy Davis, CCPW
John Catanese, CCPW

SUMMARY OF ACTION ITEMS:

Item	Description & Action	Responsible (Status)
1	Perform some analysis to come up with proposed DB and outfall in the area downstream of the man made berm. Coordinate with Louis Berger as needed.	Atkins (pending)
2	Contact MVIC to discuss the history of the berm that diverts flow into the Bowman Reservoir and determine if they are willing to accommodate these flows etc.	Atkins (pending)
3	Provide Atkins/CCRFCD with videos showing flooding in this area	John, CCPW (complete)
4	Invite Scott Millington and Louis Berger to next MPU progress meeting	Atkins (complete)
5	Review watershed area in Fairgrounds DB Project based on recommendation from Atkins. Also review and/or update Whipple Storm Drain plan (i.e., larger box or stub etc.) once Atkins provides recommended regional facility or outfall alignment in the area.	Louis Berger (pending)

SUMMARY OF DISCUSSION:

The purpose of the meeting was to discuss the hydrology and facility planning with regard to the area downstream of a berm located northeast of the Bowman Reservoir. A summary of the discussion is provided below:

- **Hydrology.** During the MPU hydrologic analysis, Atkins identified a man-made berm northeast of the Bowman Reservoir that diverts flow away from its natural flow path towards the reservoir. Atkins estimated about 5,000 cfs impacting this berm location from a tributary area of approximately 23 square miles. A map of the watershed was distributed at the meeting and is attached. Based on field investigations, the berm is not in good condition and shows signs of overtopping.

- **Inundation Area.** Atkins performed preliminary analysis to determine potential area of inundation that would result from a flow of 5,000 cfs without the berm. A map showing the inundation area was distributed and is attached to these notes. The area is significant and impacts residential areas not currently in the flood zone.

- **Flood History**. John Catanese mentioned that the inundation area delineated by Atkins is consistent with descriptions he has heard from local residents in the area. John also said he had some videos showing some flooding in those areas that he will send out.

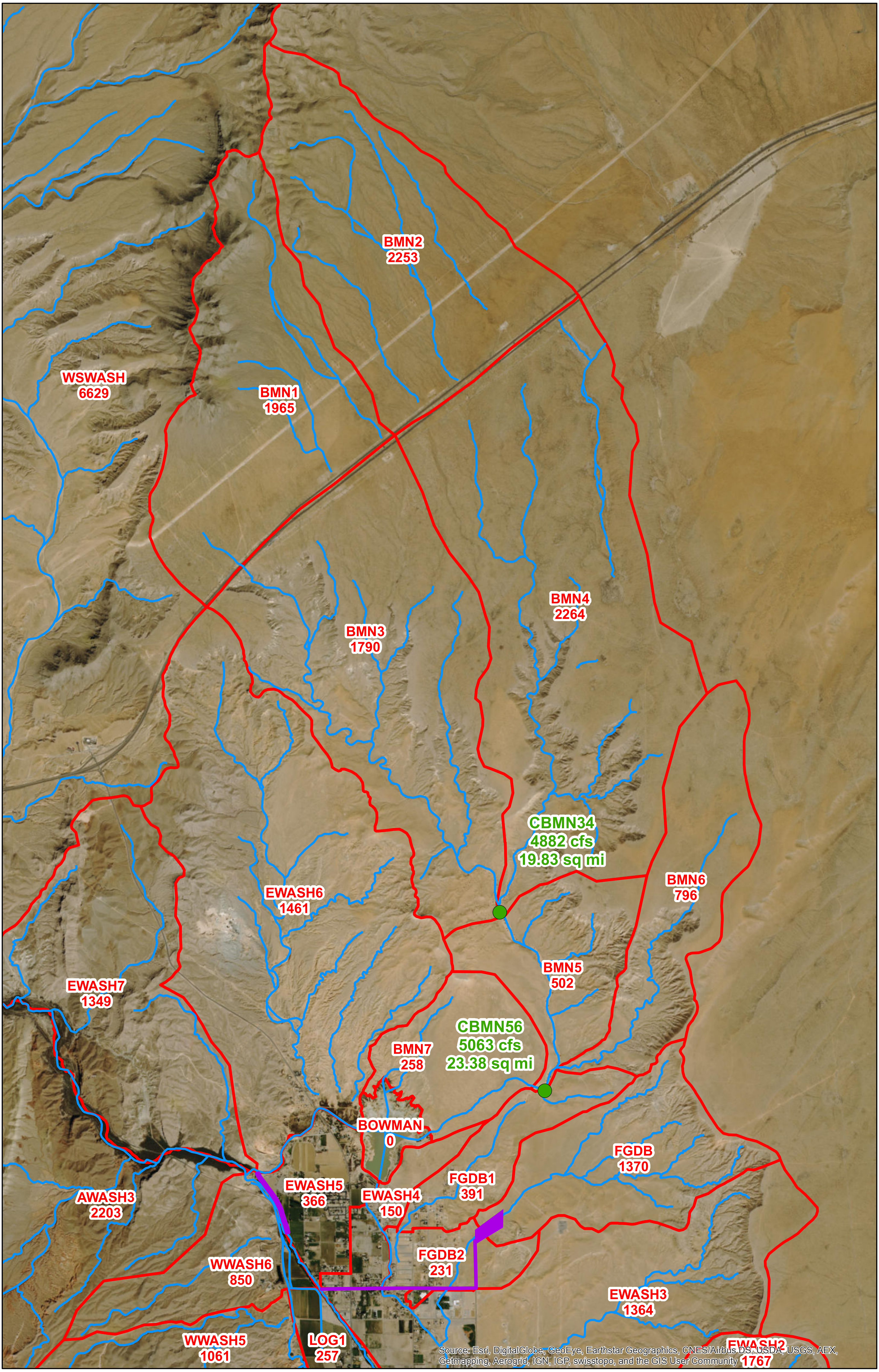
- **Recommended Plan**. After discussing various options, CCRFCD and CCPW agreed that adding a detention basin and proposed outfall to the regional plan will likely be the best alternative to mitigate the flood hazard in this area. This is the best option because topography is such that the flows cannot be diverted or redirected to the nearby Fairgrounds Detention Basin that is being designed by Louis Berger. The other option of designing/constructing an engineered levee and diverting flow to Bowman Reservoir is not desirable because of impacts on the reservoir and the dam and operations etc.

- **Proposed DB Analysis and Outfall.** Atkins will review the hydrology and come up with a plan for a proposed detention basin and outfall in order to coordinate with the Fairgrounds Detention Basin Project.

- **Fairgrounds DB Project**. Two changes or impacts will be reviewed and considered by Louis Berger for the Fairgrounds DB Project: (1) the outfall from the new, proposed detention basin may connect to their proposed storm drain system in Whipple requiring some analysis and potentially upsizing of the storm drain to a box, and (2) there is some tributary area at the upstream end of the watershed that Atkins recommended Louis Berger include in their model.

- **Next Muddy MPU Progress Meeting.** Atkins will invite Louis Berger to the next Muddy River MPU progress meeting. CCRFCD and Atkins also emphasized that it will be important for someone from CCPW to be at the upcoming meetings. Atkins will also reach out to Scott Millington to see if he can attend the next progress meeting to discuss and confirm the plan for this area.

--- End of Meeting Minutes ---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BMN1
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BMN4
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CBMN34
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1461
BMN6
796
BMN5
502
EWASH7
1349
CBMN56
5063 cfs
23.38 sq mi
BMN7
258
BOWMAN
0
FGDB
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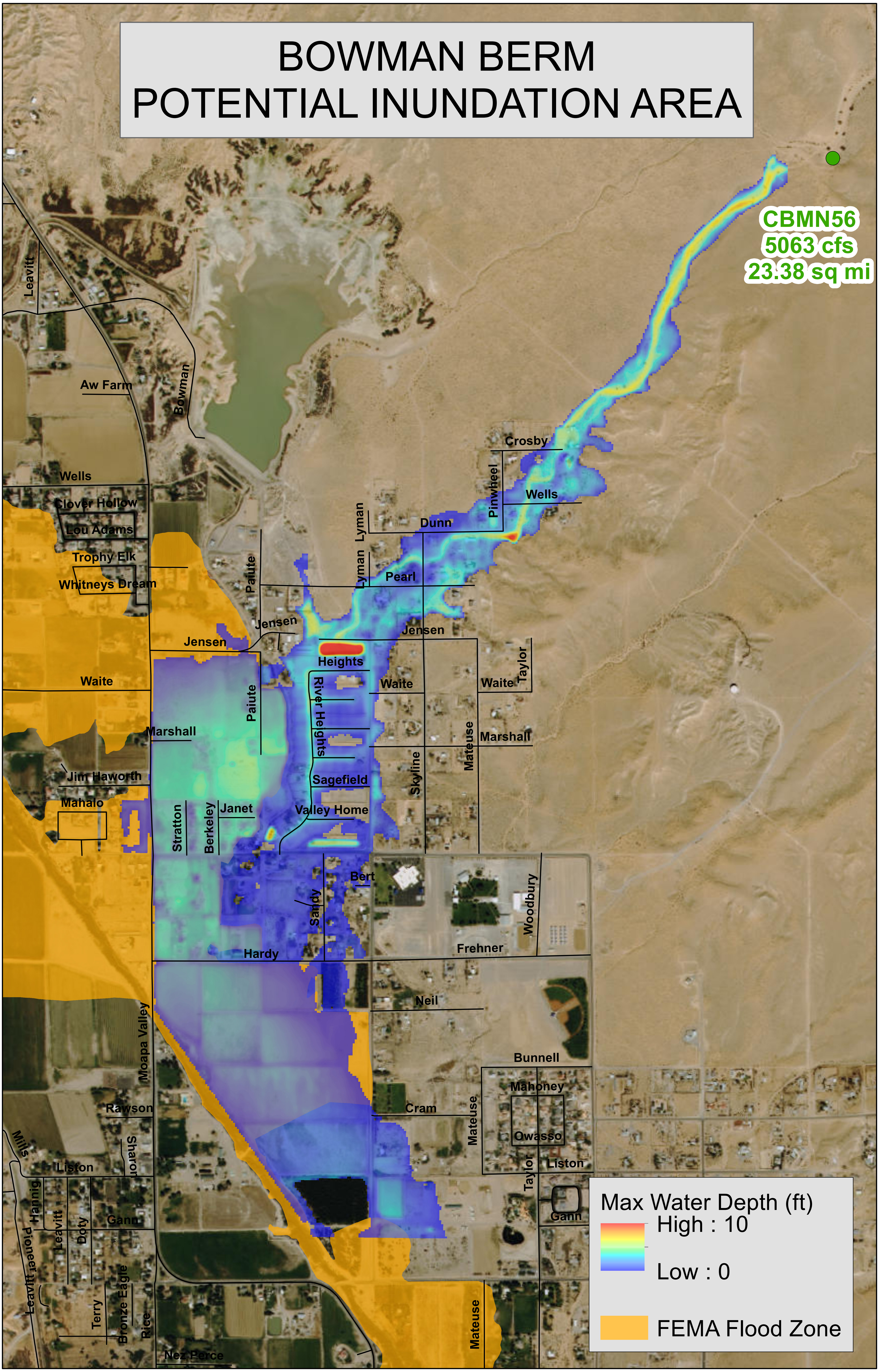
EWASH5
366
EWASH4
150
FGDB1
391
AWASH3
2203
FGDB2
231
WWASH6
850
EWASH3
1364
WWASH5
1061
LOG1
257
EWASH2
1767
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

BOWMAN BERM
POTENTIAL INUNDATION AREA



Meeting Minutes

Project:	Muddy River and Tributaries MPU		
Subject:	Meeting Minutes: Progress Meeting 4		
Date & Time:	Thursday, November 19, 2015	**Project #**	100045944
Meeting Place:	CCRFCD Conference Room	**Minutes By:**	Hongyu Deng

Present:

Tim Sutko, CCRFCD
Harshal Desai, Atkins
Brian Rowley, Atkins
Hongyu Deng, Atkins
John Tennert, CCRFCD

Joe Damiani, CCRFCD
John Catanese, CCPW
Janice Ridondo, Clark County
Jeff Douglas, Louis Berger

SUMMARY OF ACTION ITEMS:

Item	Description & Action	Responsible (Status)
1	Send Louis Berger HEC-1 models and analysis for potential detention basin and outfall that will connect to Whipple Ave SD	Atkins (pending)
2	Incorporate the MPU modeling above into design of Fairground Detention Basin project and provide Atkins with revised sizes in Whipple. Continue coordination	Louis Berger (pending)
3	Have internal discussion regarding floodplain management options and potential for possibly purchasing property in the floodplain areas	CCRFCD

SUMMARY OF DISCUSSION:

Atkins said they have made progress since the previous meeting on the facility analysis and planning. Atkins prepared figures and exhibits at various locations and shared them at the meeting for discussion purposes. The figures are attached to these meeting minutes. A summary of preliminary facility recommendations at various locations is included below:

Bowman Berm/Detention Basin

As discussed in previous meetings and at a coordination meeting with Clark County Public Works, Atkins identified a large tributary area and significant amount of flow (5,000 cfs) draining to man-made earthen berm east of the Bowman Reservoir. This berm diverts flow to the reservoir away from downstream residential areas, but it is not in good condition and downstream areas have experienced flooding.

Based on previous input from CCRFCD, Atkins came up with a detention basin plan for this area that would receive the flow that is currently being diverted at the berm and protect downstream areas. Atkins ran a HEC-1 model and sized a proosed detention basin and outfall that would tie into the proposed Whipple Avenue storm drain being designed by Louis Berger as part of the Fairgrounds Detention Basin Project. The modeling results show that the proposed storm drain in Whipple outfall may need to be upsized between Lyman St and Moapa Valley Blvd. Connecting the new proposed outfall to the Whipple Ave storm drain does not result in a significant increase in the design flow because of storm centering and the large tributary area/DARFs associated with the 20-square mile watershed. CCRFCD and Atkins and the County agreed with adding the proposed detention basin to the plan. The following decisions were made with regard to the proposed facilities in this area:

1. The proposed DB will be around 1,100 ac-ft, with an inflow around 5,000 cfs and an outflow around 250 cfs.

2. The proposed outfall pipe will be around a 60-72” RCP that will be proposed in Lyman St. This outfall will likely accept flows from the local detention basin in this area as well.

3. Atkins will provide the HEC-1 model to Louis Berger for their review and incorporation into their Whipple Avenue storm drain design. Louis Berger will provide a 72” RCP stub to the north of Whipple Avenue in Lyman Avenue for future connection.

4. Louis Berger will continue the design of their facility assuming that the berm diverts the flow to the reservoir and that the proposed DB is not in place. This will be the “worst case” design scenario in the interim condition. The watershed upstream of the earthen berm is not in Louis Berger’s watershed and a potential breach would not alleviated by their facilities anyway.

5. Louis Berger will provide Atkins with revised storm drain sizes in Whipple Ave for incorporation into the MPU.

Atkins and Louis Berger will continue to coordinate. Janice asked about the feasibility of continuing to divert flow into Bowman Reservoir by designing/building an engineered levee. CCRFCD said it is not desirable to build a levee considering the impacts on Bowman Reservoir and the MVIC operations.

Finally, Atkins and CCRFCD and the County agreed that the current flood hazard in this area should be communicated to the residents and actively managed, but this will occur outside of the MPU process and is beyond the scope of this project. This management could include maintenance or public meetings or floodplain mapping etc. Atkins has already provided hazard maps and inundation areas showing the potential flood extents for this purpose and these can be incorporated into the MPU if desired.

Wells Siding/Bowman Reservoir/Channel

Atkins stated that in previous meetings and in phone calls with Scott Millington (MVIC), he said that Wells Siding and the Bowman Reservoir and the channel between the two are impacted by flood flows. The channel facility may have some capacity and potential for providing some level of flood control. CCRFCD and Atkins and the County agreed that for now no proposed regional facilities will be added in this area, since these are MVIC facilities that serve a different purpose and do not have significant capacity.

Potential Detention Basin Upstream of Bunnell Ave and Yamashita St

Atkins reviewed another flooding area occurring at Gubler Ave and Heyer St. This area experiences flooding issues and was previously investigated and included in Louis Berger's alternative analysis as part of the Fairground Detention Basin project. Their Alternatives Memorandum displayed an estimated discharge of 1,457 cfs that impacts residential areas and results in flooding and sediment deposition. Atkins performed 2D analysis to determine potential area of inundation in this area and shared a map at the meeting (see attached) showing results. These residential areas are not currently in the flood zone.

To mitigate the flood hazard, CCRFCD and Atkins and the County agreed to add a proposed detention basin and outfall pipe in the upstream area northeast of Bunnell Ave and Yamashita St. The proposed storage volume will be around 120 ac-ft, and the proposed outfall will be aligned in Gubler Avenue, eventually discharging to the Muddy River.

Lower Muddy River

Using the new LiDAR and survey data, Atkins developed an existing-condition HEC-RAS model using 2 flow rates: 100-year flow of 21,400 cfs and lower flow of 10,000 cfs for comparison purposes. The model results were shared at the meeting. The results are informative and provide a clear picture of the existing condition and floodplain characteristics because everything is in a single model that can now be used for alternatives and evaluation of potential solutions. The model showed that even with a reduced flow of 10,000 cfs along the river, the flooding extents downstream of Cooper St are still very wide and similar to the floodplain resulting from a flow of 21,400 cfs. This is because of the lack of topographic relief and channel capacity in this area. Atkins will continue to develop model scenarios representing the proposed condition to identify proposed flood control facilities for review and discussion.

Western Washes

Atkins will look into Western Washes before next meeting to evaluate MPU facility recommendations and understand how the proposed facilities interact with the Muddy River floodplain.

Other Discussion Items:

- **Hydrology.** Atkins stated that their subconsultant Jacobs performed and independent QC review of the hydrology. Jacobs provided some helpful comments and Atkins is finalizing the hydrology.

- **2D Hydraulic Modeling.** Atkins stated that the HEC-RAS analysis is currently a steady state one-dimensional model. Two-dimensional (2D) hydraulic modeling could be a useful approach to better understand flood inundation along Lower Muddy River compared to 1D HEC-RAS model because of the breakouts out of the river and the relatively flat nature of the floodplain and flow patterns in the area. Atkins said they will do some preliminary 2D modeling to understand the benefit and level of effort and this can be discussed as a possible supplemental service at the next progress meeting.

- **Non-Structural Solutions.** CCRFCD said they will have an internal discussion with their attorney regarding potential floodplain management options involving purchasing property in the area.

- **Schedule.** Atkins shared the project schedule and is targeting March 10, 2016 to have the draft MPU report ready. This will allow the next two months of the project to be spent on detailed facility analysis and plan formulation. CCRFCD agreed.

The next progress meeting is scheduled for 2:30 PM, December 17, 2015. The progress meetings will continue in the afternoon instead of the morning going forward.

--- End of Meeting Minutes ---

SIGN-IN SHEET

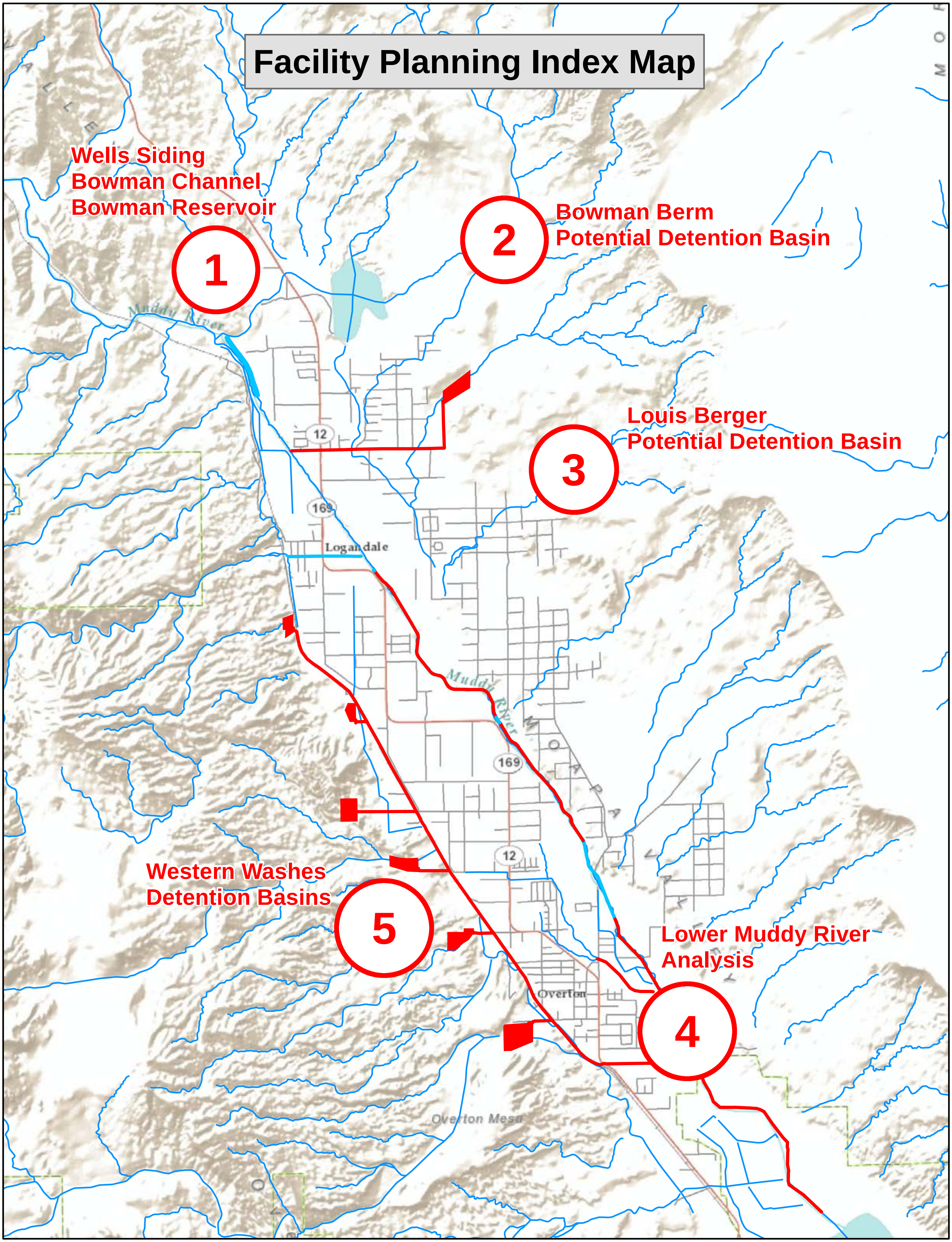
Master Plan Update for the Muddy River and Tributaries
Progress Meeting 04, November 19, 2015, 10:30 AM
Clark County Regional Flood Control District Conference Room

Name	Affiliation	Phone Number	Email Address	Initials	Attendance
Tim Sutko	CCRFCD	702-685-0000	tsutko@regionalflood.org	[illegible]	✓
Joe Damiani	CCRFCD	702-685-0000	jdamiani@regionalflood.org	[illegible]	✓
Andrew Trelease	CCRFCD		atrelease@regionalflood.org		☐
John Catanese	CCPW	702-455-6050	catanese@clarkcountynv.gov	JC	✓
Joe Yatson	CCPW	702-455-6050	jyatson@clarkcountynv.gov		☐
Garrett TerBerg	CCCP	702-455-5617	gtb@clarkcountynv.gov		☐
Janice Ridondo	Clark County	702-455-3504	jridondo@clarkcountynv.gov	[illegible]	✓
Angelo Santovito	Clark County		angelo@clarkcountynv.gov		☐
Dwayne Ako	Clark County		dako@clarkcountynv.gov		☐
Rodd Lighthouse	NDOW	775-688-1586	rlighthouse@ndow.org		☐
Tim Hunt	NDOW	775-688-1564	thunt@ndow.org		☐
Mike Zahradka	NDOW	775-688-1563	mzahradka@ndow.org		☐
Scott Millington	MVIC	702-281-7385	muddyvalley@mvdsl.com		☐
Brian Rowley	Atkins	702-551-0320	brian.rowley@atkinsglobal.com	BR	✓
Harshal Desai	Atkins	702-551-0349	harshal.desai@atkinsglobal.com	HBD	✓
Matt Baird	Atkins	702-990-7432	matt.baird@atkinsglobal.com		☐
Joe Davis	MVWD	702-397-6893	joe@moapawater.com		☐
Lon Dalley	MVWD	702-397-6893	lon@moapawater.com		☐
Hongyu Deng	Atkins	702-551-0287	hongyu.deng@atkinsglobal.com	[illegible]	✓
John Tennert	CCRFCD	702-685-0023	jtennert@regionalflood.org	[illegible]	✓
Jeff Douglas	Louis Berger	702 789 1978	jdouglas@louisberger.com	JSD	

REGIONAL FLOOD CONTROL DISTRICT

ATKINS

Facility Planning Index Map



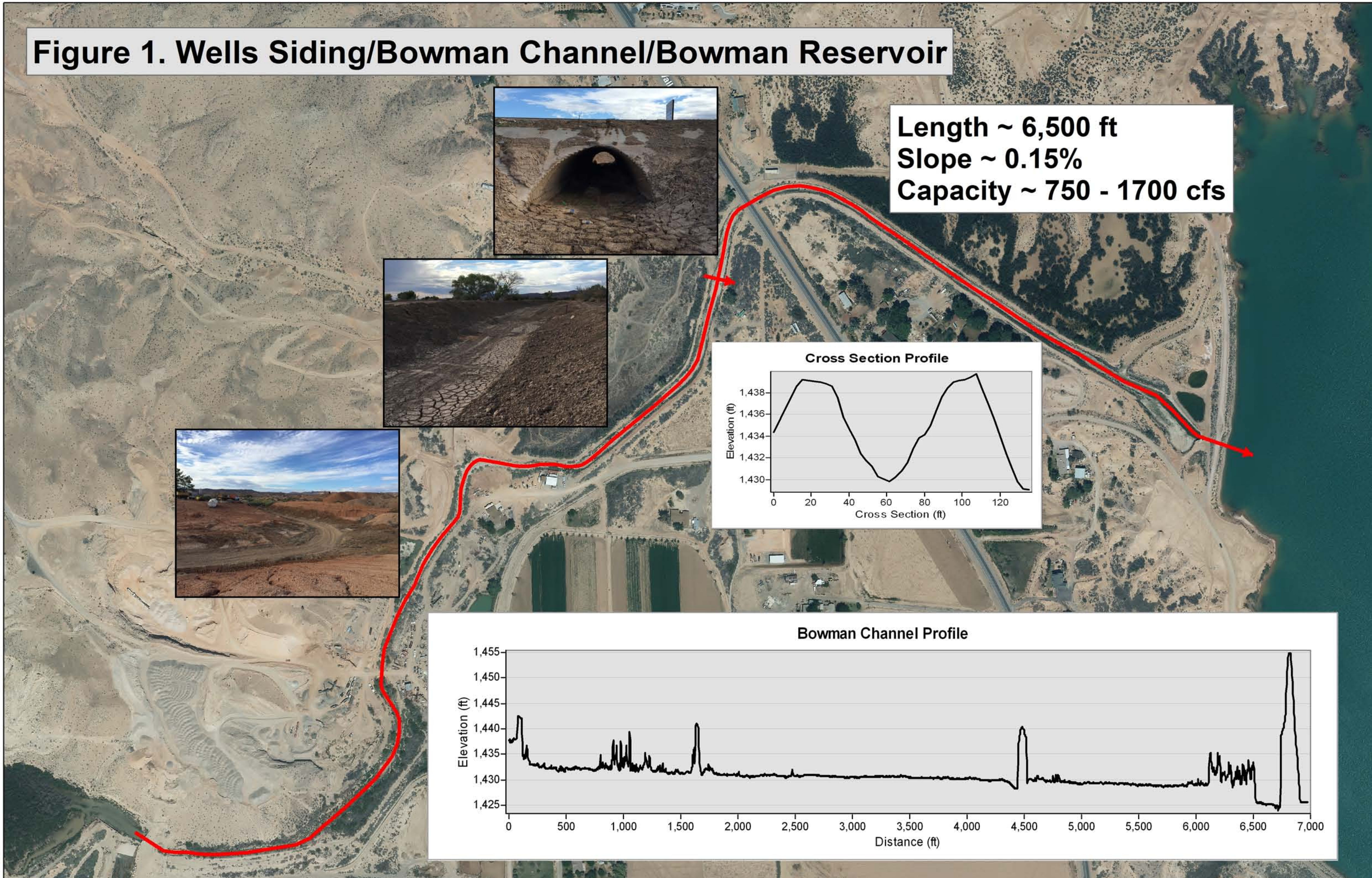


Figure 1. Wells Siding/Bowman Channel/Bowman Reservoir

BOWMAN BERM POTENTIAL INUNDATION AREA

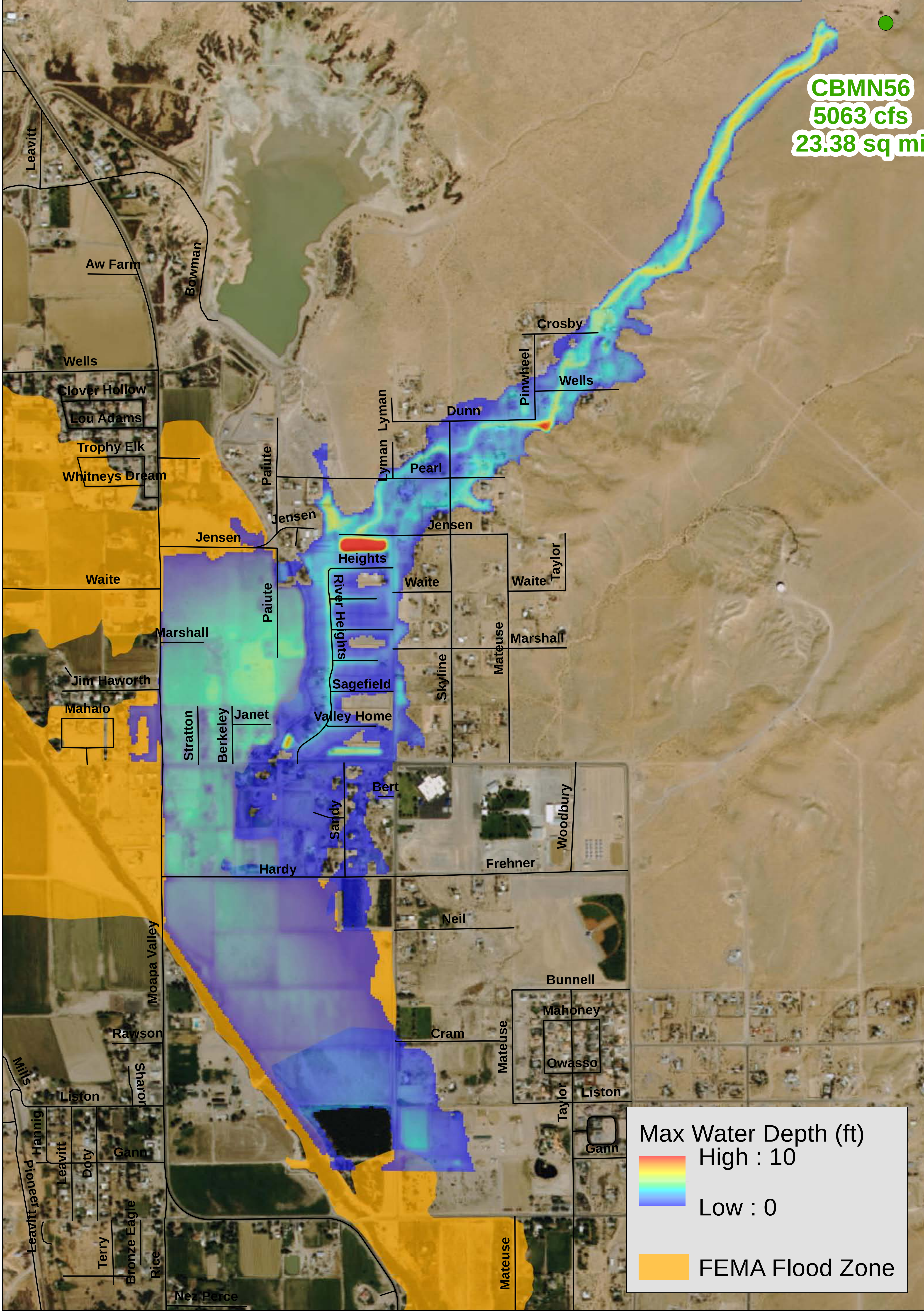
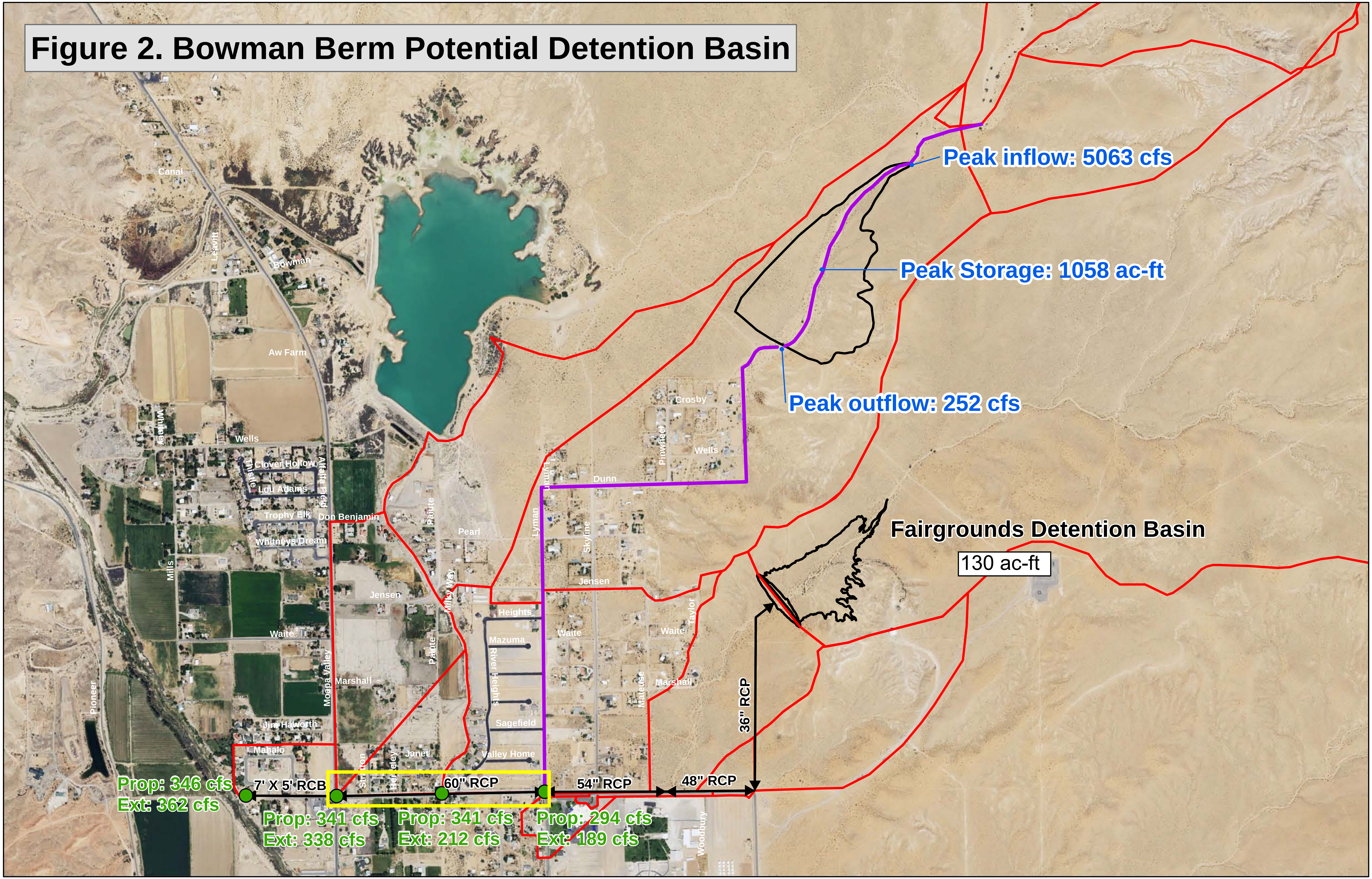


Figure 2. Bowman Berm Potential Detention Basin



LOUIS BERGER POTENTIAL DETENTION BASIN INUNDATION AREA

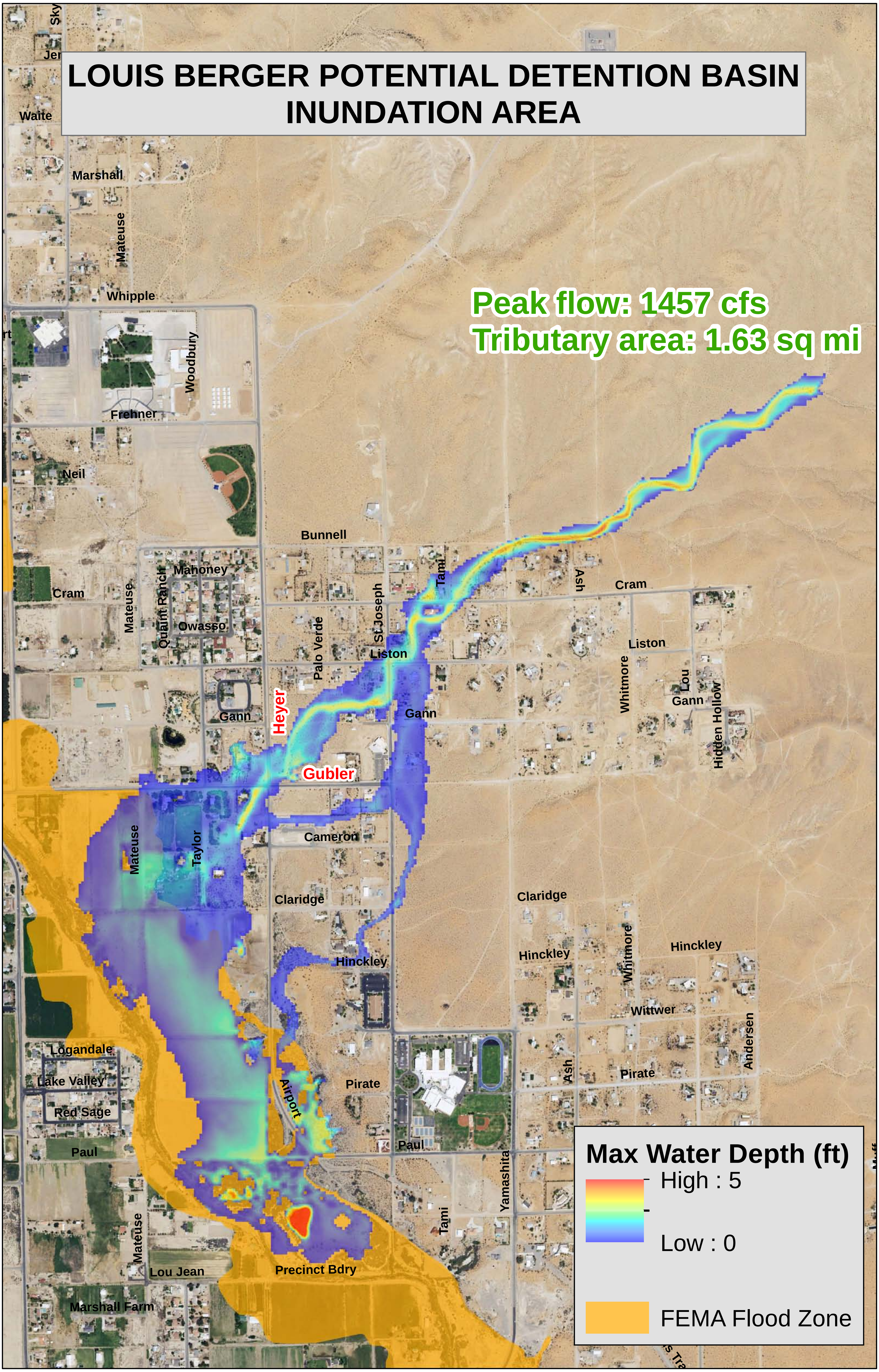
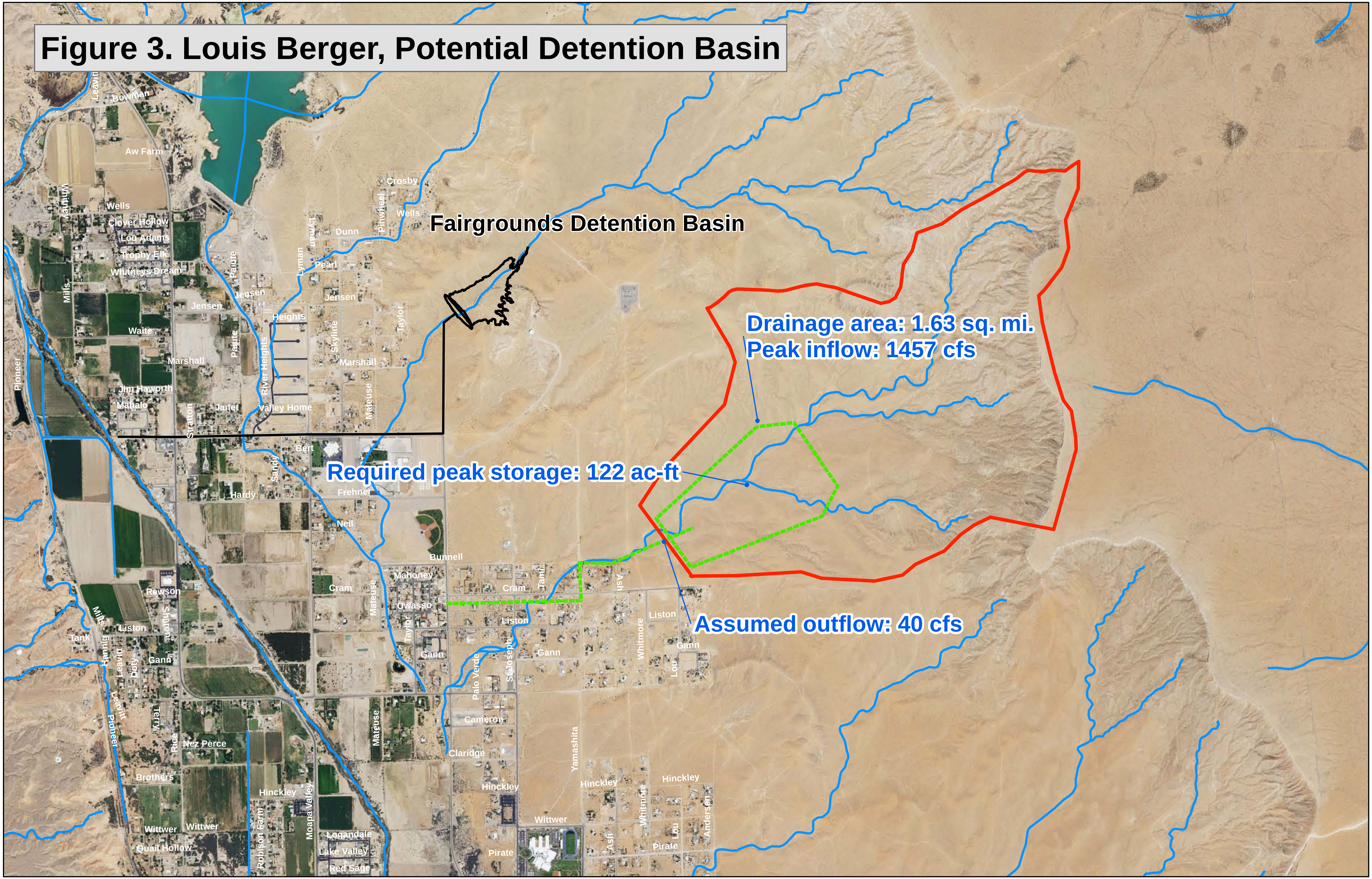


Figure 3. Louis Berger, Potential Detention Basin




Legend
Stream Centerline
Cross-Section
10,000 cfs Floodplain (Existing Condition)
100-Year Floodplain (Existing Condition)
N
1,300 650 0 1,300 2,600
Feet
1 inch = 1,300 feet

Meeting Minutes

Project:	Muddy River and Tributaries MPU
Subject:	Meeting Minutes: Progress Meeting 5
Date & Time:	Thursday, December 17, 2015 — **Project #** 100045944
Meeting Place:	CCRFCD Conference Room — **Minutes By:** Hongyu Deng

Present:

Tim Sutko, CCRFCD
Joe Damiani, CCRFCD
Andrew Trelease, CCRFCD
Rodd Lighthouse, NDOW*
Mike Zahradka, NDOW*
Brian Rowley, Atkins

John Catanese, CCPW
Joe Davis, MVWD
Lon Dalley, MVWD
Janice Ridondo, Clark County
Harshal Desai, Atkins
Hongyu Deng, Atkins

(*Attended via phone)

SUMMARY OF ACTION ITEMS:

Item	Description & Action	Responsible (Status)
1	Prepare supplemental scope/fee for HEC-RAS 2D hydraulic modeling and send to CCRFCD for authorization	Atkins (complete)
2	NDOW will send Atkins information on berm removal or modifications in the Overton WMA. Coordination will continue.	NDOW (complete)
3	Schedule CCRFCD for a presentation at future TAB meetings in Moapa and Moapa Valley in March. To be completed as time gets closer.	CCRFCD (pending)

SUMMARY OF DISCUSSION:

Atkins reported substantial progress since the previous meeting on the hydraulic modeling and facility analysis and planning. Atkins prepared figures and digital maps and shared them at the meeting for discussion purposes. The figures are attached to these meeting minutes. A summary of key discussion points are below:

Fairground Detention Basin Project Coordination

Atkins said they sent Louis Berger the HEC-1 models that were developed to size the proposed detention basin and outfall that will connect to Whipple Ave proposed facility. Atkins will continue to coordinate with Louis Berger on the sizing of regional facilities in this area for master planning purposes.

Hydraulic Modeling and Inundation Mapping

Atkins stated that they have developed several hydraulic models to help with the facility analysis and planning. The models are listed below and described further in the Facility Planning section. These models were necessary because of complex flow patterns along the Muddy River and in the Western Washes area.

- **HEC-RAS (1D).** Atkins developed an existing-condition 1D HEC-RAS model of the Lower Muddy River for the 10-, 50-, 100-, and 500-year flood events. The 100-year flow is 21,400 cfs. Atkins also developed a proposed-condition model in HEC-RAS to analyze the currently proposed regional facilities along the river.

- **HEC-RAS 2D.** Atkins prepared an existing-condition HEC-RAS 2D model using 100-year flow of 21,400 cfs. The model was effective at analyzing breakout flows and complex flow splits along the river and floodplain.

- **FLO-2D.** Atkins developed several FLO-2D models in the study area:

    1. Rainfall-runoff modeling of the Western Washes to delineate primary flow corridors.

    2. Local rainfall-runoff model in residential areas between the Muddy River and the UPRR.

    3. Eastern Washes inundation maps to delineate flood hazards and flow corridors in residential areas on the east side of the Muddy River.

Facility Planning

Based on hydraulic analysis listed above, Atkins shared facility recommendations at the meeting for discussion purposes. A summary is below:

- **Western Washes.** Atkins developed a FLO-2D rainfall-runoff model over the western washes which provided a clear delineation of flow patterns and corridors. The modeling results indicate that several subbasins will drain directly to the proposed channel along the west side of the UPRR alignment, instead of to the proposed detention basins. Atkins recommended updating the proposed channel and detention basin to account for these areas and flows. This will be done by increasing the proposed channel size or adding berms or levees to direct flows into the detention basin. CCRFCD and the County agreed with this approach so Atkins will review and revise the proposed facilities accordingly. Some of the proposed detention basin sizes will likely decrease since more flow will directly drain to the channel.

    John Catanese and Andrew Trelease asked about the possibility of breaking up the very long channel that is proposed on the west side of UPRR into different segments and possibly connecting cross-valley channels or storm drains east to the Muddy River, rather than conveying everything in a single channel to the south end of town. Atkins said this option was investigated during previous MPU studies and it was decided that the most cost effective option was a single channel along the west side of UPRR. Atkins said they will look into this in more detail before the next meeting. Atkins also stated that for planning and cost programming purposes, either option would be fairly similar and could be included in the MPU and then the alternative alignments could be considered during detailed design phase.

- **Muddy River.** Atkins initially developed an existing-condition 1D HEC-RAS model and a proposed-condition model along the Muddy River. The proposed-condition model indicates that the currently proposed Muddy River regional facilities would have capacity to convey the 100-year flow of 21,400 cfs. However, the profile of the channel shows some significant cut sections and there are questions regarding the effectiveness and feasibility of the proposed system, especially in the flat areas downstream of Cooper Street Bridge.

Because of the breakouts out of the river and flat floodplain terrain, Atkins prepared an existing-condition HEC-RAS 2D hydraulic model using flow of 21,400 cfs to better understand the flow patterns and flood inundation process. Atkins stated that the 1D model was not the most effective or accurate way to analyze the flat floodplain areas. The 2D model results (including an animation) show the breakouts at various locations along the river and flow conveyed in the overbank areas on the east and west side of the river near Lewis Avenue (see attached figure).

Atkins said they would like to request authorization of supplemental services to do additional 2D HEC-RAS modeling of the proposed condition in order to develop the proposed plan for the area and to understand impacts of building different reaches of the improvements at different times (phasing). CCRFCD asked Atkins to prepare a supplemental services scope/fee of 2D HEC-RAS modeling and send it to them for authorization.

- **Overton Wildlife Management Area.** Atkins' modeling results showed that the berm near the diversion structure in the Overton WMA has some backwater impacts on the floodplain, but it does not appear to have negative impacts to properties near Lewis Avenue. Mike and Rodd from NDOW informed everyone that they are in the process of doing some work and removing some of the berm and they will send that information to Atkins. Atkins stated they will run a model scenario with the berm and another without the berm to compare the difference and quantify any adverse impacts from the berm.

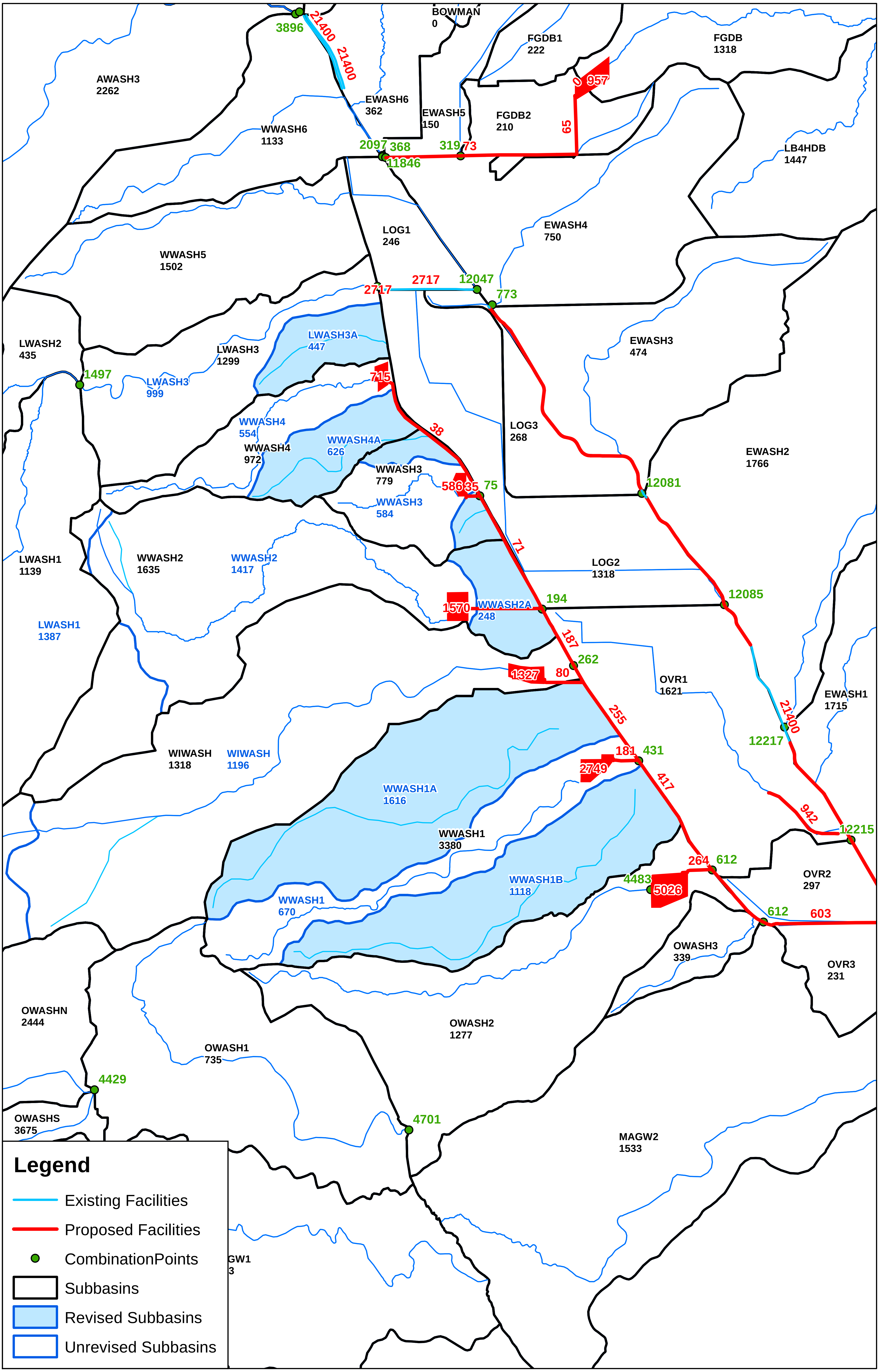
- **Eastern Washes.** Atkins developed two new inundation maps for natural washes in residential areas on the east side of the Muddy River using FLO-2D since last meeting. The modeling results show 100-year flows are relatively well contained and the inundation areas do not extend into properties outside of the current FEMA flood zone. Atkins is not recommending new proposed regional facilities in these areas. CCRFCD agreed.

- **Non-Structural Solutions.** Atkins said they had an internal discussion with their non-structural flood control team. There are several alternatives that can be discussed further, including floodplain mapping, public outreach, blanket insurance policies, purchasing properties, flood proofing, maintenance, etc. These non-structural solutions will be reviewed in more detail once the structural solutions are finalized.

- **TAB Meeting Schedule.** Joe Damiani asked about the expected time when CCRFCD can return and share the MPU results and recommendations at future TAB meetings in Moapa and Moapa Valley. Atkins said the draft MPU report is scheduled to be completed by March so that would be a good time to make the presentations. Joe said Janice Ridondo should be aware of this new schedule. Atkins will follow up as the time gets closer to get the meetings officially scheduled on the agenda.

The next progress meeting is scheduled for 2:30 PM, January 21, 2015. The progress meetings will continue in the afternoon instead of the morning going forward.

--- End of Meeting Minutes ---



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EWASH4 750
WWASH5 1502
LWASH2 435
LWASH3A 447
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LOG3 268
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OVR3 231
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GW1 3
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262
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80
255
12217
21400
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431
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417
942
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612
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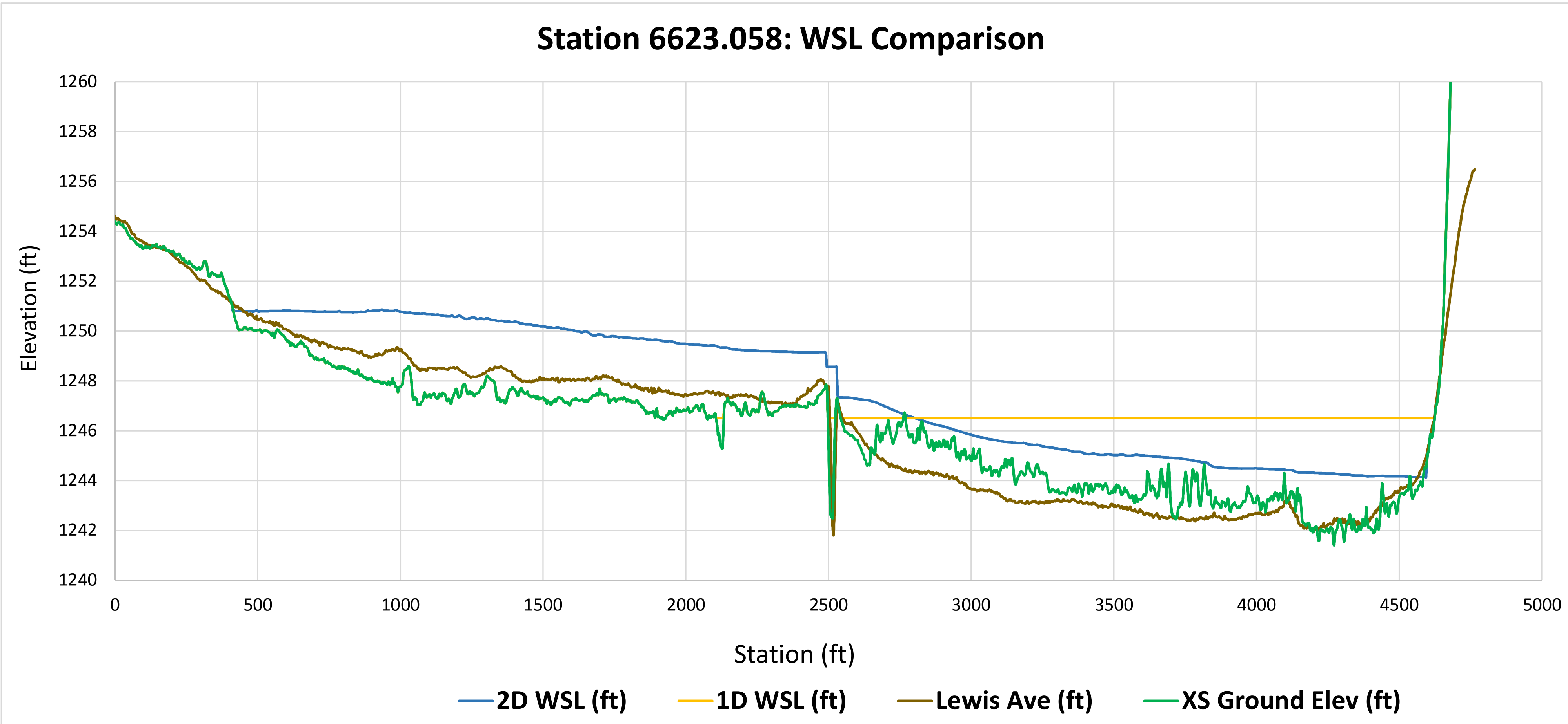
Legend
Existing Facilities
Proposed Facilities
CombinationPoints
Subbasins
Revised Subbasins
Unrevised Subbasins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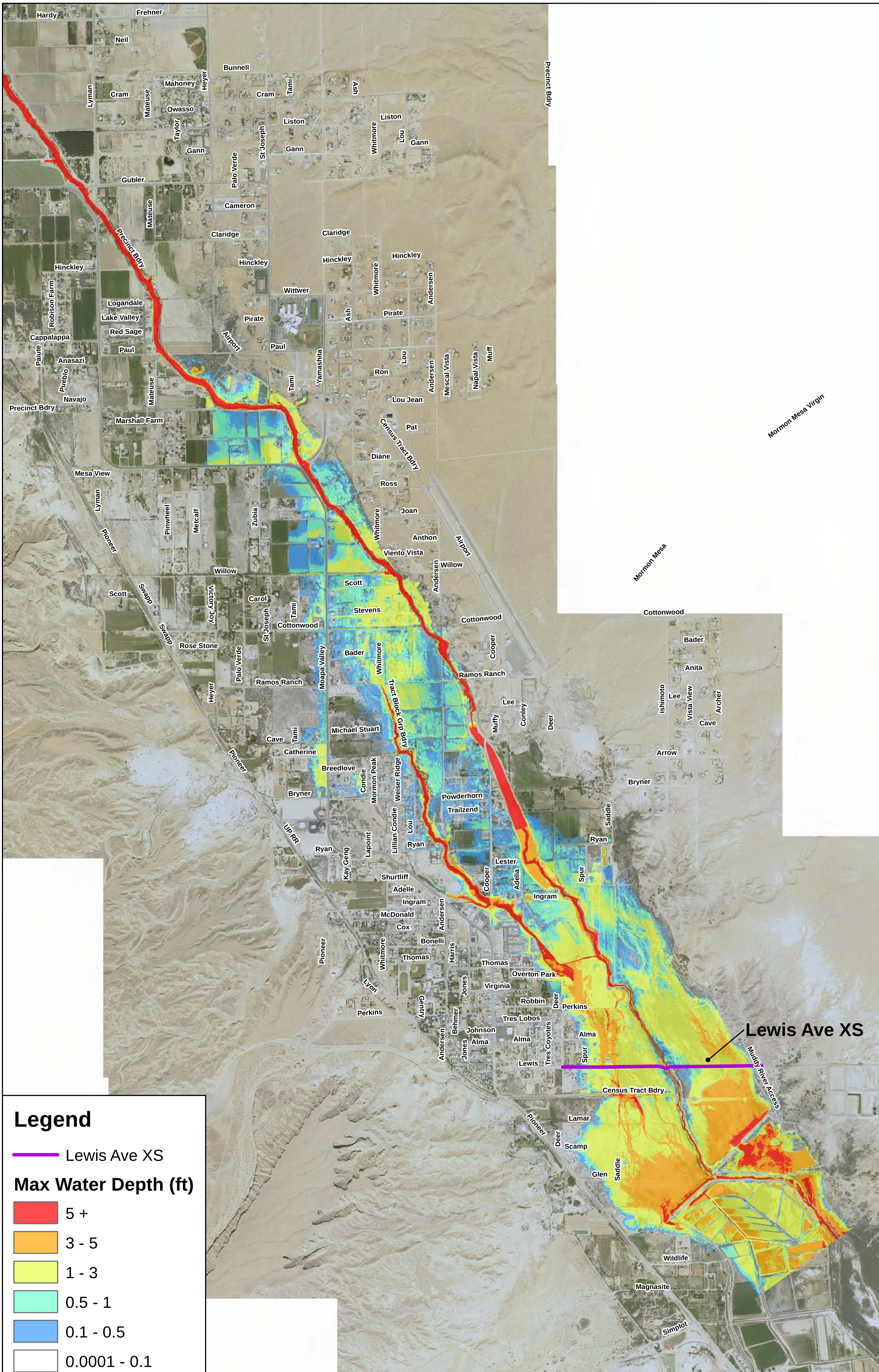
1260
1258
1256
1254
1252
1250
1248
1246
1244
1242
1240
Elevation (ft)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Station (ft)
2D WSL (ft)
1D WSL (ft)
Lewis Ave (ft)
XS Ground Elev (ft)


Lewis Ave XS
Legend
Lewis Ave XS
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0.5 - 1
0.1 - 0.5
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Frehner
Neil
Bunnell
Mahoney
Heyer
Lyman
Cram
Mateuse
Owasso
Tami
Ash
Taylor
Liston
Whitmore
Lou
Gann
St Joseph
Palo Verde
Gubler
Cameron
Precinct Bdry
Claridge
Hinckley
Andersen
Robison Farm
Logandale
Lake Valley
Red Sage
Cappalappa
Pirate
Wittwer
Airport
Paul
Paiute
Anasazi
Pueblo
Navajo
Yamashita
Ron
Mescal Vista
Napal Vista
Muff
Lou Jean
Marshall Farm
Census Tract Bdry
Pat
Diane
Mesa View
Ross
Joan
Pinwheel
Metcalf
Zubia
Pioneer
Anthon
Viento Vista
Willow
Scott
Swapp
Victory Joy
Carol
Stevens
Cottonwood
Rose Stone
Bader
Moapa Valley
Ramos Ranch
Cooper
Tract Block Grp Bdry
Lee
Muffy
Conley
Deer
Michael Stuart
Cave
Catherine
Breedlove
Condie
Mormon Peak
Weiser Ridge
Bryner
Powderhorn
Trailzend
Lillian Condie
UP RR
Ryan
Kay Geng
Lapoint
Lester
Adelia
Spur
Saddle
Shurtliff
Adelle
Ingram
McDonald
Cox
Bonelli
Thomas
Harris
Overton Park
Virginia
Jones
Lyon
Perkins
Gentry
Robbin
Tres Lobos
Behmer
Johnson
Alma
Tres Coyotes
Lewis
Muddy River Access
Lamar
Scamp
Glen
Wildlife
Magnasite
Simplot
Anita
Ishimoto
Vista View
Archer
Arrow
Mormon Mesa
Mormon Mesa Virgin

SIGN-IN SHEET

Master Plan Update for the Muddy River and Tributaries
Progress Meeting 05, December 17, 2015, 2:30 PM
Clark County Regional Flood Control District Conference Room

Name	Affiliation	Phone Number	Email Address	Initials	Attendance
Tim Sutko	CCRFCD	702-685-0000	tsutko@regionalflood.org	[illegible]	☒
Joe Damiani	CCRFCD	702-685-0000	jdamiani@regionalflood.org	[illegible]	☒
Andrew Trelease	CCRFCD		atrelease@regionalflood.org	[illegible]	☒
John Catanese	CCPW	702-455-6050	catanese@clarkcountynv.gov	[illegible]	☒
Joe Yatson	CCPW	702-455-6050	jyatson@clarkcountynv.gov		☐
Garrett TerBerg	CCCP	702-455-5617	gtb@clarkcountynv.gov		☐
Janice Ridondo	Clark County	702-455-3504	jridondo@clarkcountynv.gov	[illegible]	☒
Angelo Santovito	Clark County		angelo@clarkcountynv.gov		☐
Dwayne Ako	Clark County		dako@clarkcountynv.gov		☐
Rodd Lighthouse	NDOW	775-688-1586	rlighthouse@ndow.org		☒ phone
Tim Hunt	NDOW	775-688-1564	thunt@ndow.org		☐
Mike Zahradka	NDOW	775-688-1563	mzahradka@ndow.org		☒ phone
Jeff Douglas	Louis Berger	702-789-1978	jdouglas@louisberger.com		☐
Brian Rowley	Atkins	702-551-0320	brian.rowley@atkinsglobal.com	BR	☒
Harshal Desai	Atkins	702-551-0349	harshal.desai@atkinsglobal.com	HBD	☐
Matt Baird	Atkins	702-990-7432	matt.baird@atkinsglobal.com		☐
Joe Davis	MVWD	702-397-6893	joe@moapawater.com	[illegible]	☒
Lon Dalley	MVWD	702-397-6893	lon@moapawater.com	LD	☒
Hongyu Deng	Atkins	702-551-0287	hongyu.deng@atkinsglobal.com	[illegible]	☒
John Tennert	CCRFCD	702-685-0023	jtennert@regionalflood.org		☐

REGIONAL FLOOD CONTROL DISTRICT

ATKINS

Meeting Minutes

ATKINS

Project:	Muddy River and Tributaries MPU		
Subject:	Meeting Minutes: Progress Meeting 6		
Date & Time:	Thursday, January 21, 2016	**Project #**	100045944
Meeting Place:	CCRFCD Conference Room	**Minutes By:**	Hongyu Deng

Present:

Tim Sutko, CCRFCD
Joe Damiani, CCRFCD
Andrew Trelease, CCRFCD
Rodd Lighthouse, NDOW
Mike Zahradka, NDOW
Ron Cothran, NDOW
John Catanese, CCPW
Joe Davis, MVWD
Lon Dalley, MVWD
John Tennert, CCRFCD
Scott Millington, MVIC
Harshal Desai, Atkins
Hongyu Deng, Atkins
Brian Rowley, Atkins

SUMMARY OF ACTION ITEMS:

Item	Description & Action	Responsible (Status)
1	Continue coordination with Louis Berger on the proposed regional facilities in the Fairgrounds Detention Basin study area	Atkins (pending)
2	Provide Atkins with a map or a markup or any information regarding irrigation canals or corridors that could potentially be used as alignments for proposed regional facilities from Western Washes to the Muddy River	Scott Millington (pending)
3	Develop a 2D HEC-RAS model of the scenario with the berm in the Overton WMA removed in order to evaluate backwater effects	Atkins (pending)
4	CCRFCD will provide Atkins with cost tool adjustment factor to be used for MPU facility cost estimates	CCRFCD (pending)
5	Clark County to provide recent bid data or cost estimates for any projects in the area	Clark County (pending)

SUMMARY OF DISCUSSION:

Atkins reported that substantial progress has been made since the previous meeting with regard to hydraulic modeling and facility analysis and planning. Atkins prepared figures and digital maps that were shared on screen at the meeting for discussion purposes. Relevant figures are attached to these meeting minutes. A summary of key discussion points are below:

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Fairground Detention Basin Project Coordination

Atkins said they sent Louis Berger the most current hydrologic parameters and HEC-1 models that were developed to size the proposed detention basin and outfall that will connect to Whipple Ave proposed facility. Atkins will continue to coordinate with Louis Berger on the sizing of regional facilities in this area for master planning purposes. Louis Berger is also coordinating with the County on this project and is preparing to start with the next design phase.

Facility Planning

Based on previous hydrologic and hydraulic analysis, Atkins shared facility recommendations to address four primary flooding sources in the Lower Muddy River study area. A summary of the discussion is below:

- **Eastern Washes.** Atkins recommended adding two new detention basins in the Eastern Washes area. The first proposed detention basin is around 1250 ac-ft and is located east of the Bowman Reservoir. This basin will receive the flow that is currently being diverted by an earthen, man-made diversion to Bowman Reservoir. The outfall pipe is planned to be around a 60" to 72" RCP in Lyman St and will connect to Whipple Ave storm drain being designed by Louis Berger as part of the Fairgrounds Detention Basin Project.

  The second proposed detention basin is located east of Bunnell Ave and will intercept flow from the eastern washes and protect downstream residential areas. This basin is around 160 ac-ft, with an inflow of 1,400 cfs and an outflow around 90 cfs. The outfall pipe size will be around a 42" to 48" RCP that conveys the outflow from proposed detention basin to Muddy River at Gubler Ave. CCRFCD and the County agreed with these recommendations.

- **Muddy River Modeling.** Since the last meeting, Atkins developed 2D HEC-RAS modeling of the proposed condition, assuming all of the proposed facilities upstream of Cooper Street have been built and nothing downstream of the Cooper Street improvements has been built. This purpose of this model was to understand what the impacts would be to downstream properties near Lewis Ave if the proposed facilities upstream are built first.

  The model results were informative and indicated that the floodplain extent was very similar to the existing-condition HEC-RAS 2D model. The maximum inundation water depth increases by from 0 to 0.5 ft for most of the floodplain extent. Some of the private properties in the area were shown in relation to the floodplain to understand some of the properties and structures that may be impacted.

  Atkins stated that based on modeling and analysis, it was recommended to consider a non-structural solution for the area downstream of Cooper Street. This is because the modeling has shown that the proposed MPU facilities upstream of Cooper Street are sufficient to convey the 100-year flow and the area has topographic relief and a suitable channel geometry to be able to improve the channel. However, downstream of Cooper Street the topography is very flat and the channel conveyance is minimal. Coming up with a feasible structural solution will be very expensive. Atkins did develop some preliminary ideas for a structural solution, which would be similar to what was previously proposed in the MPU: a wide conveyance corridor with some levee structures on both sides and parallel facilities to convey local flows.

  In order to come up with a final decision, CCRFCD asked Atkins to determine what a feasible structural solution would be and how much it would cost. Then Atkins will see how many parcels that solution would protect, and divide the structural cost by the number of parcels to come up with a cost per acre for the structural solution. That cost can be compared to the non-structural cost or the cost of acquiring the properties in order to decide on the best course of action for the area.

  Atkins agreed to further develop a structural solution and to come up with some recommendations for the area.

- **Western Washes.** Atkins reviewed and finalized the hydrology and revised all of the Western Washes proposed detention basin footprints and elevation-area-discharge curves by using the LiDAR data that was acquired for the project. In addition, Atkins stated that they are sizing the basins by determining the peak storage volume required in the HEC-1 model (clear water storage) then adding 10% of that volume for sediment allowance plus an additional 1 foot of freeboard. This is appropriate for the Western Washes where high sediment loads are expected. The previous MPU analysis did not include sediment and freeboard allowance. CCRFCD agreed with this methodology. A map and summary table were shared at the meeting to show all of the proposed DB footprints and volumes (see attached).

  For the Western Wash 1 Detention Basin, Atkins shared three alternatives since the previously proposed detention basin in this area is not big enough to cutoff flows from three separate, large washes in the area. Option 1 was a single, below-grade detention basin located in public land with a berm that would cutoff flow from the south and direct it to the proposed basin. This alternative may be difficult to design because of topography and lack of slope for the berm. Option 2 was a single detention basin that would have to be located in private land (to be acquired) with a berm to the north that will direct flow to the proposed basin. Option 3 was two separate detention basins both located in public land with no berm or levee needed. Atkins asked for guidance from CCRFCD and they said to review the options and make a recommendation based on the most cost effective, feasible solutions. Atkins agreed to finalize the recommended plan for this detention basin.

  The other proposed recommendation for this area is to increase the proposed channel capacity to approximately 900 cfs to account for local flows entering the channel directly from the Western Washes. CCRFCD and the County agreed.

  John Catanese and Scott Millington asked if the proposed channel along west side of UPRR could be divided into separate projects by building cross-valley channels from UPRR to Muddy River. Scott Millington mentioned that there are some local irrigation facilities and some right-of-way that could maybe be used to convey the flow from the Western Washes detention basins to the Muddy River. Atkins asked Scott to provide any available information on these corridors if available or even a markup on a map.

  After discussing this with the group, it was agreed that this option to cut across the valley with additional facilities could be reviewed in the design phase. Atkins stated that from the perspective of master planning and cost programming, building a single channel along west side of UPRR to the south end of town would still be representative of the total facilities and funding needed for planning purposes. Even if a channel cut off some of the flow and connected sooner to the Muddy River, there would still be a need for a channel along the western side of the UPRR. Further, previous MPUs have reviewed this alternative and determined that it was most cost effective to use a single channel along the UPRR. This can be reviewed in more detail during design phase. CCRFCD and the County agreed.

- **Local Area.** The local drainage between UPRR and Muddy River drains to the Western Creek area west of the Muddy River. The previous MPU proposed a facility in this area and a parallel channel to daylight the flows back into the Muddy River. Atkins stated that this area will be reviewed in more detail once the recommended solution is finalized along the Lower Muddy River. CCRFCD agreed.

<u>**Other Discussion Items**</u>

- **Overton Wildlife Management Area.** Mike and Rodd from NDOW explained their ongoing effort to remove a berm just south of an irrigation channel and west of the diversion structure so that it essentially matches the bank or top elevation of the irrigation channel. Also, removal of the berm east of the diversion structure will begin approximately 1,650 feet east of the diversion structure and is planned to be removed for 1,000 feet in a southerly direction The berm on the northeast side of diversion structure, upstream of the Honeybee Pond, will not be lowered

Atkins showed the existing condition RAS 2D modeling results that indicate the berm is causing some backwater effects at the downstream end. Atkins will develop an additional modeling scenario to remove the berm and then compare the differences to evaluate any backwater impacts. The results will be shared at the next progress meeting.

- **Cost tool.** Atkins stated the previous 2010 MPU used 2008 Las Vegas Valley MPU cost tool with an adjustment factor of 0.765 to account for cost changes from 2008 to 2010. CCRFCD stated that Atkins should continue to use the cost tool for this MPU and that they will review the adjustment factor and provide that to Atkins.
- **Clark County Bid Data**. Atkins requested that John Catanese provide any available bid or cost estimate data from recent projects in the area (i.e., Cooper Street, Logandale Levee, etc.). Atkins will review this information to help with developing the MPU facility cost estimates.
- **TAB Meeting Schedule.** Joe Damiani said TAB meetings in Moapa Valley and Moapa are scheduled on March 9th and 29th, respectively. Atkins said the draft MPU report is scheduled to be completed by March 10th so those dates should work for final presentations. Atkins will continue to coordinate these dates and get on the agenda and prepare presentations.

The next progress meeting is scheduled for 2:30 PM, February 18, 2016.

--- End of Meeting Minutes ---

SIGN-IN SHEET

Master Plan Update for the Muddy River and Tributaries
Progress Meeting 06, January 21, 2016, 2:30 PM
Clark County Regional Flood Control District Conference Room

Name	Affiliation	Phone Number	Email Address	Initials	Attendance
Tim Sutko	CCRFCD	702-685-0000	tsutko@regionalflood.org	[illegible]	☐
Joe Damiani	CCRFCD	702-685-0000	jdamiani@regionalflood.org	[illegible]	☐
Andrew Trelease	CCRFCD		atrelease@regionalflood.org	[illegible]	☑
John Catanese	CCPW	702-455-6050	catanese@clarkcountynv.gov	[illegible]	☑
Joe Yatson	CCPW	702-455-6050	jyatson@clarkcountynv.gov		☐
Garrett TerBerg	CCCP	702-455-5617	gtb@clarkcountynv.gov		☐
Janice Ridondo	Clark County	702-455-3504	jridondo@clarkcountynv.gov		☐
Angelo Santovito	Clark County		angelo@clarkcountynv.gov		☐
Dwayne Ako	Clark County		dako@clarkcountynv.gov		☐
Rodd Lighthouse	NDOW	775-688-1586	rlighthouse@ndow.org	[illegible]	☑
Tim Hunt	NDOW	775-688-1564	thunt@ndow.org		☐
Mike Zahradka	NDOW	775-688-1563	mzahradka@ndow.org	MZ	☑
Jeff Douglas	Louis Berger	702-789-1978	jdouglas@louisberger.com		☐
Brian Rowley	Atkins	702-551-0320	brian.rowley@atkinsglobal.com	[illegible]	☑
Harshal Desai	Atkins	702-551-0349	harshal.desai@atkinsglobal.com	HBD	☑
Matt Baird	Atkins	702-990-7432	matt.baird@atkinsglobal.com		☐
Joe Davis	MVWD	702-397-6893	joe@moapawater.com	[illegible]	☑
Lon Dalley	MVWD	702-397-6893	lon@moapawater.com	LD	☑
Hongyu Deng	Atkins	702-551-0287	hongyu.deng@atkinsglobal.com	[illegible]	☑
John Tennert	CCRFCD	702-685-0023	jtennert@regionalflood.org	[illegible]	☑
Ron Cothran	NDOW	775-688-1583	Rcothran@Ndow.org	RC	✓
Scott Millington	MVIC	702-281-7385	Muddyvalley@mvdsi.com	[illegible]	

REGIONAL FLOOD CONTROL DISTRICT

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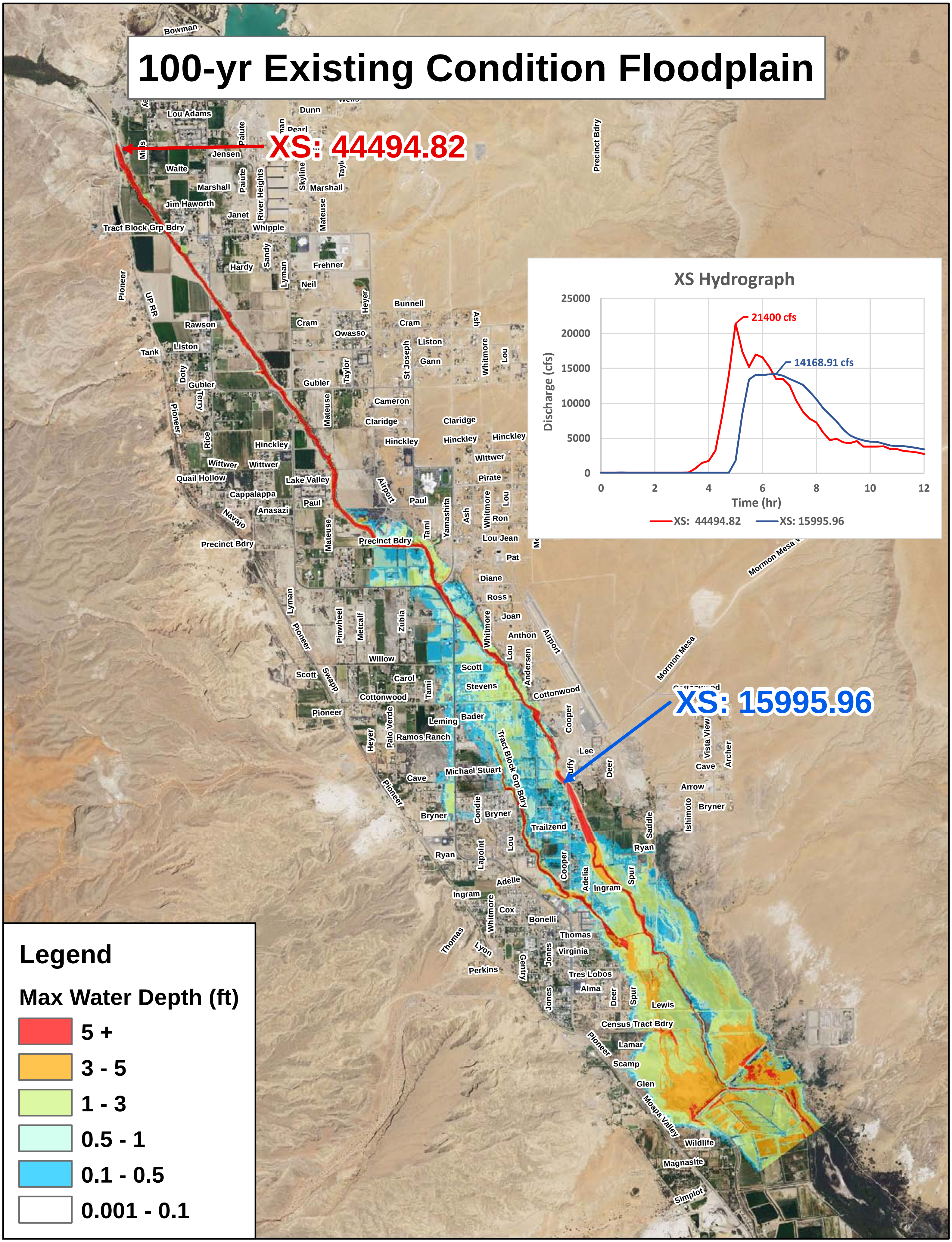
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XS Hydrograph
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Time (hr)
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20000
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12
21400 cfs
14168.91 cfs
XS: 44494.82
XS: 15995.96
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Max Water Depth (ft)
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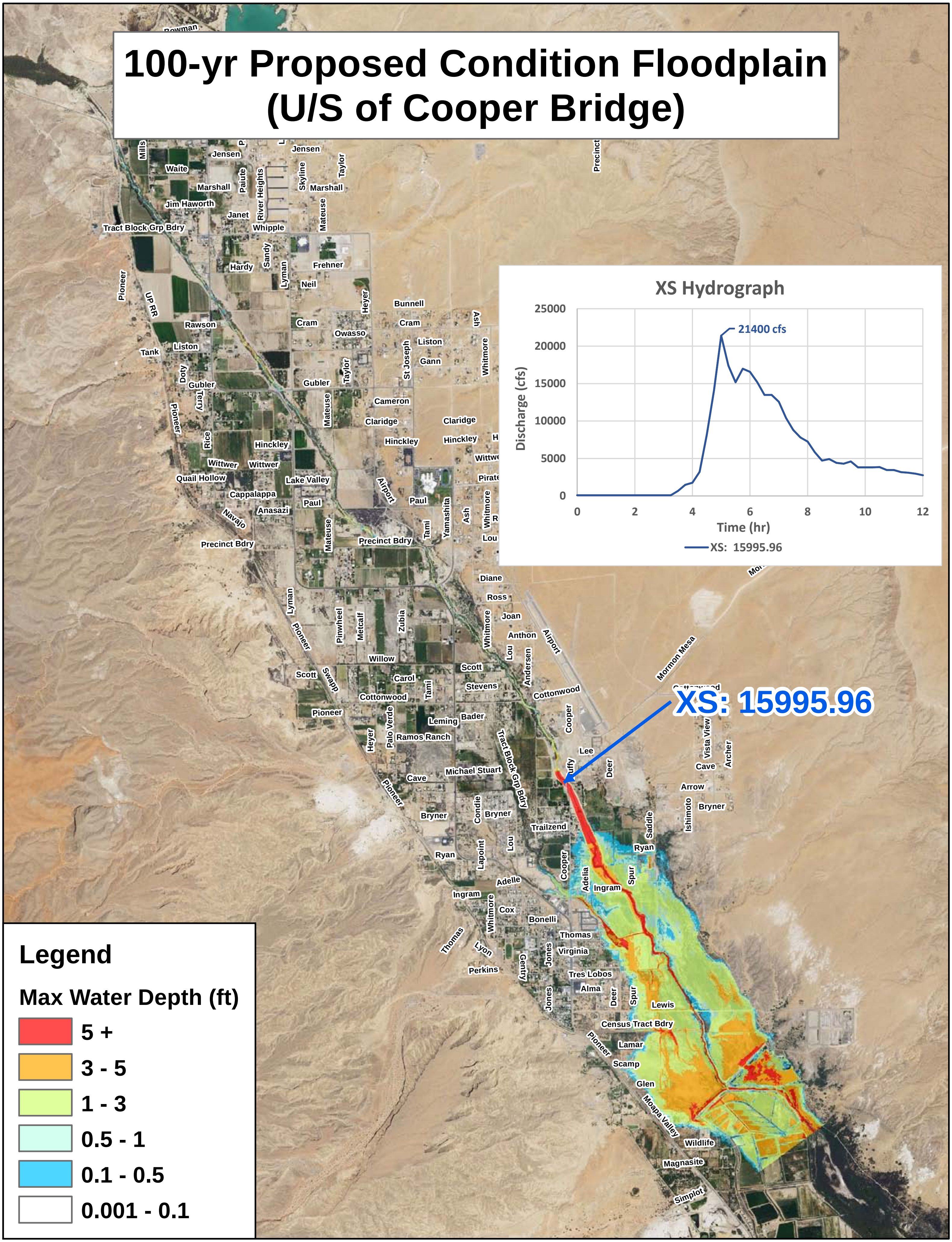

100-yr Proposed Condition Floodplain
(U/S of Cooper Bridge)
XS Hydrograph
25000
20000
15000
10000
5000
0
Discharge (cfs)
21400 cfs
0
2
4
6
8
10
12
Time (hr)
XS: 15995.96
XS: 15995.96
Legend
Max Water Depth (ft)
5 +
3 - 5
1 - 3
0.5 - 1
0.1 - 0.5
0.001 - 0.1


BMN5
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BMN8
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EWASH8
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0
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EWASH6
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EWASH5
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FGDB1
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WWASH6
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FGDB2
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157 AC-FT
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LWASH3
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WWASH4A
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WITTWER
AVE DB
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EWASH3
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WWASH4
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LOG3
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24 CFS
WWASH3
633
DUESING
AVE DB
LOG2
893
WWASH2
1430
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118 CFS
WWASH2A
338
COTTONWOOD
AVE DB
WIWASH
1215
182 AC-FT
130 CFS
WIEBER
WASH DB
316 AC-FT
198 CFS
OVR1
1115
WEST WASH
1 DB
EWASH1
1715
WWASH1C
1597
PERKINS
AVE DB
WWASH1A
1105
OVR2
297
WWASH1B
687
992 AC-FT
273 CFS
OWASH3
356
OWASH2
1277
OVR3
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MAGW2
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21400
73
65
2717
518
38
55
820
71
118
167
872
80
255
181
417
942
264
603

DETENTION BASIN NAME	ID-MILE	Current MPU			Prev. MPU		
		HEC-1 Peak Storage (ac-ft)	Proposed Storage Volume (ac-ft)	Peak Outflow (cfs)	HEC-1 Peak Storage (ac-ft)	Proposed Storage Volume (ac-ft)	Peak Outflow (cfs)
Wittwer Avenue Detention Basin	WWWT0004	76	91	31	74	76	38
Duesing Avenue Detention Basin	WWDA0009	38	49	24	45	46	35
Cottonwood Avenue Detention Basin	WWCA0050	133	156	118	142	146	118
Wieber Wash Detention Basin	WWWI0027	157	182	130	237	244	80
West Wash 1 Detention Basin	WWWA0017	266	316	198	223	229	181
Perkins Avenue Detention Basin	WWPA0018	854	992	273	1145	1179	264

Meeting Minutes

Project:	Muddy River and Tributaries MPU		
Subject:	Meeting Minutes: Progress Meeting 7		
Date & Time:	Thursday, February 18, 2016	**Project #**	100045944
Meeting Place:	CCRFCD Conference Room	**Minutes By:**	Brian Rowley

Present:

Tim Sutko, CCRFCD
Joe Damiani, CCRFCD
Andrew Trelease, CCRFCD
Mike Zahradka, NDOW (phone)
John Catanese, CCPW
Joe Davis, MVWD
Lon Dalley, MVWD
Janice Ridondo, Clark County
John Tennert, CCRFCD
Harshal Desai, Atkins
Brian Rowley, Atkins
Steve Roberts, Atkins
Marilyn Kirkpatrick, Clark County Commission

SUMMARY OF ACTION ITEMS:

Item	Description & Action	Responsible (Status)
1	Prepare draft TAB presentations for Moapa and Moapa Valley and share with CCRFCD and the County	Atkins (pending)
2	Provide Atkins with any information regarding property owners or addresses where residents have been flooded and are interested in relocating	County (Janice and/or Commissioner Kirkpatrick)

SUMMARY OF DISCUSSION:

Atkins reported that the hydrologic/hydraulic analysis and facility planning has essentially been completed. In order to stay on schedule, Atkins said they would like to finalize the recommended plan and what should be shown in the MPU. All of the recommended facilities have been discussed and agreed upon in previous meetings, except for the facilities downstream of Cooper St along the Muddy River, so that is the focus of the meeting.

Lower Muddy River:

STRUCTURAL SOLUTION:

Atkins stated that upstream of Cooper Street the recommended plan to improve the Muddy River makes sense and works with the topography since there is already an incised channel. Downstream of Cooper Street, the topography is much flatter and the solution previously shown in the MPU would be hard to implement. Since the last meeting, Atkins reviewed the recommended facilities downstream of Cooper Street with the goal to (1) ensure that the recommended facility plan was feasible and realistic, (2) determine if the parallel facility could be eliminated along the Muddy River and (3) identify the downstream limit or proposed stopping point of the regional facilities without extending a far distance past the Overton WMA diversion structure. Atkins grouped the recommended facility plan into three sections for discussion purposes and shared exhibits and figures at the meeting to go over the options. The figures are attached to these meeting minutes for reference.

After discussion, the County and CCRFCD agreed that the final facility plan would show the following:

- **Section 1 (from d/s end of Cooper St Improvements to West Creek Confluence):** In this section, the proposed facility that will be shown is a stabilized earthen channel, 200' – 400' W. This can be below grade but maintain the thalweg, which is beneficial because it allows the West Creek Channel to daylight into the Muddy River and eliminates the parallel facility. The West Creek channel will be shown as 10'W concrete channel extending from Cooper Street to the Muddy River. A dual RCB culvert will be proposed at the upstream end of the West Creek Channel and improvements and collection upstream of that area may be needed during design phase.

- **Section 2 (from West Creek Confluence to Western Washes RR Confluence):** In this section, the recommended facility will be similar to what was shown in the previous MPU, with a 600'W earthen channel and levees on each side to contain the flow. Also, the Western Washes Outfall Channel will be shown as a concrete channel that will daylight to the Muddy River thalweg. Atkins will review this channel to see if it can daylight at grade in case it is built before the Muddy River improvements are done (about 3' below grade). Janice asked about how flows west of the levees will enter, and Atkins showed that the flows in the area west of the levees will be minimal if Section 1 is constructed upstream, so no adverse impacts would be caused by the levees. A local culvert or storm drain at Lewis Ave could convey flow south to the West Wash Railroad channel to address local flows in the area and avoid any adverse impacts.

- **Section 3 (downstream of Western Wash Railroad channel and Muddy River Confluence to Overton WMA):** In this section, the recommended facility will be a levee on the west side of the Muddy River to protect private property to the west. The east side of the river corridor is all public land. The downstream limit of the facility will be the diversion structure at the Overton WMA. There will also be some channel transitioning needed at the upstream end of this section to transition the channel to natural topography and catch grade.

Other design considerations that were discussed:

- **Muddy River Concrete Lining**. In Section 1, concrete lining could be considered for the upstream reach near the Cooper St improvements where the right-of-way is narrow. This would require environmental coordination and a new permit. This would be beneficial because of the relatively high velocity expected in the channel in this reach. This option will be documented in the MPU report.

- **Lewis Ave Crossing**. During design, a low-flow crossing or other improvements will be required at Lewis Ave and the Muddy River in order to maintain roadway access during low flow events. This will be documented in the MPU report.

- **Phasing**. The phasing of the improvements in Section 1, 2, and 3 were discussed. The improvements in Section 2 and 3 cannot be built prior to Section 1 because the levees could have adverse impacts to the areas west of Muddy River. Section 1 should be the priority and could be built prior to Section 2 and 3 because it will improve the existing condition and discharge flows to the Muddy River corridor.

Atkins summarized by saying the detailed LiDAR information obtained for this project and a review of the plan in the area resulted in good progress and some revisions to the recommended plan that are feasible. Further analysis regarding phasing and the ultimate condition improvements would be needed in the design phase, but the recommended facilities are appropriate for master planning purposes.

However, everyone agreed that the improvements are expensive and may not be built for a long time. So non-structural solutions were discussed as well to mitigate the flooding in the area.

NON-STRUCTURAL SOLUTION:

Atkins shared an exhibit that showed the private parcels that are in the floodplain that would be protected by the structural solution. That exhibit is attached to these meeting minutes for reference. This provided a general idea of costs and the number of parcels/acres protected by the structural solution. Atkins stated that the non-structural solution of acquiring properties would be beneficial not only because it would be cost effective, but also because building the structural solution would be very complex and not as effective as acquiring property. CCRFCD said they would look into acquiring properties further.

Commissioner Kirkpatrick commented that the long-term structural solution has been presented before, but residents are going to continue to be flooded in the interim. She said there are residents who have had repeated flooding who are willing to relocate. Atkins asked if there was a record of which homes have flooded or where the residents are that would be interested in relocating. Commissioner Kirkpatrick and Janice said they could try to find that information and send it to Atkins.

The structural solution will be shown in the MPU, but the non-structural solution will also be documented in the text.

<u>Schedule</u>

Atkins will continue working on the draft MPU the next 2-3 weeks. Atkins will focus on the main sections of the report and the recommended facilities (i.e., maps, facility tables, and facility costs). Atkins will meet weekly with Joe and send over draft information and sections as they are ready. As of March 7th Atkins will provide whatever is ready as a draft in order to prepare for the Moapa Valley TAB. There will be some time after that to review the draft and finalize the document prior to the TAC/CAC/Board meetings. The following are key dates that were agreed upon moving forward:

Draft MPU Report Submittal and Overview Discussion	March 7th, 2016
Moapa Valley TAB	March 9th, 2016
Comment Review Workshop (CCRFCD and County)	March 16th, 2016
Moapa TAB	March 29th, 2016
TAC	April 28, 2016
CAC	May 2, 2016
CCRFCD Board	May 12, 2016

Other Discussion Items

- **Cost tool.** Atkins stated the previous 2010 MPU used 2008 Las Vegas Valley MPU cost tool with an adjustment factor of 0.765 to account for cost changes from 2008 to 2010. CCRFCD stated that Atkins should the cost tool for this MPU, but apply inflation of 6.6% (1.066 factor) to the previous factor of 0.765. In other words, the new factor that will be applied to the cost estimates is 0.815.

- **TAB Meeting Presentations.** TAB meetings in Moapa Valley and Moapa are scheduled on March 9th and 29th, respectively. Atkins said they will prepare some draft presentations and coordinate and discuss those with CCRFCD prior to March 9th. The presentations will also be shared with the County and Commissioner Kirkpatrick ahead of time if possible.

- **Report Format**. Atkins stated they will prepare the final MPU report as a spiral-bound, 8.5 x 11 report with figures included in the report. All supporting appendix material will be put on a Data CD at the back of the report instead of printing a large hard-copy volume of the appendix.

--- End of Meeting Minutes ---

SIGN-IN SHEET

Master Plan Update for the Muddy River and Tributaries
Progress Meeting 07, February 18, 2016, 2:30 PM
Clark County Regional Flood Control District Conference Room

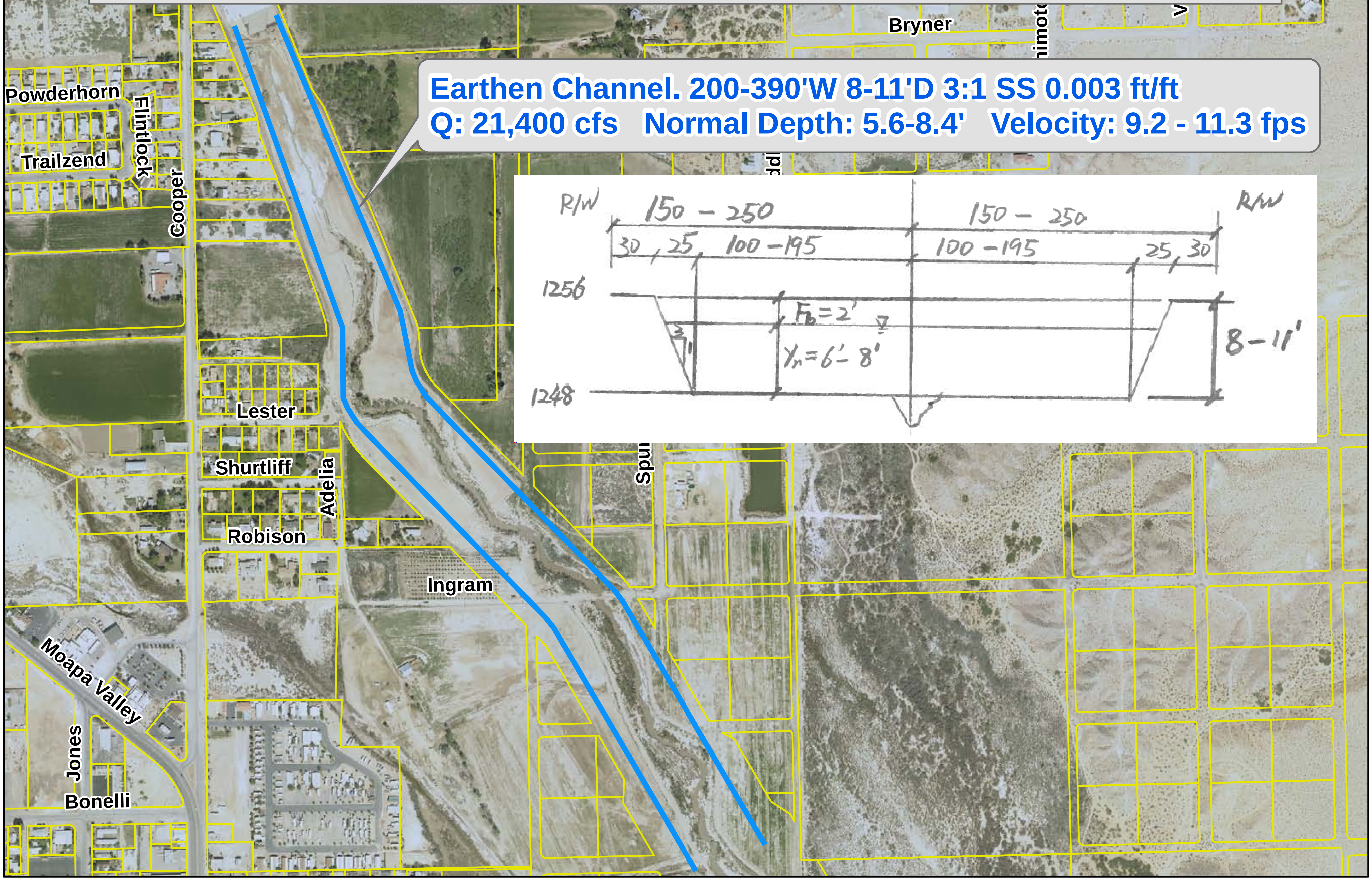
Name	Affiliation	Phone Number	Email Address	Initials	Attendance
Tim Sutko	CCRFCD	702-685-0000	tsutko@regionalflood.org	[signature]	☑
Joe Damiani	CCRFCD	702-685-0000	jdamiani@regionalflood.org	[signature]	☒
Andrew Trelease	CCRFCD		atrelease@regionalflood.org	AT	☒
John Catanese	CCPW	702-455-6050	catanese@clarkcountynv.gov	JC	☑
Joe Yatson	CCPW	702-455-6050	jyatson@clarkcountynv.gov		☐
Garrett TerBerg	CCCP	702-455-5617	gtb@clarkcountynv.gov		☐
Janice Ridondo	Clark County	702-455-3504	jridondo@clarkcountynv.gov	[signature]	☒
Angelo Santovito	Clark County		angelo@clarkcountynv.gov		☐
Dwayne Ako	Clark County		dako@clarkcountynv.gov		☐
Rodd Lighthouse	NDOW	775-688-1586	rlighthouse@ndow.org		☐
Tim Hunt	NDOW	775-688-1564	thunt@ndow.org		☐
Mike Zahradka	NDOW	775-688-1563	mzahradka@ndow.org	on phone	☑
Jeff Douglas	Louis Berger	702-789-1978	jdouglas@louisberger.com		☐
Brian Rowley	Atkins	702-551-0320	brian.rowley@atkinsglobal.com	BR	☑
Harshal Desai	Atkins	702-551-0349	harshal.desai@atkinsglobal.com	HD	☑
Matt Baird	Atkins	702-990-7432	matt.baird@atkinsglobal.com		☐
Joe Davis	MVWD	702-397-6893	joe@moapawater.com	[signature]	☒
Lon Dalley	MVWD	702-397-6893	lon@moapawater.com	LD	☑
Hongyu Deng	Atkins	702-551-0287	hongyu.deng@atkinsglobal.com		☐
John Tennert	CCRFCD	702-685-0023	jtennert@regionalflood.org	[signature]	☒
Ron Cothran	NDOW	775-688-1583	rcothran@ndow.org		☐
Scott Millington	MVIC	702-281-7385	muddyvalley@mvdsl.com		☐
Stephen Roberts	Atkins	702-263-7275			
Marilyn Kirkpatrick	County				

REGIONAL FLOOD CONTROL DISTRICT

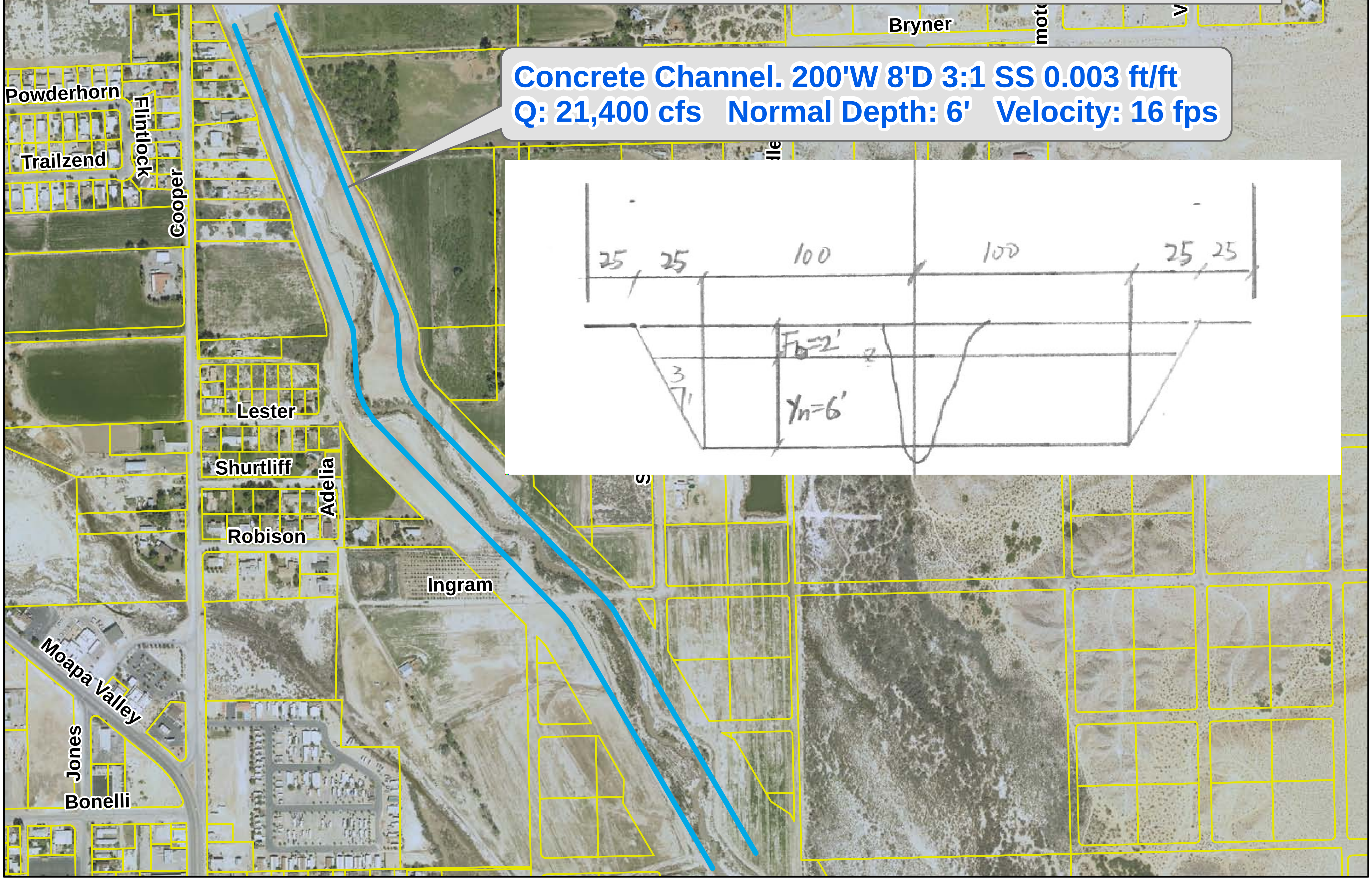
ATKINS

Constructed Concrete Channel Ends
MRLV0350
MRLV0343
SECTION 1
MRLV0276
MRWC0065
MRLV0268
MRLV0240
MRWC0000
SECTION 2
West Creek Confluence
MRLV0198
Lewis Ave Crossing
MRLV0184
SECTION 3
WWRR0000
MRLV0142
Western Washes Railroad Outfall Confluence

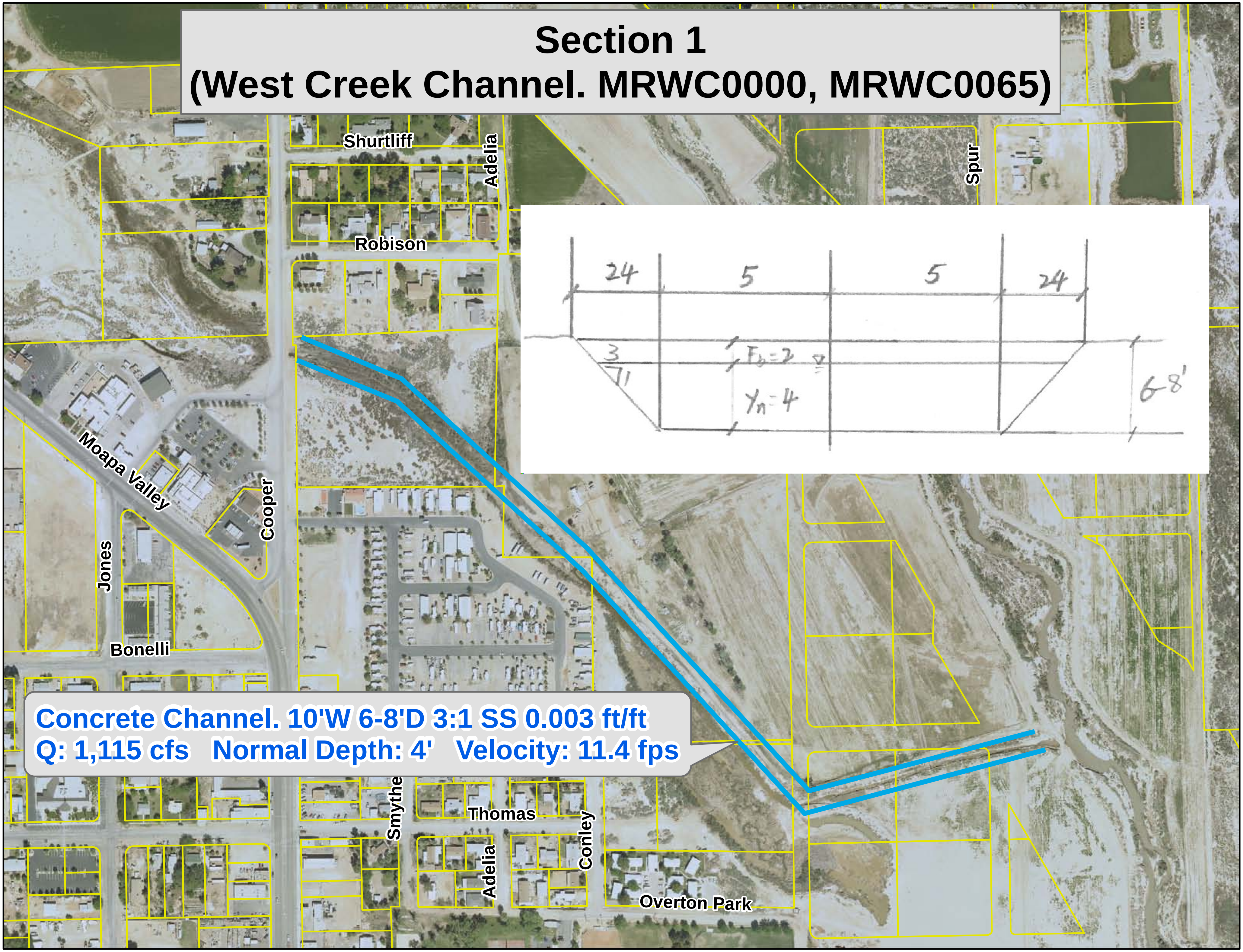
Section 1 - Option 1
(Cooper Improvement to West Creek Confluence
MRLV0240, MRLV0268, MRLV0276, MRLV0343, MRLV0350)



Section 1 - Option 2
(Cooper Improvement to West Creek Confluence MRLV0240, MRLV0268, MRLV0276, MRLV0343, MRLV0350)

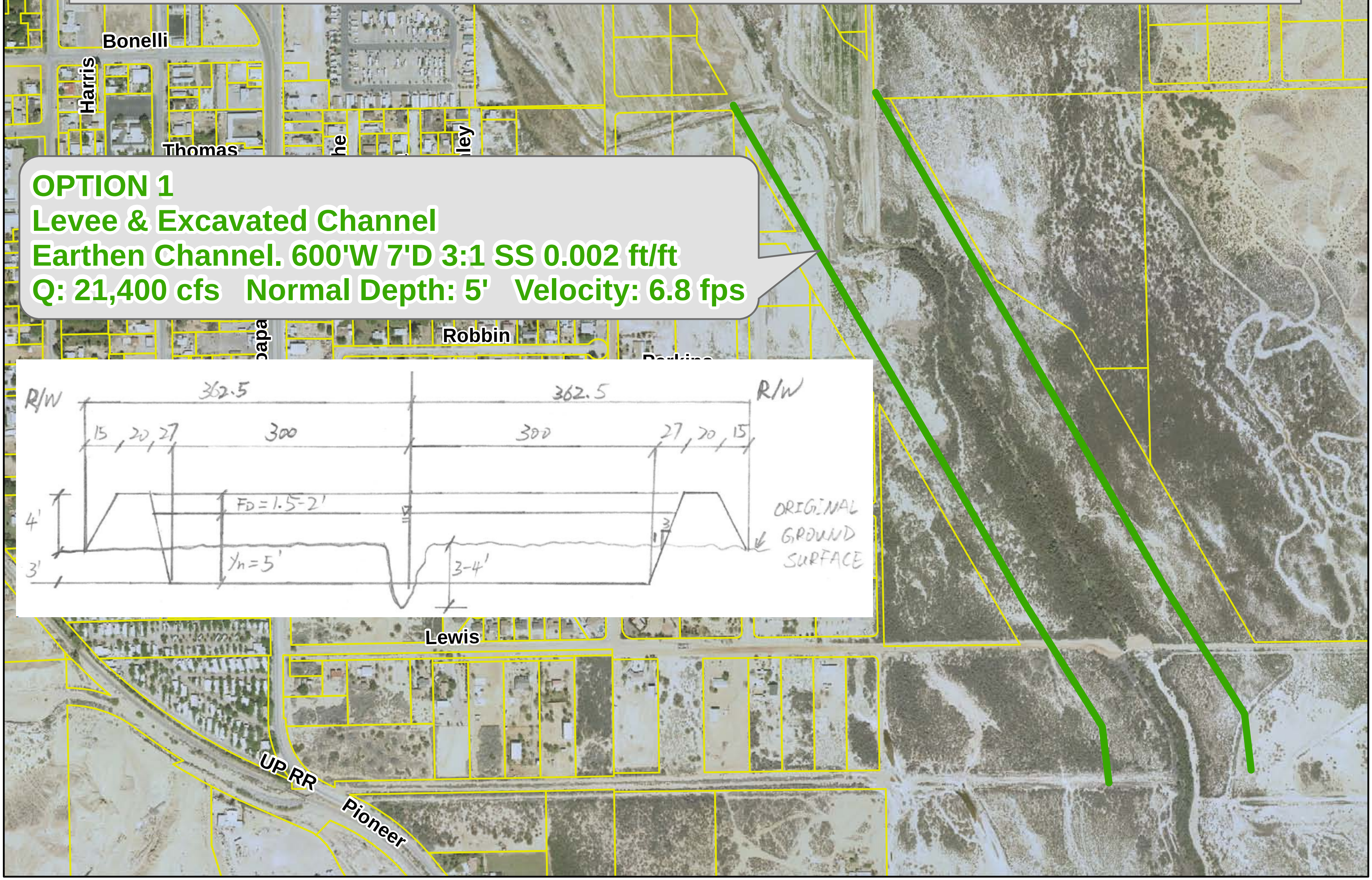


Section 1
(West Creek Channel. MRWC0000, MRWC0065)

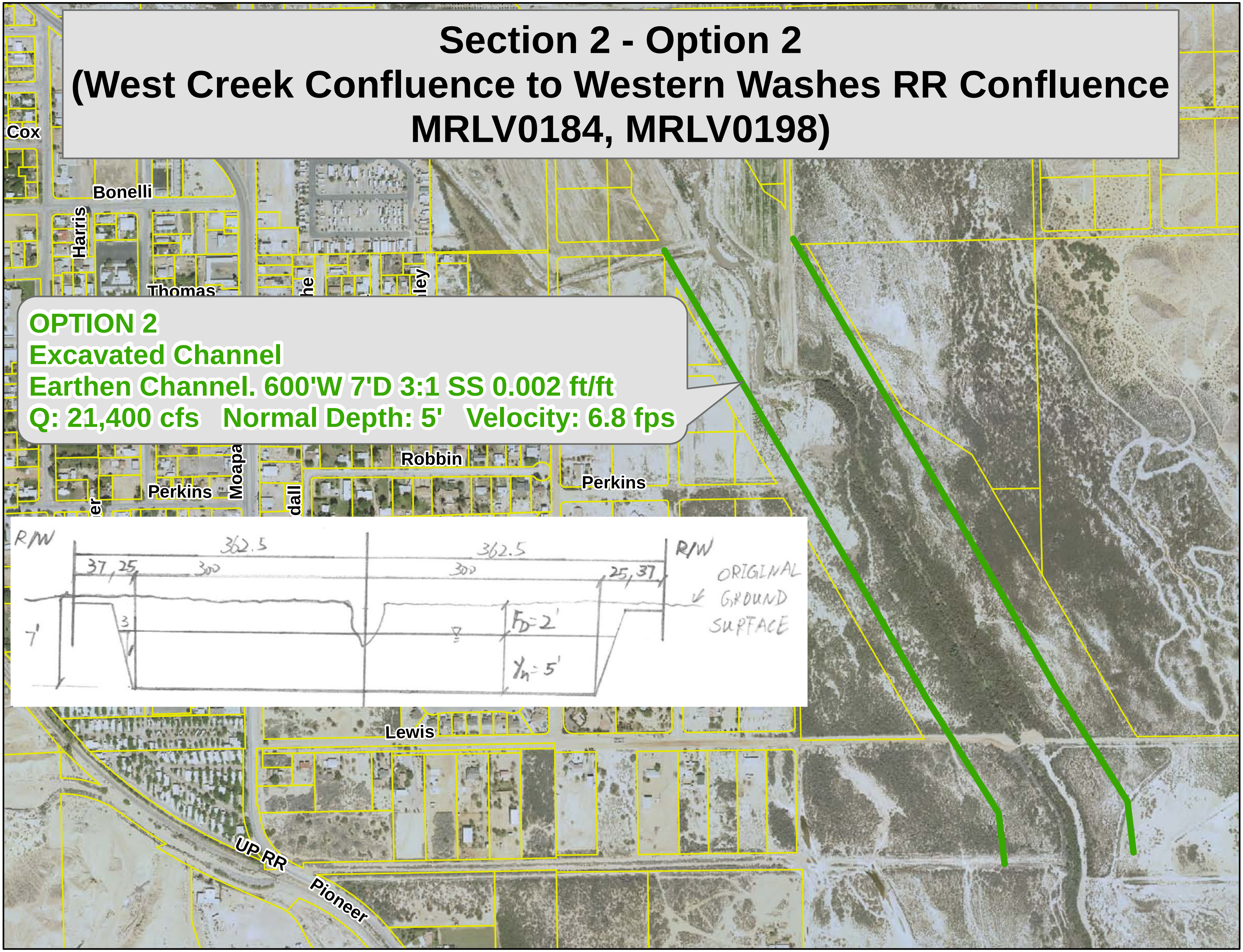


Concrete Channel. 10'W 6-8'D 3:1 SS 0.003 ft/ft
Q: 1,115 cfs   Normal Depth: 4'   Velocity: 11.4 fps

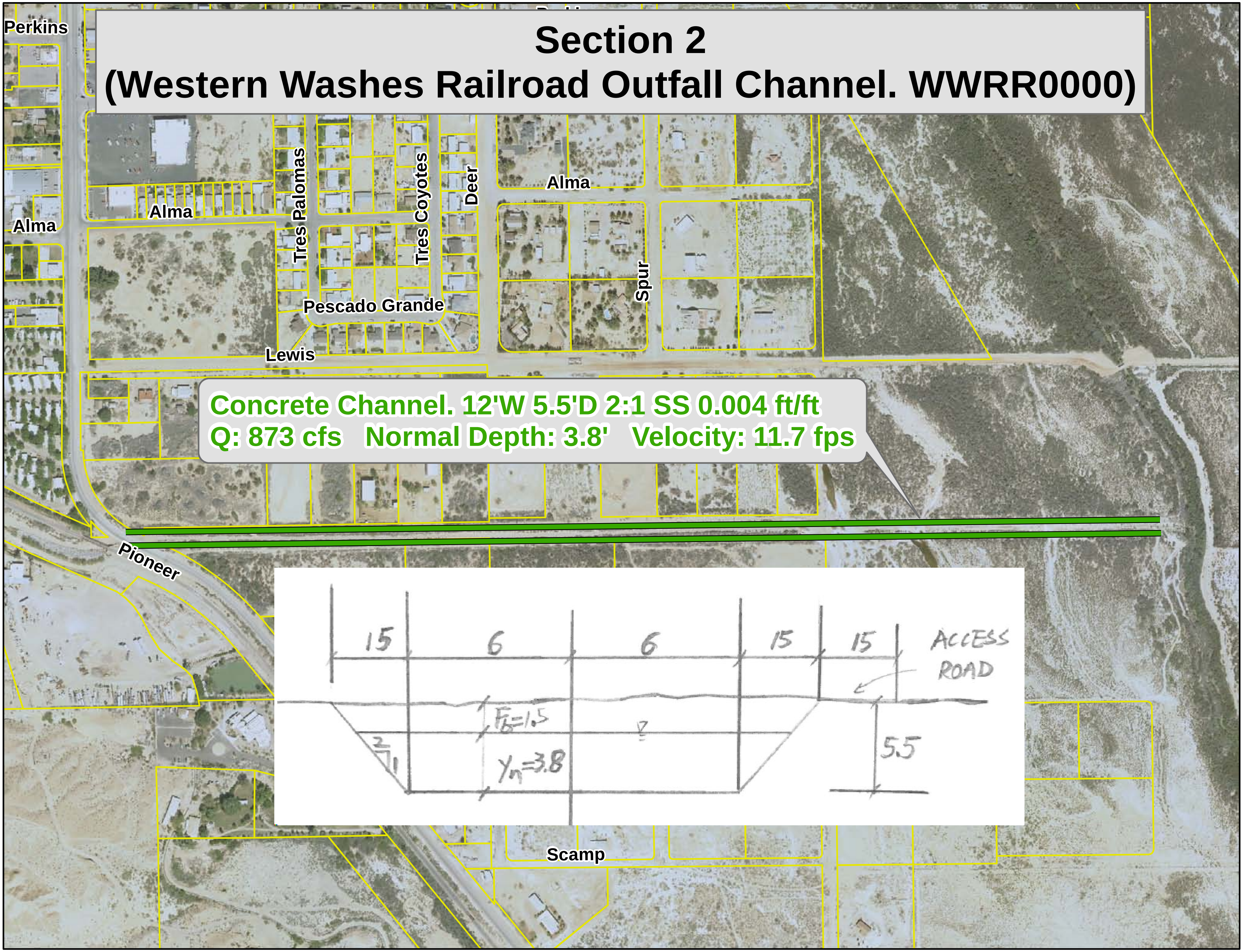
Section 2 - Option 1
(West Creek Confluence to Western Washes RR Confluence MRLV0184, MRLV0198)



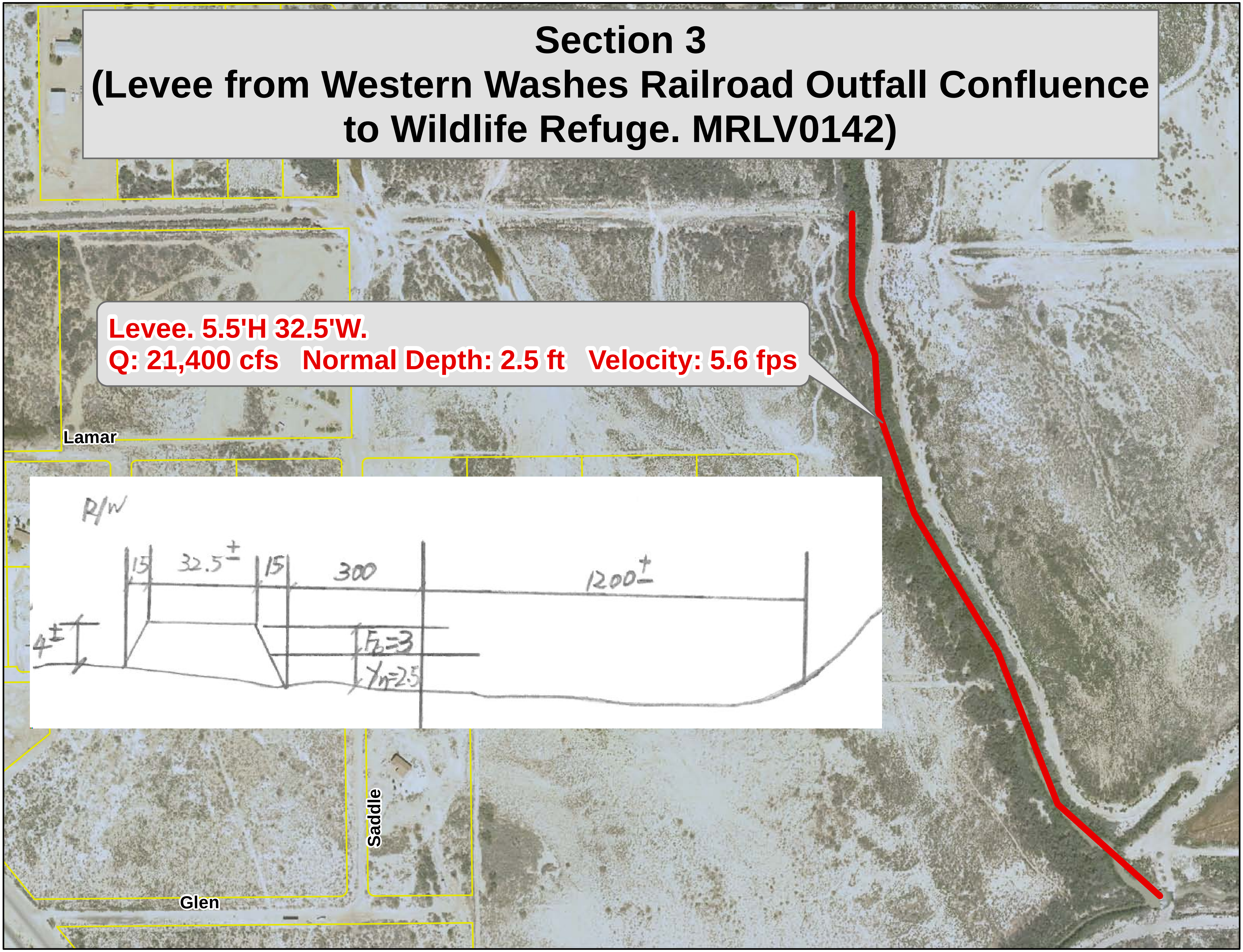
Section 2 - Option 2
(West Creek Confluence to Western Washes RR Confluence
MRLV0184, MRLV0198)

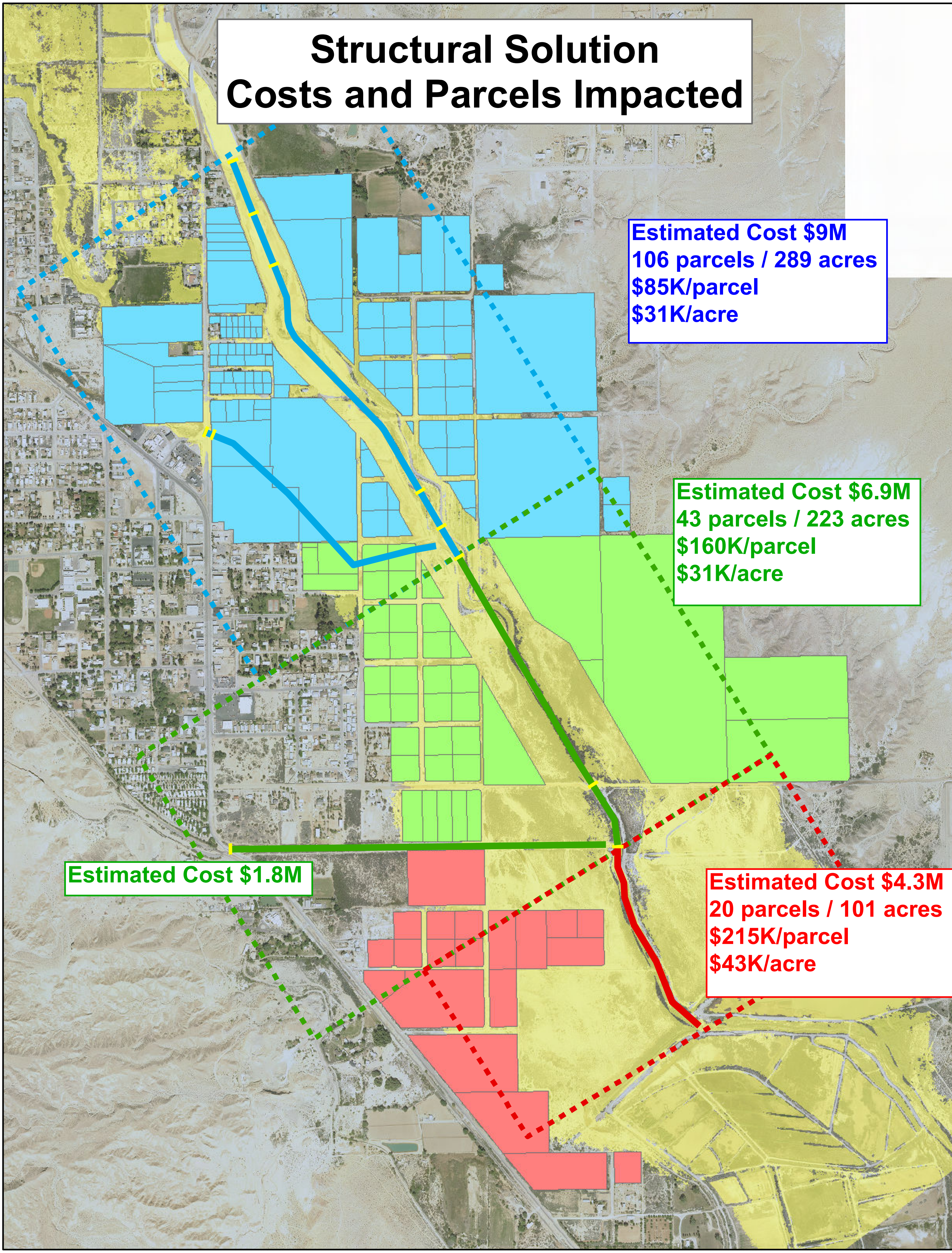


Section 2
(Western Washes Railroad Outfall Channel. WWRR0000)



Section 3
(Levee from Western Washes Railroad Outfall Confluence to Wildlife Refuge. MRLV0142)




Structural Solution
Costs and Parcels Impacted
Estimated Cost $9M
106 parcels / 289 acres
$85K/parcel
$31K/acre
Estimated Cost $6.9M
43 parcels / 223 acres
$160K/parcel
$31K/acre
Estimated Cost $1.8M
Estimated Cost $4.3M
20 parcels / 101 acres
$215K/parcel
$43K/acre

Moapa Valley Town Advisory Board

"We are dedicated to maintaining a rural lifestyle and rural quality of life in our valley."

HELD ON MARCH 9, 2016 AT 7 P.M.
MOAPA VALLEY COMMUNITY CENTER, OVERTON

MVTAB members: Chair Michael Otero; Vice-Chair Ann Markle; Marjorie Holland
Allen Johnson, Gene Houston ~ Janice Ridondo, District B - liaison
Posting Locations: Moapa Valley Community Center; Overton Post Office; Logandale Post Office; Logandale Chevron

DRAFT MEETING MINUTES

I. CALL TO ORDER

- Please silence all electronic devices; and take all private conversations outside the room.
- Conformance with Nevada Open Meeting Law- **CONFIRMED**
- Invocation and pledge.
- Introduction of Clark County staff and guests

II. ADMINISTRATIVE ACTION

- Adoption of Agenda. **MOTION TO ADOPT THE AGENDA. APPROVED. UNANIMOUS**
- Approval of draft minutes for Jan 27, 2016. **FEBRUARY MEETING WAS CANCELED**
- Public Comment. First period devoted to comments by the general public about items ON THIS AGENDA ONLY. If you wish to speak to the Board about items within its jurisdiction but not appearing on this agenda, must wait until comments by the General Public: period listed at the end of this agenda

III. REPORTS

- Presentation and update on the technical advisory committee and equity issued within the Moapa Valley School area; and take whatever action deemed appropriate.

  Dr. Larry Moses wasn't in attendance, item will be placed on the next agenda.
- Presentation and recommendations by Clark County Regional Flood Control District regarding the 2016 Flood Control Master Plan Update for the Muddy River and Tributaries

  Final presentation from Joe explaining proposed nonstructural or structural solutions. Nonstructural would mean obtaining easements or right of way from parcels. Structural would be building a levy system and put basins in place. Plans are in place for the cleaning of the Muddy River.
- ADDENDUM: Discuss if the town shall levy a tax upon itself for the purpose of constructing a community center

  Janice mentioned that the community needs to put together a committee to discuss the possibility of a ballot initiative for this year, if the residents want to add a tax to build a recreation center, deadline to decide is April 12, several residents volunteered to be on the committee.
- TAB Members reports, **NONE**
- Liaison report, **NONE**

IV. ZONING: NONE

V. COMMENTS BY THE GENERAL PUBLIC

NONE

VI. ADJOURNMENT

The next regularly scheduled meeting is for 7 p.m. Wednesday, April 13, 2016 in the Moapa Valley Community Center, with a special call date of March 30, 2016.

Moapa Valley Town Advisory Board

"We are dedicated to maintaining a rural lifestyle and rural quality of life in our valley."

HELD ON MARCH 30, 2016 AT 7 P.M.
MOAPA VALLEY COMMUNITY CENTER, OVERTON

MVTAB members: Chair Michael Otero; Vice-Chair Ann Markle; Marjorie Holland
Allen Johnson, Gene Houston ~ Janice Ridondo, District B - liaison
Posting Locations: Moapa Valley Community Center; Overton Post Office; Logandale Post Office; Logandale Chevron

DRAFT MEETING MINUTES

I. CALL TO ORDER

- Please silence all electronic devices; and take all private conversations outside the room.
- Conformance with Nevada Open Meeting Law- **CONFIRMED**
- Invocation and pledge.
- Introduction of Clark County staff and guests
  Michael Otero received a call during the meeting and needed to be excused

II. ADMINISTRATIVE ACTION

- Adoption of Agenda. **MOTION TO ADOPT THE AGENDA. APPROVED. UNANIMOUSLY**
- Approval of draft minutes for January 13, 2016 and March 9, 2016. **MOTION TO APPROVE. APPROVED UNANIMOUSLY**
- Public Comment. First period devoted to comments by the general public about items ON THIS AGENDA ONLY. If you wish to speak to the Board about items within its jurisdiction but not appearing on this agenda, must wait until comments by the General Public: period listed at the end of this agenda

III. REPORTS

- Make recommendation for 2016 Flood Control Master Plan Update for the Muddy River and Tributaries (RFC presentation at last meeting.) **TAKE ACTION TO SUPPORT OR OPPOSE**
  MOTION TO APPROVE 10 YEAR UPDATE. APPROVED UNANIMOUSLY
- Presentation and update on the technical advisory committee and equity issues within the Moapa Valley School area; and take whatever action deemed appropriate.
  Deciding how the school district is going to be broken up if at all. Town trying to make their own district so they can control their own money for the school district.
  DR. LARRY MOSES MAY HAVE BEEN UNAWARE OF THIS MEETING; STAFF WILL ASK DR. MOSES TO PRESENT AT THE NEXT MEETING
- TAB Members reports, **NONE**
- Liaison report,
  Discussion of ballot question for additional tax for rec center, suggested getting an advisory question- would the community be willing to have a tax increase to support a building?

IV. ZONING

04/20/16 BCC

- **WS-0151-16 – <u>TRENDAFILOV SAVA: WAIVERS OF DEVELOPMENT STANDARDS</u>** for the following: 1) landscaping and screening; 2) detached sidewalks adjacent to collector streets within the Moapa Valley Overlay District; 3) trash enclosure; and 4) full off-site improvement (curbs, gutters, streetlights, sidewalk and paving). **<u>DESIGN REVIEW</u>** for a manufacturing building on a portion of 31.3 acres in an M-1 (Light Manufacturing) Zone with in the Moapa Valley Overlay District. Generally located: NE corner of Swapp Dr. and Willow Ave. MK/al/ (For possible action)
  Industrial and Residential- Will be working with non-hazardous materials with no odor. Materials are safe to use in a home. Applicant stated he is willing to hire employees from within

the community. Industrial building will be 5,000 square feet and would like to build residential along North and East property line; will be single family 1 acre and larger lots. Concerns were raised that property backs up to Pinwheel and homes, drainage study, and lush landscaping.

MOTION TO WAIVE EACH ITEM WITH CONDITIONS AS FOLLOWS:

1) Landscaping and Screening: **Condition-** Required to provide title 30 landscaping what is shown on the areas where applicant will be developing. Does not have to landscape entire 31 acres. TAB allowed applicant to complete landscaping in phases as property is developed. **MOTION TO WAIVE. APPROVED UNANIMOUSLY**

2) Detached sidewalks adjacent to collector streets within the Moapa Valley Overlay District: **MOTION TO WAIVE THE DETACHED SIDEWALKS. APPROVED. UNANIMOUSLY**

3) Trash Enclosure: **MOTION TO DENY. APPROVED UNANIMOUSLY**

4) Full off-site improvement (curbs, gutters, streetlights, side walk and paving): **Conditions- PAVING ONLY** Needs to pave Swapp as needed, and pave Willow Ave. the length of the frontage of the applicant's property. Neighbors do not want the bright lights of street lights or the property itself lit up, applicant stated he would add one light at the entrance. Must have a drainage study and neighbor asked to also for a traffic study. **APPROVED UNANIMOUSLY**

5) Design Review: **Condition-** Based on design of metal structure will be painted desert brown colors with flat tan roof. **APPROVED UNANIMOUSLY**

V. COMMENTS BY THE GENERAL PUBLIC

NONE

VI. ADJOURNMENT

The next regularly scheduled meeting is for 7 p.m. Wednesday, April 13, 2016 in the Moapa Valley Community Center.

Moapa Town Advisory Board

TUESDAY, MARCH 29, 2016 AT 7 P.M.
MARLEY P. ROBINSON JUSTICE COURT & COMMUNITY CENTER

MTAB members: Chair - Tim Watkins, Vice Chair - Ryan Udall; Laurellyn Wren; Sally Wirth; Jamie Shakespear
Town Liaison: Janice Ridondo

Notice Posted: Marley P. Robinson Justice Court & Community Center, Moapa Town Library, Moapa US Post Office, and Glendale- Stagecoach Depot

DRAFT MEETING MINUTES

I. CALL TO ORDER

- **A.** Please silence all electronic devices; and be respectful of others during personal conversations
- **B.** Conformance with Nevada Open Meeting Law- **CONFIRMED**
- **C.** Pledge of Allegiance and invocation
- **D.** Introduction of Clark County staff and guests

II. ADMINISTRATIVE ACTION

- **A.** Adoption of the Agenda; **MOTION TO APPROVE AGENDA. MOTION PASSED, UNANIMOUS**
- **B.** Approval of draft minutes for January 12, 2016; **MOTION TO APPROVE. UNANIMOUS**
- **C.** Correspondence; **NONE**

III. REPORTS

- **A.** Final presentation and recommendations by Clark County **Regional Flood Control District regarding the 2016 Flood Control Master Plan Update** for the Muddy River and Tributaries; make comments, **take action to support or oppose.** The flooding is a large problem with a small population so it's hard to justify spending public dollars on a structural solution. Recommends sound flood plain management. Residents are advised to build safely and maintain flood insurance. The public right of way will be maintained. The flood zones have been mapped and identified so building in these areas is not recommended. Going to Clark County for permits is recommended. **VOTE TO SUPPORT FLOOD CONTROL PLAN, APPROVED UNANIMOUSLY**
- **B.** **TAB member reports,** Sign Committee speaking with Eagle Scout for final design and materials. The cattle guards poor condition was mentioned. The town is grateful it was paved over, but would like to see it removed in the future.
- **C.** **Liaison report,** Trailers mentioned need to be removed on 1715 E State Highway 168. The Overton Sign was mentioned briefly; the possibilities of what will happen with the sign in the future were discussed. The town is reestablishing its debt rate (outside of the property tax cap), and can go on the ballot this year. Town will need to decide which project they would like the money to go on and will need to determine a ball park amount that will be spent on the project.

IV. ZONING

- **A. NONE**

V. COMMUNITY CONCERNS

Public Comment: Portion of Henry Road in need of repair.

COMMENTS BY THE GENERAL PUBLIC

If you wish to speak on an item appearing on this agenda, public comments will be heard with each agenda item, prior to the action of the Board, after receiving recognition by the Board Chair. Comments will be limited to 3 minutes; the length may be extended by majority vote of the Board. If you wish to speak to this Board about items within its jurisdiction but not appearing on this agenda, you must wait until the "Comments by the General Public" period listed at the end of this agenda.

VII. ADJOURNMENT

The next regularly scheduled meeting is 7 p.m. Tuesday, April 12, 2016; TAB meets quarterly if no zoning items.