Golden Valley
Flood Response Plan

Prepared For:
Mohave County Flood Control District

Prepared By:
Atkins - Phoenix, AZ
First Edition: May 2015

First Revision: February 2016
Atkins – Phoenix, AZ

Second Revision: June 2016
Atkins – Phoenix, AZ

Third Revision: March 2017
Holistic Engineering and Land Management, PLLC (HELM)

Expires 6/30/19

NOTICE

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

THE HYDROLOGIC AND HYDRAULIC ANALYSES PERFORMED DURING PREPARTATION OF THIS FLOOD RESPONSE PLAN ARE INTENDED TO BE SUPPLEMENTAL AND APPROXIMATE IN NATURE. THEREFORE, THE RESULTS FROM THESE ANALYSES SHOULD NOT BE CONSIDERED DETAILED RESULTS. THE RESULTS HAVE BEEN USED TO ESTIMIATE FLOW MAGNITUDE, DEPTH AND VELOCITY THROUGHOUT THE STUDY AREA. APPROXIMIATE FLOW DEPTHS AND FLOW VELOCITIES, COUPLED WITH ENGINEERING JUDGMENT, HAVE BEEN USED TO PREDICT FLOOD HAZARD CLASSIFICATION LEVELS FOR ADULTS, CARS AND HOUSES, FOR EACH STORM SCENARIO MODELED, THROUGHOUT THE STUDY AREA. THE APPROACH FOR PREDICTING FLOOD HAZARD CLASSIFICATION LEVELS SHOULD BE REFINED USING FUTURE, COMPILED STORM AND FLOW DATA AT KEY DECISION POINTS. IT IS NOT RECOMMENDED THAT THE HYDROLOGIC AND HYDRAULIC ANALYSES AND MODELS BE USED FOR ANY OTHER PURPOSE.

Revisions

1st Edition: May 2015

1st Revision: February 2016. Added note for Appendix A, Table 4, associated with swift water rescue equipment.

2nd Revision: June 2016. Updated the web address for the flood hazard information plan in Section 1. Updated the acronyms in Table 5 and eliminated the role of the Assistant Public Works Director from the Flood Detection Warning Sequence in Table 4.

3rd Revision: March 2017. Update of primary sources of local emergency response resources. Reformatting of report to place supplemental technical information in Appendix A.

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Appendices

Expires 6/30/19

1 INTRODUCTION

The Golden Valley Flood Response Plan (FRP) is intended to be a tool (one tool out of several for flood response) for use by emergency managers and personnel responding to potentially severe flooding situations within the unincorporated Mohave County community of Golden Valley. The FRP was developed under guidance of the Mohave County Flood Control District (District). Listed below are primary sources of local emergency response resources that are key to response of severe flooding conditions within Golden Valley.

- Mohave County (MC)
- MC ALERT Flood Warning System (AFWS)
- MC Director of Risk and Emergency Management (DREM)
- MC Emergency Management Coordinator (EMC)
- MC Engineering Manager - Road Maintenance & Operations (EMRM)
- MC Flood Control District Engineer (FCDE)
- Golden Valley Fire Chief or Designee (GVFD)
- MC Public Works Director (PWD)
- MC Sheriff's Office Personnel in Golden Valley (SOAS)
- MC Sheriff's Office Dispatch Center (SODC)

The most predominant flood hazard within Golden Valley is the attempt by individuals to drive through/across a flooded wash. This commonly results in the need for swift-water rescue of individuals by the Golden Valley Fire Department. For example, the evening of August 31, 2014 the Golden Valley Fire Department responded to four swift-water rescue incidents, ultimately saving 13 individuals. Flood hazard prevention information for Mohave County can be obtained at the following website:

http://flood.mohavecounty.us

In order to better understand the extent and magnitude of potential flooding within Golden Valley, two-dimensional hydrologic and hydraulic (H&H) analyses were completed for approximately 500 square miles of contributing area. Results from the H&H analyses were used to identify key flood prone areas and associated flood hazard risks. The H&H analyses and flood risk determination are intended to be used as supplemental technical information. Discussion regarding this supplemental technical information is provided in Appendix A.

2 NOTIFICATIONS AND WARNINGS

Notifications and warnings per Golden Valley (GV) regional flood warning stage are provided below in Sections 2.1, 2.2, and 2.3. A summary table for local notifications and warnings is provided below. The ALERT Flood Warning System is monitored by Mohave County Flood Control District and AFWS Staff. The individual monitoring at any given time is designated as the AFWS Monitor in these documents.

2.1 Stage 1

STAGE 1 GV REGIONAL FLOOD RESPONSE PLAN – NWS forecast indicates flood potential for Golden Valley area.

1. NWS sends out Flood Watch for Golden Valley.
2. ALERT Flood Warning System (AFWS) receives NWS Flood Watch and automatically forwards via e-mail to the following parties:
    a. Flood Control District Engineer or Designee
    b. Development Services Director
    c. Flood Control and AFWS Staff including AFWS Monitor (AFWSM)
    d. Public Works Director
    e. County Administrator
    f. County Supervisors
    g. Engineering Manager (Road Maintenance and Operations)
    h. Golden Valley Fire Chief or Designee
    i. Emergency Management Coordinator
    j. Director of Risk and Emergency Management
    k. Mohave County Sheriff's Office Dispatch Center
    l. Las Vegas NWS
    m. Kingman Fire Department
    n. Northern Arizona Consolidated Fire Department
    o. Sherriff Office Search and Rescue
    p. Kingman Dispatch Center (Alarm)
    q. Oatman Fire Department
    r. Department of Public Safety (DPS)
    s. Arizona Department of Transportation (ADOT) – Kingman District

    The information forwarded will include the NWS Bulletin in its entirety.
3. NWS sends out notification e-mail to the listed parties under Item #2 above.

4. Flood Control District Engineer (or Designee) and Emergency Management will evaluate the forecasted severity of the weather event in coordination with the NWS and may send additional information to the personnel above, which may include the following message for probable serious flooding:

   "This is a Golden Valley Response Plan Stage 1 message. The potential need to evacuate selected areas and perform swift water rescues due to flooding may exist, but is not imminent (effective time)."

   Note: Between Stage 1 and Stage 2, as weather events develop, it is possible that the NWS will send out a thunderstorm warning or even a flood warning for Golden Valley.

2.2 Stage 2

STAGE 2 GV REGIONAL FLOOD RESPONSE PLAN– Potential for life-threatening flooding exists.

1. NWS sends out Flood Warning for Golden Valley.
2. In coordination with NWS, Emergency Management and Flood Control, evaluate flood potential of developing storms.
3. Emergency Management and Flood Control determine from evaluation of storm characteristics that a Stage 2 is necessary. AFWS Monitor sends the following message via e-mail and texting to the same personnel as in Stage 1, Step 2 above:

   "This is a Golden Valley Response Plan Stage 2 message. The potential need to evacuate selected areas is high. Golden Valley response agencies should activate personnel in preparation for possible evacuation and swift water rescue duties. Residents in Golden Valley should prepare to move to high ground upon receipt of a Golden Valley Response Plan Stage 3 message and should not cross flooded washes (effective time)."

4. Flood Control District Engineer (or Designee) or Emergency Manager will verify receipt of Stage 2 message by the Sheriff's Office Dispatch Center, Public Works, Golden Valley Fire Department, Kingman Fire Department, Northern Arizona Fire Department, Kingman Dispatch, and Sheriff's Office SAR.
5. Emergency Management contacts Development Services Director (or designee) to discuss current situation and additional preparatory measures.
6. Emergency Management contacts Golden Valley Fire District and Sheriff's Deputies to discuss the deployment of personnel to monitor the situation at KDP locations and preparation of emergency measures.
7. Emergency Management discusses event with NWS duty officer in Las Vegas.
8. Engineering Manager (Road Maintenance and Operations) or designee initiates preparatory planning with Road Department and/or Traffic Control for road closures and traffic control.

9. Update on situation will continue with frequent communication among MCSO, MCPW, MCEM, MCFCD, NWS, and GVFD.
10. MCEM monitors situation and decides when to notify other response agencies to prepare for possible disaster assistance.

2.3 Stage 3

STAGE 3 GV REGIONAL FLOOD RESPONSE PLAN– Life-threatening flooding is imminent or exists.

1. Through coordination with NWS, Emergency Management and Flood Control, an authorization of Stage 3 is made by the first available person(s) in the following list:
    a. Director of Risk and Emergency Management
    b. Emergency Management Coordinator
    c. Flood Control District Engineer or Designee
    d. Development Services Director
    e. Public Works Director or Designee
    f. County Administrator
    g. County Supervisors
2. AFWS Monitor sends the following message via e-mail and texting to the same personnel as in Stage 1, Step 2 above:

    "This is a Golden Valley Response Plan Stage 3 message. Officials are requesting evacuation of select areas as deemed necessary. Residents should move to high ground as needed and not cross flooded washes (effective time)."
3. Emergency Management will coordinate with NWS and first responders.
4. Development Services Director (or Designee) updates the County Administrator.

Emergency Management and other designated Public Works personnel respond to the situation.

Summary of Local Notifications and Warning.

Golden Valley Regional Flood Warning Stage	Local Communication	Message Content	Flood Condition Status
Stage 1 (Triggered by NWS)	NWS: NOAA Weather Radio, Commercial Radio and/or TV	NWS flood watch for Golden Valley.	Flooding possible in Golden Valley.
	AFWS communicates by e-mail/texting to: PWD, EMRM, DREM, FCDE, GVFD, SODC and SOAS	This is a Golden Valley Response Plan Stage 1 message. The potential need to evacuate selected areas and perform swift water rescues due to flooding may exist Residents should not cross flooded washes.	Flooding possible in Golden Valley.
Stage 2 (Triggered by FCDE)	NWS: NOAA Weather Radio, Commercial Radio and/or TV	NWS Flood Warning	Flooding is imminent or occurring in Golden Valley.
	FCDE or AFWSM communicates to: PWD, EMRM, DREM, GVFD, SODC, and SOAS	This is a Golden Valley Response Plan Stage 2 message. The potential need to evacuate selected areas is high. Golden Valley response agencies should activate personnel in preparation for possible evacuation and swift water rescue duties. Residents in Golden Valley should prepare to move to high ground upon receipt of a Golden Valley Response Plan Stage 3 message and should not cross flooded washes.	Heavy rainfall within Golden Valley watershed. Mohave County AFWS detects/predicts rainfall values and coverage areas associated with Golden Valley Flood Warning Stage.
Stage 3 (Triggered by DREM)	NWS: NOAA Weather Radio, Commercial Radio and/or TV	This is a High Hazard Flood for Golden Valley. Residents should move to high ground as necessary. Residents should not cross flooded washes.	Extreme rainfall within Golden Valley watershed. Mohave County AFWS detects/predicts rainfall values and coverage areas associated with Golden Valley Flood Warning Stage 3.
	DREM communicates to: FCDE, PWD, EMRM, GVFD, SODC, and SOAS	This is a Golden Valley Response Plan Stage 3 message. Notify residents to move to high ground as needed and to not cross flooded washes.	
All Clear	DREM communicates to: PWD, EMRM, FCDE, GVFD, SODC, and SOAS	Golden Valley All Clear	Flood levels within Golden Valley have dropped below critical depths. Potential for additional extreme flooding is minimal.

*Due to the extremely short response times, as short as 20 minutes, in this geographic area, as well as other areas of Mohave County, the Flood Control District relies heavily on response of agencies for assistance with evacuations and potential swift water rescues. It is critical that the volunteer swift water rescue teams have sufficient and reliable equipment to perform rescues during these potentially deadly incidents. To assure the effectiveness of these rescues, the Flood Control District occasionally assists with the purchase of new rescue equipment.

3 CANCELATION OF RESPONSE PLAN MESSAGES

3.1 Stage 1 Cancelation

CANCELATION - STAGE 1 GV REGIONAL FLOOD RESPONSE PLAN

1. Flood Control Engineer (or Designee) and Emergency Management will send the following messages to personnel identified in the above Stage 1 notification list.

   "According to the NWS, the Flood Watch in the Golden Valley area is no longer in effect. The Response Plan Stage 1 Message for the Golden Valley area is cancelled."

   "As reported earlier, in response to the NWS issuing a Flood Watch for Golden Valley, a Response Plan Stage 1 Message for the Golden Valley area was issued in accordance with the Golden Valley Flood Response Plan on *DATE*."

3.2 Stage 2 Cancelation

CANCELATION - STAGE 2 GV REGIONAL FLOOD RESPONSE PLAN

1. AFWS Monitor will send the following messages to personnel identified in the above Stage 1 notification list.

   "According to the NWS, the Flood Warning in the Golden Valley area is no longer in effect. The Response Plan Stage 2 Message for the Golden Valley area is cancelled."

   "As reported earlier, in response to the NWS issuing a Flood Warning for Golden Valley, a Response Plan Stage 2 Message for the Golden Valley area was issued in accordance with the Golden Valley Flood Response Plan on *DATE*."

3.3 Stage 3 Cancelation

CANCELATION - STAGE 3 GV REGIONAL FLOOD RESPONSE PLAN

1. AFWS Monitor will send the following messages to personnel identified in the above Stage 1 notification list.

   "According to the NWS, the Flood Warning in the Golden Valley area is no longer in effect. The flood threat is diminishing but hazards to life and property may still exist. Subsequently, an evacuation order may still be in effect. Residents should coordinate with local emergency services and/or law enforcement for more information on their specific situation."

   "As reported earlier, in response to the NWS issuing a Flood Warning for Golden Valley, combined with the Mohave County ALERT system threshold alarms, a Response Plan Stage 3 Message advising residents in the Golden Valley area to evacuate immediately was issued in accordance with the Golden Valley Flood Response Plan on *DATE*."

Appendix A

Supplemental Technical Information

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A SUPPLEMENTAL TECHNICAL INFORMATION

Supplemental technical information associated with the Golden Valley FRP is comprised of the following two components:

1. Supplemental Golden Valley Flood Hazards
2. Supplemental Flood Detection and Warning

The above supplemental technical information components are presented in the following Sections B and C. This report is intentionally short and concise to make it easily useable during a flood emergency. The technical basis for the supplemental technical information is contained in the *Request for Local Acceptance of FLO-2D Pro Report* (Atkins, May 2015), which was prepared as part of the FRP's supplemental technical information effort. All input, output and supporting data used for the hydrologic and hydraulic analyses performed for the FRP's supplemental technical information effort have been provided to the District in electronic format on an accompanying external hard drive. In addition, various flood and hazard maps have been provided for all modeled storm scenarios in electronic format on said accompanying external hard drive.

A.1 Modeled Area

The modeled area for the Golden Valley FRP supplemental technical information is located within Mohave County, just west of Kingman, AZ. In general, the modeled area is bound to the west by the Black Mountains and to the east by the Cerbat and Hualapai Mountains. The northern (upstream) limit of the modeled area are the headwaters of the Sacramento Wash in the Cerbat Mountains. The modeled area extends to the south (downstream limit) to just beyond the Oatman Highway. The Golden Valley modeled area is shown below in Figure 1.

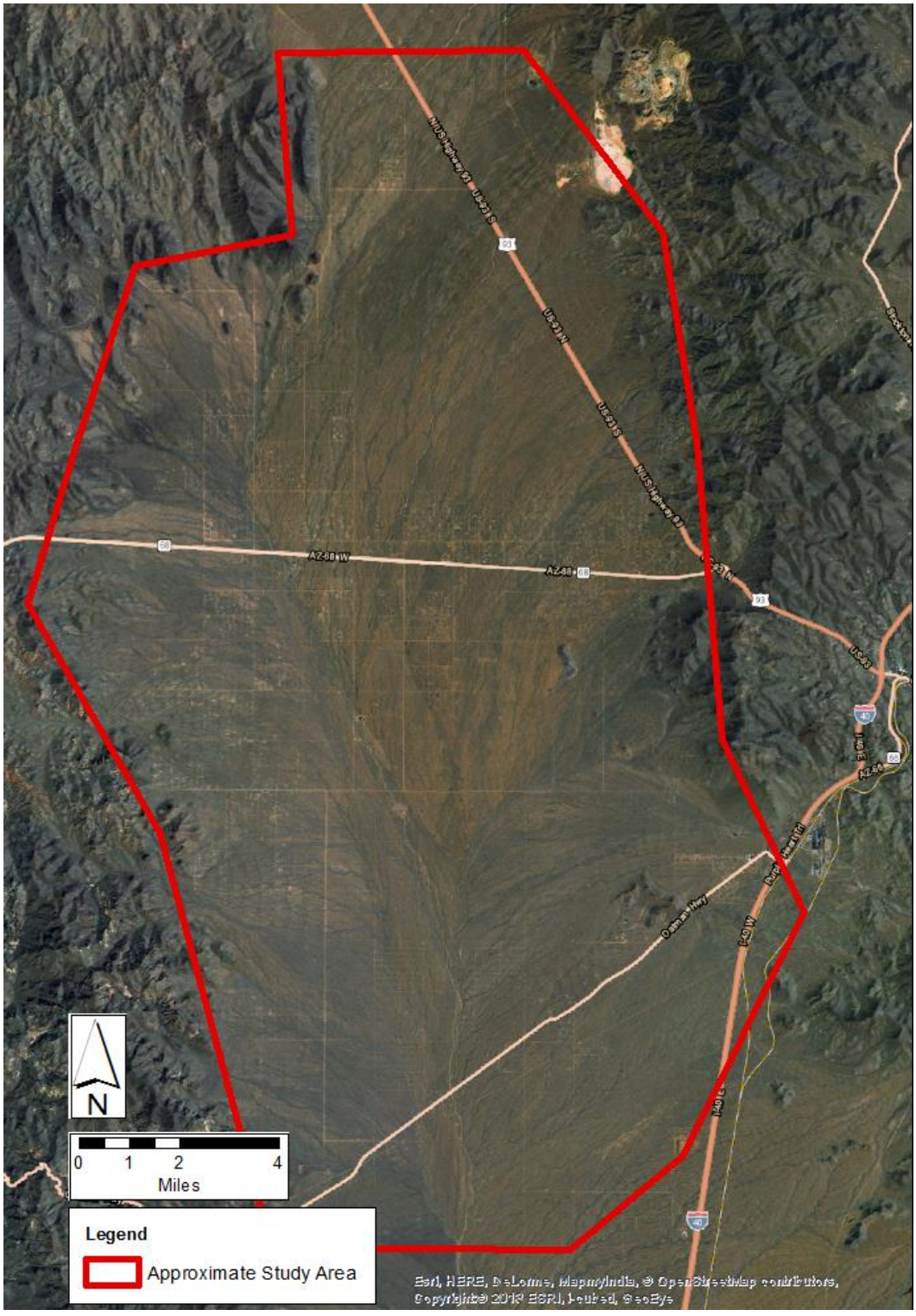


Figure 1. Golden Valley Modeled Area.

B SUPPLEMENTAL GOLDEN VALLEY FLOOD HAZARDS

Flood hazard classifications across the modeled area were developed based on the following:

1. Maximum flow depth and maximum flow velocity computed throughout the study area for a variety of storm scenarios using FLO-2D – a two-dimensional hydrologic and hydraulic modeling software platform. Eighty storm scenarios were modeled, each having a different combination of storm duration, precipitation depth and rainfall coverage area.
2. Flood hazard classifications for flood danger circumstances associated with adults, cars and houses as presented in the ACER Technical Memorandum No. 11, "Downstream Hazard Classification Guidelines", USBR, 1988.

B.1 Modeled Storm Scenarios

As stated above, 80 storm scenarios were modeled, each having a different combination of storm duration, precipitation depth and rainfall coverage area. Combinations of modeled storm duration and precipitation depth (and corresponding rainfall intensity and storm recurrence interval) are presented below in Table 1.

Table 1. Combinations of Modeled Storm Duration and Precipitation Depth.

Storm Duration (hours)	**Precipitation Depth (inches) Rainfall Intensity (inches/hour) Storm Recurrence Interval (years)**			
0.5 hrs	0.75 in 1.50 in/hr 5 yr-storm	1.00 in 2.00 in/hr 10 yr-storm	1.50 in 3.00 in/hr 50 yr-storm	2.00 in 4.00 in/hr 100 yr-storm
2 hrs	1.00 in 0.50 in/hr 2 yr-storm	1.50 in 0.75 in/hr 10 yr-storm	2.00 in 1.00 in/hr 25 yr-storm	2.50 in 1.25 in/hr 50 yr-storm
3 hrs	1.00 in 0.33 in/hr 2 yr-storm	2.00 in 0.67 in/hr 25 yr-storm	2.50 in 0.83 in/hr 50 yr-storm	3.00 in 1.00 in/hr 100 yr-storm
6 hrs	1.00 in 0.17 in/hr 2 yr-storm	1.50 in 0.25 in/hr 5 yr-storm	2.00 in 0.33 in/hr 10 yr-storm	3.00 in 0.50 in/hr 50 yr-storm

Each combination of storm duration and precipitation depth shown above in Table 1 was modeled assuming five different rainfall coverage areas over the study area. Rainfall coverage areas correspond to combinations of FLO-2D computational domains and are shown below in Table 2 and below in Figure 2 through Figure 6.

Table 2. Rainfall Coverage Areas per Combination of FLO-2D Computational Domain.

	FLO-2D Computational Domains									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Rainfall Coverage Area 1	x	x	x	x	x	x	x	x	x	x
Rainfall Coverage Area 2	x	x			x	x				x
Rainfall Coverage Area 3					x	x				x
Rainfall Coverage Area 4							x	x	x	x
Rainfall Coverage Area 5			x	x						x

The intent of this multiple storm scenario modeling approach is to provide Emergency Managers data for a range of storm duration and precipitation depth combinations (storm intensities) associated with a variety of potential rainfall coverage areas across Golden Valley. With this information (storm intensity over the full study area or a portion of the study area), in conjunction with forecasted/real-time storm information from County ALERT gages and agencies like the National Weather Service (NWS), Emergency Managers can estimate potential flood hazards (Section B.2) within Golden Valley.

FLO-2D modeling results (flood depth, flow velocity, etc.) have been provided in electronic format to the Mohave County Flood Control District (see accompanying external hard drive). This information is provided in separate FLO-2D folders that correspond to each of the 80 storm scenarios modeled. FLO-2D folder name structure (nomenclature) has been developed such that Emergency Managers are able to quickly identify each of the 80 storm scenarios when cross-referenced with Table 3 provided below in Section C. In addition, a quick reference tool ("KDP_Hazards.xlsm") has been provided to the District on the accompanying external hard drive, in which a storm scenario (FLO-2D folder name) is identified when the user enters a rainfall coverage area, precipitation depth and storm duration.

Through use of Figure 2 through Figure 6, Table 3, and forecasted/real-time storm information (storm duration and precipitation depth and/or rainfall intensity over the study area), Emergency Managers can identify closely approximating storm scenarios modeled as part of the FRP. As discussed above, estimated flooding conditions (depth, velocity, etc.) have been provided in electronic format in separate FLO-2D folders that correspond to each of the 80 modeled storm scenarios. In addition, estimated flood hazard information per storm scenario (see Section B.2) has been provided in electronic format in the corresponding FLO-2D folder. As forecasted/real-time storm conditions are tracked, Emergency Managers are able to progress through storm scenarios, thereby obtaining estimated flood conditions and flood hazard information as storm conditions change.

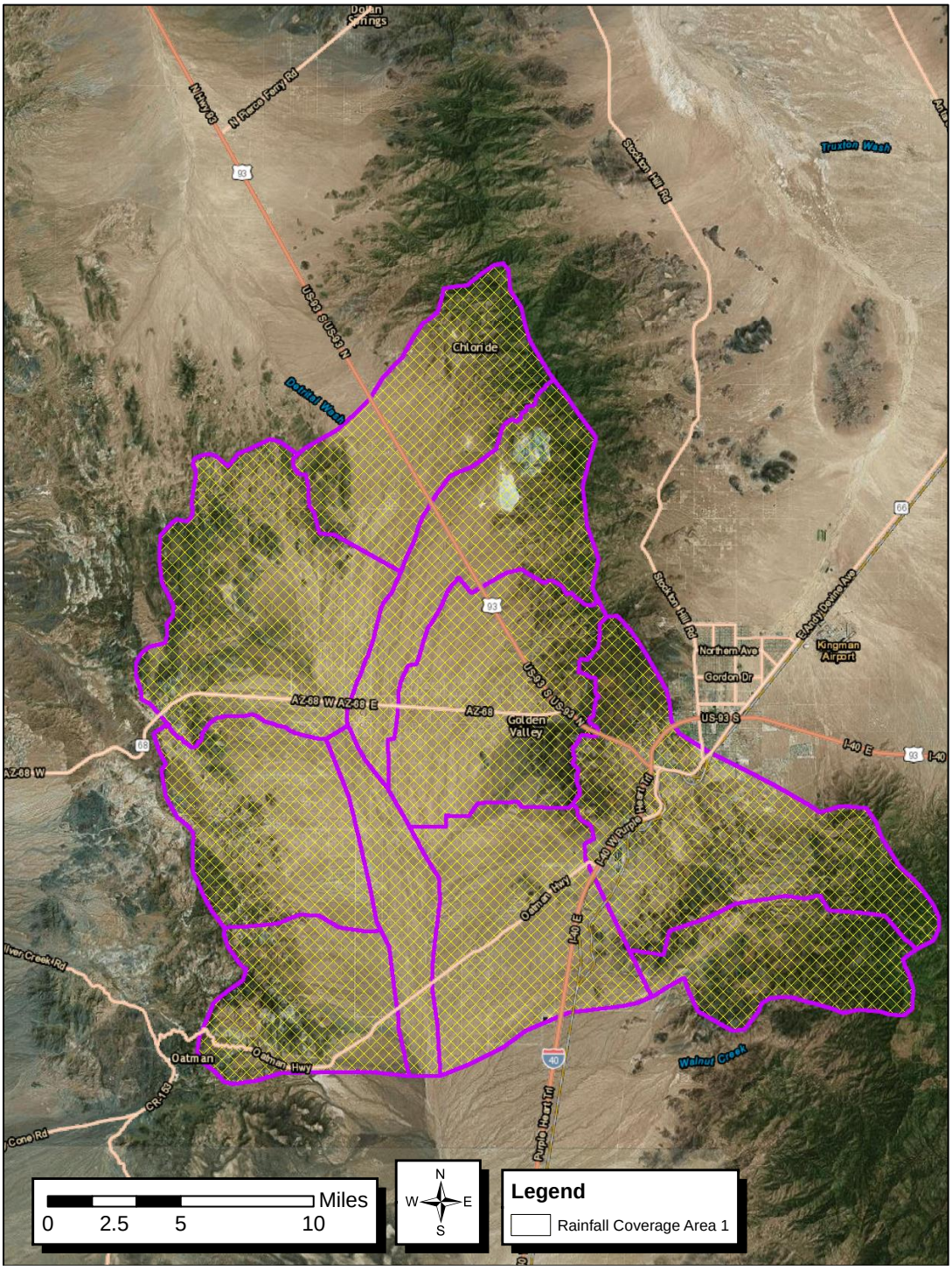


Figure 2. Rainfall Coverage Area 1 per

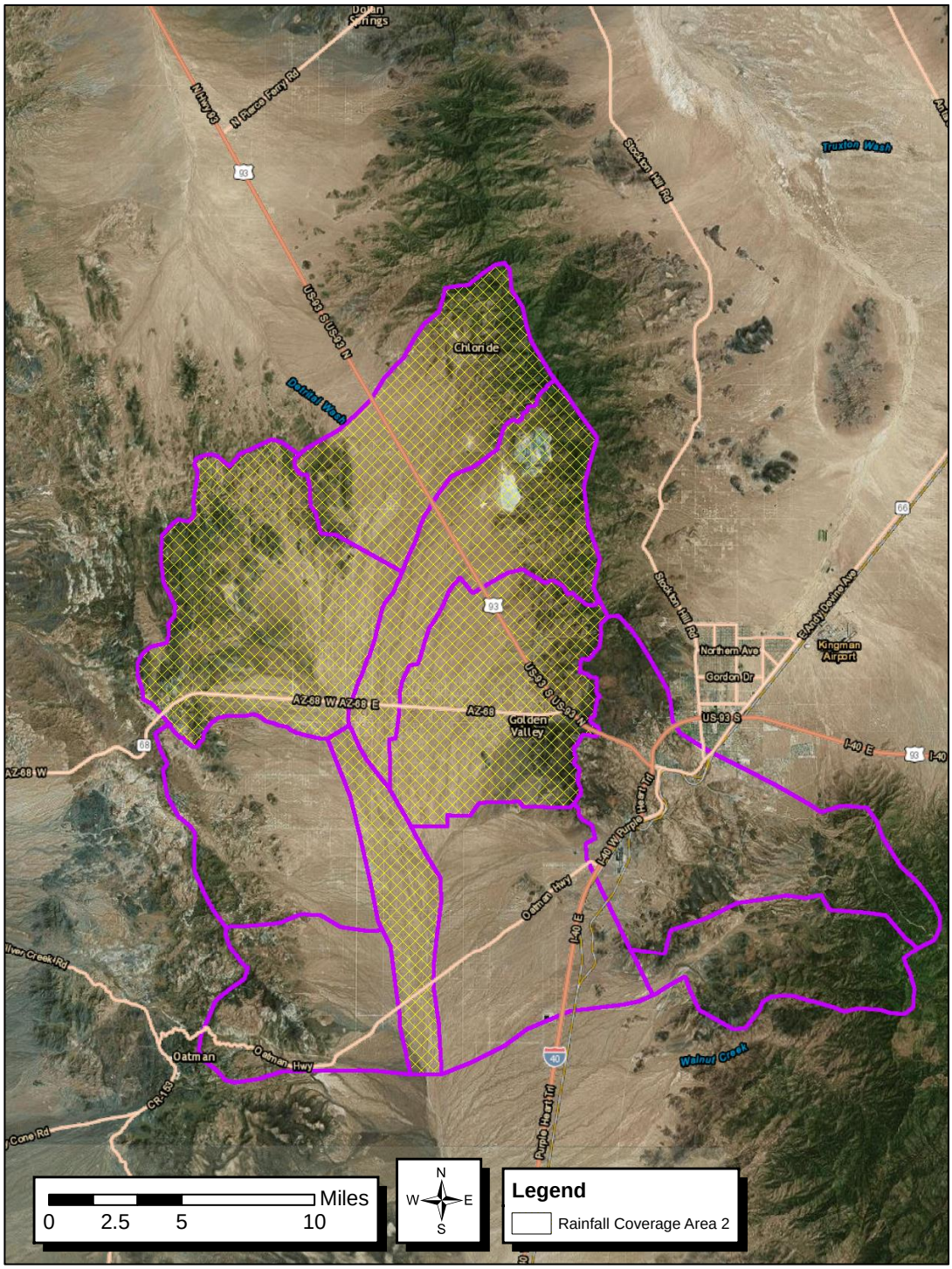


Figure 3. Rainfall Coverage Area 2 per

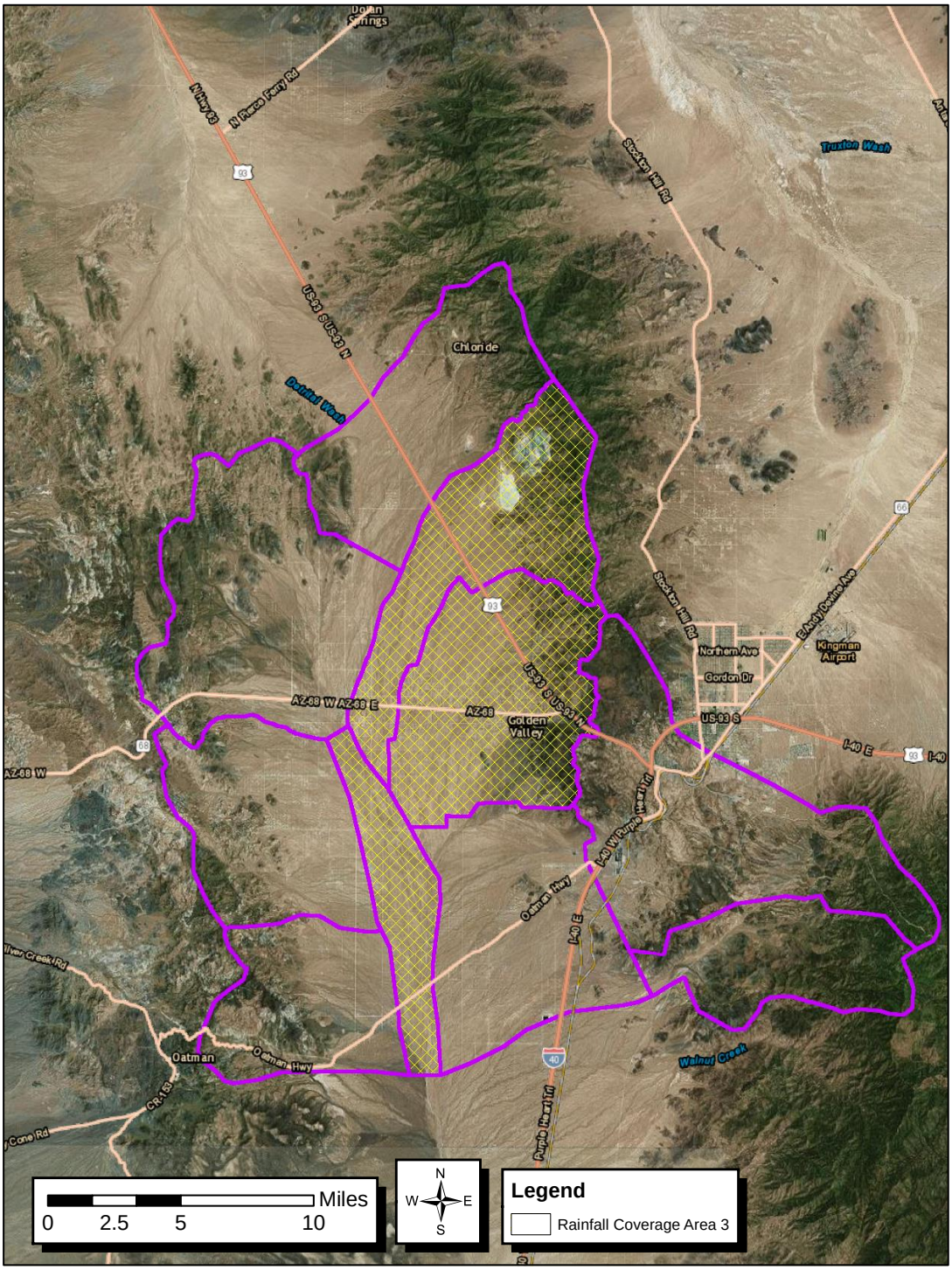


Figure 4. Rainfall Coverage Area 3 per

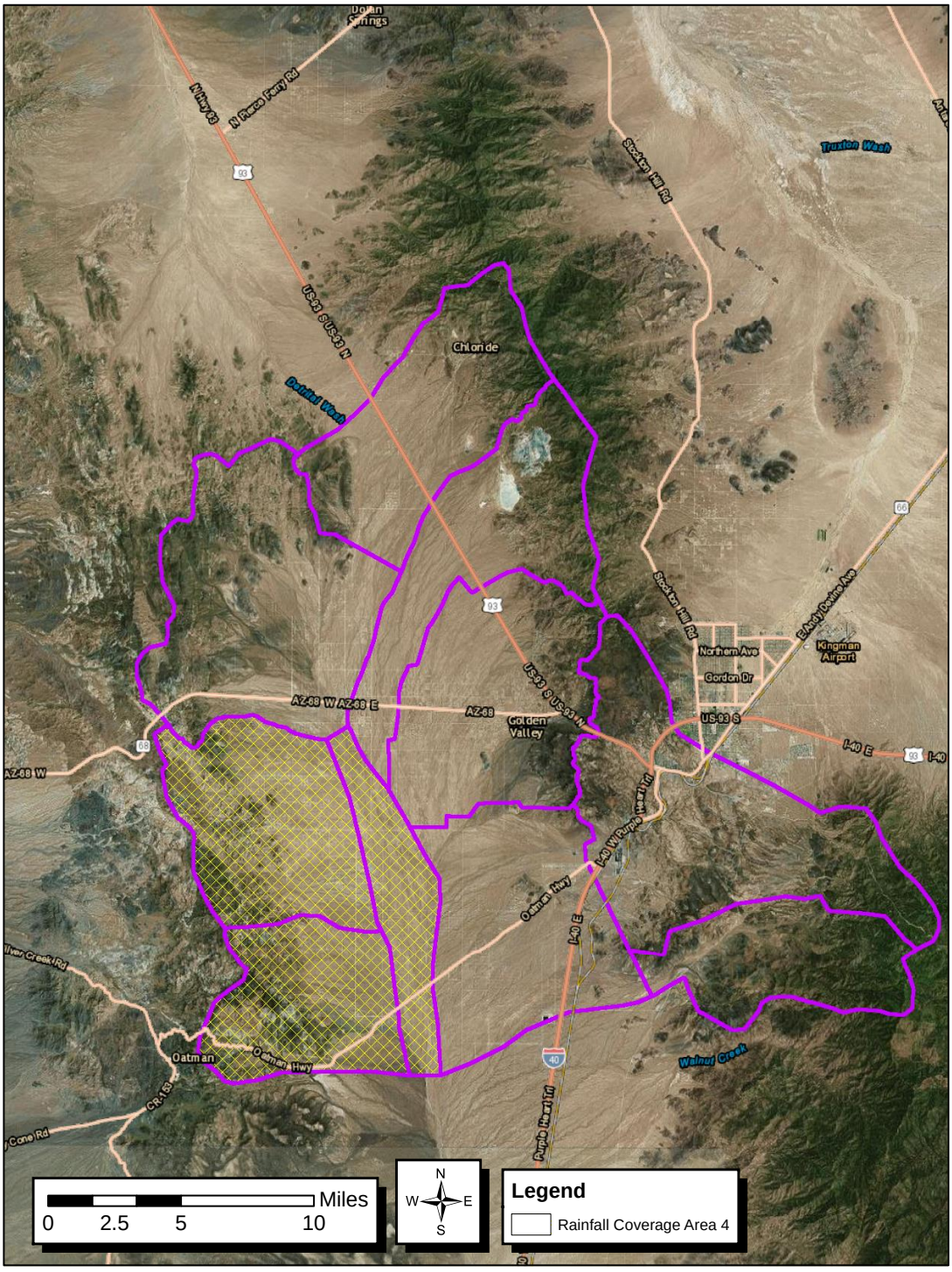


Figure 5. Rainfall Coverage Area 4 per

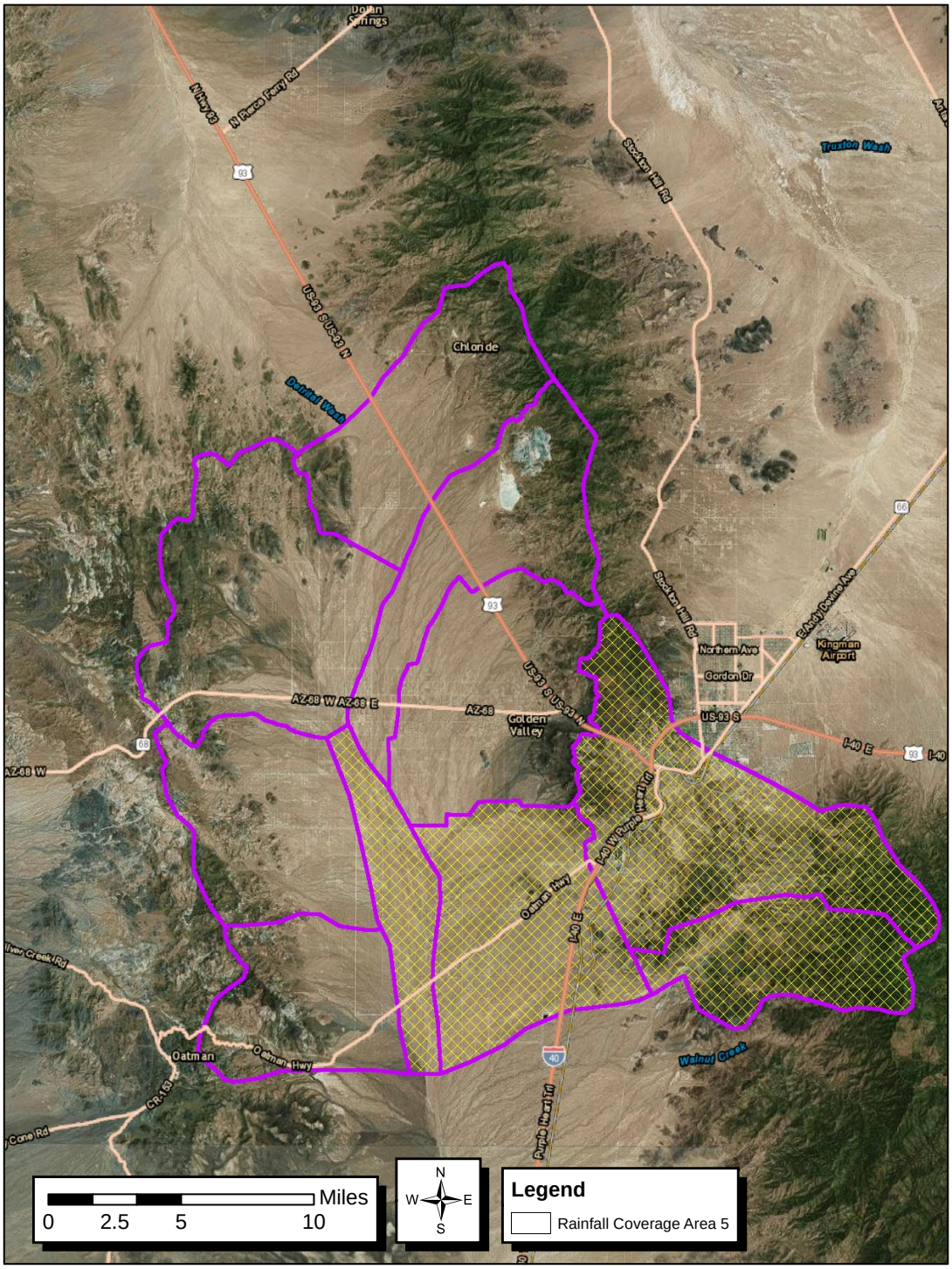


Figure 6. Rainfall Coverage Area 5 per

B.2 Hazard Classification

The ACER Technical Memorandum No. 11, "Downstream Hazard Classification Guidelines" (USBR 1988) has been prepared to provide guidance and criteria for classification of potential flood hazards for a variety of flood danger circumstances. For the purpose of the Golden Valley FRP, three flood danger circumstances were considered: flood danger for adults; flood danger for cars; and flood danger for houses. Flood hazard classification for each flood danger circumstance is determined through evaluation of estimated flow depth and flow velocity, as shown below in Figure 7, Figure 8 and Figure 9. As shown in these figures, for each flood danger circumstance, hazard classification is dependent on a combination of flow depth and flow velocity. For example, the flood hazard classification is "high danger" for adults when flow depth is five feet, with near zero flow velocity and when flow depth is six inches, with flow velocity near 10 feet per second.

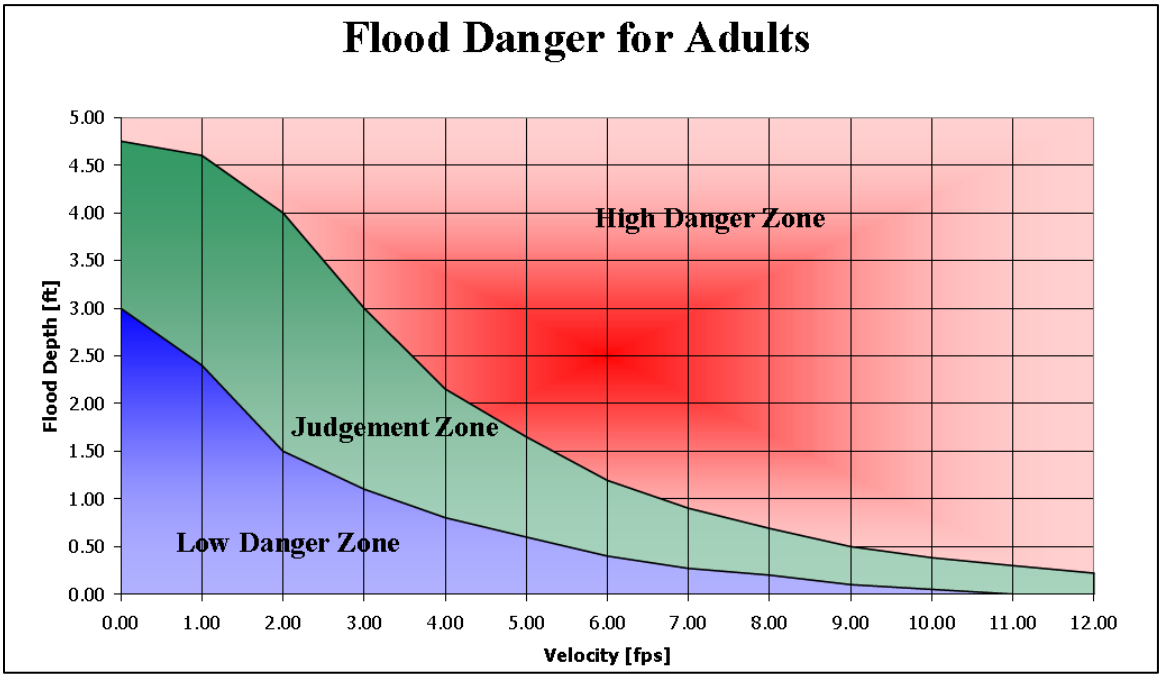


Figure 7. Flood Danger for Adults per Downstream Hazard Classification Guidelines (USBR 1988).

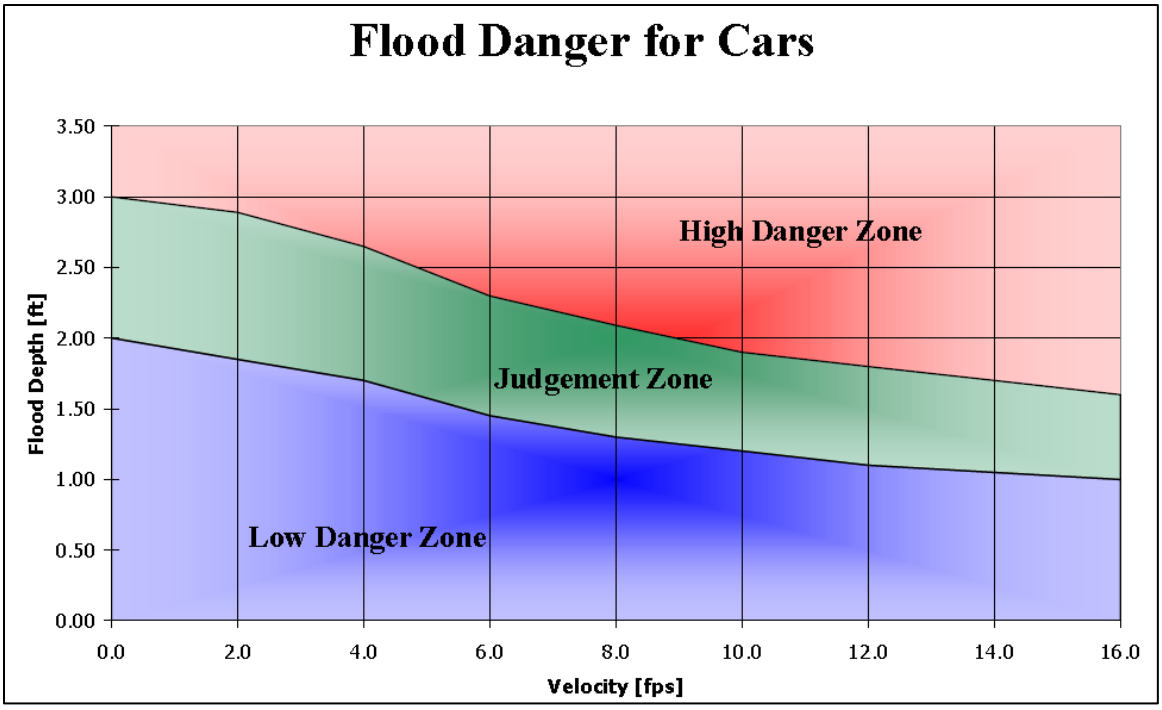


Figure 8. Flood Danger for Cars per Downstream Hazard Classification Guidelines (USBR 1988).

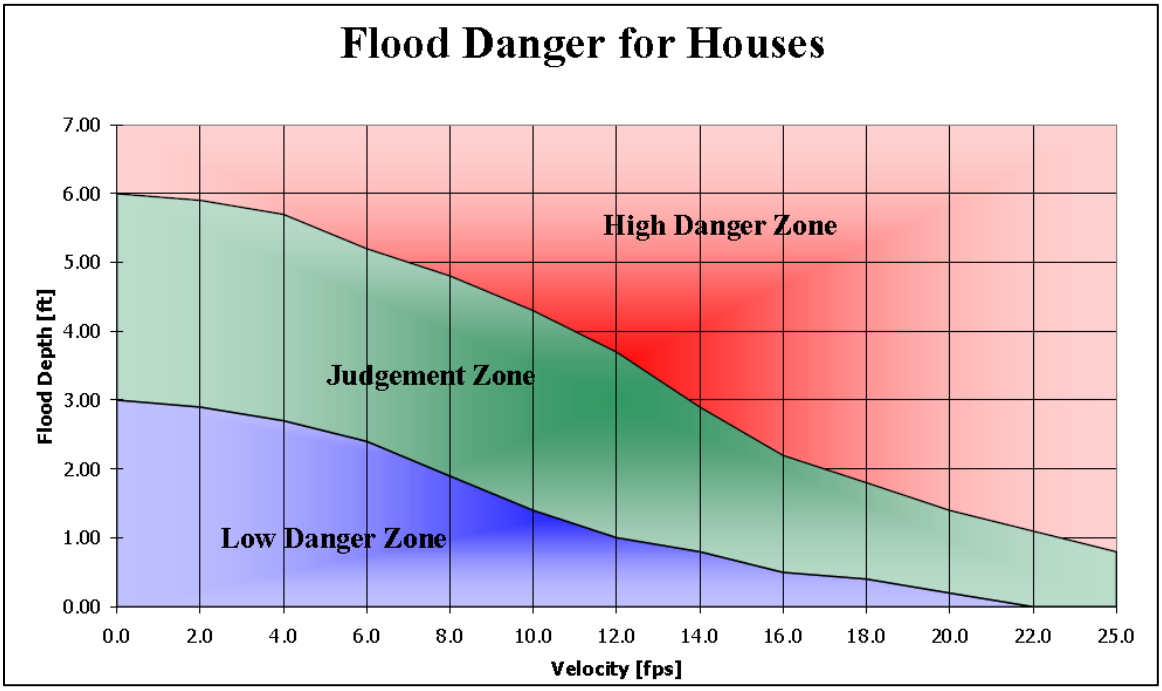


Figure 9. Flood Danger for Houses per Downstream Hazard Classification Guidelines (USBR 1988).

FLO-2D modeling performed for supplemental technical information provides estimates of maximum flow depth and maximum flow velocity across the full modeled area (approximately 500 square miles) in a gridded fashion, with this hydraulic data provided every 50 feet in the north-south and east-west directions (50'x50' grid). Using this hydraulic data, coupled with the flood hazard classification criteria for the flood danger circumstances shown in Figure 7, Figure 8 and Figure 9, flood hazards have been classified for flood dangers associated with adults, cars and houses for each of the 80 storm scenarios discussed above in Section B.1, across the full modeled area using the FLO-2D 50'x50' grid. Flood hazard classifications for adult, car and house flood danger circumstances, across the modeled area and for each of the 80 modeled storm scenarios, have been provided to the Mohave County Flood Control District in GIS format (see accompanying external hard drive).

In addition, flood hazard classifications have been provided for the flood danger circumstances discussed above at 41 Key Decision Point (KDP) locations distributed throughout the more populated portion of the Golden Valley study area. These 41 KDP locations have been identified to help Emergency Managers better plan for action based on forecasted/real-time storm events. A map of the 41 KDP locations is attached. Flood hazard classifications for adult, car and house flood danger circumstances at the 41 KDP locations is also provided in table format ("KDP_Hazards.xlsm"), located on the accompanying external hard drive:

Finally, maps (PDF file format) showing the flood hazard classifications for the adults, car, and house flood danger circumstances at the 41 KDP locations, for each of the 80 storm scenarios modeled (see Section B.1), are provided on the accompanying external hard drive.

C SUPPLEMENTAL FLOOD DETECTION AND WARNING

Supplemental flood detection and warning criteria were developed by evaluating hazard classification for flood danger associated with a car crossing a flooded wash at the 41 Key Decision Point (KDP) locations discussed in Section B.2 and shown on the attached KDP map. The flood danger for cars was selected, rather than for adults and/or houses, due to vehicle crossings of flooded washes being the most prevalent, reoccurring flood danger condition in Golden Valley. Based on the range of hazard classifications at each of the 41 KDP locations, for all 80 modeled storm scenarios (see Section B.1), a Golden Valley regional flood warning stage was assigned to each storm scenario using the following approach:

1. Identify hazard classification for flood danger associated with cars crossing a flooded wash at each of the 41 KDP locations using the hazard classification guidelines discussed in Section B.2.
2. Identify the number of low, medium and high hazard classifications (for cars crossing a flooded wash) at the 41 KDP locations, per storm scenario.
3. Assign the following weight per hazard classification:
    1. Low hazard classification (LHC) weight – 1
    2. Medium hazard classification (MHC) weight – 2
    3. High hazard classification (HHC) weight – 3
4. Calculate overall, weighted hazard classification score for each storm scenario based on the following equation:

    Weighted Hazard Classification Score = LHC + (2)(MHC) + (3)(HHC)
5. For each storm scenario, assign Golden Valley regional flood warning stage based on the following weighted hazard classification score criteria:
    1. Weighted Hazard Classification Score < 20 = Regional Flood Warning Stage 1
    2. 20 ≤ Weighted Hazard Classification Score ≤ 60 = Regional Flood Warning Stage 2
    3. 60 < Weighted Hazard Classification Score = Regional Flood Warning Stage 3

The supplemental Golden Valley regional flood warning stage per modeled storm scenario is provided below in Table 3. Table 3 also includes the following information per modeled storm: FLO-2D model folder name; storm duration; precipitation depth; storm intensity; rainfall coverage area; and KDP locations of high hazard flood danger for cars crossing a flooded wash. In addition, a summary of the flood detection warning sequence for each Golden Valley flood warning stages is provided below in Table 4. A list of acronyms used in flood warning procedures is provided below in Table 5.

In addition, a quick reference tool to identify the Golden Valley regional flood warning stage associated with each of the 80 modeled storm scenarios is provided on the accompanying external hard drive (see "KDP_Hazards.xlsm").

Table 3. Golden Valley Supplemental Flood Warning Stage per Modeled Storm Scenario.

Model No.	FLO-2D Folder Name	Storm Duration (hours)	Precipitation Depth (inches)	Storm Intensity (in/hr)	Rainfall Coverage Area (FLO-2D Computational Domain)	KDP Locations for High Hazard Flood Danger for Cars Crossing a Wash	Golden Valley Regional Flood Warning Stage
1	GV_05_1_1	0.5	0.75	1.50	1 - 10	1, 2 9, 10, 11, 14, 15, 17, 18, 19, 21, 27, 31, 32, 33, 35, 36, 37, 39, 40, 41	3
2	GV_05_1_2	0.5	0.75	1.50	1, 2, 5, 6, 10	9, 10, 11, 14, 15, 17, 18, 19, 21, 27, 31, 32, 33, 39, 40, 41	3
3	GV_05_1_3	0.5	0.75	1.50	5, 6, 10	9, 14, 15, 17, 19, 21, 31, 32, 33, 39, 40	2
4	GV_05_1_4	0.5	0.75	1.50	7, 8, 9, 10	35, 37, 40	1
5	GV_05_1_5	0.5	0.75	1.50	3, 4, 10	39, 40	1
6	GV_05_2_1	0.5	1.00	2.00	1 - 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 25, 27, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
7	GV_05_2_2	0.5	1.00	2.00	1, 2, 5, 6, 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 25, 27, 31, 32, 33, 39, 40, 41	3
8	GV_05_2_3	0.5	1.00	2.00	5, 6, 10	5, 8, 9, 12, 13, 14, 15, 17, 19, 21, 25, 31, 32, 33, 39, 40	3
9	GV_05_2_4	0.5	1.00	2.00	7, 8, 9, 10	35, 37, 38, 39, 40	2
10	GV_05_2_5	0.5	1.00	2.00	3, 4, 10	39, 40	1

Table 3. Golden Valley Supplemental Flood Warning Stage per Modeled Storm Scenario.

Model No.	FLO-2D Folder Name	Storm Duration (hours)	Precipitation Depth (inches)	Storm Intensity (in/hr)	Rainfall Coverage Area (FLO-2D Computational Domain)	KDP Locations for High Hazard Flood Danger for Cars Crossing a Wash	Golden Valley Regional Flood Warning Stage
11	GV_05_3_1	0.5	1.50	3.00	1 - 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 26, 27, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
12	GV_05_3_2	0.5	1.50	3.00	1, 2, 5, 6, 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
13	GV_05_3_3	0.5	1.50	3.00	5, 6, 10	5, 8, 9, 12, 13, 14, 15, 17, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
14	GV_05_3_4	0.5	1.50	3.00	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2
15	GV_05_3_5	0.5	1.50	3.00	3, 4, 10	26, 39, 40, 41	1
16	GV_05_4_1	0.5	2.00	4.00	1 - 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 26, 27, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
17	GV_05_4_2	0.5	2.00	4.00	1, 2, 5, 6, 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
18	GV_05_4_3	0.5	2.00	4.00	5, 6, 10	5, 8, 9, 12, 13, 14, 15, 17, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
19	GV_05_4_4	0.5	2.00	4.00	7, 8, 9, 10	27, 35, 36, 37, 38, 39, 40, 41	2
20	GV_05_4_5	0.5	2.00	4.00	3, 4, 10	26, 27, 39, 40, 41	1

Table 3. Golden Valley Supplemental Flood Warning Stage per Modeled Storm Scenario.

Model No.	FLO-2D Folder Name	Storm Duration (hours)	Precipitation Depth (inches)	Storm Intensity (in/hr)	Rainfall Coverage Area (FLO-2D Computational Domain)	KDP Locations for High Hazard Flood Danger for Cars Crossing a Wash	Golden Valley Regional Flood Warning Stage
21	GV_2_1_1	2	1.00	0.50	1 - 10	1, 2, 4, 9, 10, 11, 12, 13, 14, 18, 19, 21, 27, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
22	GV_2_1_2	2	1.00	0.50	1, 2, 5, 6, 10	1, 2, 4, 9, 10, 11, 12, 13, 14, 18, 19, 21, 27, 31, 32, 33, 39, 40, 41	3
23	GV_2_1_3	2	1.00	0.50	5, 6, 10	9, 12, 13, 14, 18, 21, 31, 32, 33, 39, 40	2
24	GV_2_1_4	2	1.00	0.50	7, 8, 9, 10	35, 37, 38, 39, 40	2
25	GV_2_1_5	2	1.00	0.50	3, 4, 10	39, 40	1
26	GV_2_2_1	2	1.50	0.75	1 - 10	1, 2, 4, 5, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 26, 27, 31, 32, 33, 35, 37, 38, 39, 40, 41	3
27	GV_2_2_2	2	1.50	0.75	1, 2, 5, 6, 10	1, 2, 4, 5, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 27, 31, 32, 33, 39, 40, 41	3
28	GV_2_2_3	2	1.50	0.75	5, 6, 10	5, 9, 12, 13, 14, 15, 17, 19, 21, 22, 31, 32, 33, 39, 40	3
29	GV_2_2_4	2	1.50	0.75	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2
30	GV_2_2_5	2	1.50	0.75	3, 4, 10	26, 39, 40, 41	1
31	GV_2_3_1	2	2.00	1.00	1 - 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 26, 27, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3

Table 3. Golden Valley Supplemental Flood Warning Stage per Modeled Storm Scenario.

Model No.	FLO-2D Folder Name	Storm Duration (hours)	Precipitation Depth (inches)	Storm Intensity (in/hr)	Rainfall Coverage Area (FLO-2D Computational Domain)	KDP Locations for High Hazard Flood Danger for Cars Crossing a Wash	Golden Valley Regional Flood Warning Stage
32	GV_2_3_2	2	2.00	1.00	1, 2, 5, 6, 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
33	GV_2_3_3	2	2.00	1.00	5, 6, 10	5, 8, 9, 12, 13, 14, 15, 17, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
34	GV_2_3_4	2	2.00	1.00	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2
35	GV_2_3_5	2	2.00	1.00	3, 4, 10	26, 39, 40, 41	1
36	GV_2_4_1	2	2.50	1.25	1 - 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
37	GV_2_4_2	2	2.50	1.25	1, 2, 5, 6, 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
38	GV_2_4_3	2	2.50	1.25	5, 6, 10	5, 8, 9, 12, 13, 14, 15, 17, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
39	GV_2_4_4	2	2.50	1.25	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2
40	GV_2_4_5	2	2.50	1.25	3, 4, 10	26, 39, 40, 41	1
41	GV_3_1_1	3	1.00	0.33	1 - 10	1, 2, 4, 10, 11, 12, 13, 14, 18, 19, 21, 27, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
42	GV_3_1_2	3	1.00	0.33	1, 2, 5, 6, 10	1, 2, 4, 10, 11, 12, 13, 14, 18, 19, 21, 27, 31, 32, 33, 39, 40, 41	3

Table 3. Golden Valley Supplemental Flood Warning Stage per Modeled Storm Scenario.

Model No.	FLO-2D Folder Name	Storm Duration (hours)	Precipitation Depth (inches)	Storm Intensity (in/hr)	Rainfall Coverage Area (FLO-2D Computational Domain)	KDP Locations for High Hazard Flood Danger for Cars Crossing a Wash	Golden Valley Regional Flood Warning Stage
43	GV_3_1_3	3	1.00	0.33	5, 6, 10	12, 13, 14, 19, 21, 31, 32, 33, 39, 40	2
44	GV_3_1_4	3	1.00	0.33	7, 8, 9, 10	35, 37, 38, 39, 40	2
45	GV_3_1_5	3	1.00	0.33	3, 4, 10	39, 40	1
46	GV_3_2_1	3	2.00	0.67	1 - 10	1, 2, 4, 5, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 26, 27, 28, 35, 36, 37, 38, 39, 40, 41	3
47	GV_3_2_2	3	2.00	0.67	1, 2, 5, 6, 10	1, 2, 4, 5, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 27, 28, 31, 32, 33, 39, 40, 41	3
48	GV_3_2_3	3	2.00	0.67	5, 6, 10	5, 9, 12, 13, 14, 15, 17, 19, 21, 22, 27, 28, 31, 32, 33, 39, 40, 41	3
49	GV_3_2_4	3	2.00	0.67	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2
50	GV_3_2_5	3	2.00	0.67	3, 4, 10	26, 39, 40, 41	1
51	GV_3_3_1	3	2.50	0.83	1 - 10	1, 2, 4, 5, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 26, 27, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
52	GV_3_3_2	3	2.50	0.83	1, 2, 5, 6, 10	1, 2, 4, 5, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
53	GV_3_3_3	3	2.50	0.83	5, 6, 10	5, 9, 12, 13, 14, 15, 17, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3

Table 3. Golden Valley Supplemental Flood Warning Stage per Modeled Storm Scenario.

Model No.	FLO-2D Folder Name	Storm Duration (hours)	Precipitation Depth (inches)	Storm Intensity (in/hr)	Rainfall Coverage Area (FLO-2D Computational Domain)	KDP Locations for High Hazard Flood Danger for Cars Crossing a Wash	Golden Valley Regional Flood Warning Stage
54	GV_3_3_4	3	2.50	0.83	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2
55	GV_3_3_5	3	2.50	0.83	3, 4, 10	26, 39, 40, 41	1
56	GV_3_4_1	3	3.00	1.00	1 - 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 26, 27, 28, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
57	GV_3_4_2	3	3.00	1.00	1, 2, 5, 6, 10	1, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
58	GV_3_4_3	3	3.00	1.00	5, 6, 10	5, 8, 9, 12, 13, 14, 15, 17, 19, 21, 22, 25, 27, 28, 30, 31, 32, 33, 39, 40, 41	3
59	GV_3_4_4	3	3.00	1.00	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2
60	GV_3_4_5	3	3.00	1.00	3, 4, 10	26, 39, 40, 41	1
61	GV_6_1_1	6	1.00	0.17	1 - 10	1, 2, 10, 11, 13, 18, 19, 21, 27, 32, 33, 35, 37, 39, 40, 41	3
62	GV_6_1_2	6	1.00	0.17	1, 2, 5, 6, 10	1, 2, 10, 11, 13, 18, 19, 21, 27, 32, 33, 39, 40, 41	3
63	GV_6_1_3	6	1.00	0.17	5, 6, 10	13, 19, 21, 32, 33, 39, 40	2
64	GV_6_1_4	6	1.00	0.17	7, 8, 9, 10	37, 40	1
65	GV_6_1_5	6	1.00	0.17	3, 4, 10	39, 40	1
66	GV_6_2_1	6	1.50	0.25	1 - 10	1, 2, 4, 10, 11, 12, 13, 14, 18, 19, 21, 22, 27, 31, 32, 33, 35, 37, 38, 39, 40, 41	3

Table 3. Golden Valley Supplemental Flood Warning Stage per Modeled Storm Scenario.

Model No.	FLO-2D Folder Name	Storm Duration (hours)	Precipitation Depth (inches)	Storm Intensity (in/hr)	Rainfall Coverage Area (FLO-2D Computational Domain)	KDP Locations for High Hazard Flood Danger for Cars Crossing a Wash	Golden Valley Regional Flood Warning Stage
67	GV_6_2_2	6	1.50	0.25	1, 2, 5, 6, 10	1, 2, 4, 10, 11, 12, 13, 14, 18, 19, 21, 22, 27, 31, 32, 33, 39, 40, 41	3
68	GV_6_2_3	6	1.50	0.25	5, 6, 10	12, 13, 14, 19, 21, 22, 31, 32, 33, 39, 40	2
69	GV_6_2_4	6	1.50	0.25	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2
70	GV_6_2_5	6	1.50	0.25	3, 4, 10	39, 40	1
71	GV_6_3_1	6	2.00	0.33	1 - 10	1, 2, 4, 10, 11, 12, 13, 14, 18, 19, 21, 22, 27, 28, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
72	GV_6_3_2	6	2.00	0.33	1, 2, 5, 6, 10	1, 2, 4, 10, 11, 12, 13, 14, 18, 19, 21, 22, 27, 28, 31, 32, 33, 39, 40, 41	3
73	GV_6_3_3	6	2.00	0.33	5, 6, 10	12, 13, 14, 19, 21, 22, 28, 31, 32, 33, 39, 40	2
74	GV_6_3_4	6	2.00	0.33	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2
75	GV_6_3_5	6	2.00	0.33	3, 4, 10	39, 40, 41	1
76	GV_6_4_1	6	3.00	0.50	1 - 10	1, 2, 4, 5, 9, 10, 11, 12, 13, 14, 15, 18, 19, 21, 22, 27, 28, 31, 32, 33, 35, 36, 37, 38, 39, 40, 41	3
77	GV_6_4_2	6	3.00	0.50	1, 2, 5, 6, 10	1, 2, 4, 5, 9, 10, 11, 12, 13, 14, 15, 18, 19, 21, 22, 27, 28, 31, 32, 33, 39, 40, 41	3
78	GV_6_4_3	6	3.00	0.50	5, 6, 10	5, 9, 12, 13, 14, 15, 19, 21, 22, 28, 31, 32, 33, 39, 40, 41	3
79	GV_6_4_4	6	3.00	0.50	7, 8, 9, 10	35, 37, 38, 39, 40, 41	2

Table 3. Golden Valley Supplemental Flood Warning Stage per Modeled Storm Scenario.

Model No.	FLO-2D Folder Name	Storm Duration (hours)	Precipitation Depth (inches)	Storm Intensity (in/hr)	Rainfall Coverage Area (FLO-2D Computational Domain)	KDP Locations for High Hazard Flood Danger for Cars Crossing a Wash	Golden Valley Regional Flood Warning Stage
80	GV_6_4_5	6	3.00	0.50	3, 4, 10	39, 40, 41	1

Table 4. Summary of the Supplemental Flood Detection Warning Sequence for Golden Valley Warning Stages.

Golden Valley Regional Flood Warning Stage	Local Communication	Message Content	Flood Condition Status
Stage 1 (Triggered by NWS)	NWS: NOAA Weather Radio, Commercial Radio and/or TV	NWS flood watch for Golden Valley.	Flooding possible in Golden Valley.
	AFWS communicates by e-mail/texting to: PWD, EMRM, DREM, FCDE, GVFD, SODC and SOAS	This is a Golden Valley Response Plan Stage 1 message. The potential need to evacuate selected areas and perform swift water rescues due to flooding may exist Residents should not cross flooded washes.	Flooding possible in Golden Valley.
Stage 2 (Triggered by FCDE)	NWS: NOAA Weather Radio, Commercial Radio and/or TV	NWS Flood Warning	Flooding is imminent or occurring in Golden Valley.
	FCDE or AFWSM communicates to: PWD, EMRM, DREM, GVFD, SODC, and SOAS	This is a Golden Valley Response Plan Stage 2 message. The potential need to evacuate selected areas is high. Golden Valley response agencies should activate personnel in preparation for possible evacuation and swift water rescue duties. Residents in Golden Valley should prepare to move to high ground upon receipt of a Golden Valley Response Plan Stage 3 message and should not cross flooded washes.	Heavy rainfall within Golden Valley watershed. Mohave County AFWS detects/predicts rainfall values and coverage areas associated with Golden Valley Flood Warning Stage 2 per Table 3 above.
Stage 3 (Triggered by DREM)	NWS: NOAA Weather Radio, Commercial Radio and/or TV	This is a High Hazard Flood for Golden Valley. Residents should move to high ground as necessary. Residents should not cross flooded washes.	Extreme rainfall within Golden Valley watershed. Mohave County AFWS detects/predicts rainfall values and coverage areas associated with Golden Valley Flood Warning Stage 3 per Table 3 above.
	DREM communicates to: FCDE, PWD, EMRM, GVFD, SODC, and SOAS	This is a Golden Valley Response Plan Stage 3 message. Notify residents to move to high ground as needed and to not cross flooded washes.	
All Clear	DREM communicates to: PWD, EMRM, FCDE, GVFD, SODC, and SOAS	Golden Valley All Clear	Flood levels within Golden Valley have dropped below critical depths. Potential for additional extreme flooding is minimal.

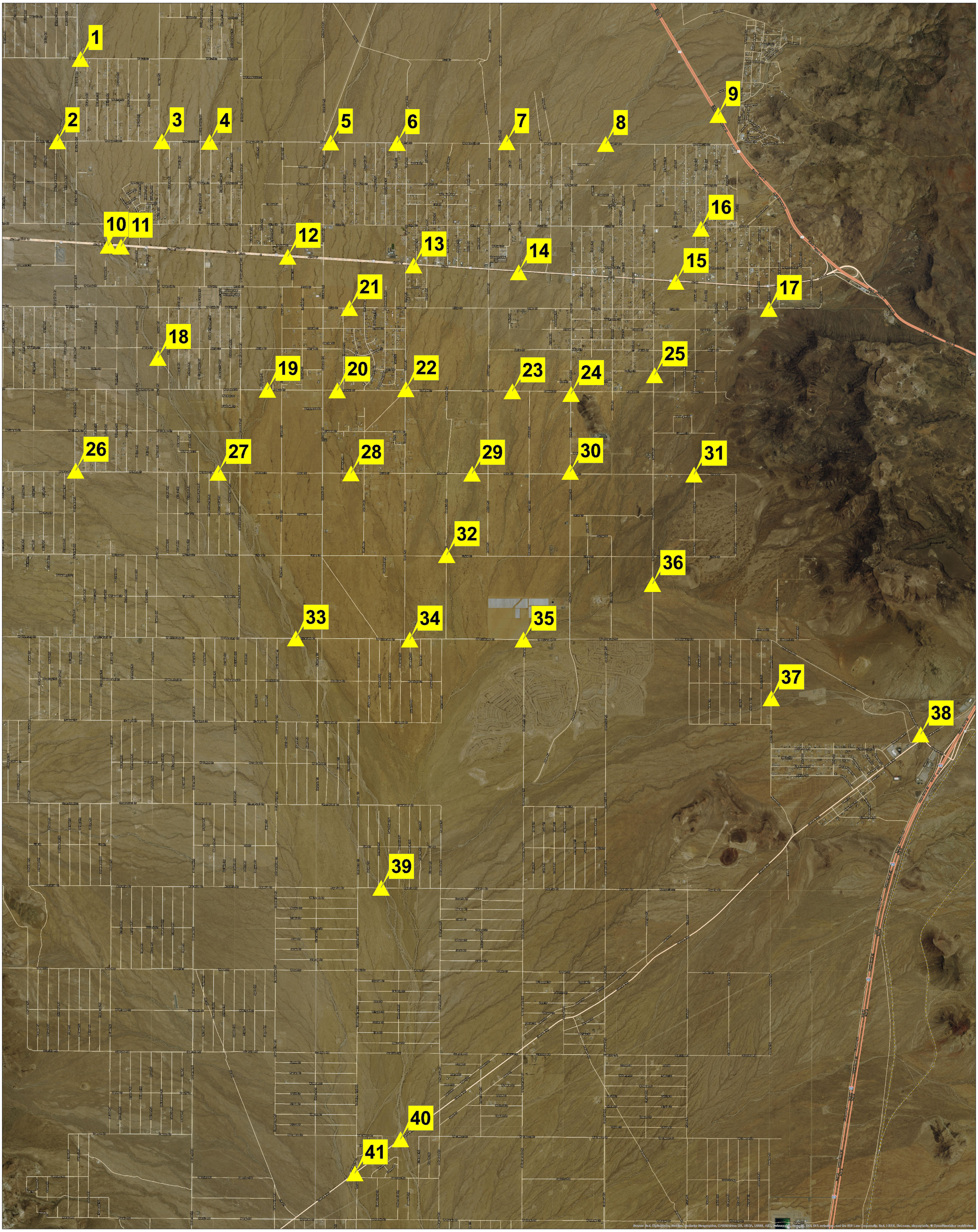
*Due to the extremely short response times, as short as 20 minutes, in this geographic area, as well as other areas of Mohave County, the Flood Control District relies heavily on response of agencies for assistance with evacuations and potential swift water rescues. It is critical that the volunteer swift water rescue teams have sufficient and reliable equipment to perform rescues during these potentially deadly incidents. To assure the effectiveness of these rescues, the Flood Control District occasionally assists with the purchase of new rescue equipment.

Table 5. List of Acronyms Used in Flood Warning Procedures.

GVFD	Golden Valley Fire Chief or Designee
MC	Mohave County
PWD	MC Public Works Director
SOAS	MC Sheriff's Office Personnel in Golden Valley
SODC	MC Sheriff's Office Dispatch Center
AFWS	MC ALERT Flood Warning System
DREM	MC Director of Risk and Emergency Management
EMRM	MC Engineering Manager (Road Maintenance & Operations)
FCDE	MC Flood Control District Engineer

Attachment
(Appendix A)

Map - Key Decision Point (KDP) Locations



SEAL OF MOHAVE COUNTY ARIZONA · DITAT DEUS · 1864

ATKINS

Legend

Key Decision Point Location

N

0 0.5 1 2

Miles

EXHIBIT A-1
KEY DECISION POINT (KDP) LOCATIONS
GOLDEN VALLEY FLOOD RESPONSE PLAN

MAY 2015