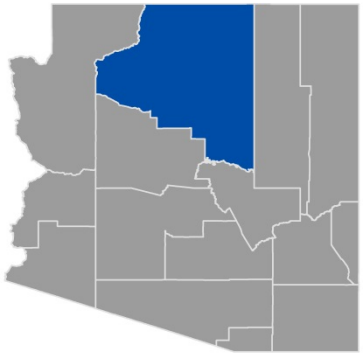
FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 3



COCONINO COUNTY, ARIZONA

AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
COCONINO COUNTY UNINCORPORATED AREAS	040019
FLAGSTAFF, CITY OF	040020
FREDONIA, TOWN OF	040021
HAVASUPAI INDIAN RESERVATION	040023
PAGE, CITY OF	040113
SEDONA, CITY OF	040130
TUSAYAN, TOWN OF	040139
WILLIAMS, CITY OF	040027

FEMA

REVISED:

Preliminary July 30, 2015

FLOOD INSURANCE STUDY NUMBER
04005CV001B

Version Number 2.3.2.2

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FLOOD INSURANCE STUDY REPORT
COCONINO COUNTY, ARIZONA

SECTION 1.0 – INTRODUCTION

1.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a voluntary Federal program that enables property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, sea-walls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA), which is a component of the Department of Homeland Security (DHS).

Participation in the NFIP is based on an agreement between local communities and the Federal Government. If a community adopts and enforces floodplain management regulations to reduce future flood risks to new construction and substantially improved structures in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The community's floodplain management regulations must meet or exceed criteria established in accordance with Title 44 Code of Federal Regulations (CFR) Part 60.3, *Criteria for land Management and Use*.

SFHAs are delineated on the community's Flood Insurance Rate Maps (FIRMs). Under the NFIP, buildings that were built before the flood hazard was identified on the community's FIRMs are generally referred to as "Pre-FIRM" buildings. When the NFIP was created, the U.S. Congress recognized that insurance for Pre-FIRM buildings would be prohibitively expensive if the premiums were not subsidized by the Federal Government. Congress also recognized that most of these floodprone buildings were built by individuals who did not have sufficient knowledge of the flood hazard to make informed decisions. The NFIP requires that full actuarial rates reflecting the complete flood risk be charged on all buildings constructed or substantially improved on or after the effective date of the initial FIRM for the community or after December 31, 1974, whichever is

later. These buildings are generally referred to as “Post-FIRM” buildings.

1.2 Purpose of this Flood Insurance Study Report

This Flood Insurance Study (FIS) Report revises and updates information on the existence and severity of flood hazards for the study area. The studies described in this report developed flood hazard data that will be used to establish actuarial flood insurance rates and to assist communities in efforts to implement sound floodplain management.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive than the minimum Federal requirements. Contact your State NFIP Coordinator to ensure that any higher State standards are included in the community’s regulations.

1.3 Jurisdictions Included in the Flood Insurance Study Project

This FIS Report covers the entire geographic area of Coconino County, Arizona.

The jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the 8-digit Hydrologic Unit Codes (HUC-8) sub-basins affecting each, are shown in Table 1. The Flood Insurance Rate Map (FIRM) panel numbers that affect each community are listed. If the flood hazard data for the community is not included in this FIS Report, the location of that data is identified.

The location of flood hazard data for participating communities in multiple jurisdictions is also indicated in the table.

Jurisdictions that have no identified SFHAs as of the effective date of this study are indicated in the table. Changed conditions in these communities (such as urbanization or annexation) or the availability of new scientific or technical data about flood hazards could make it necessary to determine SFHAs in these jurisdictions in the future.

Table 1: Listing of NFIP Jurisdictions

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C0025G[1], 04005C0050G[1], 04005C0075G[1], 04005C0100G[1], 04005C0125G[1], 04005C0150G[1], 04005C0156G, 04005C0157G, 04005C0158G, 04005C0159G, 04005C0165G[1], 04005C0166G[1], 04005C0167G, 04005C0168G[1], 04005C0169G[1], 04005C0176G, 04005C0177G[1], 04005C0178G[1], 04005C0179G[1], 04005C0185G, 04005C0190G, 04005C0195G, 04005C0225G, 04005C0250G[1], 04005C0275G[1], 04005C0300G[1], 04005C0325G[1], 04005C0350G, 04005C0375G, 04005C0400G, 04005C0425G[1], 04005C0450G[1], 04005C0475G[1], 04005C0500G[1], 04005C0525G[1], 04005C0550G[1], 04005C0575G[1], 04005C0600G[1], 04005C0625G[1], 04005C0650G, 04005C0675G[1], 04005C0700G[1], 04005C0725G, 04005C0750G,	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas (cont.)	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C0775G[1], 04005C0800G[1], 04005C0825G[1], 04005C0850G[1], 04005C0875G[1], 04005C0900G[1], 04005C0925G[1], 04005C0950G[1], 04005C0975G[1], 04005C1000G[1], 04005C1025G[1], 04005C1050G, 04005C1075G, 04005C1100G, 04005C1125G[1], 04005C1150G[1], 04005C1175G[1], 04005C1200G[1], 04005C1225G[1] 04005C1250G[1], 04005C1275G[1], 04005C1300G[1], 04005C1325G[1], 04005C1350G[1], 04005C1375G[1], 04005C1400G[1], 04005C1425G[1], 04005C1450G[1], 04005C1475G[1], 04005C1500G[1], 04005C1525G[1], 04005C1550G[1], 04005C1575G[1], 04005C1600G[1], 04005C1625G[1], 04005C1650G[1], 04005C1675G[1], 04005C1700G[1], 04005C1725G[1], 04005C1750G[1], 04005C1775G[1], 04005C1800G[1], 04005C1825G[1], 04005C1850G[1],	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas (cont.)	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C1875G[1], 04005C1900G[1], 04005C1925G[1], 04005C1950G[1], 04005C1975G[1], 04005C2000G[1], 04005C2000G[1], 04005C2025G[1], 04005C2050G[1], 04005C2075G[1], 04005C2100G[1], 04005C2125G[1], 04005C2150G[1], 04005C2175G[1], 04005C2200G[1], 04005C2225G[1], 04005C2250G[1], 04005C2275G[1], 04005C2300G[1], 04005C2325G[1], 04005C2350G[1], 04005C2375G[1], 04005C2400G[1], 04005C2425G[1], 04005C2450G[1], 04005C2475G[1], 04005C2500G[1], 04005C2525G[1], 04005C2550G[1], 04005C2575G[1], 04005C2600G[1], 04005C2625G[1], 04005C2650G[1], 04005C2700G[1], 04005C2725G[1], 04005C2750G[1], 04005C2775G[1], 04005C2800G[1], 04005C2825G[1], 04005C2850G[1], 04005C2875G[1], 04005C2900G[1], 04005C2925G[1], 04005C2950G[1],	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas (cont.)	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C2975G[1], 04005C3000G[1], 04005C3025G[1], 04005C3050G[1], 04005C3075G[1], 04005C3100G[1], 04005C3125G[1] 04005C3150G[1], 04005C3175G[1], 04005C3200G, 04005C3225G, 04005C3250G, 04005C3275G[1], 04005C3300G, 04005C3325G[1], 04005C3350G[1], 04005C3375G[1], 04005C3400G[1], 04005C3425G[1], 04005C3450G[1], 04005C3475G[1], 04005C3500G[1], 04005C3525G[1], 04005C3550G[1], 04005C3575G[1], 04005C3600G[1], 04005C3625G[1], 04005C3650G[1], 04005C3675G[1], 04005C3700G[1], 04005C3725G[1], 04005C3750G[1], 04005C3775G, 04005C3800G, 04005C3825G, 04005C3850G, 04005C3875G[1], 04005C3900G, 04005C3925G[1], 04005C3950G[1], 04005C3975G[1], 04005C4000G[1], 04005C4025G[1], 04005C4050G[1],	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas (cont.)	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C4075G[1], 04005C4100G[1], 04005C4125G[1], 04005C4150G[1], 04005C4175G[1], 04005C4200G[1], 04005C4225G[1], 04005C4250G[1], 04005C4275G[1], 04005C4300G, 04005C4325G, 04005C4350G, 04005C4375G, 04005C4400G, 04005C4425G, 04005C4450G[1], 04005C4475G[1], 04005C4500G[1], 04005C4525G, 04005C4550G[1], 04005C4575G[1], 04005C4600G[1], 04005C4625G[1], 04005C4650G[1], 04005C4675G[1], 04005C4700G[1], 04005C4725G[1], 04005C4750G[1], 04005C4775G[1], 04005C4800G[1], 04005C4825G[1], 04005C4850G, 04005C4875G, 04005C4900G, 04005C4925G, 04005C4950G[1], 04005C4975G[1], 04005C5000G[1], 04005C5025G, 04005C5050G, 04005C5075G[1], 04005C5100G[1], 04005C5125G[1], 04005C5150G[1],	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas (cont.)	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C5175G[1], 04005C5200G[1], 04005C5225G[1], 04005C5250G[1], 04005C5275G[1], 04005C5300G[1], 04005C5325G[1], 04005C5350G[1], 04005C5375G[1], 04005C5400G[1], 04005C5425G[1], 04005C5450G[1], 04005C5475G[1], 04005C5500G[1], 04005C5525G[1], 04005C5550G[1], 04005C5575G, 04005C5600G[1], 04005C5625G[1], 04005C5650G[1], 04005C5675G[1] 04005C5700G[1] 04005C5725G[1], 04005C5750G[1], 04005C5775G[1], 04005C5800G, 04005C5825G, 04005C5850G[1], 04005C5875G[1], 04005C5900G[1], 04005C5925G[1], 04005C5950G[1], 04005C5975G[1], 04005C6000G[1], 04005C6025G[1], 04005C6050G[1], 04005C6075G[1], 04005C6100G[1], 04005C6125G[1], 04005C6150G[1], 04005C6175G[1], 04005C6200G[1], 04005C6225G[1], 04005C6250G[1],	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas (cont.)	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C6275G, 04005C6300G, 04005C6325G[1], 04005C6330G[1], 04005C6335G[1], 04005C6336G[1], 04005C6337G[1], 04005C6338G[1], 04005C6339G, 04005C6341G[1], 04005C6342G[1], 04005C6343G, 04005C6344G[1], 04005C6375G[1], 04005C6400G[1], 04005C6425G, 04005C6430G[1], 04005C6435G[1], 04005C6440G, 04005C6445G[1], 04005C6455G[1], 04005C6460G[1], 04005C6465G[1], 04005C6470G, 04005C6500G[1], 04005C6525G[1], 04005C6550G[1], 04005C6575G[1], 04005C6600G[1], 04005C6625G[1], 04005C6650G, 04005C6675G, 04005C6700G, 04005C6701G[1], 04005C6703G[1], 04005C6704G[1], 04005C6710G, 04005C6715G[1], 04005C6720G[1], 04005C6750G, 04005C6775G, 04005C6800G, 04005C6801G, 04005C6802G,	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas (cont.)	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C6803G[1], 04005C6804G, 04005C6806G, 04005C6807G, 04005C6808G, 04005C6809G, 04005C6811G, 04005C6812G, 04005C6813G[1], 04005C6814G[1], 04005C6816G, 04005C6818G, 04005C6819G, 04005C6826G, 04005C6827G, 04005C6831G, 04005C6832G, 04005C6833G, 04005C6834G, 04005C6836G, 04005C6838G, 04005C6839G, 04005C6845G, 04005C6875G, 04005C6900G[1], 04005C6925G[1], 04005C6950G[1], 04005C6975G, 04005C7000G, 04005C7025G[1], 04005C7050G[1], 04005C7075G[1], 04005C7100G[1], 04005C7125G 04005C7127H 04005C7129H 04005C7130G[1], 04005C7130H 04005C7131H 04005C7132H 04005C7133H 04005C7134H 04005C7136G[1], 04005C7137G[1],	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas (cont.)	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C7138G, 04005C7139G[1], 04005C7145H, 04005C7155G, 04005C7175G, 04005C7200G, 04005C7225G[1], 04005C7250G[1], 04005C7275G[1], 04005C7300G, 04005C7325G, 04005C7350G[1], 04005C7375G[1], 04005C7400G[1], 04005C7425G[1], 04005C7430G[1], 04005C7431G[1], 04005C7432G, 04005C7434G, 04005C7442G[1], 04005C7444G, 04005C7451G, 04005C7452G[1], 04005C7453G, 04005C7454G[1], 04005C7457H, 04005C7459H, 04005C7460H, 04005C7461G, 04005C7462G, 04005C7463G, 04005C7464G[1], 04005C7466G[1], 04005C7467H, 04005C7468G[1], 04005C7469G[1], 04005C7500H, 04005C7505G, 04005C7510G, 04005C7511G, 04005C7512G, 04005C7513G[1], 04005C7514G, 04005C7520G,	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Coconino County, Unincorporated Areas (cont.)	040019	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	04005C7550G[1] 04005C7575G[1] 04005C7600G[1], 04005C7625G, 04005C7650G, 04005C7657G, 04005C7659G, 04005C7670G[1], 04005C7700G, 04005C7716G[1], 04005C7717G, 04005C7718G[1], 04005C7719G, 04005C7725G, 04005C7750G, 04005C7775G[1], 04005C7800G[1], 04005C7825G[1], 04005C7850G, 04005C7875G, 04005C7900G, 04005C7925G[1], 04005C7950G[1], 04005C7975G[1], 04005C8000G[1], 04005C8025G[1], 04005C8050G[1], 04005C8075G[1], 04005C8100G[1], 04005C8125G[1], 04005C8150G[1], 04005C8175G[1], 04005C8200G[1], 04005C8225G[1], 04005C8250G[1], 04005C8275G[1], 04005C8300G[1], 04005C8325G[1], 04005C8350G[1], 04005C8375G[1], 04005C8400G[1], 04005C8425G[1], 04005C8450G[1], 04005C8475G[1],	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Flagstaff, City of	040020	15020015, 15060202	04005C6802G, 04005C6804G, 04005C6806G, 04005C6807G, 04005C6808G, 04005C6809G, 04005C6812G, 04005C6814G[1], 04005C6816G, 04005C6817G, 04005C6818G, 04005C6819G, 04005C6826G, 04005C6827G, 04005C6828G, 04005C6829G, 04005C6831G, 04005C6832G, 04005C6833G, 04005C6834G, 04005C6836G, 04005C6837G, 04005C6838G, 04005C6839G, 04005C6845G, 04005C7131H, 04005C7132H, 04005C7155G	
Fredonia, Town of	040021	15010003	04005C0156G, 04005C0157G, 04005C0158G, 04005C0159G	
Havasupai Indian Reservation	040023	15010002, 15010004	04005C2150G[1], 04005C2175G[1], 04005C2200G[1], 04005C2225G[1], 04005C2625G[1], 04005C2650G[1], 04005C2675G[1], 04005C2700G[1], 04005C2725G[1], 04005C3175G[1], 04005C3200G, 04005C3225G, 04005C3250G, 04005C3750G[1],	
Page, City of	040113	14070006	04005C0375G, 04005C0400G	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Sedona, City of	040130	15060202	04005C7444G, 04005C7463G, 04005C7657G, 04005C7659G, 04005C7700G	
Tusayan, Town of	040139	15010004	04005C3825G, 04005C3850G	
Williams, City of	040027	15010004, 15060201, 15060202	04005C6330G[1], 04005C6335G[1], 04005C6337G[1], 04005C6338G[1], 04005C6339G, 04005C6341G[1], 04005C6342G[1], 04005C6343G, 04005C6344G[1], 04005C6375G[1], 04005C6701G[1], 04005C6702G, 04005C6703G[1], 04005C6704G[1], 04005C6706G, 04005C6710G, 04005C6750G	

[1] Panel Not Printed

1.4 Considerations for using this Flood Insurance Study Report

The NFIP encourages State and local governments to implement sound floodplain management programs. To assist in this endeavor, each FIS Report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent annual chance flood elevations (the 1% annual chance flood elevation is also referred to as the Base Flood Elevation (BFE)); delineations of the 1% annual chance and 0.2% annual chance floodplains; and 1% annual chance floodway. This information is presented on the FIRM and/or in many components of the FIS Report, including Flood Profiles, Floodway Data tables, Summary of Non-Coastal Stillwater Elevations tables, and Coastal Transect Parameters tables (not all components may be provided for a specific FIS).

This section presents important considerations for using the information contained in this FIS Report and the FIRM, including changes in format and content. Figures 1, 2, and 3 present information that applies to using the FIRM with the FIS Report.

- Part or all of this FIS Report may be revised and republished at any time. In addition, part of this FIS Report may be revised by a Letter of Map Revision (LOMR), which does not involve republication or redistribution of the FIS Report. Refer to Section 6.5 of this FIS

Report for information about the process to revise the FIS Report and/or FIRM.

It is, therefore, the responsibility of the user to consult with community officials by contacting the community repository to obtain the most current FIS Report components. Communities participating in the NFIP have established repositories of flood hazard data for floodplain management and flood insurance purposes. Community map repository addresses are provided in Table 31, "Map Repositories," within this FIS Report.

- New FIS Reports are frequently developed for multiple communities, such as entire counties. A countywide FIS Report incorporates previous FIS Reports for individual communities and the unincorporated area of the county (if not jurisdictional) into a single document and supersedes those documents for the purposes of the NFIP.

  The initial Countywide FIS Report for Coconino County became effective on September 3, 2010. Refer to Table 28 for information about subsequent revisions to the FIRMs.

- FEMA does not impose floodplain management requirements or special insurance ratings based on Limit of Moderate Wave Action (LiMWA) delineations at this time. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. If the LiMWA is shown on the FIRM, it is being provided by FEMA as information only. For communities that do adopt Zone VE building standards in the area defined by the LiMWA, additional Community Rating System (CRS) credits are available. Refer to Section 2.5.4 for additional information about the LiMWA.

  The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Visit the FEMA Web site at http://www.fema.gov or contact your appropriate FEMA Regional Office for more information about this program.

- Previous FIS Reports and FIRMs may have included levees that were accredited as reducing the risk associated with the 1% annual chance flood based on the information available and the mapping standards of the NFIP at that time. For FEMA to continue to accredit the identified levees, the levees must meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled "Mapping of Areas Protected by Levee Systems."

  Since the status of levees is subject to change at any time, the user should contact the appropriate agency for the latest information regarding levees presented in Table 9 of this FIS Report. For levees owned or operated by the U.S. Army Corps of Engineers (USACE), information may be obtained from the USACE national levee database. For all other levees, the user is encouraged to contact the appropriate local community.

- FEMA has developed a *Guide to Flood Maps* (FEMA 258) and online tutorials to assist users in accessing the information contained on the FIRM. These include how to read panels and step-by-step instructions to obtain specific information. To obtain this guide and other assistance in using the FIRM, visit the FEMA Web site at http://www.fema.gov.

KANE COUNTY, UTAH

KAIBAB INDIAN RESERVATION

COCONINO COUNTY 040019

TOWN OF FREDONIA 040021

KAIBAB INDIAN RESERVATION

MOHAVE COUNTY

KAIBAB NATIONAL FOREST

GRAND CANYON NATIONAL PARK

NAVAJO NATION

GRAND CANYON NATIONAL PARK

HULALAPAI INDIAN RESERVATION

HAVASUPAI INDIAN RESERVATION 040023

TOWN OF TUSAYAN 040139

KAIBAB NATIONAL FOREST

COCONINO COUNTY 040019

COCONINO NATIONAL FOREST

KAIBAB NATIONAL FOREST

COCONINO NATIONAL FOREST

CITY OF WILLIAMS 040027

YAVAPAI COUNTY

PRESCOTT NATIONAL FOREST

14070007 Paria

15010003 Kanab

15010002 Grand Canyon

15010001 Lower Colorado-Marble Canyon

15010004 Havasu Canyon

15020016 Lower Little Colorado

15060201 Big Chino-Williamson Valley

15060202 Upper Verde

15010007 Red Lake

0157G 9/3/2010
0176G 9/3/2010
** 0177G 9/3/2010
0185G 9/3/2010
0156G 9/3/2010
** 0179G 9/3/2010
0225G 9/3/2010
** 0250G 9/3/2010
** 0275G 9/3/2010
** 0300G 9/3/2010
0158G 9/3/2010
0159G 9/3/2010
** 0178G 9/3/2010
* 0165G 9/3/2010
** 0166G 9/3/2010
0167G 9/3/2010
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*** 0575G 9/3/2010
** 0600G 9/3/2010
** 0625G 9/3/2010
0650G 9/3/2010
** 0675G 9/3/2010
** 0925G 9/3/2010
** 0950G 9/3/2010
** 0975G 9/3/2010
** 1000G 9/3/2010
* 1025G 9/3/2010
1050G 9/3/2010
1075G 9/3/2010
** 1325G 9/3/2010
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** 1375G 9/3/2010
** 1400G 9/3/2010
** 1425G 9/3/2010
** 1450G 9/3/2010
** 1475G 9/3/2010
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** 1750G 9/3/2010
** 1775G 9/3/2010
** 1800G 9/3/2010
** 1825G 9/3/2010
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*** 1875G 9/3/2010
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** 2150G 9/3/2010
** 2175G 9/3/2010
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** 2250G 9/3/2010
** 2275G 9/3/2010
** 2300G 9/3/2010
*** 2325G 9/3/2010
* 2575G 9/3/2010
* 2600G 9/3/2010
*** 2625G 9/3/2010
** 2650G 9/3/2010
** 2675G 9/3/2010
** 2700G 9/3/2010
** 2725G 9/3/2010
** 2750G 9/3/2010
** 2775G 9/3/2010
** 2800G 9/3/2010
** 2825G 9/3/2010
** 3175G 9/3/2010
3200G 9/3/2010
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3250G 9/3/2010
** 3325G 9/3/2010
** 3350G 9/3/2010
* 3075G 9/3/2010
* 3100G 9/3/2010
* 3125G 9/3/2010
*** 3150G 9/3/2010
** 3275G 9/3/2010
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** 3875G 9/3/2010
* 4125G 9/3/2010
* 4150G 9/3/2010
* 4175G 9/3/2010
*** 4200G 9/3/2010
** 4225G 9/3/2010
** 4250G 9/3/2010
** 4275G 9/3/2010
4300G 9/3/2010
4325G 9/3/2010
4350G 9/3/2010
4375G 9/3/2010
4400G 9/3/2010
* 4650G 9/3/2010
*** 4675G 9/3/2010
*** 4700G 9/3/2010
*** 4725G 9/3/2010
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** 4775G 9/3/2010
** 4800G 9/3/2010
** 4825G 9/3/2010
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*** 5175G 9/3/2010
*** 5200G 9/3/2010
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** 5250G 9/3/2010
** 5275G 9/3/2010
** 5300G 9/3/2010
** 5325G 9/3/2010
** 5350G 9/3/2010
** 5375G 9/3/2010
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** 5900G 9/3/2010
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** 6400G 9/3/2010
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6702G 9/3/2010
6710G 9/3/2010
6775G 9/3/2010
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6675G 9/3/2010
6700G 9/3/2010
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** 6704G 9/3/2010
6750G 9/3/2010
** 6715G 9/3/2010
** 6720G 9/3/2010
****7025G 9/3/2010
****7050G 9/3/2010
****7075G 9/3/2010
****7100G 9/3/2010
* 7350G 9/3/2010
* 7375G 9/3/2010
****7400G 9/3/2010
****7425G 9/3/2010

1 in = 11 miles

N

0 3 6 12 18 24 Miles

Map Projection:
UTM Zone 12N
North American Datum 1983

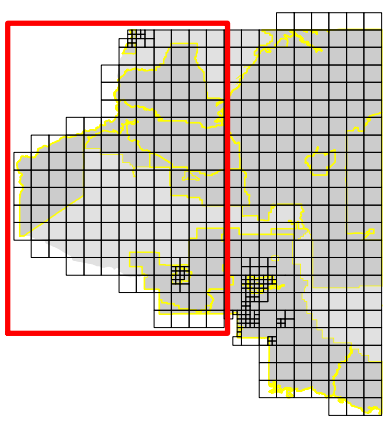
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

* Panel not printed - Area in Zone D
** Panel not printed - No special flood hazard areas
*** Panel not printed - Reservation in Zone D, Rest of panel in Zone X
**** Panel not printed - Prescott National Forest Zone D, Rest of panel in Zone X
***** Panel not printed - Apache-Sitgreaves Forest Zone D, Rest of panel in Zone X

COUNTY LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX (Sheet 1 of 3)

COCONINO COUNTY, ARIZONA And Incorporated Areas
PANELS PRINTED:
0156, 0157, 0158, 0159, 0167, 0176, 0185, 0190, 0195, 0225, 0650, 1050, 1075, 3200, 3225, 3250, 3300, 3775, 3800, 3825, 3850, 4300, 4325, 4350, 4375, 4400, 4850, 4875, 4900, 4925, 5800, 5825, 6275, 6300, 6339, 6343, 6650, 6675, 6700, 6702, 6706, 6710, 6750, 6775

PRELIMINARY
7/30/2015

FEMA

MAP NUMBER
04005CIND0B
MAP REVISED

SAN JUAN COUNTY, UTAH

GLEN CANYON NATIONAL RECREATION AREA

KANE COUNTY, UTAH

*** 0025G 9/3/2010

*** 0050G 9/3/2010

*** 0075G 9/3/2010

* 0100G 9/3/2010

GLEN CANYON NATIONAL RECREATION AREA

* 0125G 9/3/2010

* 0150G 9/3/2010

14080205 Lower San Juan

** 0325G 9/3/2010

0350G 9/3/2010

0375G 9/3/2010

0400G 9/3/2010

*** 0425G 9/3/2010

*** 0450G 9/3/2010

*** 0475G 9/3/2010

* 0500G 9/3/2010

* 0525G 9/3/2010

14070007 Paria

14070006 Lower Lake Powell

** 0700G 9/3/2010

0725G 9/3/2010

CITY OF PAGE 040113

0750G 9/3/2010

* 0775G 9/3/2010

* 0800G 9/3/2010

*** 0825G 9/3/2010

* 0850G 9/3/2010

* 0875G 9/3/2010

* 0900G 9/3/2010

COCONINO COUNTY 040019

1100G 9/3/2010

*** 1125G 9/3/2010

* 1150G 9/3/2010

* 1175G 9/3/2010

* 1200G 9/3/2010

* 1225G 9/3/2010

* 1250G 9/3/2010

* 1275G 9/3/2010

* 1300G 9/3/2010

NAVAJO NATION

*** 1500G 9/3/2010

* 1525G 9/3/2010

* 1550G 9/3/2010

* 1575G 9/3/2010

* 1600G 9/3/2010

* 1625G 9/3/2010

* 1650G 9/3/2010

* 1675G 9/3/2010

* 1700G 9/3/2010

KAIBAB NATIONAL FOREST

15010001 Lower Colorado-Marble Canyon

GRAND CANYON NATIONAL PARK

*** 1900G 9/3/2010

* 1925G 9/3/2010

* 1950G 9/3/2010

* 1975G 9/3/2010

* 2000G 9/3/2010

* 2025G 9/3/2010

* 2050G 9/3/2010

* 2075G 9/3/2010

* 2100G 9/3/2010

15020018 Moenkopi Wash

*** 2350G 9/3/2010

* 2375G 9/3/2010

* 2400G 9/3/2010

* 2425G 9/3/2010

* 2450G 9/3/2010

* 2475G 9/3/2010

* 2500G 9/3/2010

* 2525G 9/3/2010

* 2550G 9/3/2010

NAVAJO COUNTY

*** 2850G 9/3/2010

* 2875G 9/3/2010

* 2900G 9/3/2010

* 2925G 9/3/2010

* 2950G 9/3/2010

* 2975G 9/3/2010

* 3000G 9/3/2010

* 3025G 9/3/2010

* 3050G 9/3/2010

HOPI INDIAN RESERVATION

HOPI INDIAN RESERVATION

*** 3375G 9/3/2010

*** 3400G 9/3/2010

* 3425G 9/3/2010

* 3450G 9/3/2010

* 3475G 9/3/2010

* 3500G 9/3/2010

* 3525G 9/3/2010

* 3550G 9/3/2010

* 3575G 9/3/2010

3900G 9/3/2010

*** 3925G 9/3/2010

* 3950G 9/3/2010

* 3975G 9/3/2010

* 4000G 9/3/2010

* 4025G 9/3/2010

* 4050G 9/3/2010

* 4075G 9/3/2010

* 4100G 9/3/2010

KAIBAB NATIONAL FOREST

15020016 Lower Little Colorado

15020017 Dinnebito Wash

4425G 9/3/2010

*** 4450G 9/3/2010

*** 4475G 9/3/2010

*** 4500G 9/3/2010

4525G 9/3/2010

* 4550G 9/3/2010

* 4575G 9/3/2010

* 4600G 9/3/2010

* 4625G 9/3/2010

15010004 Havasu Canyon

** 4950G 9/3/2010

*** 4975G 9/3/2010

*** 5000G 9/3/2010

5025G 9/3/2010

5050G 9/3/2010

* 5075G 9/3/2010

* 5100G 9/3/2010

* 5125G 9/3/2010

* 5150G 9/3/2010

15020012 Corn-Oraibi

NAVAJO NATION

COCONINO NATIONAL FOREST

COCONINO COUNTY 040019

WUPATKI NATIONAL MONUMENT

** 5475G 9/3/2010

** 5500G 9/3/2010

** 5525G 9/3/2010

*** 5550G 9/3/2010

5575G 9/3/2010

*** 5600G 9/3/2010

* 5625G 9/3/2010

* 5650G 9/3/2010

* 5675G 9/3/2010

15020013 Polacca Wash

COCONINO COUNTY 040019

1 in = 10 miles

N

0 2.5 5 10 15 20 Miles

Map Projection:
UTM Zone 12N
North American Datum 1983

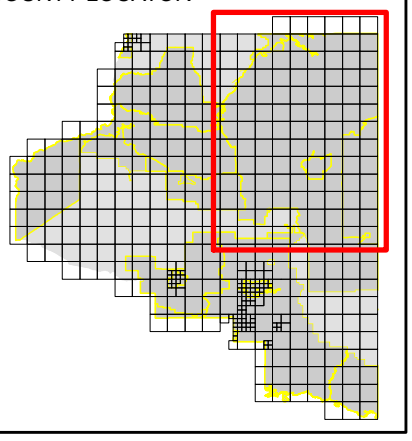
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

* Panel not printed - Area in Zone D
** Panel not printed - No special flood hazard areas
*** Panel not printed - Reservation in Zone D, Rest of panel in Zone X
**** Panel not printed - Prescott National Forest Zone D, Rest of panel in Zone X
***** Panel not printed - Apache-Sitgreaves Forest Zone D, Rest of panel in Zone X

COUNTY LOCATOR



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX (Sheet 2 of 3)

COCONINO COUNTY, ARIZONA And Incorporated Areas
PANELS PRINTED:

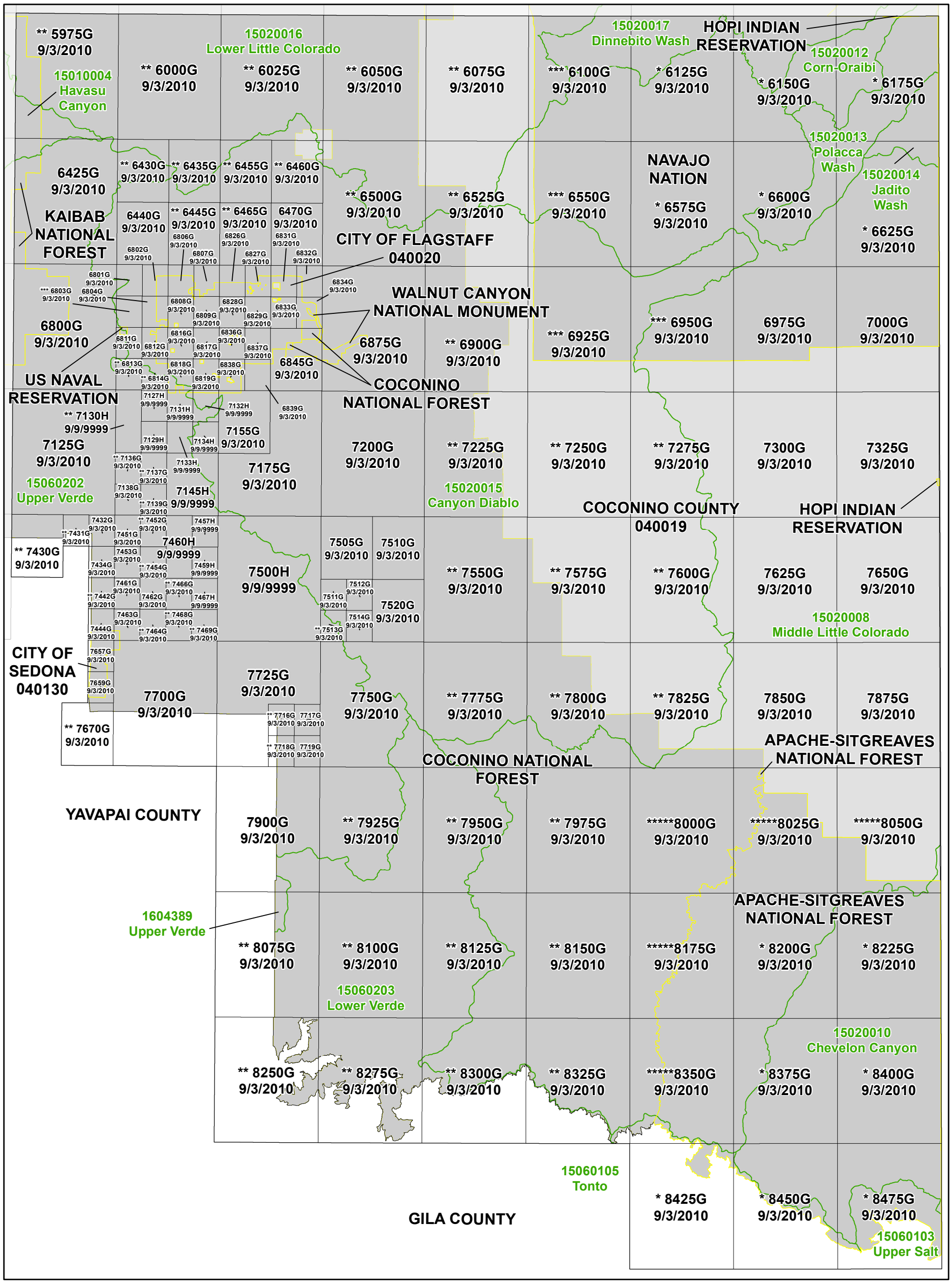
0350, 0375, 0400, 0725, 0750, 1100, 3900, 4425, 4525, 5025, 5050, 5575

PRELIMINARY
7/30/2015

FEMA

MAP NUMBER
04005CIND0B

MAP REVISED



1 in = 6 miles

0 2.5 5 10 15 Miles

Map Projection:
UTM Zone 12N
North American Datum 1983

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

* Panel not printed - Area in Zone D
** Panel not printed - No special flood hazard areas
*** Panel not printed - Reservation in Zone D, Rest of panel in Zone X
**** Panel not printed - Prescott National Forest Zone D, Rest of panel in Zone X
***** Panel not printed - Apache-Sitgreaves Forest Zone D, Rest of panel in Zone X

COUNTY LOCATOR

NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX (Sheet 3 of 3)

COCONINO COUNTY, ARIZONA And Incorporated Areas

PANELS PRINTED:

6425, 6440, 6470, 6800, 6801, 6802, 6804, 6806, 6807, 6808, 6809, 6811, 6812, 6816, 6817, 6818, 6819, 6826, 6827, 6828, 6829, 6831, 6832, 6833, 6834, 6836, 6837, 6838, 6839, 6845, 6875, 6975, 7000, 7125, 7127, 7129, 7131, 7132, 7133, 7134, 7138, 7145, 7155, 7175, 7200, 7300, 7325, 7432, 7434, 7444, 7451, 7453, 7457, 7459, 7460, 7461, 7462, 7463, 7467, 7500, 7505, 7510, 7511, 7512, 7514, 7520, 7625, 7650, 7657, 7659, 7700, 7717, 7719, 7725, 7750, 7850, 7875, 7900

PRELIMINARY
7/30/2015

FEMA

MAP NUMBER
04005CIND0B

MAP REVISED

Figure 2: FIRM Notes to Users

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

For community and countywide map dates, refer to Table 28 in this FIS Report.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

PRELIMINARY FIS REPORT: FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period, at the final Consultation Coordination Officer's meeting, or during the statutory 90-day appeal period. Approved requests for changes will be shown on the final printed FIRM.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

FLOODWAY INFORMATION: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.

FLOOD CONTROL STRUCTURE INFORMATION: Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 4.3 "Non-Levee Flood Protection Measures" of this FIS Report for information on flood control structures for this jurisdiction.

Figure 2. FIRM Notes to Users

PROJECTION INFORMATION: The projection used in the preparation of the map was Universal Transverse Mercator (UTM) Zone 12N. The horizontal datum was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

ELEVATION DATUM: Flood elevations on the FIRM are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

Local vertical monuments may have been used to create the map. To obtain current monument information, please contact the appropriate local community listed in Table 31 of this FIS Report.

BASE MAP INFORMATION: Base map information shown on this FIRM was derived from multiple sources. Digital orthoimagery was provided by the United States Department of Agriculture Farm Service Agency. This information was derived from orthophotography at a 1-meter resolution dated 2013. Vector base map files were provided by Coconino County Public Works and compiled in 2012. For information about base maps, refer to Section 6.2 “Base Map” in this FIS Report.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Figure 2. FIRM Notes to Users

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Coconino County, Arizona, corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 28 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.

SPECIAL NOTES FOR SPECIFIC FIRM PANELS

This Notes to Users section was created specifically for Coconino County, Arizona**,** effective **December 31, 9999.** This section is not applicable to this FIS project

FLOOD RISK REPORT: A Flood Risk Report (FRR) may be available for many of the flooding sources and communities referenced in this FIS Report. The FRR is provided to increase public awareness of flood risk by helping communities identify the areas within their jurisdictions that have the greatest risks. Although non-regulatory, the information provided within the FRR can assist communities in assessing and evaluating mitigation opportunities to reduce these risks. It can also be used by communities developing or updating flood risk mitigation plans. These plans allow communities to identify and evaluate opportunities to reduce potential loss of life and property. However, the FRR is not intended to be the final authoritative source of all flood risk data for a project area; rather, it should be used with other data sources to paint a comprehensive picture of flood risk.

Figure 3: Map Legend for FIRM

SPECIAL FLOOD HAZARD AREAS: *The 1% annual chance flood, also known as the base flood or 100-year flood, has a 1% chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1% annual chance flood. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. See note for specific types. If the floodway is too narrow to be shown, a note is shown.*

Special Flood Hazard Areas subject to inundation by the 1% annual chance flood (Zones A, AE, AH, AO, AR, A99, V and VE)

Zone A — The flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone.

Zone AE — The flood insurance rate zone that corresponds to the 1% annual chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone.

Zone AH — The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone.

Zone AO — The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the hydraulic analyses are shown within this zone.

Zone AR — The flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

Zone A99 — The flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or flood depths are shown within this zone.

Zone V — The flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this zone.

Zone VE — Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone.

Regulatory Floodway determined in Zone AE.

Figure 3: Map Legend for FIRM

OTHER AREAS OF FLOOD HAZARD

Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.

Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone.

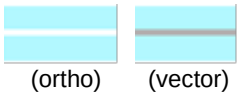
Area with Reduced Flood Risk due to Levee: Areas where an accredited levee, dike, or other flood control structure has reduced the flood risk from the 1% annual chance flood. See Notes to Users for important information.

OTHER AREAS

Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

Unshaded Zone X: Areas of minimal flood hazard.

FLOOD HAZARD AND OTHER BOUNDARY LINES



Flood Zone Boundary (white line on ortho-photography-based mapping; gray line on vector-based mapping)

Limit of Study

Jurisdiction Boundary

Limit of Moderate Wave Action (LiMWA): Indicates the inland limit of the area affected by waves greater than 1.5 feet

GENERAL STRUCTURES

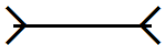
Aqueduct
Channel
Culvert
Storm Sewer

Channel, Culvert, Aqueduct, or Storm Sewer

Dam
Jetty
Weir

Dam, Jetty, Weir

Levee, Dike, or Floodwall

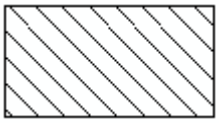


Bridge

Bridge

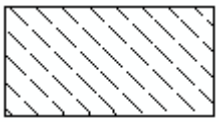
Figure 3: Map Legend for FIRM

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AND OTHERWISE PROTECTED AREAS (OPA): *CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.*



CBRS AREA
09/30/2009

Coastal Barrier Resources System Area: Labels are shown to clarify where this area shares a boundary with an incorporated area or overlaps with the floodway.



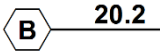
OTHERWISE PROTECTED AREA
09/30/2009

Otherwise Protected Area

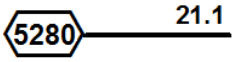
REFERENCE MARKERS

River mile Markers

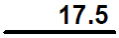
CROSS SECTION & TRANSECT INFORMATION



Lettered Cross Section with Regulatory Water Surface Elevation (BFE)



Numbered Cross Section with Regulatory Water Surface Elevation (BFE)

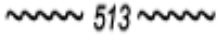


Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)

Coastal Transect

Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation.

Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping.



Base Flood Elevation Line

ZONE AE
(EL 16)

Static Base Flood Elevation value (shown under zone label)

ZONE AO
(DEPTH 2)

Zone designation with Depth

ZONE AO
(DEPTH 2)
(VEL 15 FPS)

Zone designation with Depth and Velocity

Figure 3: Map Legend for FIRM

BASE MAP FEATURES	
Missouri Creek	River, Stream or Other Hydrographic Feature
234	Interstate Highway
234	U.S. Highway
234	State Highway
234	County Highway
MAPLE LANE	Street, Road, Avenue Name, or Private Drive if shown on Flood Profile
RAILROAD	Railroad
	Horizontal Reference Grid Line
	Horizontal Reference Grid Ticks
+	Secondary Grid Crosshairs
Land Grant	Name of Land Grant
7	Section Number
R. 43 W. T. 22 N.	Range, Township Number
$^{42}76^{000m}E$	Horizontal Reference Grid Coordinates (UTM)
365000 FT	Horizontal Reference Grid Coordinates (State Plane)
80° 16’ 52.5”	Corner Coordinates (Latitude, Longitude)

SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS

2.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1% annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2% annual chance (500-year) flood is employed to indicate additional areas of flood hazard in the community.

Each flooding source included in the project scope has been studied and mapped using professional engineering and mapping methodologies that were agreed upon by FEMA and Coconino County as appropriate to the risk level. Flood risk is evaluated based on factors such as known flood hazards and projected impact on the built environment. Engineering analyses were performed for each studied flooding source to calculate its 1% annual chance flood elevations; elevations corresponding to other floods (e.g. 10-, 4-, 2-, 0.2-percent annual chance, etc.) may have also been computed for certain flooding sources. Engineering models and methods are described in detail in Section 5.0 of this FIS Report. The modeled elevations at cross sections were used to delineate the floodplain boundaries on the FIRM; between cross sections, the boundaries were interpolated using elevation data from various sources. More information on specific mapping methods is provided in Section 6.0 of this FIS Report.

Depending on the accuracy of available topographic data (Table 23), study methodologies employed (Section 5.0), and flood risk, certain flooding sources may be mapped to show both the 1% and 0.2% annual chance floodplain boundaries, regulatory water surface elevations (BFEs), and/or a regulatory floodway. Similarly, other flooding sources may be mapped to show only the 1% annual chance floodplain boundary on the FIRM, without published water surface elevations. In cases where the 1% and 0.2% annual chance floodplain boundaries are close together, only the 1% annual chance floodplain boundary is shown on the FIRM. Figure 3, "Map Legend for FIRM", describes the flood zones that are used on the FIRMs to account for the varying levels of flood risk that exist along flooding sources within the project area. Table 2 and Table 3 indicate the flood zone designations for each flooding source and each community within Coconino County, Arizona, respectively.

Table 2, "Flooding Sources Included in this FIS Report," lists each flooding source, including its study limits, affected communities, mapped zone on the FIRM, and the completion date of its engineering analysis from which the flood elevations on the FIRM and in the FIS Report were derived. Descriptions and dates for the latest hydrologic and hydraulic analyses of the flooding sources are shown in Table 13. Floodplain boundaries for these flooding sources are shown on the FIRM (published separately) using the symbology described in Figure 3. On the map, the 1% annual chance floodplain corresponds to the SFHAs. The 0.2% annual chance floodplain shows areas that, although out of the regulatory floodplain, are still subject to flood hazards.

Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data. The procedures to remove these areas from the SFHA are described in Section 6.5 of this FIS Report.

2.2 Floodways

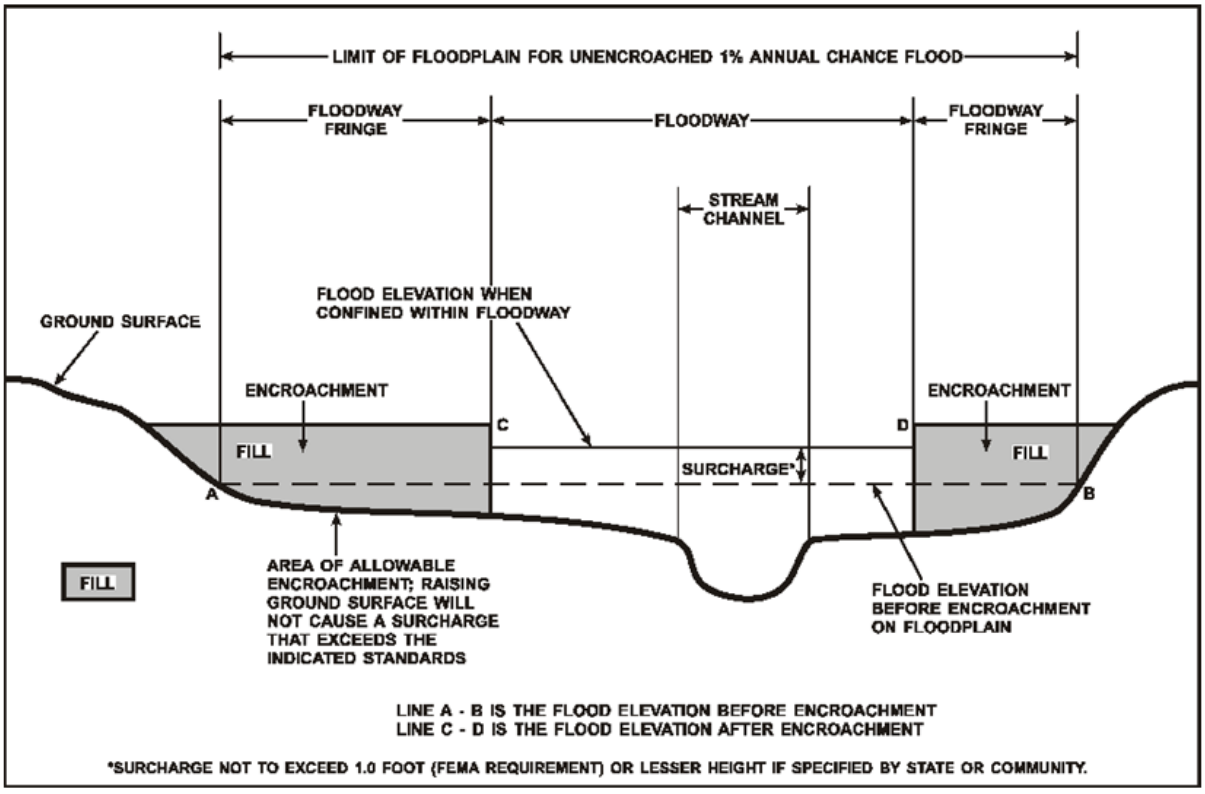
Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the

encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard.

For purposes of the NFIP, a floodway is used as a tool to assist local communities in balancing floodplain development against increasing flood hazard. With this approach, the area of the 1% annual chance floodplain on a river is divided into a floodway and a floodway fringe based on hydraulic modeling. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment in order to carry the 1% annual chance flood. The floodway fringe is the area between the floodway and the 1% annual chance floodplain boundaries where encroachment is permitted. The floodway must be wide enough so that the floodway fringe could be completely obstructed without increasing the water surface elevation of the 1% annual chance flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.

To participate in the NFIP, Federal regulations require communities to limit increases caused by encroachment to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this project are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway projects.

Figure 4: Floodway Schematic



Floodway widths presented in this FIS Report and on the FIRM were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. For certain stream segments, floodways were adjusted so that the amount of floodwaters conveyed on each side of the

floodplain would be reduced equally. The results of the floodway computations have been tabulated for selected cross sections and are shown in Table 24, “Floodway Data.”

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Baderville Tributary to Rio de Flag	Coconino County Unincorporated Areas	Confluence with Rio de Flag	Approximately 0.2 miles south of Hashknife Trail Road	15020015	1.7		Y	AE	1/1981
Bow and Arrow Wash	City of Flagstaff	Approximately 1,800 feet upstream of Lake Mary Road	South Lone Tree Road crossing	15020015	3.5		Y	AE	4/2004
Cataract Creek	City of Williams	Approximately 0.36 miles north of US Interstate 40	0.5 miles upstream Santa Fe Reservoir dam	15010004	3		Y	AE	3/1981
Cataract Creek Tributary	City of Williams	Confluence with Cataract Creek	City Reservoir	15010004	0.9		Y	AE	3/1981
Cemetary Wash	City of Williams	US Interstate 40	Approximately 0.12 miles west of City of Williams	15010004	0.8		Y	AE	3/1981
Clay Avenue Wash (Rio de Flag confluence)	City of Flagstaff	0.3 mile upstream from confluence with Rio de Flag	0.925 mile upstream from confluence with Rio de Flag	15020015	0.625		Y	AE	4/2004
Clay Avenue Wash	City of Flagstaff	Intersection of West Clay Avenue and Interstate 40 Business	Forest Service Road 506	15020015	2		Y	AE	3/1/1995

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Clay Avenue Wash Split Flow	City of Flagstaff	Confluence with Clay Avenue Wash approximately 125 feet downstream of W. Shellie Dr.	Confluence with Clay Avenue Wash approximately 750 feet upstream of W. Shellie Dr.	15020015	0.2		N	AE	1/1981
Country Club Wash	City of Flagstaff	Confluence with Rio de Flag	Golf course pond north side of East Mt. Pleasant Drive	15020015	1.1		Y	AE	1/1981
Detention Basin	City of Flagstaff	S Wild West Trail	Approximately 0.2 miles upstream from S Wild West Trail.	15020015		0.009	N	AE	1/1981
Dewey Grade Wash	Coconino County Unincorporated Areas	Confluence with Pumphouse Wash	South Old Munds Highway	15060202			Y	AE	11/2012
Fanning Drive Wash	City of Flagstaff	Confluence with Rio de Flag	Approximately 140 feet north east of Skyline Dr. and Forest Brook St.	15020015	2.1		Y	AE	9/30/1995
Gravesite Wash	Coconino County Unincorporated Areas	Confluence with Pumphouse Wash	Mountainaire Road	15060202			Y	AE	11/2012
Harrenburg Wash	Coconino County Unincorporated Areas	Confluence with Pumphouse Wash	Approximately 1,400 feet above the confluence with Pumphouse Wash	15060202	0.27		Y	AE	11/2012

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Howard Draw Wash	Coconino County Unincorporated Areas	Lower Lake Mary	Intersection of Forest Service Road 235 and Crimson Road	15020015	2		Y	AE	1/1981
Kanab Creek	Town of Fredonia	Approximately 0.2 miles north east of Rt. 89A and Cowboy Dr.	Approximately 0.3 miles north east of Rt. 89A and Cowboy Dr.	15010003	0.2		Y	AE	3/1981
Mormon Lake	Coconino County Unincorporated Areas	Northern Intersection of Mormon Lake Road and Country Road 3.	Southern Intersection of Mormon Lake Road and Country Road 3.	15020015		4.83	N	A	1/1981
Mountainaire Wash	Coconino County Unincorporated Areas	Confluence with Schoolhouse Draw	Approximately 1.1 miles above the confluence with Schoolhouse Draw	15060202	1.1		Y	AE	11/2012
Munds Canyon Creek	Coconino County Unincorporated Areas	Confluence with Oak Creek	Eastern end of Thompson Road	15060202	0.5		Y	AE	1981
Munds Park Wash	Coconino County Unincorporated Areas	Interstate 17	Approximately 0.95 miles upstream from E. Pinewood Blvd.	15060202	2.5		Y	AE	9/2012
Munds Park Wash Right Overbank	Coconino County Unincorporated Areas	Odell Lake	E. Pinewood Blvd	15060202	0.37		N	AE	9/2012

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Munds Park Wash West	Coconino County Unincorporated Areas	Confluence with Munds Park Wash	Interstate 17	15060202	2.7		N	AE	9/2012
Oak Creek	City of Sedona, Coconino County Unincorporated Areas	Approximately 0.5 miles north of Grasshopper Point	Oak Creek Terrace Resort along Rt. 89A	15060202	11.8		Y	AE	9/30/1988
O'Neil Springs Wash	Coconino County Unincorporated Areas	Confluence with Pumphouse Wash	Approximately 2,800 feet above the confluence with Pumphouse Wash	15060202	0.53		Y	AE	11/2012
O'Neil Tank Wash	Coconino County Unincorporated Areas	Confluence with Pumphouse Wash	Approximately 1,200 feet above the confluence with Pumphouse Wash	15060202	0.23		Y	AE	11/2012
Peaceful Valley Wash	City of Flagstaff	Confluence with Rio de Flag	Approximately 1.5 miles east of the south end of Lake Elaine	15020015	2.2		Y	AE	1/1981
Peak View Wash	City of Flagstaff	Approximately 130 feet downstream of Cooper Drive	Approximately 120 feet upstream of Lois Lane	15020015	0.2		Y	AE	4/2004
Penstock Avenue Wash	City of Flagstaff	Railhead Ave.	Smokerise Dr.	15020015	0.5		Y	AE	9/5/1995

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Pumphouse Wash	Coconino County Unincorporated Areas	Effective Zone A limits, approximately 2.8 miles downstream of Interstate 17	Effective Zone A limits, approximately 1.9 miles upstream of Interstate 17	15060202	4.7		Y	AE	11/2012
Rio de Flag (upstream study)	City of Flagstaff, Coconino County Unincorporated Areas	Narrows Dam	Approximately 500 feet downstream of the Hidden Hollow Road crossing	15020015	1.2		Y	AE	12/2008
Rio de Flag (downstream study)	City of Flagstaff, Coconino County Unincorporated Areas	Rio Ranch Road crossing	Route 66	15020015	15.1		Y	AE	12/2008
Rio de Flag Split Flow	City of Flagstaff	Confluence with Rio de Flag at N. Bonito St.	Confluence with Rio de Flag near N. Thorpe Road	15020015	0.2		Y	AE	1/1981
Santa Fe Wash East	City of Williams	Approximately 0.36 miles north of US Interstate 40	Rt. 66	15010004	1.9		Y	AE	3/1981
Santa Fe Wash West	City of Williams	Approximately 0.36 miles north of US Interstate 40	North Grand Canyon Blvd.	15010004	1.6		Y	AE	3/1981

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Schoolhouse Draw	Coconino County Unincorporated Areas	Confluence with Pumphouse Wash	Approximately 2.2 miles above the confluence with Pumphouse Wash	15060202	2.2		Y	AE	11/2012
Schultz Creek	City of Flagstaff, Coconino County Unincorporated Areas	Approximately 2,000 feet downstream of the Fort Valley Road crossing	Shultz Pass Road	15020015	1.4		Y	AE, AO	4/2004
Sinclair Wash	City of Flagstaff, Coconino County Unincorporated Areas	Confluence with Rio de Flag	Approximately 0.14 miles west of Constitution Blvd.	15020015	3.5		Y	AE	1/1981
Soldier Wash	City of Sedona	Confluence with Oak Creek	Approximately 100 feet south of Rt. 89A	15060202	0.6		Y	AE	1981
Spruce Avenue Wash	City of Flagstaff	North of Walmart on Huntington Dr.	Approximately 0.13 miles north of crossing the Arizona National Scenic Trail	15020015	2		Y	AE	1/1981
Stoneman Lake	Coconino County Unincorporated Areas	Stoneman Lake Road	Lake View Ct.	15060202		0.24	N	AE	3/1981

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Switzer Canyon Wash	City of Flagstaff, Coconino County Unincorporated Areas	East Route 66 crossing	Approximately 2,800 feet upstream of San Francisco Street crossing	15020015	4.9		Y	AE, AH	4/2004
Tributary 1 To Baderville Tributary	Coconino County Unincorporated Areas	Confluence with Baderville Tributary	Approximately 275 feet west of N. Hadrians Walk	15020015	0.5		Y	AE	1/1981
Tributary 2 To Baderville Tributary	Coconino County Unincorporated Areas	Confluence with Baderville Tributary	Approximately 75 feet north of N. Galloway Trail	15020015	0.3		Y	AE	1/1981
Unnamed Wash	City of Flagstaff	W. High Country Trail	Detention Basin	15020015	0.4		Y	AE	1/1981
Unnamed Wash 1	Coconino County Unincorporated Areas	Confluence with Munds Park Wash West	Approximately 200 upstream from NF-94620	15060202	2.4		Y	AE	9/2012
West Street Wash	City of Flagstaff	6^{th} Ave.	Approximately 0.12 miles east of Cedar Ave.	15020015	0.4		N	AE	1/1981
Unnamed Streams, Tucker Flat Wash, Schoolhouse Draw, Pumphouse Wash, Wildcat Canyon Creek, Rio de Flag, Cataract Creek	Coconino County Unincorporated Areas, City of Flagstaff, City of Williams	Not Provided	Not Provided	15010004, 15020015, 15060202,	Not Provided		N	A	4/2008

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Various Streams within Coconino County	Coconino County, Havasupai Indian Reservation, City of Sedona, Town of Tusayan	Not Provided	Not Provided	14070006, 14070007, 17080205, 15010001, 15010002, 15010003, 15010004, 15010007, 15020008, 15020010, 15020012, 15020013, 15020014, 15020015, 15020016, 15020017, 15020018, 15060103, 15060105, 15060201, 15060202, 15060203	Not Provided		N	A	1/1981
Various Streams within the City of Flagstaff	City of Flagstaff	Not Provided	Not Provided	15020015, 15060202	Not Providied		N	A	1/1981
Various Streams within the Town of Fredonia	Town of Fredonia	Not Provided	Not Provided	15010003	Not Providied		N	A	3/1981
Various Streams within the City of Williams	City of Williams	Not Provided	Not Provided	15010004, 15060201, 15060202	Not Providied		N	A	3/1981

All floodways that were developed for this Flood Risk Project are shown on the FIRM using the symbology described in Figure 3. In cases where the floodway and l% annual chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown on the FIRM. For information about the delineation of floodways on the FIRM, refer to Section 6.3.

2.3 Base Flood Elevations

The hydraulic characteristics of flooding sources were analyzed to provide estimates of the elevations of floods of the selected recurrence intervals. The Base Flood Elevation (BFE) is the elevation of the 1% annual chance flood. These BFEs are most commonly rounded to the whole foot, as shown on the FIRM, but in certain circumstances or locations they may be rounded to 0.1 foot. Cross section lines shown on the FIRM may also be labeled with the BFE rounded to 0.1 foot. Whole-foot BFEs derived from engineering analyses that apply to coastal areas, areas of ponding, or other static areas with little elevation change may also be shown at selected intervals on the FIRM.

Cross sections with BFEs shown on the FIRM correspond to the cross sections shown in the Floodway Data table and Flood Profiles in this FIS Report. BFEs are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM.

2.4 Non-Encroachment Zones

Some States and communities use non-encroachment zones to manage floodplain development. For flooding sources with medium flood risk, field surveys are often not collected and surveyed bridge and culvert geometry is not developed. Standard hydrologic and hydraulic analyses are still performed to determine BFEs in these areas. However, floodways are not typically determined, since specific channel profiles are not developed. To assist communities with managing floodplain development in these areas, a “non-encroachment zone” may be provided. While not a FEMA designated floodway, the non-encroachment zone represents that area around the stream that should be reserved to convey the 1% annual chance flood event. As with a floodway, all surcharges must fall within the acceptable range in the non-encroachment zone.

General setbacks can be used in areas of lower risk (e.g. unnumbered Zone A), but these are not considered sufficient where unnumbered Zone A is replaced by Zone AE. The NFIP requires communities to ensure that any development in a non-encroachment area causes no increase in BFEs. Communities must generally prohibit development within the area defined by the non-encroachment width to meet the NFIP requirement.

Non-encroachment determinations may be delineated where it is not possible to delineate floodways because specific channel profiles with bridge and culvert geometry were not developed. Any non-encroachment determinations for this Flood Risk Project have been tabulated for selected cross sections and are shown in Table 25, “Flood Hazard and Non-Encroachment Data for Selected Streams.” Areas for which non-encroachment zones are provided show BFEs and the 1% annual chance floodplain boundaries mapped as zone AE on the FIRM but no floodways.

2.5 Coastal Flood Hazard Areas

This section is not applicable to this Flood Risk Project.

2.5.1 Water Elevations and the Effects of Waves

This section is not applicable to this Flood Risk Project.

Figure 5: Wave Runup Transect Schematic

[Not Applicable to this Flood Risk Project.]

2.5.2 Floodplain Boundaries and BFEs for Coastal Areas

This section is not applicable to this Flood Risk Project.

2.5.3 Coastal High Hazard Areas

This section is not applicable to this Flood Risk Project.

Figure 6: Coastal Transect Schematic

[Not Applicable to this Flood Risk Project.]

2.5.4 Limit of Moderate Wave Action

This section is not applicable to this Flood Risk Project.

SECTION 3.0 – INSURANCE APPLICATIONS

3.1 National Flood Insurance Program Insurance Zones

For flood insurance applications, the FIRM designates flood insurance rate zones as described in Figure 3, "Map Legend for FIRM." Flood insurance zone designations are assigned to flooding sources based on the results of the hydraulic or coastal analyses. Insurance agents use the zones shown on the FIRM and depths and base flood elevations in this FIS Report in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

The 1% annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (e.g. Zones A, AE, V, VE, etc.), and the 0.2% annual chance floodplain boundary corresponds to the boundary of areas of additional flood hazards.

Table 3 lists the flood insurance zones in the unincorporated and incorporated areas of Coconino County.

Table 3: Flood Zone Designations by Community

Community	Flood Zone(s)
Coconino County, Unincorporated Areas	A, AE, AO, X
Flagstaff, City of	A, AE, AH, AO, X
Fredonia, Town of	A, AE, X
Havasupai Indian Reservation	A, X
Page, City of	AE, X
Sedona, City of	A, AE, X
Tusayan, Town of	A, X
Williams, City of	A, AE, AH, AO, X

3.2 Coastal Barrier Resources System

This section is not applicable to this Flood Risk Project.

Table 4: Coastal Barrier Resources System Information

[Not Applicable to this Flood Risk Project.]

SECTION 4.0 – AREA STUDIED

4.1 Basin Description

Table 5 contains a description of the characteristics of the HUC-8 sub-basins within which each community falls. The table includes the main flooding sources within each basin, a brief description of the basin, and its drainage area.

Table 5: Basin Characteristics

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Lower Colorado-Marble Canyon	15010001	Colorado River	Contains ~7.9% of the county area in the northern third of the county. The HUC8 is entirely contained within the county and encompasses only unincorporated areas.	1467

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Grand Canyon	15010002	Colorado River	Contains ~7.3% of the county area along the western edge. The HUC8 encompasses unincorporated areas and a small portion of the Havasupai Indian Reservation. Flood hazards have not been studied in this HUC8 within Coconico County.	2551
Havasu Canyon	15010004	Havasu Creek	Contains ~15.7% of the county area within the middle of the county. This HUC8 is the largest watershed within the county and is contained entirely within the county. This HUC8 encompasses mostly unincorprated areas as well as most of the Havaupai Indian Reservation and most of the City of Williams.	2932
Red Lake	15010007	Truxton Wash	Contains ~0.25% of the county area along the western edge, encompassing unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	1415
Middle Little Colorado	15020008	Little Colorado River	Contains ~8.0% of the county area in the southern third of the county. Encompasses only unincorporated areas.	2522
Chevelon Canyon	15020010	Pierce Wash	Contains ~1.3% of the county area along the southern tip of the county. Encompasses only unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	819
Corn-Oraibi	15020012	Oraibi Wash	Contains ~0.60% % of the county area along the eastern edge, encompassing unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	731
Polacca Wash	15020013	Polacca Wash	Contains ~0.34% % of the county area along the eastern edge, encompassing unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	1155

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Jadito Wash	15020014	Jadito Wash	Contains ~0.08% % of the county area along the eastern edge, encompassing unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	938
Canyon Diablo	15020015	San Franscisco Wash	Contains ~6.4% of the county area in the southern third of the county. This HUC8 is entirely contained within the county and includes almost all of the City of Flagstaff as well as unincorporated areas.	1198
Lower Little Colorado	15020016	Little Colorado River	Contains ~12.83% of the county area in the center of the county. This HUC8 is second largest watershed in the county and is entirely contained within the county. This HUC8 only encompasses unincorporated areas.	2392
Dinnebito Wash	15020017	Dinnebito Wash	Contains ~2.5% of the county area along the eastern edge, encompassing unincorprated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	818
Moenkopi Wash	15020018	Moenkopi Wash	Contains ~9.5% of the county area in the northeastern portion of the county. It is the third largest HUC8 within the county and encompasses only unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	2649
Upper Salt	15060103	Salt River	Contains ~0.09% % of the county area along the southern edge, encom areas county. Flood hazards have not been studied in this HUC8 within Coconico County.	2152
Tonto	15060105	Tonto Creek	Contains ~0.06% % of the county area along the southern edge, encompassing unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	1047

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Big Chino-Williamson Valley	15060201	Big Chino Wash	Contains ~4.9% of the county area along the western edge of the county. Contains mostly unincrporated areas but also includes a small portion of the City of Williams.	2153
Upper Verde	15060202	Verde River	Contains ~5.8% of the county area along the south western edge of the county. Contains mostly unincorporated areas and all of the City of Sedona. Also contains portions of the City of Williams and the City of Flagstaff.	2506
Lower Lake Powell	14070006	Colorado River	Contains ~7.5% of the county area along the northeastern corner of the county. The HUC8 encompasses mostly unincorporated areas as well as the entire City of Page.	2934
Paria	14070007	Paria River	Contains ~2.0% of the county area along the northern edge., encompassing only unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	1418
Lower San Juan	14080205	San Juan River	Contains ~0.24% % of the county area along the northeastern corner, encompassing unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	2437
Kanab	15010003	Kanab Creek	Contains ~5.3% of the county area along the northwestern corner, encompassing mostly unincorporated areas as well as the entire Town of Fredonia.	2362
Lower Verde	15060203	Verde River	Contains ~1.4% of the county area along the southern edge, encompassing only unincorporated areas. Flood hazards have not been studied in this HUC8 within Coconico County.	1965

4.2 Principal Flood Problems

Table 6 contains a description of the principal flood problems that have been noted for Coconino County by flooding source.

Table 6: Principal Flood Problems

Flooding Source	Description of Flood Problems
Cataract Creek	The history of flooding in the City of Williams area indicates that constrictive hydraulic structures are a major contributing factor to flooding. Floodflows, backed up by constrictive hydraulic structures at road crossings, spread into the floodplain areas and in some instances flow overland into other washes. The overland floodflows are generally shallow, causing low-lying structures to be inundated by flows less than one foot deep. The flood of December 1978 was caused by rainfall on the snow-covered mountains above the City of Williams. Floodflows on Cataract Creek backed up at 5th Street, causing weir flow over 5th Street. This flow went overland, crossing at 2nd Street and the Burlington Northern & Santa Fe Railway. Flow also broke out on Cataract Creek at Edison Avenue, causing shallow flooding east to 2nd Street. This flood was estimated to have been approximately a 75-year flood.
Howard Draw Wash	Flooding has occurred on Howard Draw Wash in 1993, 1995, and 2004 affecting the subdivisions of Lake Mary Park and Lake Mary Meadows. High-water elevations on Lower Lake Mary in May 1980 ponded into the lower areas of Howard Draw Wash, inundating some roads and driveways, and making access difficult to some homes.
Kanab Creek	In the Town of Fredonia, floods on Kanab Creek are caused by snowmelt and rain on snow during the spring, and heavy rains in July and August. The first great flood on Kanab Creek to do appreciable damage occurred on July 29, 1883. It flooded all the farmlands and meadowlands in the canyon near Kanab, along with all the field crops south of the village, and scoured out a broad channel below the former valley floodplain. In 1884 and 1885, the flooding occurred daily for 3 or 4 weeks, continuing the erosion of the channel. As a result of these 3 years of floods, the streambed was cut down approximately 70 feet for a distance of 15 miles downstream of Kanab. Since 1886, the trenching action has continued, extending upward to the extreme headwaters of Kanab Creek and throughout its tributaries (USBR, 1974). In 1890, an irrigation dam was built at the site of the present irrigation dam in the Town of Fredonia. That dam was washed away before it was completed. Another dam was completed in about 1892 and served until 1909. In that year, it was also washed away by a tremendous flood. The existing irrigation dam was completed a couple of years later (USBR, 1974). There is no documented history of flooding since 1909. No recurrence interval of stage-discharge information for the Town of Fredonia have been established for the past floods. Recurrence intervals on past floods have not been estimated because of the large amount of erosion and deposition associated with the flooding of this stream.
Mormon Lake	History of water-surface elevations and flooding from Mormon Lake indicates a wide range of water levels. Mormon Lake has been dry on numerous occasions through the years. In 1927, a peninsula on the southwest comer of Mormon Lake became an island due to high water. The saddle of this peninsula has been checked to be an approximate elevation of 7,118 feet NA VD. This was the highest water level ever reached according to long-time residents of the area. The water level has fluctuated between these extremes through the years, with USGS topographic maps (USGS, 1965) giving an

Flooding Source	Description of Flood Problems
	elevation of 7,110 feet NAVD for the lake. Flood damages due to high water levels appear to have been slight in the past on Mormon Lake.
Munds Park Wash	History of flooding in the Munds Park Wash area is limited. However, as recently as December 2004, the golf course at Pinewood Country Club and adjacent residences were inundated by significant flooding. Flooding in 1979 at the Mormon Lake Road crossing spread to the west and caused shallow flooding in a small development before returning to Odell Lake. The Mormon Lake Road crossing has been changed from a dip section to a bridge, thus changing the potential for flooding at this site. Also, during flooding in 1979, the spillway on Odell Lake was washed out, causing flooding of the sparsely populated golf course area downstream. This spillway was rebuilt after the flooding in 1979.
Oak Creek	In Coconino County, in the City of Sedona, Oak Creek has flooded many times in past years. Significant flood flows occurred in the following years as recorded at the USGS gage station at Cornville: 1885, 1938, 1952, 1956, 1964, 1967, 1969, 1970, 1976, 1978, 1979, 1980, 1993, 1995, and 2004. In the flooding of 1980, the discharge measured at the Cornville gage station was 18,000 cubic feet per second (cfs) on February 15 and 25,000 cfs on February 19. These floods were estimated by the study contractor to have had approximately a 2-percent annual chance (50-year) recurrence interval in the vicinity of the City of Sedona. Damage due to flooding has been mostly in the form of erosion and, therefore, loss of land.
Rio de Flag	Significant flooding occurred in the upper reaches of the Rio de Flag in December 2004 affecting the unincorporated community of Fort Valley. Additionally, significant floodflows occurred on Rio de Flag in the following years: 1888, 1896, 1903, 1905, 1916, 1920, 1923, 1937, 1938, 1950, 1963, 1966, and 1973. Although some documentation exists for these floods, the descriptions are limited to flooding within the City of Flagstaff Due to light development in these areas at that time, damages were probably limited to erosion and loss of land.
Rio de Flag and associated streams within the City of Flagstaff	The past history of flooding within the City of Flagstaff indicates that flooding may occur during any season of the year. Three types of storms produce precipitation in the area: general winter storms, general summer storms, and local storms. Summer storms normally are high-intensity, short-duration local storms, but severe, general summer storms, usually associated with tropical cyclones, also occur. General winter storms cover large areas and are usually of long duration. Their intensities are normally light to moderate. Because climatic and drainage area characteristics are not conducive to continuous runoff, streamflow only occurs during and after rainfall and during periods of snowmelt. In areas of high permeability, as in the northern part of the drainage basin, little runoff occurs even from heavy rains. The following is a list of descriptions of known floods. The sources of these descriptions are newspaper accounts, railroad records, museum publications, U.S. Soil Conservation Service reports, and Flagstaff city officials (USACE-Los Angeles, 1975). November 1888 – Flood was caused by intense rainfall of less than 1-day duration. It was during this flood that the “Bottomless Pits” opened up on the surface. A newspaper article in 1903 calls 1888 the largest flood to have

Flooding Source	Description of Flood Problems
	occurred. Water extended from old Hotel Weatherford to the school and was said to be “deep enough for a horse to swim.” There may have been another flood, equally serious, in August 1888. July 1896 – Following heavy rain of short duration, the river overflowed its banks in many places within the City of Flagstaff, finding its old channel where the stream enters the city. South of the city, flat areas were covered with water. April 1903 – Melting snow and falling rain caused the river to overflow its banks and take its former course through the City of Flagstaff When the river reached its highest stage, that portion of the city lying between Leroux and Sitgreaves Streets, in the flat part of the city just north of the railroad tracks, was under 1 to 15 inches of water. The area of Coconino County south of the tracks and west of the stream was flooded. Since 1896, the river has had little water flowing in it. November 1905 – There was no mention of flooding in November or any other time of the year. The month of November, however, was the wettest month on record, to 1905. It rained 7.10 inches, which is 4.88 inches above average for the month of November. U.S. Weather Bureau records indicate 3.91 inches of rain fell between November 11 and November 27. January 1916 – Several days of snow and rain caused the river to run full, threatening to overflow in places. However, a freezing period retarded runoff from snowmelt enough to prevent damage. There had never been such a snowfall followed by steady rains, according to the oldest resident. The U.S. Weather Bureau measured 54 inches of snow in January, with an estimated 12 inches total water equivalent of snow and rainfall. February 1920 – A 3-day rain, falling on already saturated soil, resulted in flooding not equaled in the previous 25 years. The river overflowed its banks and converted the area south of the city into a sizable lake. In the Bottomless Pits area, water was said to be 30 feet deep, but this was probably an exaggeration. Railroad records give a high-water elevation of 6,765.3 feet NAVD, indicating a depth of approximately 19 feet. Flow in the Bottomless Pits area was augmented by runoff from Slaughter House, Switzer, and several other smaller canyons. Runoff could have been greater had it not snowed in Fort Valley. Precipitation in the City of Flagstaffwas reported to be 1.85 inches. September 1923 – Nearly 3 days of hard rain caused the river to overflow its banks and flood more than one-third of the city, forming a lake that covered almost all the south side and extended to the east for several miles. Railroad records give a higher water elevation in the Bottomless Pits area of 6,762 feet NAVD. Precipitation in the City of Flagstaff was reported to be 2.12 inches. April 1937 – The river, through the city, was near or at channel capacity for several days because of melting snow. This was the first time since 1923 that floodwaters flowed into the Bottomless Pits. The water-surface elevation in the Bottomless Pits area is not known. March 1938 - Continuous rain falling on melting snow forced the river far over its banks at some points, and floodwaters lapped the floodbeams of several bridges. Much of the south side was under water. March 1950 – Rain and snowmelt caused the river to flow bankfull from Park

Flooding Source	Description of Flood Problems
	Lake to O'Leary Street. There was little, if any, overflow. August 1963 – An intense thunderstorm occurred on August 2, dumping 1.71 inches on the City of Flagstaff in 1 hour. One-half inch is said to have fallen in 5 minutes. Although the river was approximately 3 feet deep just north of the railroad tracks and lacked some 2 feet of overflowing, serious local flooding occurred in the vicinity of Aspen and Beaver Streets. March 1966 – Snowmelt flood. Elevation of high-water mark in Bottomless Pits area was 6,756 feet NAVD. April 1973 – Snowmelt flood. The river flowed bank-full for several days. No overflow. High-water elevation of 6,754.8 feet NAVD was estimated by a consultant to the city. The USGS measured a peak of 23 5 cfs at their staff gage north of the city. Flooding problems are aggravated by natural obstructions to floodflows including brush, trees, and other vegetation growing along the streambanks in the floodplain. These obstructions impede the flow of floodwaters, causing backwater and increased floodwater depths. Also, debris, such as brush, trees, and manmade objects, can be carried along by the floodwaters and possibly block bridge or culvert crossings. This debris is capable of causing a reduction in flow through the structure resulting in a higher backwater condition and increased floodwater depths. Many of the study areas in the City of Flagstaff consist of a small-capacity channel with many crossings and heavily developed floodplains. In such places, floodwater easily exceeds the capacity of the main flow channel and overflows into the floodplains where it is further impeded by the heavy development.
Stoneman Lake	History of water-surface elevations and flooding from Stoneman Lake indicates a wide range of water levels. Stoneman Lake has also been dry or near dry on numerous occasions through its history. According to long-time residents of the area, the lake was at a record high elevation in the spring of 1980. The level was recorded at 6,733.4 feet NAVD on May 2, 1980. The lake level rose slightly after that. The USGS topographic maps (USGS, 1965) report a water-surface elevation of 6, 720 feet NAVD for the lake. Flood damages on Stoneman Lake have been in the form of inundation of land.
Various flooding sources	Significant flood events have affected several unincorporated communities in Coconino County in recent years, most notably 1993, 1995, and 2004. Affected communities include Fort Valley, Kachina Village, Mountain Dell, Pine Del, Munds Park, and Oak Creek Canyon.

Table 7 contains information about historic flood elevations in the communities within Coconino County.

Table 7: Historic Flooding Elevations

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Rio de Flag	Bottemless Pits area	6,765.3	February 1920	N/A	Railroad records
Rio de Flag	Bottemless Pits area	6,762	September 1923	N/A	Railroad records
Rio de Flag	Bottemless Pits area	6,756	March 1966	N/A	High-water mark
Rio de Flag	N/A	6,754.8	April 1973	N/A	Flagstaff consultant

4.3 Non-Levee Flood Protection Measures

Table 8 contains information about non-levee flood protection measures within Coconino County such as dams, jetties, and or dikes. Levees are addressed in Section 4.4 of this FIS Report.

Table 8: Non-Levee Flood Protection Measures

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Cataract Creek	N/A	Breaching street crossings	Along the upper Cataract Creek	Floodplain management measures used in the past to reduce potential flood damages consisted of breaching street crossings on upper Cataract Creek to increase the capacity of the wash.
Cataract Creek	Embankment ID #20	Leveel like embankment	Within the City of Williams	A shallow levee like embankment structure was constructed along Cataract Creek.
City Park Reservoir	City Park Reservoir	Reservoir	South of the City of Williams	City Park Reservoir was considered in the Coconino County FIS; however, due to the small size and storage capabilities of the dam, the flood protection provided by the dam is limited.
Kanab Creek	N/A	Berm	Town of Fredonia, east side of Kanab Creek from the irrigation dam upstream to around the area east of McKinney Street	This berm provides flood protection by containing the 1-percent annual chance flood to Kanab Creek, thereby minimizing flooding between U.S. Alternate Highway 89 and Kanab Creek below McKinney Street.
Kanab Creek	Flood Retarding Structure and Diversion Channel	Retarding structure and diversion channel	Northeast of the Town of Frediona	Constructed by the U.S. Soil Conservation Service in the early 1970s northeast of town. The Flood Retarding Structure will retain the 1-percent annual chance flood originating from alluvial flooding from northeast of town. The Diversion Channel has a 100 cfs release rate.
Munds Park Wash	Odell Dam	Small, earth filled dam	Immediately upstream of Pinewood Country Club	A small, earthen dam with a concrete spillway creating Odell Lake, but its effect in reducing potential flood damage is minimal.

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Munds Park Wash	N/A	Bridge	Intersection of Mormon Lake Road and Munds Park Wash	A bridge has been built at to replace a dip-section. This bridge will reduce flooding potential in a development southwest of the intersection.
Oak Creek	N/A	Small dikes and riprapped embankments	Along Oak Creek in Coconino County	Several small dikes and riprapped embankments have been constructed by private landowners along Oak Creek in Coconino County to protect their property from inundation and erosion during floods.
Rio de Flag	Embankment ID #14	Levee like embankment	Intersection of Rio de Flag and Interstate 40.	A shallow levee like embankment structure was constructed along Rio de Flag.
Santa Fe Reservoir	Santa Fe Reservoir	Reservoir	Within the City of Williams	This dam was considered in the original study of the City of Williams. Due to the small size and storage capability of the dam, the flood protection provided is limited.
Schoolhouse Draw and Pumphouse Draw	Embankment ID #10	Levee like embankment	South of the City of Flagstaff	A shallow levee like embankment structure was constructed along Schoolhouse Draw and Pumphouse Draw.
Stoneman Lake	N/A	Small dike	Along Stoneman Lake	A small dike was built along Stoneman Lake in 1956 by the SCS and a private landowner to protect a portion of the surrounding area from flooding. Although the dike was built to have 2-foot freeboard above the highest-known water level at that time, the dike is presently under water. No significant building damage occurred due to the overtopping of the dike.

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Tucker Flat Wash	Embankment ID #7	Levee like embankment	Tucker Flat Wash, eastern Coconino County	A shallow levee like embankment structure was constructed along Tucker Flat Wash.
Unnamed Stream	Embankment ID #3	Levee like embankment	City of Flagstaff	A shallow levee like embankment structure was constructed along an unnamed stream.
Unnamed Stream	Embankment ID #11	Levee like embankment	Along U.S. Route 66	A shallow levee like embankment structure was constructed along an unnamed stream.
Upper Saginaw Reservoir	Upper Saginaw Reservoir	Reservoir	Within the City of Williams	This reservoir may or may not remain due to questions pertaining to the safety of the reservoir dam. This dam was considered in the original study of the City of Williams. Due to the small size and storage capability of the dam, the flood protection provided is limited.
Wildcat Canyon Creek	Embankment ID #12	Levee like embankment	East of the City of Flagstaff	A shallow levee like embankment structure was constructed along Wildcat Canyon Creek.

4.4 Levees

This section is not applicable to this Flood Risk Project.

Table 9: Levees

[Not Applicable to this Flood Risk Project.]

SECTION 5.0 – ENGINEERING METHODS

For the flooding sources in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded at least once on the average during any 10-, 25-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 25-, 50-, 100-, and 500-year floods, have a 10-, 4-, 2-, 1-, and 0.2% annual chance, respectively, of being equaled or exceeded during any year.

Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedance) during the term of a 30-year mortgage is approximately 26 percent (about 3 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

The engineering analyses described here incorporate the results of previously issued Letters of Map Change (LOMCs) listed in Table 27, "Incorporated Letters of Map Change", which include Letters of Map Revision (LOMRs). For more information about LOMRs, refer to Section 6.5, "FIRM Revisions."

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. A summary of the hydrologic methods applied to develop the discharges used in the hydraulic analyses for each stream is provided in Table 13. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 10. Frequency Discharge-Drainage Area Curves used to develop the hydrologic models may also be shown in Figure 7 for selected flooding sources. A summary of 51tillwater elevations developed for non-coastal flooding sources is provided in Table 11. (Coastal 51tillwater elevations are discussed in Section 5.3 and shown in Table 17.) Stream gage information is provided in Table 12.

Table 10: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Baderville Tributary to Rio de Flag	At confluence with Rio de Flag	8.1	*	*	*	385	*
Bow and Arrow Wash	Near Bennett Drive	*	*	*	*	146	*
Bow and Arrow Wash	At Yaqui Drive	*	*	*	*	155	*
Bow and Arrow Wash	At Intersection of Zumi Drive and Walapai Drive	*	*	*	*	194	*
Bow and Arrow Wash	Approximately 1,320 feet upstream of Lone Tree Road	*	*	*	*	243	*
Bow and Arrow Wash	Approximately 3,960 feet downstream of Lone Tree Road	*	*	*	*	320	*
Bow and Arrow Wash	At confluence with Rio de Flag	2.9	160	*	320	420	700
Cataract Creek	Upstream of Santa Fe Reservoir Dam	4.95	173	*	601	1,099	2,500
Cataract Creek	Downstream of Santa Fe Reservoir Dam	4.95	110[1]	*	411[1]	938[1]	2,200[1]
Cataract Creek	Downstream of confluence at Cataract Creek Tributary	6.61	136	*	486	1,064	2,400
Cataract Creek	At confluence with West Cataract Creek	7.15	153	*	519[2]	1,080[2]	2,400
Cataract Creek	At U.S. Highways 66 & 89	7.15	153	*	524	1,107	2,400
Cataract Creek Tributary	Downstream of City Park Dam	1.4	28[1]	*	91[1]	186[1]	360[1]
Cataract Creek Tributary	Upstream of City Park Dam	1.4	64	*	257	481	1,100
Cemetary Wash	At confluence with West Cataract Creek	1.06	47[1]	*	185[1]	259[1]	*
Cemetary Wash	At U.S. Highways 66 & 89	1.06	50	*	209	385	1,050
Clay Avenue Wash	At confluence with Rio de Flag	12.7	80	*	290	450	1,020
Clay Avenue Wash	Approximately one mile above confluence with Rio de Flag	12.6	70	*	280	440	1,000

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Clay Avenue Wash	Near upstream limit of detailed study	9.7	45	*	210	340	795
Clay Avenue Wash Split Flow	At confluence with Clay Avenue Wash	[3]	1	*	36	77	257
Country Club Wash	At confluence with Rio de Flag	1.6	60	*	130	170	300
Country Club Wash	At upstream limit of detailed study, downstream of two reservoirs	1.0	20	*	40	50	90
Dewey Grade Wash	***	*	57	79	96	116	168
Fanning Drive Wash	At confluence with Rio de Flag	2.60	290	*	570	730	1,200
Fanning Drive Wash	At Linda Vista Drive	1.03	118	*	238	307	506
Fanning Drive Wash	At upstream limit of detailed study	0.93	100	*	210	270	450
Gravesite Wash	***	*	96	128	154	183	258
Gravesite Wash	***	*	211	281	338	402	567
Harrenburg Wash	***	6.54	1,981	2,735	3,357	4,066	5,899
Howard Draw Wash	At confluence with Lower Lake Mary	9.5	2,370	*	3,920	4,510	6,400
Kanab Creek	At downstream limit of detailed study	287.0	2,830	*	7,560	10,500	21,500
Mountainaire Wash	***	1.52	656	897	1,095	1,320	1,899
Munds Canyon Creek	At confluence with Oak Creek	64.3	6,180	*	11,160	14,520	23,000
Munds Park Wash	Downstream of Pinewood Boulevard	*	3,577	4,556	5,215	5,937	7,844
Munds Park Wash	Upstream of Pinewood Boulevard	*	3,578	4,644	5,484	6,375	8,563
Mund Park Wash Right Overbank	**	*	1	88	269	438	719
Oak Creek	At Coconino-Yavapai County boundary	245.9	9,450[4]	*	20,310[4]	26,920[4]	45,650[4]
Oak Creek	At confluence of Soldier Wash	236.8	9,930[4]	*	20,770[4]	27,200[4]	45,700
Oak Creek	Approximately 0.6 mile downstream of confluence of Wilson Canyon	225.4	10,350[4]	*	21,160[4]	27,450[4]	45,000
Oak Creek	At confluence of Munds Canyon Creek	215.4	11,230	*	21,950	27,930	45,000
Oak Creek	Upstream of confluence of Munds Canyon Creek	151.0	7,050	*	13,980	17,140	28,000

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Oak Creek	Approximately 0.75 mile downstream of Banjo Bill Campground	142.9	6,850	*	13,660	16,710	27,000
Oak Creek	At confluence of West Fork Oak Creek	134.3	6,510	*	13,080	15,960	26,000
Oak Creek	Approximately 1.5 miles downstream of confluence of Pumphouse Wash	87.3	3,570	*	6,780	8,240	13,000
O'Neil Springs Wash	***	*	50	67	81	96	135
O'Neil Tank Wash	***	*	315	419	504	600	846
Peaceful Valley Wash	At confluence with Rio de Flag	4.3	110	*	260	360	670
Peaceful Valley Wash	At upstream limit of study	1.7	40	*	100	140	260
Peak View Wash	At confluence with Rio de Flag (after diversion at Cooper Drive)	0.94	*	*	*	20	*
Peak View Wash	Just upstream of the intersection of Cooper Drive and Peak View Tributary Wash	0.94	*	*	*	105	*
Penstock Avenue Wash	At confluence with Rio de Flag	2.3	30	*	90	140	310
Pumphouse Wash	***	4.27	1,397	1,912	2,303	2,744	3,880
Pumphouse Wash	***	12.16	3,122	4,332	5,412	6,551	9,446
Pumphouse Wash	***	18.7	4,665	6,469	8,090	9,860	14,307
Pumphouse Wash	***	20.32	4,885	6,766	8,406	10,353	15,103
Rio de Flag	Approximately 3.0 miles upstream of confluence with San Francisco Wash (at downstream limit of study)	198.38	1,401	*	3,239	4,484	8,300
Rio de Flag	Flow upstream of final Tributary	129.55	1,123	*	2,573	3,502	6,500
Rio de Flag	Flow upstream of Townsend Bridge	121.61	1,086	*	2,487	3,376	6,100
Rio de Flag	Upstream of U.S. Highway 66	110.6	1,050	*	2,400	3,250	5,800
Rio de Flag	At confluence of Switzer Canyon Wash	98.9	1,050	*	2,400	3,250	5,800
Rio de Flag	Above confluence of Bow and Arrow Wash	80.3	900	*	2,000	2,700	4,750

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Rio de Flag	At confluence of Sinclair Wash	67.3	600	*	1,350	1,850	3,300
Rio de Flag	Upstream of confluence of Clay Avenue Wash	53.7	510	*	1,100	1,450	3,000
Rio de Flag	Above Crescent Drive	50.5	290	*	840	1,300	2,900
Rio de Flag	At Narrows Dam	43.3	260	*	760	1,200	2,600
Rio de Flag	At confluence of Hidden Hollow Wash	30.6	70	*	410	680	1,650
Rio de Flag	Approximately 0.5 mile downstream of road proceeding south from Arizona Snow Bowl Access Road	29.0	70	*	400	660	1,600
Rio de Flag	Approximately 0.5 mile upstream of road proceeding south from Arizona Snow Bowl Access Road	23.5	50	*	320	530	1,300
Rio de Flag	Approximately 1.33 miles upstream of U.S. Highway 180	12.2	17	*	142	246	642
Rio de Flag Split Flow	At confluence with Rio de Flag	[5]	5	*	278	456	1,260
Santa Fe Wash East	At confluence with Cataract Creek	5.82	304	*	792	1,305	2,500
Santa Fe Wash East	Upstream of confluence of Santa Fe Wash West	4.91	156	*	481	836	1,750
Santa Fe Wash East	At U.S. Highways 66 and 89	0.92	81	*	250	421	900
Santa Fe Wash West	At confluence with Santa Fe Wash East	0.91	184	*	419	708	1,340
Santa Fe Wash West	At U.S. Highways 66 & 89	0.56	182	*	393	633	1,340
Schoolhouse Wash	***	3.04	776	1,072	1,317	1,598	2,323
Schoolhouse Wash	***	4.55	1,260	1,737	2,130	2,578	3,735
Schoolhouse Wash	***	5.17	1,405	1,939	2,378	2,879	4,215
Schultz Creek	At confluence with Rio de Flag	6.0	*	*	*	440	*
Sinclair Wash	At confluence with Rio de Flag	11.6	350	*	670	890	1,600
Sinclair Wash	At Palmer Avenue	8.0	100	*	320	470	990
Sinclair Wash	At upstream limit of detailed study	5.4	50	*	180	270	600
Soldier Wash	At confluence with Oak Creek	3.3	890	*	1,420	1,720	2,450
Spruce Avenue Wash	At Santa Fe Avenue	7.3	240	*	460	580	930
Spruce Avenue Wash	Above East Linda Vista Drive	5.7	60	*	180	260	520

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Spruce Avenue Wash	Near upstream limit of detailed study	5.3	50	*	160	230	480
Switzer Canyon Wash	At confluence with Rio de Flag	11.0	280	*	600	800	1,400
Switzer Canyon Wash	At downstream Turquoise Drive crossing	2.1	80	*	190	250	450
Switzer Canyon Wash	At upstream corporate limits	*	*	*	*	150	*
Switzer Canyon Wash	Approximately 528 feet upstream of intersection of Juniper Avenue and Turquoise Drive	*	*	*	*	150	*
Switzer Canyon Wash	At upstream of Route 66	2.1	*	*	*	250	*
Switzer Canyon Wash	At Atchison, Topeka, Santa Fe Railway	*	79	*	108	252	454
Switzer Canyon Wash	At Enterprise Road	*	101	*	250	346	642
Tributary 1 to Baderville Tributary	At stream mile 0.76	3.42	*	*	*	162	*
Tributary 2 to Baderville Tributary	At stream mile 1.28	1.5	*	*	*	73	*
Unnamed Wash 1	**	*	4,885	6,379	7,560	8,788	11,838
West Street Wash	Below south driveway of High School	0.3	22	*	45	58	97

* Not calculated for this Flood Risk Project

** Not provided (JEF, 2012)

*** Not Provided (Atkins, 2012)

[1] Decrease due to storage upstream

[2] Decrease due to overbank losses upstream

[3] Floods caused by overflow from Clay Avenue Wash; hence, no applicable drainage area other than the drainage area of Clay Avenue Wash at this location.

[4] Decrease due to overbank storage upstream

[5] Floods caused by overflow from Rio de Flag; hence, no applicable drainage area other than the drainage area of Rio de Flag at this location.

Figure 7: Frequency Discharge-Drainage Area Curves

[Not Applicable to this Flood Risk Project.]

Table 11: Summary of Non-Coastal Stillwater Elevations

Flooding Source	Location	Elevations (feet NAVD88)				
		10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Mormon Lake	22 miles south-southest of the City of Flagstaff	7,115.9	*	*	7,120.4	7,123.4
Detention Basin	South of Sinclair Wash within the City of Flagstaff	*	*	*	6,925.4	*
Stoneman Lake (with diversion ditch closed)	30 miles south-southeast of the City of Flagstaff	6,728.6	*	*	6,732.8	6,735.2

*Not calculated for this Flood Risk Project

Table 12: Stream Gage Information used to Determine Discharges

Flooding Source	Gage Identifier	Agency that Maintains Gage	Site Name	Drainage Area (Square Miles)	Period of Record	
					From	To
Cataract Creek Tributary	N/A	USGS	N/A	N/A	N/A	N/A
Kanab Creek	N/A	USGS	N/A	N/A	1959	1968
Munds Park Wash	143	Yavapai County	Munds Park	N/A	12/7/1989	11/1994
Oak Creek	09504420	USGS	Oak Creek near Sedona	355	4/14/1985	N/A

5.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Base flood elevations on the FIRM represent the elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations. These whole-foot elevations may not exactly reflect the elevations derived from the hydraulic analyses. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For streams for which hydraulic analyses were based on cross sections, locations of selected cross sections are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 6.3), selected cross sections are also listed on Table 24, “Floodway Data.”

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 13. Roughness coefficients are provided in Table 14. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Table 13: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Baderville Tributary to Rio de Flag	Confluence with Rio de Flag	Approximately .2 miles south of Hashknife Trail Road	Normal-depth calculations	HEC-2 step-backwater, WSPRO, J635	1/1981	AE w/ Floodway	Normal-depth calculations were used to determine the starting water-depth elevation for Baderville Tributary. Hydraulic calculations were performed using two USGS models. WSPRO was used for the culvert, road overflow, and floodway computations at Bader and Suzette Roads and the floodway analyses at cross sections D, E, G, and H. The backwater analyses and remaining floodway elevation computations were carried out by the J635 computer model (USGS, undated). Cross sections used for the study were surveyed by USGS personnel in October 1989. Normal-depth calculations were used to determine the starting water-depth elevation for Baderville Tributary. The revised hydraulic analysis was performed using the USACE HEC-2 stepbackwater computer program. Because of the new topography, the BFEs were increased, the 1- and 0.2-percent annual chance floodplain boundaries were modified, and the 1-percent annual chance floodway was realigned. The HEC-2 hydraulic computer model was used to determine the base flood elevations. The starting water-surface elevation was taken from the previous study. The cross-section data for the channelized portions of the wash was obtained from the USGS and the City of Flagstaff Engineering Division. Overbank information was obtained from aerial topographic maps. Roughness coefficients were chosen by engineering judgment and based on field observations.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bow and Arrow Wash	Approximately 1,800 feet upstream of Lake Mary Road	South Lone Tree Road crossing	The discharges used were obtained from the City of Flagstaff FIS	HEC-RAS Version 3.1.3	4/2004	AE w/ Floodway	The expansion and contraction coefficients used in the HEC-RAS model were determined from the HEC-RAS User's Manual. For gradual transitions, which include more reaches in this study, the contraction and expansion coefficients were set as 0.1 and 0.3, respectively. At locations where the cross-sectional area and flow direction change abruptly, values of 0.2 to 0.4 and 0.4 to 0.6 were used for these coefficients. At structure location values of 0.3 and 0.5 were used. Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. In this model, there appears to be two locations that produce hydraulic jumps due to a culvert and a change in slope. The first location is 1/2 mile downstream of Lake Mary Road along the wash. The channel in this location changes from a steep to a gradual slope, thus creating a hydraulic jump. The second location is just downstream of Lake Mary Road at the culvert outlet. There are several locations showing divided flows. These divided flows appear to be isolated islands and appear to be hydraulically connected both upstream and downstream. There are several locations showing divided flows. These divided flows appear to be isolated islands and appear to be hydraulically connected both upstream and downstream.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Bow and Arrow Wash (cont.)	Approximately 1,800 feet upstream of Lake Mary Road	South Lone Tree Road crossing	The discharges used were obtained from the City of Flagstaff FIS	HEC-RAS Version 3.1.3	4/2004	AE w/ Floodway	All along the wash between Leupp Drive to Yaqui Drive, there are several locations of supercritical flow conditions. These are mainly due to the wash crossings at developed areas. This development constricts flow between properties, thus creating either an expansion or contraction between cross sections.
Cataract Creek	Approximately 0.36 miles north of US Interstate 40	0.5 miles upstream Santa Fe Reservoir dam	SCS TR-20	HEC-2 step-backwater	3/1981	A, AE w/ Floodway AO	Results were compared with data taken from a USGS gage station with 14 years of record on a tributary to Cataract Creek. Discharges on portions of Cataract Creek decrease due to overbank losses upstream. Discharges on portions of Cataract Creek decrease due to overbank losses upstream. Starting water-surface elevations for Cataract Creek were derived from normal-depth calculations.
Cataract Creek (Embankment ID #20)	Floodplain downstream of the interstate	Upstream of Interstate 40	Not Provided	Approximate analyses of “behind levee” flooding	4/2008	A	Embankment with inventory ID # 20 is located on Cataract Creek. Based on topographic information from the USGS (i.e., 10m DEMs) the approximate area of 1-percent annual chance flooding in the event of failure of the structure was delineated to connect the discontinuous floodplain from upstream of Interstate 40 to the floodplain downstream of the interstate.
Cataract Creek Tributary	Confluence with Cataract Creek	City Reservoir	SCS TR-20	HEC-2 step-backwater	3/1981	AE w/ Floodway	Results were compared with data taken from a USGS gage station with 14 years of record on a tributary to Cataract Creek. Discharges decrease with increasing drainage area on Cataract Creek Tributary due to storage upstream.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Cataract Creek Tributary (cont.)	Confluence with Cataract Creek	City Reservoir	SCS TR-20	HEC-2 step-backwater	3/1981	AE w/ Floodway	No profile is shown for Cataract Creek Tributary for approximately 370 feet downstream of City Port Dam due to the extreme steepness of the spillway (an approximate 18-foot vertical drop per 100 feet). Starting water-surface elevations for Cataract Creek Tributary were derived from normal-depth calculations.
Cemetary Wash	US Interstate 40	Approximately 0.12 miles west of City of Williams	SCS TR-20	HEC-2 step-backwater	3/1981	AE w/ Floodway	Results were compared with data taken from a USGS gage station with 14 years of record on a tributary to Cataract Creek. Discharges on Cemetary Wash due to overbank losses upstream. Starting water-surface elevations for Cemetary Wash were derived from a rating curve for the culverts at Interstate Highway 40.
Clay Avenue Wash (Rio de Flag confluence)	0.3 mile upstream from confluence with Rio de Flag	0.925 mile upstream from confluence with Rio de Flag	Not Provided	HEC-RAS Version 3.1.3, BOSS RMS Version 2000	4/2004	AE w/ Floodway	The revised hydraulic analyses resulted in changes to the BFEs, modifications to the floodplain boundaries, and the addition of a floodway along Clay Avenue Wash from approximately 0.300 mile upstream to 0.925 mile upstream of the confluence with Rio de Flag. In support of this revision, the following technical data were submitted: • A topographic map of Clay Avenue Wash from 0.300 mile upstream to 0.925 mile upstream of the confluence with Rio de Flag, prepared by the City of Flagstaff, dated May 1988; and

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Clay Avenue Wash (Rio de Flag confluence) (cont.)	0.3 mile upstream from confluence with Rio de Flag	0.925 mile upstream from confluence with Rio de Flag	Not Provided	HEC-RAS Version 3.1.3, BOSS RMS Version 2000	4/2004	AE w/ Floodway	• As-built drawings of Westglen Mobile Home Park, Public and Private Improvements, prepared by P & D Technologies, dated January 25, 1989. The work study maps consisted of the 2-foot contour intervals topographic mapping. Also, USGS 7.5-minute quadrangle topographic mapping with a 1:24,000 scale, and 20-foot contour intervals. However, due to the lack of accuracy or inconsistencies between mapping sources, these maps were used as reference purposes only and topographic information was obtained by field survey.
Clay Avenue Wash	Intersection of West Clay Avenue and Interstate 40 Business	Forest Service Road 506	HEC-1	HEC-2 step-backwater	3/1/1995	AE w/ Floodway	The USACE had previously studied Rio de Flag and Sinclair Wash in a 1975 report (USACE-Los Angeles, 1975). A study addressing floodflow peaks on Rio de Flag and other tributaries within the City ofFlagstaff, including Clay Avenue Wash, Fanning Drive Wash, Sinclair Wash, and Switzer Canyon Wash, was published for the City of Flagstaff in 1979 (Arizona Engineering Company, 1979). A complete review of the hydrology of both reports was conducted. The hydrology model from the City of Flagstaff report (Arizona Engineering Company, 1979) was adopted with minor modifications for use in this FIS. Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. Clay Avenue Wash has divided flow between cross sections P and T.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Clay Avenue Wash Split Flow	Confluence with Clay Avenue Wash approximately 125 feet downstream of W. Shellie Dr.	Confluence with Clay Avenue Wash approximately 750 feet upstream of W. Shellie Dr.	Not Provided	Not Provided	1/1981	AE	Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. At the Rio de Flag and Clay Avenue Wash areas of split flow, the 10-percent annual chance flood is contained in the main channel.
County Club Wash	Confluence with Rio de Flag	Golf course pond north side of East Mt. Pleasant Drive	HEC-1	HEC-2 step-backwater	1/1981	AE w/ Floodway	Starting water-surface elevations for Rio de Flag, Peaceful Valley Wash, and Country Club Wash were based on storage-routing using the USACE HEC-1 computer program (USACE-HEC, 1973). The storage-routing condition occurring at U.S. Highway 66 causes ponding upstream of U.S. Highway 66 past the confluences of Peaceful Valley Wash and Country Club Wash with Rio de Flag for the 10-, 2-, 1-, and 0.2-percent annual chance floods. Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation.
Detention Basin	S Wild West Trail	Approximately 0.2 miles upstream from S Wild West Trail.	Not Provided	Not Provided	Not Provided	AE	None
Dewey Grade Wash	Confluence with Pumphouse Wash	South Old Munds Highway	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	None

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Fanning Drive Wash	Confluence with Rio de Flag	Approximately 140 feet north east of Skyline Dr. and Forest Brook St.	HEC-1	HEC-2 step-backwater	9/30/1995	AE w/ Floodway	The USACE had previously studied Rio de Flag and Sinclair Wash in a 1975 report (USACELos Angeles, 1975). A study addressing floodflow peaks on Rio de Flag and other tributaries within the City ofFlagstaff, including Clay Avenue Wash, Fanning Drive Wash, Sinclair Wash, and Switzer Canyon Wash, was published for the City of Flagstaff in 1979 (Arizona Engineering Company, 1979). A complete review of the hydrology of both reports was conducted. The hydrology model from the City of Flagstaff report (Arizona Engineering Company, 1979) was adopted with minor modifications for use in this FIS. No 0.2-percent annual chance flood elevations were modeled or plotted on the profiles for Fanning Drive Wash. The capacity of the wash would not convey the 0.2-percent annual chance flood. Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. One area of shallow flooding along Fanning Drive Wash breaks out along LindaVista Drive and flows south to U.S. Highway 66. Another area of shallowflooding occurs between Fanning Drive Wash, Linda Vista Drive, and Fanning Drive.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Fanning Drive Wash (cont.)	Confluence with Rio de Flag	Approximately 140 feet north east of Skyline Dr. and Forest Brook St.	HEC-1	HEC-2 step-backwater	9/30/1995	AE w/ Floodway	No 0.2-percent annual chance flood elevations were modeled or plotted on the profiles for Fanning Drive Washe. It is estimated that the 0.2-percent annual chance flood event for Fanning Drive Wash will break out between stations 1.88 and 1.50 along Linda Vista Drive. Most of this flooding will not return to the channel. The culvert on Fanning Drive Wash at the railroad has a small capacity compared to the entire flow; therefore, a weir equation was used to determine the backwater elevation behind the railroad embankment. No floodway is shown for this area.
Gravesite Wash	Confluence with Pumphouse Wash	Mountainaire Road	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	None
Harrenburg Wash	Confluence with Pumphouse Wash	Approximately 1,400 feet above the confluence with Pumphouse Wash	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	None
Howard Draw Wash	Lower Lake Mary	Intersection of Forest Service Road 235 and Crimson Road	SCS TR-20	HEC-2 step-backwater	1/1981	AE w/ Floodway	Because of the similar hydrologic characteristics of the Howard Draw Wash drainage area with that of the Oak Creek area, the TR-20 computer program (USDA, 1965) was also used to perform the hydrologic analysis for Howard Draw Wash, using similar input data. Because starting water-surface elevations for Howard Draw Wash were dependent on lake elevations of Lower Lake Mary, it was necessary to establish the lake elevations for selected recurrence intervals. This was done using a previous hydrology report for the City of Flagstaff (Hydrology Consultants, Inc., 1975).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Kanab Creek	Approximately 0.2 miles north east of Rt. 89A and Cowboy Dr.	Approximately 0.3 miles north east of Rt. 89A and Cowboy Dr.	SCS TR-20 with Type 1 Storm Distribution. USGS Regression Equation, and USGS Index Method	HEC-2 step-backwater	3/1981	AE w/ Floodway	Several hydrologic methods were used to establish discharge-frequency relationships for Kanab Creek through the Town of Fredonia. The SCS TR-20 computer program (USDA, 1965) was used, with a Type 1 storm distribution applied with precipitation data obtained from National Oceanic and Atmospheric Atlas Volumes VI and VIII (NOAA, 1973B). The USGS Regression Equation (ADOT, 1978) and the USGS Index Method (USGS, 1962) were also used. These results were compared with the results obtained from a USGS gaging station with 9 years of record (1959 to 1968) on Kanab Creek above the Town of Fredonia as a further check of the results. Approximate flooding for Lost Spring Wash was determined from a Flood Hazard Boundary Map (FIA, 1978), and tied into detailed flooding from Kanab Creek. Floodway widths extend beyond the Coconino County boundary for Kanab Creek.
Mormon Lake	Northern Intersection of Mormon Lake Road and Country Road 3.	Southern Intersection of Mormon Lake Road and Country Road 3.	SCS methods described in Technical Service Center Technical Note-P0-6	HEC-2 step-backwater	1/1981	A	Analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for Mormon Lake. No lake gage records exist for Mormon Lake. Approximate historic lake elevations were determined from recollections of long-time local residents and observations of high water marks from U.S. Forest Service aerial photographs (USDA, 1978). Water-surface elevations were established in June 1980 when they were above normal water elevations.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Mormon Lake (cont.)	Northern Intersection of Mormon Lake Road and Country Road 3.	Southern Intersection of Mormon Lake Road and Country Road 3.	SCS methods described in Technical Service Center Technical Note- P0-6	HEC-2 step-backwater	1/1981	A	The 1-percent annual chance frequency lake elevation for Mormon Lake was established by adding the volume from a 10-day duration, 1-percent annual chance frequency storm to the mean maximum lake elevation as determined from historic information. The 10-day duration rainfall for a 1-percent annual chance storm was computed using SCS methods described in Technical Service Center Technical Note- P0-6 (USDA, 1975). Precipitation values for the analysis were derived from the National Oceanic and Atmospheric Administration Atlas, Volume III (NOAA, 1973A). Using the rainfall computed for the 10-day duration, 1-percent annual chance storms along with runoff curve numbers, the net volume of runoff was calculated using SCS procedures. An elevation versus storage rating curve was prepared for Mormon Lake. Storage volume was computed by the use of USGS topographic maps (USGS, 1965). Using the mean maximum water-surface elevations determined from historic information with the net volumes of runoff for the 10-day duration storms and the elevation versus storage rating curves, the lake water-surface elevation for the selected recurrence interval was determined. No 2-percent annual chance flood elevation was determined for Mormon Lake.
Mountainaire Wash	Confluence with Schoolhouse Draw	Approximately 1.1 miles above the confluence with Schoolhouse Draw	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	None

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Munds Canyon Creek	Confluence with Oak Creek	Eastern end of Thompson Road	SCS TR-20	HEC-2 step-backwater	1981	AE w/ Floodway	Input data for the TR-20 computer program was prepared for the Yavapai County FIS as part of the hydrology report on Oak Creek in Yavapai County (FEMA, 1991). To obtain peak floodflows at the required concentration points of Oak Creek and tributaries, Soldier Wash, and Munds Canyon, it was necessary to modify the TR-20 model by adding additional concentration points. Further modification, in the form of higher areal reduction factors applied to the precipitation data, was necessary to model the relatively higher peak floodflows occurring from the smaller drainage areas. Therefore, peak discharges for Munds Canyon, Soldier Wash, Munds Park, and upper reaches of Oak Creek are higher than peak discharges obtained at the same location when the lower Oak Creek peak discharges were being investigated.
Munds Park Wash	Interstate 17	Approximately 0.95 miles upstream from E. Pinewood Blvd.	Xpswmm	HEC-RAS, xp2D	9/2012	AE w/ Floodway	Odell Lake was hydrologically modeled as “at capacity” – the water surface being at the spillway crest elevation (6474 feet) just prior to storm event. This approach was employed for two reasons: 1. The water surface elevation is commonly at the spillway crest elevation. 2. Runoff storage and flow attenuation would be minimal, providing more conservative hydrologic results for flood hazard mapping. Gage data at the downstream limit of the study area was analyzed for comparison against computed peak. Xpswmm models were arranged for computation of

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Munds Park Wash (cont.)	Interstate 17	Approximately 0.95 miles upstream from E. Pinewood Blvd.	Xpswmm	HEC-RAS, xp2D	9/2012	AE w/ Floodway	hydrographs at key locations for use in xp2D modeling of the Munds Park meadow and golf course areas immediately east and west of Interstate 17. The xpswmm-computed hydrographs were hydraulically routed with xp2D through the meadow and golf course areas and finally through the Interstate 17 Bridge crossing of Munds Park Wash at the downstream limit of the study area. Because hydraulic routing of the xpswmm hydrographs was accomplished with the use of xp2D, combining xpswmm hydrographs at the downstream limit of the study area was not required. However, xp2D flow cross-sections were used to ascertain hydrograph information at key locations, including the Interstate 17 Bridge opening at the downstream limit of the study area. The peak discharges from the xp2D-computed hydrographs at the downstream limit of the study area were compared against the available gage data to determine the validity of hydrologic results (xpswmm model results), which were used to develop the hydraulic models (xp2D models). Essentially, xpswmm model hydrographs were used as inflow input data for xp2D modeling; and therefore, if the hydraulic results – at the downstream limit of the study area – correlate well with the available gage data at this location, the hydrologic modeling results can be considered reasonable. HEC-RAS modeling was used for hydraulic analyses of studied streams that exhibit riverine-type flow conditions. These riverine streams include: Munds Park Wash, upstream of Odell Lake.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Munds Park Wash (cont.)	Interstate 17	Approximately 0.95 miles upstream from E. Pinewood Blvd.	Xpswmm	HEC-RAS, xp2D	9/2012	AE w/ Floodway	Xp2D modeling was used for hydraulic analyses of studied streams that exhibit shallow, broad flow during frequent events and/or ponded conditions during large events. These studied streams include: Munds Park Wash upstream of the Interstate 17 Bridge crossing, through the Pinewood Development Golf Course, and within the Odell Lake reservoir area. Munds Park Wash has a bridge structure located at Pinewood Boulevard which, due to a lack of capacity, creates a flow split to the right that creates the Munds Park Wash Right Overbank reach. This reach is modeled in HEC-RAS and the modeled flows are taken from the HEC-RAS output at the cross-section just upstream of the bridge. The 100-year velocities through the Main Channel reach are approximately 10 ft/s to 13 ft/s. Munds Park Wash located on the east side of Interstate 17 consists primarily of a golf course with scattered residential and commercial areas. The xp2D area incorporates Odell Lake, which is approximately 14-feet higher than the golf course measured from the spillway elevation of 6,474 feet. Munds Park Wash outlets under Interstate 17 through Munds Canyon located on the southern boundary of the project area. Munds Park West Wash joins Munds Park Wash just prior to the outlet through Munds Canyon.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Munds Park Wash (cont.)	Interstate 17	Approximately 0.95 miles upstream from E. Pinewood Blvd.	Xpswmm	HEC-RAS, xp2D	9/2012	AE w/ Floodway	The outlet through Munds Canyon is narrow and deep, which constricts and ultimately backs up the flow from Munds Park Wash and Munds Park West Wash onto the golf course area east of Interstate 17. The golf course area subsequently becomes a "ponded" area with a relatively constant flood elevation of 6,464.4 feet during the 100-year event while the flow is metered out through Munds Canyon. This ponding results in high water depths and low flow velocities within the golf course area. It is worth noting that the fire station located along Pinewood Boulevard adjacent to the country club building is within the 100-year floodplain limits. The topographic LiDAR data received by the County indicates that the existing ground elevation adjacent to the fire station building is roughly at 6,462.5 feet. The actual finished floor elevation of the structure is unknown at the time of this report (JEF, 2012).
Munds Park Wash Right Overbank	Odell Lake	E. Pinewood Blvd.	Xpswmm	HEC-RAS	9/2012	AE	The bridge does not have capacity to convey flows greater than the 10-year discharge through the opening; therefore, flow splits to the right of the bridge. This split is modeled as the Munds Park Wash Right Overbank reach in the HEC-RAS model. The cross-section bank stations at the upstream face of the bridge (RS 7.8661) were placed at the abutment locations; therefore, the Right Overbank reach flow rate (modeled discharge) is equivalent to the calculated right overbank flow at RS 7.8661 (JEF, 2012).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Munds Park Wash West	Confluence with Munds Park Wash	Interstate 17	Xpswmm	xp2D	9/2012	AE	Munds Park Wash and Munds Park Wash West watershed runoff concentrates at the Interstate 17 Bridge crossing of Munds Park Wash. At this location flow is forced into and through the narrow Munds Park Canyon channel section (see below Photograph 2-1). This contraction of flow at the canyon opening induces a significant backwater/ponding condition within the Pinewood Country Club Golf Course. This backwater/ponding condition, in turn, is also the tailwater condition impacting Munds Park Wash West conveyance under Interstate 17 via the 3-12'x12' RCBC structure. Flow through the 3-12'x12' RCBC structure is a complex phenomenon controlled by the volume and depth of runoff east of Interstate 17, the timing of Munds Park Wash and Munds Park Wash West hydrographs, the extent of backwater from the east through the structure, and the rate at which flow is conveyed into and through the canyon section of stream downstream of Interstate 17. To hydraulically model the backwater/ponding condition occurring east of Interstate 17, as well as the related complex hydraulic condition associated with the Munds Park Wash West culvert crossing under Interstate 17, two-dimensional modeling with xp2D was utilized. This model was selected in particular because it is well suited for modeling the unsteady flow, potentially in both directions, through the Munds Park Wash West Interstate 17 culvert. Additional discussion regarding xp2D model development is provided in Section 5.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Munds Park Wash West (cont.)	Confluence with Munds Park Wash	Interstate 17	Xpswmm	xp2D	9/2012	AE	Munds Park Wash east of Interstate 17 is a ponded condition, which creates a high tailwater effect on Munds Park Wash West at the 3-12'x12' RCBC located at the Interstate 17 crossing. This culvert structure is the outlet of Munds Park Wash West and conveys flow into the Munds Park Wash area east of the interstate. As the ponding east of Interstate 17 occurs, the culverts are unable to efficiently convey the flow from the west side to the east side of Interstate 17. The result is a backup of flow on the west side of Interstate 17 to an elevation of roughly 6,466.5 feet during the 100-year event – this is also a relatively "ponded" condition. This 100-year water surface elevation is high enough to overtop Interstate 17 at the culvert location; Interstate 17 is at roughly 6,464 feet. Munds Park Wash West flow overtops the interstate and flows into the golf course area to the east during the 25-, 50-, 100-, and 500-year events. Flow in the vicinity of the mobile home/RV park is relatively slow with typical 100-year flow velocities of roughly 1 ft/s to 2 ft/sec. This is primarily a function of the relatively high land-use n-vale associated with the mobile home/RV park (land-use n-value of 0.15), which dampens flow velocity. The mobile home/RV park consists of a high density of seasonal units; thus, the high land-use n-value of 0.15. The mobile home/RV park area also constricts the flow, forcing it to the southwest where a relatively small, constructed drainage diversion channel runs adjacent to the park. Theconstricting of flow backs the water up further into the meadow

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Munds Park Wash West (cont.)	Confluence with Munds Park Wash	Interstate 17	Xpswmm	xp2D	9/2012	AE	area upstream of the mobile home/RV park, where the flow profile is relatively flat, creating a relatively "ponded" condition. Flow depths during the 100-year event, within the mobile home/RV park are approximately 2 feet to 5 feet. The 100-year flood depth profile on the west side of Interstate 17 has relatively little fall. This relatively shallow profile, combined with relatively slow flowing water (flow in the vicinity of the mobile home/RV park is relatively slow with typical velocities of roughly 1 ft/s to 2 ft/sec), results in a relatively "ponding" condition west of Interstate 17 during the 100-year event (JEF, 2012).
Oak Creek	Approximately 0.5 miles north of Grasshopper Point	Oak Creek Terrace Resort along Rt. 89A	SCS TR-20	HEC-2 step-backwater	9/30/1988	AE w/ Floodway	Input data for the TR-20 computer program was prepared for the Yavapai County FIS as part of the hydrology report on Oak Creek in Yavapai County (FEMA, 1991). To obtain peak floodflows at the required concentration points of Oak Creek and tributaries, Soldier Wash, and Munds Canyon, it was necessary to modify the TR-20 model by adding additional concentration points. Further modification, in the form of higher areal reduction factors applied to the precipitation data, was necessary to model the relatively higher peak floodflows occurring from the smaller drainage areas. Therefore, peak discharges for Munds Canyon, Soldier Wash, Munds Park, and upper reaches of Oak Creek are higher than peak discharges obtained at the same location when the lower Oak Creek peak discharges were being investigated.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Oak Creek (cont.)	Approximately 0.5 miles north of Grasshopper Point	Oak Creek Terrace Resort along Rt. 89A	SCS TR-20	HEC-2 step-backwater	1981	AE w/ Floodway	Discharges on Oak Creek decrease with increasing drainage area between Munds Canyon Creek and the Yavapai County boundary due to overbank storage. The hydrologic analysis of the watershed affecting the Oak Creek area in the City of Sedona, including Soldier Wash, was performed using the NRCS TR-20 computer program (FEMA, 1991). Input data for the TR-20 computer program were prepared for the Yavapai County FIS as part of the hydrology report on Oak Creek in Yavapai County (USGS, 1973). To obtain peak floodflows at the required concentration points of Oak Creek and Soldier Wash, it was necessary to modify the TR-20 model by adding additional concentration points. Further modification, in the form of higher area reduction factors applied to the precipitation data, was necessary to model the relatively higher peak flood flows occurring from the smaller drainage areas. Therefore, peak discharges for Soldier Wash and upper reaches of Oak Creek are higher than peak discharges obtained at the same location when the lower Oak Creek peak discharges were being investigated. Discharges on Oak Creek decrease with increasing drainage area between Munds Canyon Creek and the Yavapai County line due to overbank storage.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Oak Creek (cont.)	Approximately 0.5 miles north of Grasshopper Point	Oak Creek Terrace Resort along Rt. 89A	SCS TR-20	HEC-2 step-backwater	1981	AE w/ Floodway	This revised hydraulic analysis was based on more detailed topographic information for the right overbank of Oak Creek at cross section S. The result of this analysis was an increase in the BFEs and a decrease in the width of the Special Flood Hazard Area and floodway along Oak Creek between cross sections Rand T. In addition, the width of the floodway was increased by 27 feet at cross section V. Due to the confined nature and high velocities on Oak Creek between cross sections AP and BU, and between cross sections BV and CE, the !-percent annual chance floodplain was designated as the floodway.
O'Neil Springs Wash	Confluence with Pumphouse Wash	Approximately 2,800 feet above the confluence with Pumphouse Wash	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	None
O'Neil Tank Wash	Confluence with Pumphouse Wash	Approximately 1,200 feet above the confluence with Pumphouse Wash	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	None
Peaceful Valley Wash	Confluence with Rio de Flag	Approximately 1.5 miles east of the south end of Lake Elaine	HEC-1	HEC-2 step-backwater	1/1981	AE w/ Floodway	Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Peaceful Valley Wash (cont.)	Confluence with Rio de Flag	Approximately 1.5 miles east of the south end of Lake Elaine	HEC-1	HEC-2 step-backwater	1/1981	AE w/ Floodway	Starting water-surface elevations for Peaceful Valley Wash were based on storage-routing using the USACE HEC-1 computer program (USACE-HEC, 1973). The storage-routing condition occurring at U.S. Highway 66 causes ponding upstream of U.S. Highway 66 past the confluences of Peaceful Valley Wash.
Peak View Wash	Approximately 130 feet downstream of Cooper Drive	Approximately 120 feet upstream of Lois Lane	HEC-1	HEC-2 step-backwater	4/2004	AE w/ Floodway	Country Club Wash with Rio de Flag for the 10-, 2-, 1-, and 0.2-percent annual chance floods. Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. In this model, there appears to be two locations where hydraulic jumps occur. The two locations, south of Mountain Drive and the other south of Lois Lane, both hydraulic jumps are due to the culverts at the crossing locations and the slope transition between steep to gradual at the structure, thus creating high velocities and hydraulic jumps downstream of the structure location. There is no divided flow in this model. However, there is a flow split at Cooper Drive near the confluence with the Rio de Flag Wash. There are two locations where supercritical flow conditions occur.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Penstock Avenue Wash	Railhead Ave.	Smokerise Dr.	HEC-1	HEC-2 step-backwater	9/5/1995	AE w/ Floodway	Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. Shallow flooding occurs east of Penstock Avenue Wash from between Empire and Commerce Avenues to between Railhead Avenue and U.S. Highway 66. No 0.2-percent annual chance flood elevations were modeled or plotted on the profiles for Penstock Avenue. It is estimated that the 0.2-percent annual chance flood event for Penstock Avenue Wash will break out below station 0.894 and return at station 0.11 resulting in shallow flooding of not more than 1.0 foot on the average. Most of this flooding will not return to the channel.
Pumphouse Wash	Effective Zone A limits, approximately 2.8 miles downstream of Interstate 17	Effective Zone A limits, approximately 1.9 miles upstream of Interstate 17	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	Along Pumphouse Wash there are several homes/ buildings, close in proximity, which significantly impact the active flow in the floodplain; therefore, ineffective area was placed along the buildings to constrict the active flow area. This occurs mainly between cross sections 6514 through 8848. The floodway analysis for Pumphouse Wash was discontinued upstream of interstate Interstate 17, due to backwater from the interstate embankment and culvert capacity. This area is ponding, so evaluating a floodway limit in this section was not deemed necessary. The floodway was discontinued between Pumphouse Wash cross sections 15194 through 16391.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Pumphouse Wash (cont.)	Effective Zone A limits, approximately 2.8 miles downstream of Interstate 17	Effective Zone A limits, approximately 1.9 miles upstream of Interstate 17	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	Structure 8515 along Pumphouse Wash was skewed manually in HEC-RAS to account for the smaller bridge opening due to its alignment along Pinon Trail. The bounding cross sections are perpendicular to the floodplain, so the geometry for the bridge was input into HEC-RAS with the smaller opening, rather than applying a skew angle in HEC-RAS. Structure 7693 along Pumphouse Wash was skewed using the HEC-RAS option in the modeling program, resulting in applying the skew angle automatically to the structure and bounding cross sections. The thalweg for Pumphouse Wash is forced to turn 90 degrees, just east of the Interstate 17, to flow through the Interstate 17 culvert (Structure 15073) and continue west. Before the construction of Interstate 17, the Pumphouse Wash had a more natural geometry and flowed north-east to south-west without the 90 degree turn at the interstate crossing. Since the construction of the interstate, Structure 15073 (Interstate 17 culvert) along Pumphouse Wash forces the upstream flow to backwater on the east side of the interstate due to the highway embankment and culvert constriction. Because the interstate causes a backwater effect and the velocity head is negligible compared to the depth of flow, a junction at the intersection of Pumphouse Wash and Schoolhouse Draw was deemed not necessary. Pumphouse Wash Structure 6970 is a triple barrel 12'x10' RCB culvert (modeled as bridge) with an interior angle under Pinon

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Pumphouse Wash (cont.)	Effective Zone A limits, approximately 2.8 miles downstream of Interstate 17	Effective Zone A limits, approximately 1.9 miles upstream of Interstate 17	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	Trial, with two boxes (right side) having a shorter length than the third box (left side). This structure was modeled as a straight culvert on a skew in HEC-RAS assuming all three box culverts had a uniform length matching the longer culvert. This approximation was deemed appropriate for the purpose of floodplain mapping with the longer box length approximating the hydraulic losses occurring from the nonstandard geometry. Modeling, in the area of Pinon Trail on Pumphouse Wash, contained numerous closely spaced, low-flow driveway access structures, with non-standard geometries, and large skew angles. Adequate distance between structures did not exist to apply the standard cross section spacing at each structure. Therefore, minor adverse water surface slopes exist in the model in this area, limited to 0.3 feet or less. An attempt was made to stabilize the model, which included the deletion of extraneous cross sections where possible, and ignoring small wooden walkway bridges (Atkins, 2012).
Pumphouse Wash (Embankment ID #10)	Floodplain downstream of Interstate 17	Upstream of Interstate 17	Not Provided	Approximate analyses of “behind levee” flooding	4/2008	A	Embankment with inventory ID # 10 is located on Schoolhouse Draw and Pumphouse Wash. Based on topographic information from the USGS (i.e., 10m DEMs) the approximate area of 1-percent annual chance flooding in the event of failure of the structure was delineated to connect the discontinuous floodplain from upstream of Interstate 17 to the floodplain downstream of the interstate.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Rio de Flag (upstream study)	Narrows Dam	Approximately 500 feet downstream of the Hidden Hollow Road crossing	HEC-1	HEC-2 step-backwater, HEC-RAS step-backwater Version 3.1.3	12/2008	AE w/ Floodway	The USACE had previously studied Rio de Flag and Sinclair Wash in a 1975 report (USACE-Los Angeles, 1975). A study addressing floodflow peaks on Rio de Flag and other tributaries within the City of Flagstaff, including Clay Avenue Wash, Fanning Drive Wash, Sinclair Wash, and Switzer Canyon Wash, was published for the City of Flagstaff in 1979 (Arizona Engineering Company, 1979). A complete review of the hydrology of both reports was conducted. The hydrology model from the City of Flagstaff report (Arizona Engineering Company, 1979) was adopted with minor modifications for use in this FIS. An area of shallow flooding of less than 1. 0 foot occurs along Fremont Boulevard near its intersection with Rio de Flag. For the Rio de Flag restudy, the 10-, 2-, and 1-percent annual chance discharges were obtained using a transfer equation derived from USGS, 1999. The 0.2-percent annual chance discharge was obtained using graphical interpolation from log-probabilities plots. Hydrology flow values for the Rio de Flag were generated using the integration of FIS flow values and the USGS regression equations for various points along the stream path, and were extrapolated from existing FIS data for the 0.2-percent annual chance flood event where USGS equations were not available.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Rio de Flag (upstream study) (cont.)	Narrows Dam	Approximately 500 feet downstream of the Hidden Hollow Road crossing	HEC-1	HEC-2 step-backwater, HEC-RAS step-backwater Version 3.1.3	12/2008	AE w/ Floodway	A combined terrain was compiled using a combination of available 3' DEM data, digitized contour data associated with the effective study and 30' USGS DEMs for the Rio de Flag. Hydraulics were then calculated in HEC-RAS Version 3 .1.3 and used as the basis for determining floodplain and floodway extents. The fourth apparent hydraulic jump is approximately 300 feet downstream of the culvert at Fremont Boulevard due to steep slopes and the impoundment created by Narrows Dam downstream. There are several locations that appear to produce supercritical flow conditions. Most of these locations are associated with roadway crossings and include the following: • Downstream from the culvert outlet at Fremont Boulevard, it appears that the flow is confined to the roadway culvert. This and the steep grades upstream from the culvert result in an acceleration of the flow and supercritical flow conditions. • Upstream from the culvert inlet at Fremont Boulevard, it appears that the flow is confined to the roadway culvert. This and the steep grades upstream result in an acceleration of the flow and supercritical flow conditions. • Approximately 430 feet northwest of the roadway intersection of Fremont Boulevard and Boldt Drive, it appears that the flow is confined to the roadway culvert, thus creating supercritical flow conditions.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Rio de Flag (downstream study)	Rio Ranch Road crossing	Route 66	HEC-1	HEC-2 step-backwater, HEC-RAS step-backwater Version 3.1.3	12/2008	AE w/ Floodway	The USACE had previously studied Rio de Flag and Sinclair Wash in a 1975 report (USACE-Los Angeles, 1975). A study addressing floodflow peaks on Rio de Flag and other tributaries within the City of Flagstaff, including Clay Avenue Wash, Fanning Drive Wash, Sinclair Wash, and Switzer Canyon Wash, was published for the City of Flagstaff in 1979 (Arizona Engineering Company, 1979). A complete review of the hydrology of both reports was conducted. The hydrology model from the City of Flagstaff report (Arizona Engineering Company, 1979) was adopted with minor modifications for use in this FIS. Starting water-surface elevations for Rio de Flag were based on storage-routing using the USACE HEC-1 computer program (USACE-HEC, 1973). The storage-routing condition occurring at U.S. Highway 66 causes ponding upstream of U.S. Highway 66 past the confluences of Peaceful Valley Wash and Country Club Wash with Rio de Flag for the 10-, 2-, 1-, and 0.2-percent annual chance floods. Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Rio de Flag (downstream study) (cont.)	Rio Ranch Road crossing	Route 66	HEC-1	HEC-2 step-backwater, HEC-RAS step-backwater Version 3.1.3	12/2008	AE w/ Floodway	The best available mapping was used for approximate study analysis. Approximate study areas, described as lower Rio de Flag (approximately 1.7 miles), were studied to determine delineations for the 1-percent annual chance flood by use of normal depth calculations using Manning's equation. The remaining approximate study areas, described as Rio de Flag (approximately 0.7 mile below U.S. Highway 66), were delineated for the 1-percent annual chance flood based on the City of Flagstaff drainage report (Arizona Engineering Company, 1979). An area of divided flow occurs on Rio de Flag along Bonito Street from Thorpe Road to Elm Avenue. For the Rio de Flag restudy, the 10-, 2-, and 1-percent annual chance discharges were obtained using a transfer equation derived from USGS, 1999. The 0.2-percent annual chance discharge was obtained using graphical interpolation from log-probabilities plots. Hydrology flow values for the Rio de Flag were generated using the integration of FIS flow values and the USGS regression equations for various points along the stream path, and were extrapolated from existing FIS data for the 0.2-percent annual chance flood event where USGS equations were not available. A combined terrain was compiled using a combination of available 3' DEM data, digitized contour data associated with the effective study and 30' USGS DEMs for the

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Rio de Flag (downstream study) (cont.)	Rio Ranch Road crossing	Route 66	HEC-1	HEC-2 step-backwater, HEC-RAS step-backwater Version 3.1.3	12/2008	AE w/ Floodway	Rio de Flag. Hydraulics were then calculated in HEC-RAS Version 3 .1.3 and used as the basis for determining floodplain and floodway extents. In this model, there are four apparent locations that produce hydraulic jumps due to culverts and a steep slope, approximately,1/2 mile downstream of the culvert located at El Paso Road, due to a steep slope in the wash. This slope creates high velocities and supercritical flow conditions. The second location is just downstream of the culvert at El Paso Road and the third location is just downstream of the culvert at El Compressor Road, both due to the obstruction of flow from the culvert. Just south of the county boundary continuing about ½ mile downstream along the wash, the flow is not contained in the channel and spreads over a large area. The cross sections show several small islands, but they are just local high points and the flow appears to be hydraulically connected. Hydrology flow values for the Rio de Flag were generated using the integration of FIS flow values and the USGS regression equations for various points along the stream path, and were extrapolated from existing FIS data for the 0.2-percent annual chance flood event where USGS equations were not available. There are several locations that appear to produce supercritical flow conditions. Most of these locations are associated with roadway crossings and include the following:

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Rio de Flag (downstream study) (cont.)	Rio Ranch Road crossing	Route 66	HEC-1	HEC-2 step-backwater, HEC-RAS step-backwater Version 3.1.3	12/2008	AE w/ Floodway	• Approximately 330 feet southeast of the county boundary, it appears that the inundation limits are contracting between cross sections, thus creating a supercritical flow conditions. • Approximately 300 feet north of the county boundary, the slope gradually increases. This slope creates high velocities and supercritical flow conditions that continue in several different areas to approximately 1,850 feet south of the county boundary. Hydraulic model variables were obtained primarily from two sources: the existing FIS for the eastern portion of the study reach, and the Entellas restudy conducted in 2004 for the western portion of the study reach. This current study combined both model sections into one continuous model and incorporated the revised flow values. The floodways presented in this study were computed on the basis of equalconveyance reduction from each side of the floodplain. There are two exceptions to this statement. The first occurs from cross sections CJ to DE on Rio de Flag, through a heavily urbanized area of the City of Flagstaff, where the equalconveyance reduction method failed to produce an appropriate floodway. With the approval of the City of Flagstaff and FEMA, a floodway was established through this area of Rio de Flag using fixed encroachments. The second exception occurs from U.S. Highway 66 to approximately cross section AN on the lower reach of detailed study of Rio de Flag. This reach of Rio de Flag is subjected to ponding of floodwaters behind

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Rio de Flag (downstream study) (cont.)	Rio Ranch Road crossing	Route 66	HEC-1	HEC-2 step-backwater, HEC-RAS step-backwater Version 3.1.3	12/2008	AE w/ Floodway	U.S. Highway 66 due to a relatively small-capacity culvert under the high U.S. Highway 66 road embankment. The floodplain elevations and delineations on this reach of Rio de Flag were determined using the storage-routing option of the HEC-1 hydrology computer program. This storage-routing analysis involved determining the peak flood elevation occurring for the volume of floodwater entering the area behind U.S. Highway 66, the volume of floodwater exiting at the highway, and the storage capacity behind the highway. It, therefore, was also necessary to determine the floodway for this ponded area of Rio de Flag by volume analysis. The established floodway limits could not allow the base flood water-surface elevation to rise by more than 1.0 foot if the floodway fringe were to be completely filled in. It was found that an acceptable floodway could not be established in the ponded area of Rio de Flag, so the floodplain delineation was also established as the floodway limit.
Rio de Flag (Embankment ID #20)	At Interstate 40	At Interstate 40	Taken from 1996 FIS	HEC-RAS	4/2008	A	Embankment with structure ID # 14 is located on the Rio de Flag at Interstate 40. A hydrologic analysis, which included extrapolation of the discharges in the FIS dated August 2, 1996, was used to determine the discharges in the Rio de Flag for the without 1-40 embankment scenario. A hydraulic HEC-RAS model was developed for this reach using cross section and bridge data from the existing hydraulic models for the Rio de Flag. These hydraulics models

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Rio de Flag (Embankment ID #20) (cont.)	At Interstate 40	At Interstate 40	Not Provided	HEC-RAS	4/2008	A	were obtained from FEMA and the 2004 TSDN prepared by Entellus. The resulting floodplain showing the approximate area of 1-percent annual chance flooding in the event of failure of the 1-40 embankment was delineated using topographic data from the City of Flagstaff, the 10 m DEMs from the USGS and an undated FEMA workmap for the Rio de Flag.
Rio de Flag Split Flow	Confluence with Rio de Flag at N. Bonito St.	Confluence with Rio de Flag near N. Thorpe Road	Not Provided	Not Provided	1/1981	AE w/ Floodway	Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. Rio de Flag Split Flow is separated from the main channel by an area of shallow flooding between Navajo Drive and Thorpe Road. The water-surface elevations are slightly higher in the main channel than in the adjacent area of ponding due to the slight amount of head needed to initiate weir flow. At the Rio de Flag and Clay Avenue Wash areas of split flow, the 10-percent annual chance flood is contained in the main channel.
Santa Fe Wash East	Approximately 0.36 miles north of US Interstate 40	Rt. 66	SCS TR-20	HEC-2 step-backwater	3/1981	AE w/ Floodway AH	Results were compared with data taken from a USGS gage station with 14 years of record on a tributary to Cataract Creek. Starting water-surface elevations for Santa Fe Wash East were determined using critical depth.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Santa Fe Wash West	Approximately 0.36 miles north of US Interstate 40	North Grand Canyon Blvd.	SCS TR-20	HEC-2 step-backwater	3/1981	AE w/ Floodway AH, AO	Results were compared with data taken from a USGS gage station with 14 years of record on a tributary to Cataract Creek. A shallow flooding area east of the City of Williams for Santa Fe Wash West was determined using HEC-2 computations (USACE-HEC, 1976) and engineering judgment. For the areas studied by approximate methods, 1-percent annual chance elevations were determined from normal depth calculations using Manning's equation. Starting water-surface elevations for Santa Fe Wash West were taken from Santa Fe Wash East.
Schoolhouse Draw	Confluence with Pumphouse Wash	Approximately 2.2 miles above the confluence with Pumphouse Wash	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	There is a large building located along the Schoolhouse Draw low-flow channel, resulting in this building being located in the middle of the floodplain. This structure, located between cross sections 5983 and 6076, was modeled in HEC-RAS by applying a blocked obstruction area. The floodway analysis for Schoolhouse Draw was discontinued upstream of interstate Interstate 17, due to backwater from the interstate embankment and culvert capacity. This area is ponding, so evaluating a floodway limit in this section was not deemed necessary. The floodway was discontinued between Schoolhouse Draw cross sections 5 through 2126.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Schoolhouse Draw (cont.)	Confluence with Pumphouse Wash	Approximately 2.2 miles above the confluence with Pumphouse Wash	HEC-1, Version 4.1	HEC-RAS, Version 4.1.0	11/2012	AE w/ Floodway	Structure 9327 along Schoolhouse Draw was skewed using the HEC-RAS option in the modeling program, resulting in applying the skew angle automatically to the structure and bounding cross sections. The Schoolhouse Draw merges into the Pumphouse Wash just upstream of Interstate 17 culvert (Structure 15073), on the east side of the interstate. The Schoolhouse Draw used the water surface elevation at Pumphouse Wash cross section 15194 as the downstream boundary condition. The backwater limits correlate with the scarring of the natural ground per aerial imagery. The upstream limits of the study at Schoolhouse Draw tie into an existing Zone A floodplain. In order to provide a transition to the wider Zone A limits, an area of Zone A floodplain was added (Atkins, 2012).
Schoolhouse Draw (Embankment ID #10)	Floodplain downstream of Interstate 17	Upstream of Interstate 17	Not Provided	Approximate analyses of "behind levee" flooding	4/2008	A	Embankment with inventory ID # 10 is located on Schoolhouse Draw and Pumphouse Wash. Based on topographic information from the USGS (i.e., 10m DEMs) the approximate area of 1-percent annual chance flooding in the event of failure of the structure was delineated to connect the discontinuous floodplain from upstream of Interstate 17 to the floodplain downstream of the interstate.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Schultz Creek	Approximately 2,000 feet downstream of the Fort Valley Road crossing	Shultz Pass Road	The discharges used were obtained from the City of Flagstaff FIS	HEC-RAS Version 3.1.3	4/2004	AE w/ Floodway AO	Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. The expansion and contraction coefficients used in the HEC-RAS model were determined from the HEC-RAS User's Manual. For gradual transitions, which include more reaches in this study, the contraction and expansion coefficients were set as 0.1 and 0.3, respectively. At locations where the cross-sectional area and flow direction change abruptly, values of 0.2 to 0.4 and 0.4 to 0.6 were used for these coefficients. At structure location values of 0.3 and 0.5 were used. In this model, there are several apparent locations that produce hydraulic jumps due to culverts and a confluence with Rio de Flag. At approximately 120 feet north of the confluence with Rio de Flag, there appears to be a hydraulic jump. This is due to the drop into the Rio de Flag at the confluence. Between Mary Russell Way and just downstream of Colter House Road, there are several locations in between these two roadways that have apparent hydraulic jumps, due to the obstructions of the culverts at the roadway crossings. Approximately 400 feet north of the confluence with Rio de Flag Wash, there is some flow that may leave the main wash.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Schultz Creek (cont.)	Approximately 2,000 feet downstream of the Fort Valley Road crossing	Shultz Pass Road	The discharges used were obtained from the City of Flagstaff FIS	HEC-RAS Version 3.1.3	4/2004	AE w/ Floodway	This flow is assumed to be small and the split was ignored in the model. Schultz Creek has a well-defined channel upstream of Highway 180. Downstream from the highway, the flow spreads through a wide area of shallow flow. There are several locations that appear to produce supercritical flow conditions. • Approximately 2,000 feet above the confluence with Rio de Flag, the wash flows through a developed area, where the flow is forced through streets and alleys resulting in supercritical flows. • Upstream from Highway 180, approximately 1/3 of a mile the slope gradually increases. This slope creates high velocities and supercritical flow conditions that continue to Highway 180. • Upstream from Mary Russell Way, it appears that the flow is confined to the roadway culvert. This and the steep grades upstream result in an acceleration of the flow and supercritical flow conditions that continues to approximately 1,300 feet north of the roadway crossing. • Approximately 340 feet south of the city boundary, it appears that the inundation limits are contracting between cross sections, thus creating a supercritical flow conditions that continue to the corporate boundary limits.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Sinclair Wash	Confluence with Rio de Flag	Approximately 0.14 miles west of Constitution Blvd.	HEC-1	HEC-2 step-backwater	1/1981	AE w/ Floodway	The USACE had previously studied Rio de Flag and Sinclair Wash in a 1975 report (USACE-Los Angeles, 1975). A study addressing floodflow peaks on Rio de Flag and other tributaries within the City ofFlagstaff, including Clay Avenue Wash, Fanning Drive Wash, Sinclair Wash, and Switzer Canyon Wash, was published for the City of Flagstaff in 1979 (Arizona Engineering Company, 1979). A complete review of the hydrology of both reports was conducted. The hydrology model from the City of Flagstaff report (Arizona Engineering Company, 1979) was adopted with minor modifications for use in this FIS. Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation.
Soldier Wash	Approximately 100 feet south of Rt. 89A	Confluence with Oak Creek	SCS TR-20	HEC-2 step-backwater	1981	AE w/ Floodway	Input data for the TR-20 computer program was prepared for the Yavapai County FIS as part of the hydrology report on Oak Creek in Yavapai County (FEMA, 1991). The hydrologic analysis affecting Soldier Wash was performed using the NRCS TR-20 computer program (FEMA, 1991). Input data for the TR-20 computer program were prepared for the Yavapai County FIS as part of the hydrology report on Oak Creek in Yavapai County (USGS, 1973). To obtain peak floodflows at the required concentration points of Soldier Wash, it was necessary to modify the TR-20 model by adding additional

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Soldier Wash (cont)	Approximately 100 feet south of Rt. 89A	Confluence with Oak Creek	SCS TR-20	HEC-2 step-backwater	1981	AE w/ Floodway	concentration points. Further modification, in the form of higher area reduction factors applied to the precipitation data, was necessary to model the relatively higher peak flood flows occurring from the smaller drainage areas. Therefore, peak discharges for Soldier Wash are higher than peak discharges obtained at the same location when the lower Oak Creek peak discharges were being investigated.
Spruce Avenue Wash	North of Walmart on Huntington Dr.	Approximately 0.13 miles north of crossing the Arizona National Scenic Trail	HEC-1	HEC-2 step-backwater	1/1981	AE w/ Floodway	Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. The best available mapping was used for approximate study analysis. Approximate study areas, described as lower Spruce Avenue Wash, were studied to determine delineations for the 1-percent annual chance flood by use of normal depth calculations using Manning's equation. Shallow flooding occurs along Spruce Avenue Wash from Linda Vista Drive south along Grandview Drive and First and Second Streets to the Atchison, Topeka & Santa Fe Railroad. Shallow flooding occurs between Spruce Avenue Wash and West Street Wash below First Avenue. An area of shallow flooding east of Spruce Avenue Wash occurs between Cedar Avenue south along Rose and Third Streets to just north of Sixth Avenue. Another area of shallow flooding occurs along the northern end of Paradise Road and between Paradise Road and Spruce Avenue Wash north of Park Way.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Stoneman Lake	Stoneman Lake Road	Lake View Ct.	Frequency Analysis Regression Equations	Frequency Analysis	3/1981	AE	Analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for Stoneman Lake. No lake gage records exist for Stoneman Lake. Approximate historic lake elevations were determined from recollections of long-time local residents and observations of high water marks from U.S. Forest Service aerial photographs (USDA, 1978). Water-surface elevations were established in June 1980 when they were above normal water elevations. Elevations of various recurrence intervals were determined for Stoneman Lake using a frequency analysis of a synthetic lake record generated by a water-balance accounting model that was calibrated to information on historic lake levels. Documentation of the model development and assumptions are presented in the report *Stoneman Lake Elevation- Frequency Analysis, Coconino County, Arizona* (Dames & Moore, 1982). The hydrologic assumptions used in developing the revision were taken from a report, *Methods for Estimating the Magnitude and Frequency of Floods in Arizona* (Roeske, 1978). Regression equations for the high-elevation region in that report were applied to the study area.
Switzer Canyon Wash	East Route 66 crossing	Approximately 2,800 feet upstream of San Francisco Street crossing	HEC-1	HEC-2 step-backwater, USACE Computer Program 723-X6-L Water – Surface Profiles	4/2004	AE w/ Floodway, AH	The USACE had previously studied Rio de Flag and Sinclair Wash in a 1975 report (USACE-Los Angeles, 1975). A study addressing floodflow peaks on Rio de Flag and other tributaries within the City ofFlagstaff, including Clay Avenue Wash, Fanning Drive Wash, Sinclair Wash, and Switzer Canyon Wash, was published for the

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Switzer Canyon Wash (cont.)	East Route 66 crossing	Approximately 2,800 feet upstream of San Francisco Street crossing	HEC-1	HEC-2 step-backwater, USACE Computer Program 723-X6-L Water – Surface Profiles	4/2004	AE w/ Floodway, AH	City of Flagstaff in 1979 (Arizona Engineering Company, 1979). A complete review of the hydrology of both reports was conducted. The hydrology model from the City of Flagstaff report (Arizona Engineering Company, 1979) was adopted with minor modifications for use in this FIS. Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. An area of ponding occurs along Switzer Canyon Wash between Huntington Drive and Interstate Highway 40. The revision along Switzer Canyon Wash was based on new detailed flooding for Switzer Canyon Wash produced by the USACE, Los Angeles District, as part of the Limited Map Maintenance Program study for the City of Flagstaff, Arizona. The hydraulic analysis was performed using the USACE Computer Program 723-X6-L Water –Surface Profiles. A hydraulic analysis was performed to determine the channel capacity for Switzer Canyon Wash. Cross sections for the hydraulic analysis were taken from topographic maps at a scale of 1:1,200, with a contour interval of 2 feet (Aerial Mapping Company, 1975). Cross sections in all detailed study areas were located at close intervals upstream and downstream of pipe culverts to investigate possible significant backwater effects. All road crossings were surveyed to obtain pipe sizes and elevation

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Switzer Canyon Wash cont.)	Confluence with Rio de Flag	Approximately 488 feet north of San Francisco St.	Discharges obtained from the City of Flagstaff FIS (1996)	HEC-2 step-backwater, USACE Computer Program 723-X6-L Water – Surface Profiles	4/2004	AE w/ Floodway, AH	data. The portion of Switzer Canyon Wash from the upstream Turquoise Drive crossing to the Meadow Lark Drive crossing is an underground pipe which is assumed to be 50-percent open during a 1-percent annual chance flood event. The discharge through the pipe was calculated to be 100 cfs by using Chart 6 of the Hydraulic Charts for the Selection of Highway Culverts (USDOT, 1965). In this model, there are several apparent locations that produce hydraulic jumps due to culverts and changes in slopes. Just south of Turquoise Drive, the culvert produces high velocities through the structure and a hydraulic jump downstream. Approximately 780 feet southeast of Forest Avenue along the wash, the culvert produces high velocities through the structure and a hydraulic jump downstream. Other locations of hydraulic jumps; southeast of the intersection of Turquoise Drive and Oak Avenue due to the culvert at this location; south of McPhearson Park Driveway due to the culvert at this location; and lastly, approximately 480 feet north of McPhearson Park Driveway and continues to about 670 feet upstream of the channel. The grade slightly increases in this location, thus creating hydraulic jumps in this area. There are several locations showing divided flow, these divided flows appear to be isolated islands and appear to be hydraulically connected both upstream and downstream. There are five locations where supercritical flow conditions occur.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Switzer Canyon Wash cont.)	Confluence with Rio de Flag	Approximately 488 feet north of San Francisco St.	HEC-1	HEC-2 step-backwater, USACE Computer Program 723-X6-L Water – Surface Profiles	4/2004	AE w/ Floodway, AH	Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, “Without Floodway” elevations presented in Table 9 for certain downstream cross sections of Switzer Canyon Wash are lower than the regulatory flood elevations in that area, which must take into account the !-percent annual chance flooding due to backwater from other sources.
Tributary 1 To Baderville Tributary	Confluence with Baderville Tributary	Approximately 275 feet west of N. Hadrians Walk	Normal-depth calculations	HEC-2 step-backwater, WSPRO, J635	1/1981	AE	None
Tributary 2 To Baderville Tributary	Confluence with Baderville Tributary	Approximately 75 feet north of N. Galloway Trail	Normal-depth calculations	HEC-2 step-backwater, WSPRO, J635	1/1981	AE	None
Tucker Flat Wash (Embankment ID #7)	Floodplain downstream of Burlington Northern Santa Fe Railroad	Upstream of Burlington Northern Santa Fe Railroad	Not Provided	Approximate analyses of “behind levee” flooding	4/2008	A	Embankment with inventory ID # 7 is located on Tucker Flat Wash. Based on topographic information from the USGS (i.e., 10m DEMs) the approximate area of 1-percent annual chance flooding in the event of failure of the structure was delineated to connect the discontinuous floodplain from upstream of Burlington Northern Sante Fe Railroad to the floodplain downstream of the railroad.
Unnamed Stream (Embankment ID #3)	Not Provided	Not Provided	Not Provided	Approximate analyses of “behind levee” flooding	4/2008	A	Embankment with inventory ID # 3 is located on an unnamed stream. Based on the FIS and topographic information provided by the City of Flagstaff, a shallow flooding analysis was used to delineate the approximate area of 1-percent annual chance flooding in the event of failure of the structure.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Unnamed Stream (Embankment ID #11)	Floodplain downstream os U.S. Route 666	Upstream of U.S. Route 66	Not Provided	Approximate analyses of "behind levee" flooding	4/2008	A	Embankment with inventory ID # 11 is located on an unnamed stream. Based on topographic information from the USGS (i.e., 10m DEMs) the approximate area of 1-percent annual chance flooding in the event of failure of the structure was delineated to connect the discontinuous floodplain from upstream of U.S. Route 66 to the floodplain downstream of U.S. Route 66.
Unnamed Wash	W. High Country Trail	Detention Basin	Not Provided	Not Provided	1/1981	AE w/ Floodway	The best available mapping was used for approximate study analysis. Approximate study areas, described as Unnamed Wash (intersection of Interstate Highways 40 and 17), were studied to determine delineations for the 1-percent annual chance flood by use of normal depth calculations using Manning's equation.
Unnamed Wash 1	Confluence with Munds Park Wash West	Approximately 200 upstream from NF-94620	Xpswmm	HEC-RAS	9/2012	AE	Unnamed Wash 1 is relatively flat along the upstream segment of the reach (RS 1.2831 to RS 2.4203, stations measured from the confluence with Munds Park Wash West) with an approximate channel slope of 0.3 percent. The channel bed slope steepens dramatically downstream of cross-section RS 1.2831 to an approximate slope of 1.1 percent. As a result of this change in profile, the upper segment has 100-year velocities generally less than 10 ft/sec and the lower segment has 100-year velocities ranging from 11 ft/s to 17 ft/sec. The upstream segment of the reach is generally wide with braided flow paths, the downstream segment is deeply incised and extremely rocky and vegetated (JEF, 2012).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
West Street Wash	6th Ave.	Approximately 0.12 miles east of Cedar Ave.	HEC-1	HEC-2 step-backwater	1/1981	AE	Water-surface elevations in the City of Flagstaff were computed with obstruction of modeled hydraulic structures considered. This approach was considered necessary because of the high debris potential due to urbanization and natural vegetation. A drainage pipe at Sixth Avenue intercepts a large portion of the West Street Wash 1-percent annual chance discharge. The remaining discharge causes shallow flooding with an average depth of less than 1 foot south of Sixth Avenue, between Izabel Street and East Street. West Street Wash has divided flow between Second and Johnson Avenues.
Wildcat Canyon Creek (Embankment ID #12)	Floodplain downstream of Country Highway 394	Upstream of Country Highway 394	Not Provided	Approximate analyses of "behind levee" flooding	4/2008	A	Embankment with inventory ID # 12 is located on Wildcat Canyon Creek. Based on topographic information from the USGS (i.e., 10m DEMs) the approximate area of 1-percent annual chance flooding in the event of failure of the structure was delineated to connect the discontinuous floodplain from upstream of County Highway 394 to the floodplain downstream of the highway.
Various Streams Studied by Approximate Methods within Coconino County	Not Provided	Not Provided	Approximate Study	Not Provided	1/1981	A	None
Various Streams Studied by Approximate Methods within the City of Flagstaff	Not Provided	Not Provided	Approximate Study	Not Provided	1/1981	A	None

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Various Streams Studied by Approximate Methods within the Town of Fredonia	Not Provided	Not Provided	Approximate Study	Not Provided	3/1981	A	None
Various Streams Studied by Approximate Methods within the City of Williams	Not Provided	Not Provided	Approximate Study	Not Provided	3/1981	A	None

Table 14: Roughness Coefficients

Flooding Source	Channel “n”	Overbank “n”
Bow and Arrow Wash	0.017-0.072	L: 0.017-0.150, R: 0.017-0.200
Cataract Creek	0.014-0.055	L: 0.014-0.077, R: 0.014-0.077
Cataract Creek Tributary	0.014-0.055	L: 0.014-0.077, R: 0.014-0.077
Clay Avenue Wash	0.024-0.040	L: 0.030-0.100, R: 0.045-0.050
Country Club Wash	0.017-0.034	L: 0.031-0.034, R: 0.031-0.034
Dewey Grade Wash	0.018-0.045	*
Fanning Drive Wash	0.017-0.043	L: 0.020-0.053, R: 0.020-0.053
Gravesite Wash	0.018-0.045	*
Harrenburg Wash	0.018-0.045	*
Howard Draw Wash	0.030-0.045	L: 0.040-0.055, R: 0.040-0.050
Mountainaire Wash	0.018-0.045	*
Munds Canyon Creek	0.065-0.073	L: 0.080-0.088, R: 0.080-0.088
Munds Park Wash	0.040-0.070	0.065-0.095
Oak Creek	0.030-0.080	L: 0.079-0.180 R: 0.079-0.135
O’Neil Springs Wash	0.018-0.045	*
O’Neil Tank Wash	0.018-0.045	*
Peaceful Valley Wash	0.034	L: 0.036 R: 0.036
Peak View Wash	0.040-0.053	L: 0.045-0.058 R: 0.045-0.058
Penstock Avenue Wash	0.015-0.038	L: 0.028-0.150 R: 0.028-0.150
Pumphouse Wash	0.018-0.045	*
Rio de Flag	0.015-0.061	L: 0.015-0.150 R: 0.015-0.150

Flooding Source	Channel “n”	Overbank “n”
Santa Fe Wash East	0.015-0.072	L: 0.036-0.107 R: 0.039-0.107
Schoolhouse Wash	0.018-0.045	*
Schultz Creek	0.015-0.085	L: 0.045-0.120 R: 0.047-0.120
Sinclair Wash	0.024-0.040	L: 0.045-0.050 R: 0.045-0.050
Soldier Wash	0.018-0.050	L: 0.070-0.090 R: 0.055-0.090
Spruce Avenue Wash	0.020-0.040	L: 0.020-0.150 R: 0.020-0.150
Switzer Canyon Wash	0.030-0.085	L: 0.035-0.150 R: 0.018-0.113
Unnamed Wash 1	0.035-0.080	0.060-0.095
West Street Wash	0.035-0.045	L: 0.050-0.150 R: 0.050-0.150

* Not provided

5.3 Coastal Analyses

This section is not applicable to this Flood Risk Project.

Table 15: Summary of Coastal Analyses
[Not Applicable to this Flood Risk Project.]

5.3.1 Total Stillwater Elevations

This section is not applicable to this Flood Risk Project.

Figure 8: 1% Annual Chance Total Stillwater Elevations for Coastal Areas
[Not Applicable to this Flood Risk Project.]

Table 16: Tide Gage Analysis Specifics
[Not Applicable to this Flood Risk Project.]

5.3.2 Waves

This section is not applicable to this Flood Risk Project.

5.3.3 Coastal Erosion

This section is not applicable to this Flood Risk Project.

5.3.4 Wave Hazard Analyses

This section is not applicable to this Flood Risk Project.

Table 17: Coastal Transect Parameters
[Not Applicable to this Flood Risk Project.]

Figure 9: Transect Location Map
[Not Applicable to this Flood Risk Project.

5.4 Alluvial Fan Analyses

This section is not applicable to this Flood Risk Project.

Table 18: Summary of Alluvial Fan Analyses
[Not Applicable to this Flood Risk Project.]

Table 19: Results of Alluvial Fan Analyses
[Not Applicable to this Flood Risk Project.]