



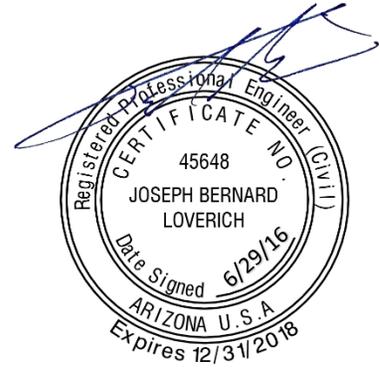
# Memorandum

**DATE:** June 29, 2016

**TO:** **Aric Stewart, PE, CFM; Coconino County**  
Joe Loverich, PE, CFM; JE Fuller/Hydrology and Geomorphology, Inc.

**FROM:** Mike Kellogg, PG, CFM, GISP; JE Fuller/Hydrology and Geomorphology, Inc.  
**Coconino County Post-Wildfire Flood and Debris-Flow Risk Assessment:**

**RE:** **County Wide Assessment and Prioritization and Pilot Area Selection Summary**



## Introduction

Trends of increasing wildfire size and severity across the western U.S. (Dennison et al., 2014; Westerling et al., 2006; Williams et al., 2010) and concurrent encroachment and development into the wildland-urban interface (WUI) (Moritz et al., 2014; Stein et al., 2013) place more people and infrastructure at greater risks from wildfires and the aftermaths of fires. Wildfires dramatically alter watershed hydrologic conditions, substantially increasing the potential for post-fire floods and debris-flows (Moody and Ebel, 2012; Neary et al., 2005; Riley et al., 2013). To further complicate matters in the Southwestern U.S., wildfire season ends with the onset of monsoonal rainfall, which may ultimately extinguish wildfires while producing large floods and debris flows in the immediate aftermath of a fire. These scenarios allow for very little time to assess post-wildfire damages and hydrologic changes, and to implement mitigation measures.

The purpose of this project is to conduct an assessment of the potential for debris flows and post-fire flooding, as well as their impacts to downstream communities, in the immediate aftermath of a reasonable-scenario wildfire in northern Arizona.

The results from this project will help the County and local municipalities identify mitigation needs, previously unrecognized hazard zones, and emergency planning and response needs, and will also provide information to help the U.S. Forest Service identify areas for targeted fuel reduction treatments.

This project is divided into nine tasks. Task 1 and 2 are described in this memorandum.

**Task 1: County-Wide Assessment & Prioritization.**

**Task 2: Pilot Area Selection.**

Task 3: Pre-Wildfire Hydrologic Modeling.

Task 4: Pre-Fire Debris Flow Risk Assessment.

Task 5: Burn Severity Scenario Modeling.

Task 6: Post-Wildfire Hydrologic Modeling.

Task 7: Post-Wildfire Debris Flow Risk Assessment.

Task 8: Risk Zone Mapping.

Task 9: Community Outreach.



## **Task 1: County-Wide Assessment & Prioritization Summary**

Task 1 of the project consisted of a County-wide reconnaissance-level assessment of wildfire and debris flow vulnerable lands. The assessment was completed using Geographic Information System (GIS) based analyses utilizing coverages for the following:

*Table 1. Coverage and Source*

Coverage	Source
Topography	USGS 10-meter Digital Elevation Model (DEM)
HUC-12 Watersheds	USGS
Land Ownership and Assessor Parcels	Coconino County
Buildings	Coconino County
ADWR Jurisdictional Dams	Coconino County
Highways, Railways, and Streets	Coconino County
Severe Fire Potential	<a href="https://www.frames.gov/partner-sites/firesev/firesev-home/">https://www.frames.gov/partner-sites/firesev/firesev-home/</a>
Critical Facilities	Coconino County Multi-Jurisdictional Hazard Mitigation Plan
Gas Transmission Mains	Kinder Morgan and Transwestern Gas

Below is an explanation of how each GIS coverage listed in Table 1 was used in the county-wide assessment. The resulting product of this task is a GIS polygon dataset representing post-wildfire debris-flow risk corridors within Coconino County. A more detailed explanation of how the debris-flow risk dataset was developed is included later in this section, however it is important to mention the dataset here because the GIS coverages defined below were used in its development.

- Topography – The USGS 10-meter digital elevation model (DEM) was utilized as the base topography. GIS geoprocessing tools were used to create separate county-wide slope datasets from the DEM:
  - Slopes of 15 degrees and greater (areas of potential debris-flow initiation)
  - Slopes of 5 degrees and greater (areas of potential debris-flow runoff)
  - Slopes of less than 5 degrees (areas at low risk of debris-flow impacts)
- HUC-12 Watersheds – The USGS Hydrologic Unit Code (HUC) 12 coverage was used to identify drainage corridors within the same watershed which aided in the selection of the Pilot Areas.
- Land Ownership and Assessor Parcels – The County Assessor’s land ownership coverage was used as a weighting factor in the debris flow risk area assessment. Debris flow risk areas that intersect existing developed or potentially developable land (e.g. Private or State Trust) or existing county assessor parcels were assigned a weighting factor relative to the hazard (defined below).
- Buildings – The GIS coverage representing the footprint of buildings within Coconino County was used as a weighting factor in the debris flow risk area assessment. Debris flow risk areas that intersect the building footprints were assigned a weighting factor relative to the hazard.
- Arizona Department of Water Resources (ADWR) Jurisdictional Dams – The dam coverage is a GIS point file dataset that identifies the location of all ADWR jurisdictional dams within Coconino County. Dams located on watercourses that are subject to debris flows pose a higher hazard than



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watercourses without dams. Debris flow risk areas that intersect jurisdictional dams were assigned a weighting factor relative to the hazard.

- Highways, Railways, and Streets – This GIS coverage was used as a weighting factor in the debris flow risk area assessment. Debris flow risk areas that intersected the infrastructure dataset were assigned a weighting factor relative to the hazard.
- Severe Fire Potential – The U.S. Department of Agriculture (USDA) in partnership with the University of Idaho developed the Fire Severity Mapping System (FIRESEV) project for the purpose of providing critical information about the potential ecological effects of wildland fire to fire managers across the western U.S.<sup>1</sup> A major component of FIRESEV is a comprehensive GIS dataset of the western U.S. depicting the potential severity of wildfires. A major component of FIRESEV is a comprehensive map of the western U.S. depicting the potential for fires to burn with high severity if they should occur. Developed as a 30m-resolution raster dataset, the map is intended to be an online resource that managers can download and use to evaluate the potential ecological effects associated with new and potential fire events. The data is classified into a burn severity ranking from 0% to 100%, with 100% being the greatest potential for high severity fires. The FIRESEV dataset also includes areas of non-burnable land. For the purpose of this study the dataset was parsed into the following:
  - High Burn Severity (75%-100%)
  - Moderate Burn Severity (25%-75%)
  - Low Burn Severity (10%-25%)
  - Very Low Burn Severity (0%-10%)

Only Moderate and High Burn Severity areas were considered in this analysis. It is assumed that Very Low Burn Severity, Low Severity, and Non-Burnable areas would not experience post-wildfire debris flow hazards. Figure 1 shows the final Severe Fire Potential dataset for Coconino County.

- Critical Facilities – The Coconino County Multi-Jurisdictional Hazard Mitigation Plan (MHJMP) includes a GIS dataset representing physical assets within Coconino County and the incorporated jurisdictions within the county. One subset of the asset dataset includes facilities that each jurisdiction identified as critical. These critical facilities are represented by a point file GIS dataset. Debris flow risk areas that intersected the critical facilities dataset were assigned a weighting factor relative to the hazard.
- Gas Transmission Mains – This polyline GIS dataset represents the alignment of gas transmission lines within Coconino County. Debris flow risk areas that intersected this dataset were assigned a weighting factor relative to the hazard.

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<sup>1</sup> <https://www.frames.gov/partner-sites/firesev/firesev-home/>



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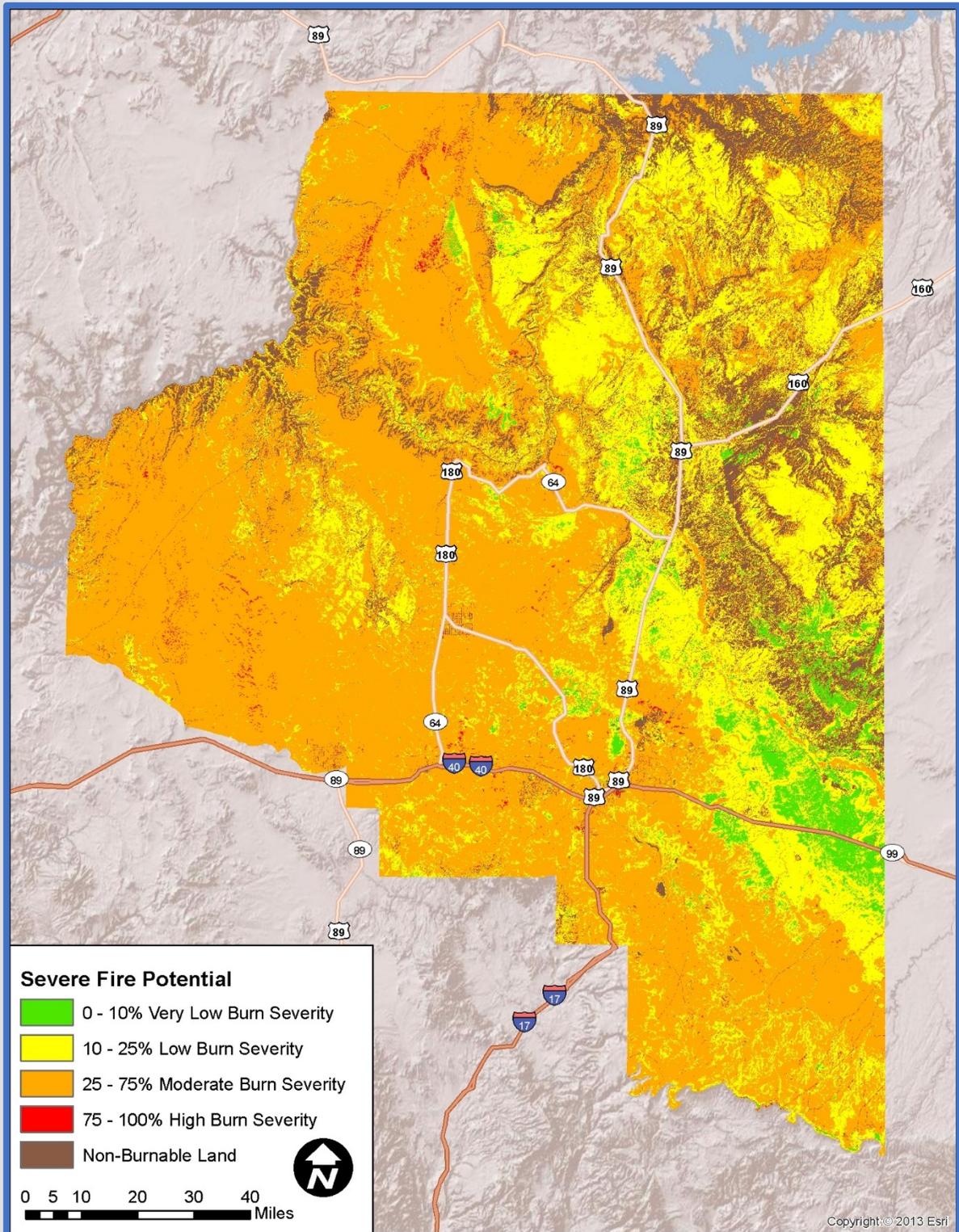


Figure 1. Severe Fire Potential



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Researchers have documented that debris flow initiation zones range on slopes from 15 degrees (27%) to greater than 40 degrees (84%) (Melton, 1965, Takahashi, 1981; Rickenmann and Zimmermann, 1993; Coe and others, 2008; Webb and others, 2008a; Kean and others, 2013; Youberg, 2014). This information served as the foundation for the debris flow risk area analysis, the steps of this analysis are described below.

As stated previously, the USGS 10 meter DEM dataset was used to generate a slope dataset of 15 degrees and greater (Figure 2). Assuming debris flow initiation will only occur within this slope range, all other slopes within Coconino County were eliminated as candidates for initiating a debris flow.

Once the potential debris flow initiation zones were identified, drainage corridors in which a potential debris flow might occur were defined using a series of GIS geoprocessing tools described below.

- **Flow Accumulation** – A Flow Accumulation raster, derived from a Flow Direction grid, represents accumulated flow into each cell. The Flow Direction grid defines the direction that surface water flows, based on topography, and the Flow Accumulation grid defines how many cells flow into each cell.
- **Stream Network** – A Stream Network raster to define stream channels was created from the Flow Accumulation raster channels. A Stream Network raster is created by selecting a flow accumulation threshold, the minimum number of grid cells that drain into a given cell, that defines the beginning of a stream channel. The goal of this analysis was to identify channels in which debris flow initiation might occur and exclude downstream channel segments beyond which debris flows are likely to travel. In this analysis, the Stream Network is defined by flow accumulation thresholds ranging from  $\geq 800$  to  $\leq 100,000$ . These thresholds define channel segments with reasonable headwater locations and limit downstream channel segments that are too far from debris-flow sources to be of concern.
- **Debris Flow Risk Corridors** – The resulting Stream Network raster was converted to a polyline dataset representing all channels that potentially produce debris flows. Debris-flow risk corridors were defined by applying a 100-meter buffer to the polyline dataset. Analysis of debris-flows after the 2010 Schultz Fire suggests the runout of most debris flows did not extend beyond a 5-degree slope. Thus, the county-wide 5-degree slope dataset was used to “cutoff” the debris flow risk corridors. It should be noted that although a debris flow is unlikely to extend much beyond a 5-degree slope, hyper-concentrated and other sediment-laden flooding could continue downslope beyond the 5-degree limit, and could potentially impact communities and infrastructure.

The final step in this assessment is to intersect debris flow risk corridors with the severe fire potential dataset. All debris flow risk corridors not coincident with either the moderate or high burn severity areas were eliminated. Figure 3 shows the final debris flow risk areas created from this analysis.



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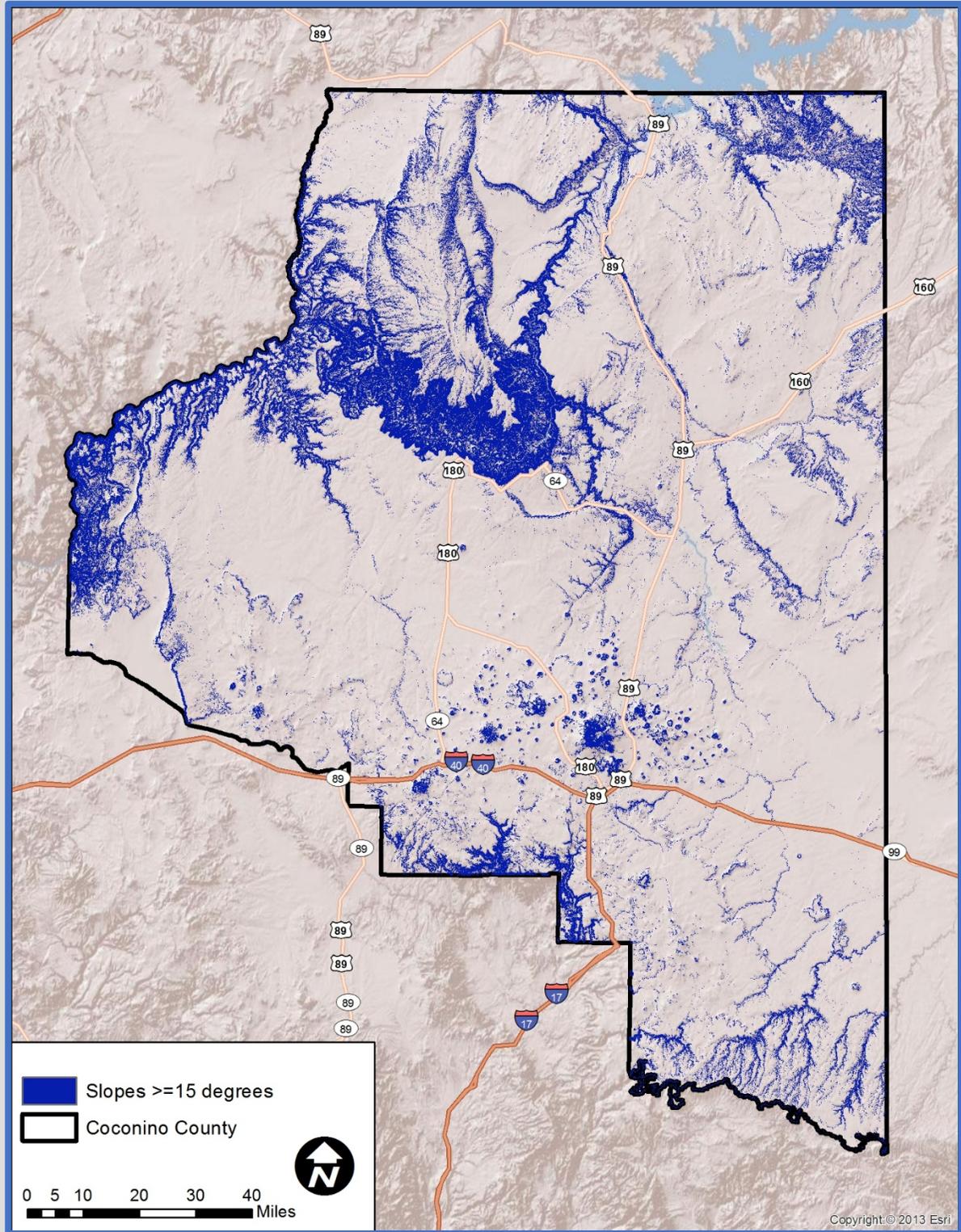


Figure 2. Slopes >= 15 Degrees

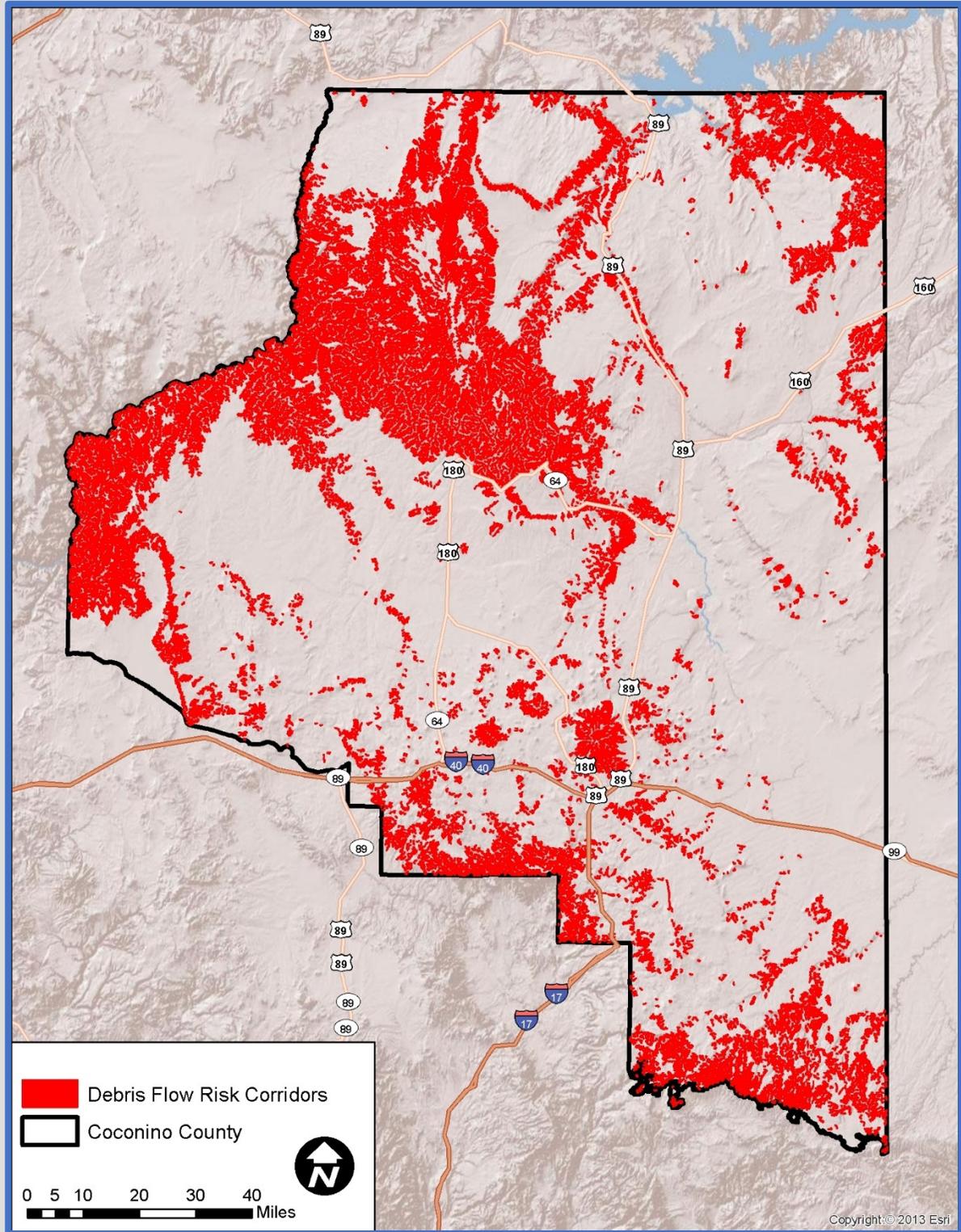


Figure 3. Post-Wildfire Debris-Flow Risk Corridors



The debris flow risk dataset provides Coconino County with a valuable planning tool to identify areas that may be subject to debris flow hazards during a post-wildfire scenario. Although this analysis resulted in county-wide data, it is recognized that some areas within the county would have more severe consequences should a wildfire and subsequent debris-flows occur. Post-wildfire debris-flow risk corridors that intersect dams, buildings, roads, and other infrastructure would be far more devastating than a debris-flow risk corridor that occurred on undeveloped land. A series of weighting criteria were developed to identify which post-wildfire debris-flow risk corridors have the highest potential adverse consequences. Infrastructure that, if damaged or destroyed by a debris flow, would result in substantial loss of life and/or property (such as dams) were assigned a high weighting criterion. Table 2 lists the criterion, and the assigned weighting factor. The weighting criteria was applied to each individual debris-flow risk corridor. Those with the highest resulting value have the highest potential adverse consequences from post-wildfire debris flows. *Figure 4* highlights the 10 highest ranking debris-flow corridors based on the weighting criteria.

*Table 2. Debris Flow Risk Corridor Weighting Criteria*

Criteria	Number of Features within the Debris Flow Risk Corridors	Weighting Factor per Feature
Dams	13	100
Critical Facilities	10	80
Buildings	593	70
Highways, Railways, Streets, Pipelines	1,279	40
Parcels <sup>1</sup>	2,191	10
Ownership <sup>2</sup>	2,951	2
1. Number of assessor parcels within the debris flow risk corridors		
2. Land ownership (Private or State Trust) areas within the debris flow risk corridors		

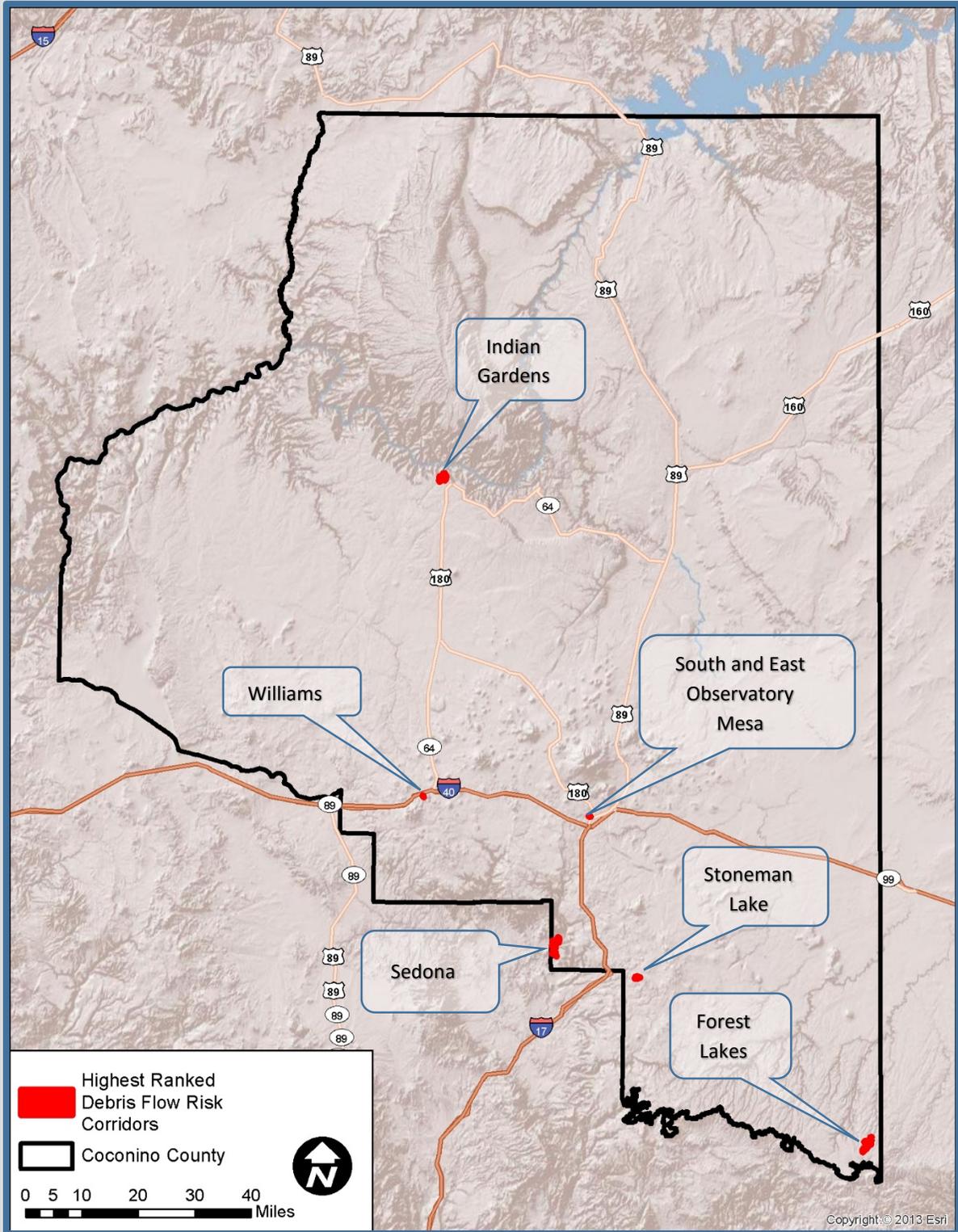


Figure 4. Highest Ranked Debris Flow Risk Corridors Task 2: Pilot Area Selection



**Task 2: Pilot Area Identification**

The purpose of Task 2 is to evaluate the debris-flow risk areas that were identified in Task 1 and select two pilot study areas that will be carried forward in the project and studied in depth. Once these pilot study areas are selected they will be studied for both debris-flow and flooding risk.

Debris-flow risk areas identified in Task 1 were used as a guide to highlight potential pilot study areas. These risk areas are generally confined to a specific flow path within a larger watershed. With this understanding, potential pilot study areas were defined by delineating a watershed which encompasses the debris-flow risk area and the potential flood risk area. Potential pilot study areas are generally much smaller than the HUC-12 watersheds, so that a focused and detailed study can be completed.

Determination of the two pilot watersheds was a two-tiered process. First, the team discussed each of the 10 highest ranking debris-flow risk areas shown in Figure 4 with the purpose of determining which areas appear to be good candidates for further evaluation. The 10 potential areas with each associated HUC-12 watershed and description are listed in Table 3 below.

*Table 3. Debris-flow Risk Area Descriptions*

<b>Name</b>	<b>HUC-12 Watershed</b>	<b>Description</b>	<b>Move forward?</b>
Williams	Cataract Creek Headwaters	One debris-flow risk area identified is on High School Hill flowing north into the City of Williams. Although this risk area is on a short and steep watershed, it is not likely to produce a large volume of debris. The risk area is however in the Cataract Creek watershed that appears to pose great risk to Williams if it burns. Also, the drainages of Upper Cataract Creek, though they did not rank high for debris-flow risk, may pose a significant flooding risk to the dams above the City and the City infrastructure below. This area is recommended to move forward.	Yes
Sedona (5 Areas)	Middle Oak Creek	There are 5 debris-flow risk areas that impact areas within Sedona. They include the drainage that impacts Sedona Community Cemetery/Poco Diablo Resort, three drainages west of Oak Creek that cross Brewer Road, and one area north of Uptown. These risk areas appear to impact many homes which is why they rank high and this area is recommended to move forward.	Yes
Stoneman Lake	Red Tank Draw	Includes the drainages that flow into the east side of Stoneman Lake. This appears to be a significant flowpath and impacts many structures. This area is recommended to move forward.	Yes
South Observatory Mesa	Upper Rio De Flag	This includes a short, steep watershed that flows southeast through Oldtown Flagstaff. There are multiple homes within the risk area but the area was not recommended to move	No



		forward since it originates at the top of a Mesa and is not likely to produce large volumes of debris.	
Indian Gardens	Trinity Creek – Colorado River	This area encompasses multiple fingers of the Garden Creek drainage on the south rim of the Grand Canyon. It was included for consideration due to the very steep watershed slopes and the debris-flow risk corridors that impacted several structures. Although some structures may be impacted by debris-flows, there may be a low probability that the watershed will experience a severe burn due to the vegetation density. The area is also within the Grand Canyon National Park Boundary. This area is not recommended to move forward.	No
Forest Lakes	Dogie Tanks - Jacks Canyon	Forest Lakes is located at the top of St. Joe Canyon which flows north and the debris flow corridor appears to originate north of the residential area in the canyon. The methodology utilized to define debris-flow corridors included the flowpath upstream of the steep initiation area which includes the residential area. Since the area that actually poses risk does not affect any structures, the area was not recommended to move forward.	No

The process of identifying areas prone to post-wildfire debris-flow and flood risk not only relied on the numerical ranking scheme, but also application of common sense and engineering judgment to find watersheds that appear to be at risk. After inspection of the maps and ranking, two additional areas, listed in Table 4, were included in the consideration that appear to exhibit characteristics similar to the east side of the San Francisco Peaks which was impacted by the 2010 Schultz Fire. It is important to remember that these lists do not define all areas that may pose a post-wildfire debris-flow or flood risk.

*Table 4. Additional Debris-flow Risk Area Descriptions*

Name	HUC-12 Watershed	Description	Move forward?
Fort Valley	Upper Rio De Flag	The area encompasses the upper Rio de Flag watershed and includes the area north and south of Highway 180 in the Fort Valley area. The drainages above Big and Little Leroux Springs appear to pose a post-wildfire debris-flow risk that have the potential to increase the severity of the downstream flooding. This area is recommended to move forward.	Yes
Spruce Avenue Wash	Lower Rio De Flag	This area includes the headwaters of the Spruce Avenue Wash drainage between the east side of Dry Lake Hills and the west side of Mount Elden. There is a significant population that may be prone to flood risks in the event of a wildfire, and debris-flows have the potential to increase the severity of that flooding. This area is recommended to move forward.	Yes



The second tier of the watershed evaluation process involved studying each of the 5 areas that were selected to move forward. Table 5 describes the location of each area and the potential limits of each study area.

*Table 5. Potential Pilot Study Areas*

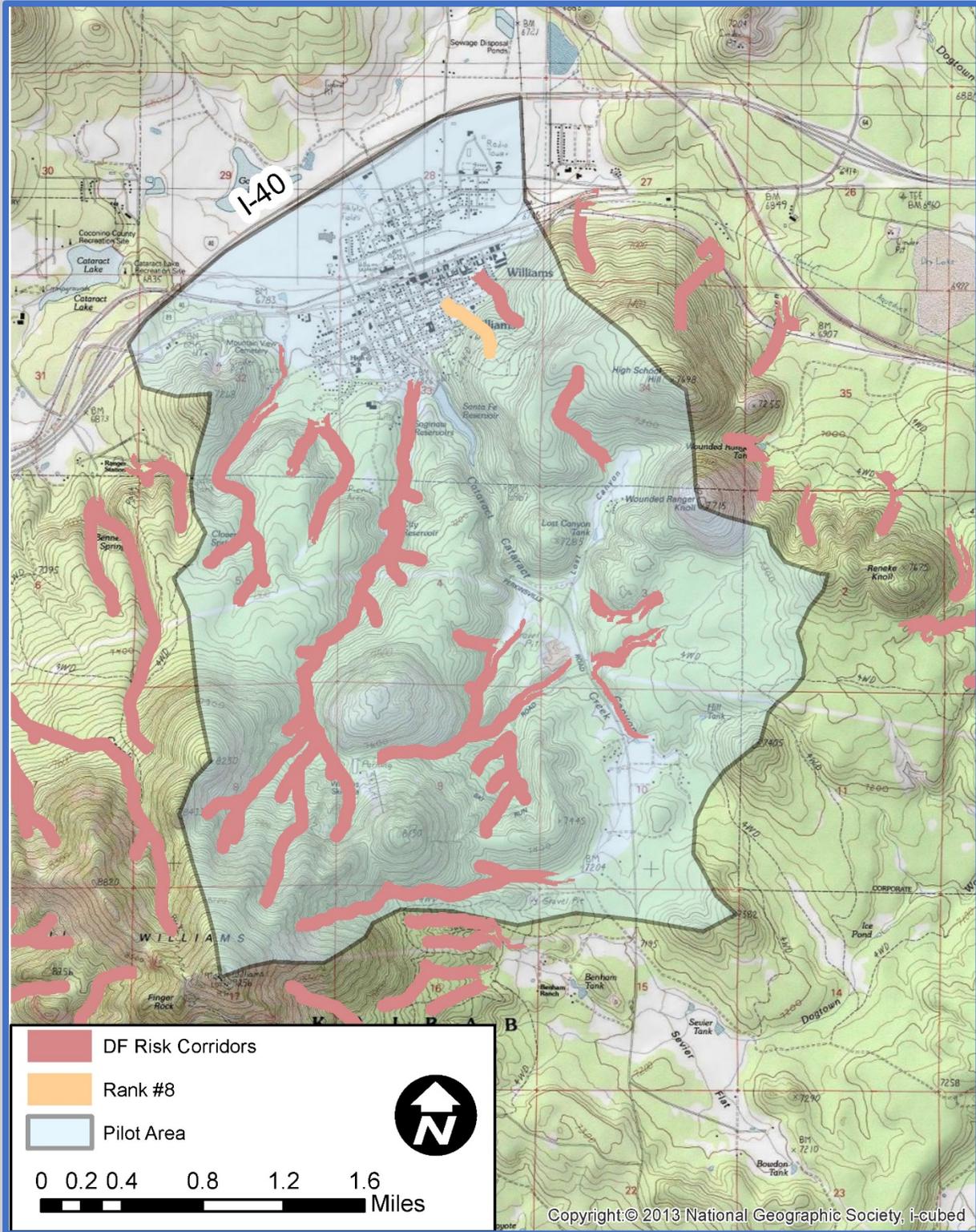
#	Name	HUC-12 Watershed Name	Area of Debris-flow Study	Flooding study	Community Impacted
1	Williams	Cataract Creek Headwaters	Upper Cataract Creek drainages/ High School Hill	Cataract Creek drainages extending to I-40	City of Williams
2	Fort Valley	Upper Rio De Flag	Big and Little Leroux Spring area	Upper Rio de Flag watershed ending at South Snow Bowl Road	Fort Valley
3	Spruce Avenue Wash	Lower Rio De Flag	East side of Dry Lake Hills/west side of Mount Elden	Spruce Avenue Wash watershed	City of Flagstaff
4	Sedona	Middle Oak Creek	Multiple drainages within the Sedona Area	Multiple drainages that outlet into Oak Creek. Oak Creek is not included.	City of Sedona
5	Stoneman Lake	Red Tank Draw	East Side of Stoneman Lake	East Side of Stoneman Lake	Ponderosa Paradise

The following sections present a summary of the initial assessment of post-wildfire debris-flow and flooding risk associated with each potential pilot area.



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## Pilot Area #1 – Williams





### *Williams Pilot Area Description*

The pilot study area will focus on a portion of the upper Cataract Creek watershed which drains the northeast side of Bill Williams Mountain. Debris-flow risk would be analyzed within the area identified above and flooding would be analyzed within the Cataract Creek watershed that impacts Williams.

### *Williams Post-Wildfire Debris-Flow Risk*

Williams is at risk from post-wildfire debris-flows originating on High School Hill as well as Bill Williams Mountain. One of the highest ranking post-wildfire debris-flow risk areas in Coconino County is on High School Hill, impacting Williams from the south. A lower ranked but still important debris-flow risk corridor impacts the City Dam Reservoir, Upper Saginaw Reservoir, and Saginaw Reservoir. Post-wildfire debris-flows have the potential to impact the dams upstream of Williams as well as the water quality of the City's major source of drinking water.

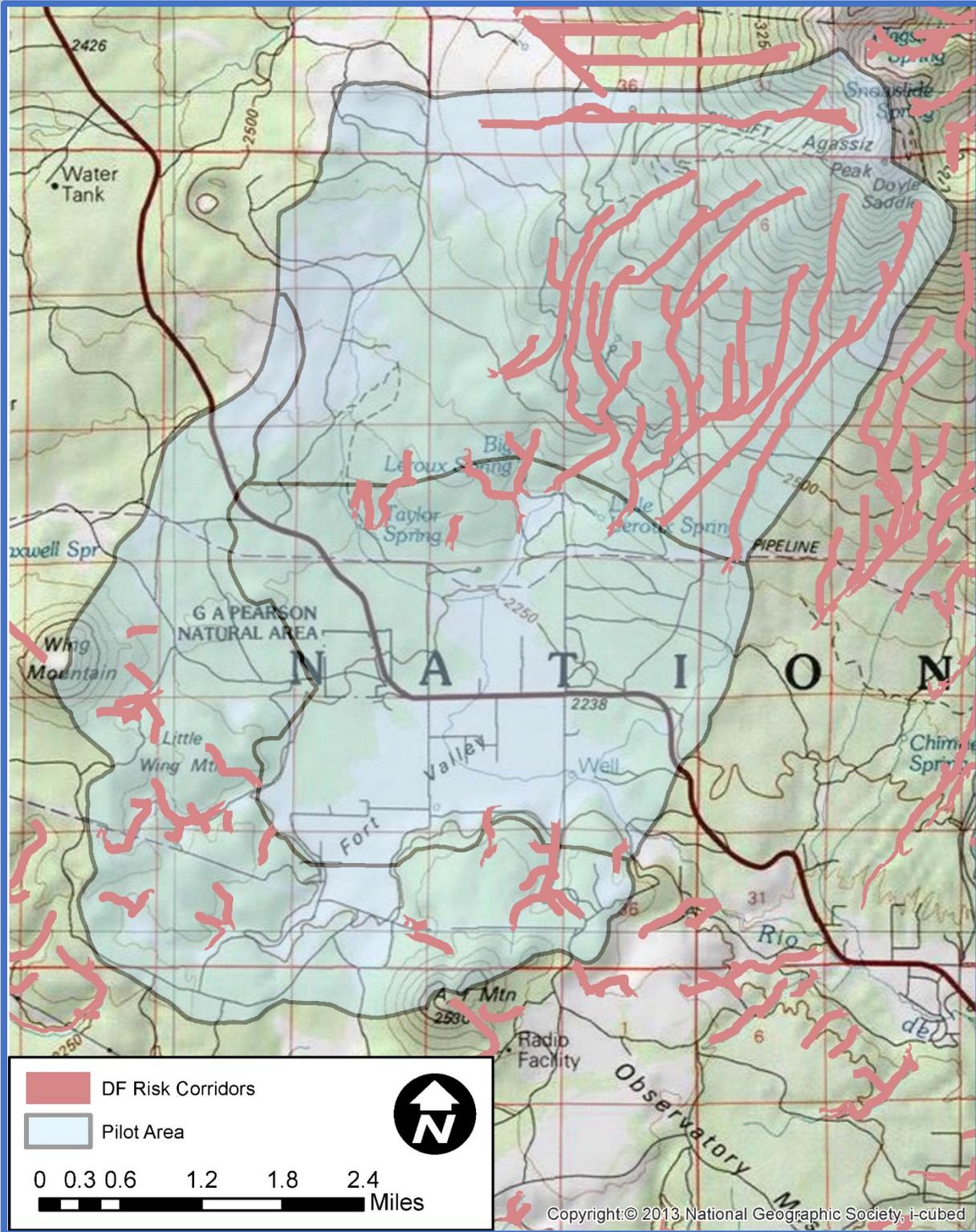
### *Williams Flooding Risk*

The City of Williams is at risk for post fire flooding due to its location at the confluence of two main Cataract Creek tributaries. These tributaries have ADWR Jurisdictional dams directly upstream of the City, but the dams have insufficient flood control storage volumes. Due to the flat topography of the City, an increase in runoff volume following a wildfire would have a significant impact to the town.



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## Pilot Area #2 – Fort Valley



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### *Fort Valley Pilot Area Description*

The pilot study area will focus on the upper Rio de Flag watershed which drains a portion of the southwest side of the San Francisco Peaks and extending south to A1 Mountain. Post-wildfire Debris-flow risk would be analyzed in the Big and Little Leroux Spring area and flooding impacts would be analyzed to the confluence of the Rio de Flag and South Snowbowl Road.

### *Fort Valley Debris-flow Risk*

The Big and Little Leroux Spring watercourses drain into the north Fort Valley area creating a debris-flow risk for the homes in the area. The debris-flows may not directly impact the developed neighborhoods, but impacts from subsequent sediment-laden floods could be more severe due to upstream debris-flows. These debris-flows do not rank among the highest in Coconino County.

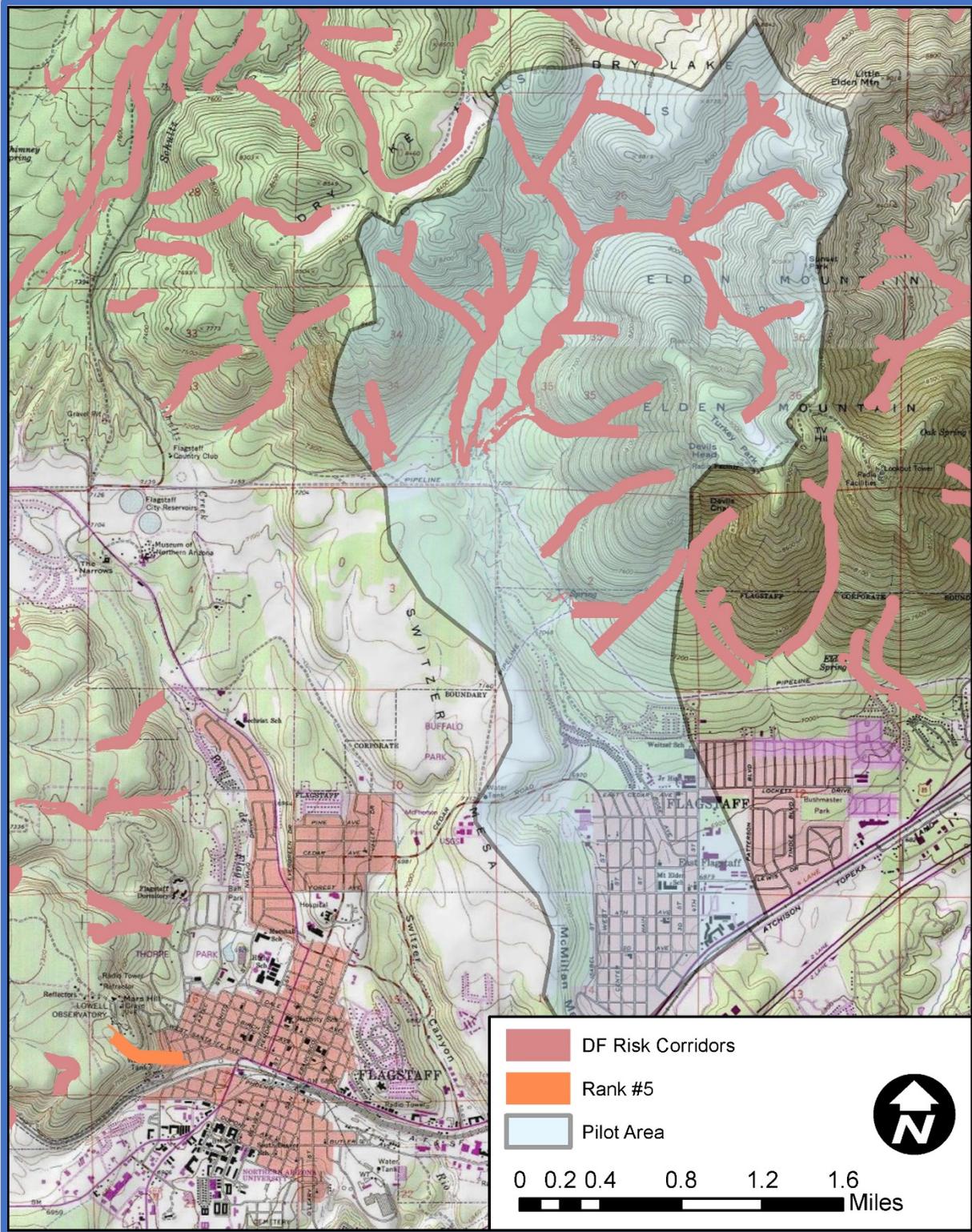
### *Fort Valley Flooding Risk*

The Fort Valley area is at risk for post-wildfire flooding. A wildfire within the watershed could increase the discharge in the Rio de Flag within the meadow area and downstream towards Cheshire. Due to the flat topography of Fort Valley and the lack of major storm water infrastructure, an increase in runoff volume from a wildfire could have a significant impact to the area.



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## Pilot Area #3 – Spruce Avenue Wash





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## *Spruce Avenue Wash Pilot Area Description*

The pilot study area will focus on the headwaters of the Spruce Avenue Wash which divides the Dry Lake Hills and Mount Elden. Debris-flow Risk would be analyzed within the area identified above and flooding impacts would be analyzed to the confluence of the Spruce Avenue Wash and the Rio de Flag.

## *Spruce Avenue Wash Debris-flow Risk*

The Mount Elden Lookout Road neighborhood is at risk from debris-flows originating on the east side of the Dry Lake Hills and the west side of Mount Elden. The debris-flows may directly impact several homes, but downstream impacts from subsequent sediment-laden floods could be more severe due to the debris-flows. These debris-flows do not rank among the highest in Coconino County.

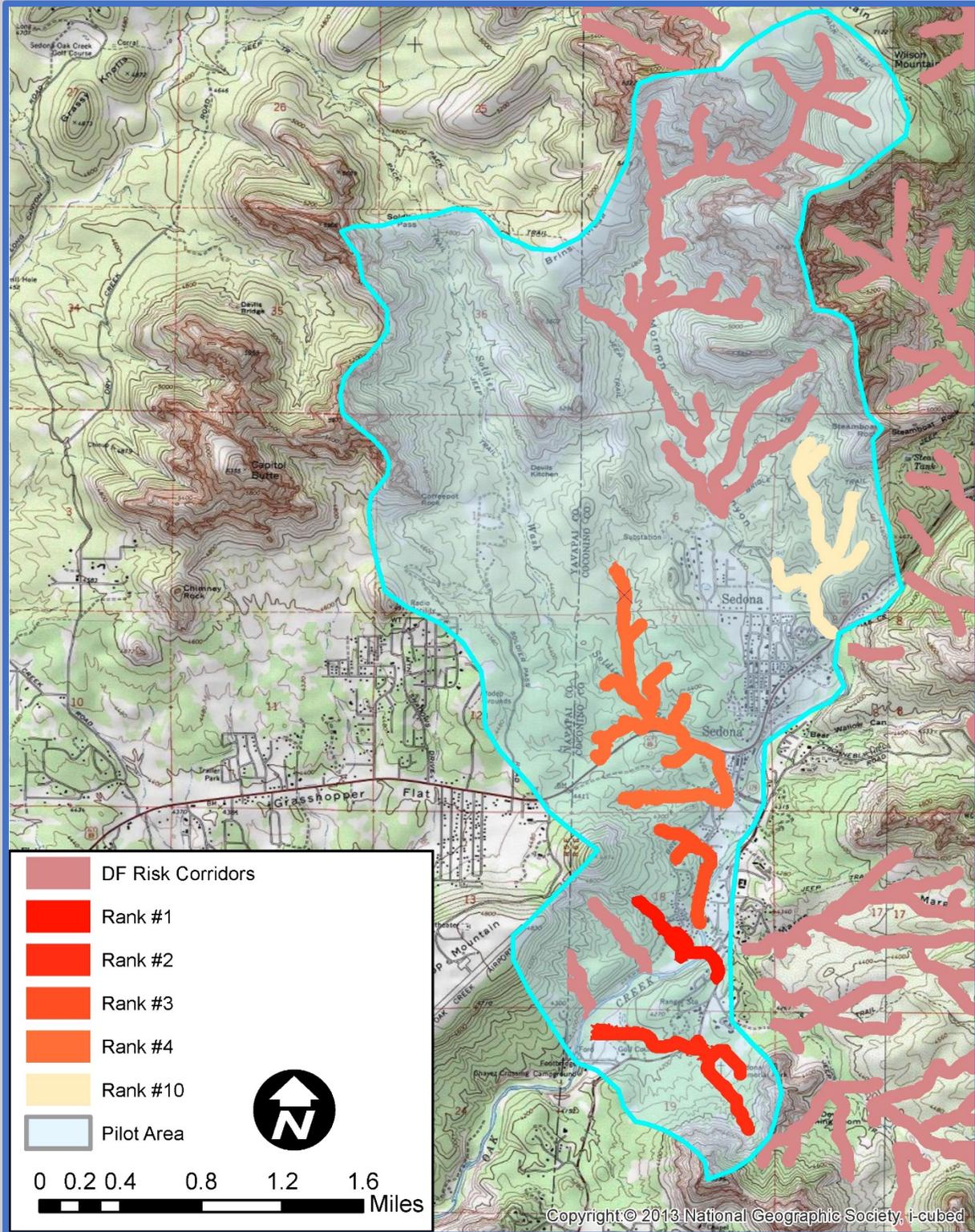
## *Spruce Avenue Wash Flooding Risk*

The east side of Flagstaff is at risk for post-wildfire flooding. The headwaters of the Spruce Avenue Wash are on Mount Elden and the Dry Lake Hills and a wildfire within the watershed could increase the discharge in Spruce Avenue Wash and the Rio de Flag. Spruce Avenue Wash flows through the Sunnyside neighborhood and an increase in the runoff could cause significant impacts.



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## Pilot Area #4 – South Sedona





## *Sedona Pilot Area Description*

The proposed Sedona pilot area encompasses many debris-flow corridors, including 5 of the top 10 ranked corridors in the County due to the nature of the topography. The pilot study area would extend from the Sedona Cemetery in the south to Wilson Mountain in the north. Debris-flow Risk and flooding impacts will be analyzed within the area identified above.

## *Sedona Debris-flow Risk*

There are several neighborhoods at risk from debris-flows originating in the steep sandstone canyons that drain towards Oak Creek. The majority of these are short, steep, sparsely vegetated watersheds with channels that drain through the housing developments and outlet into Oak Creek. They include the drainages that impact Sedona Community Cemetery/Poco Diablo Resort, three drainages west of Oak Creek that cross Brewer Road, and one area north of Uptown. These risk areas appear to impact many homes which is why they rank high. However, the watersheds that encompasses these risk areas have characteristics similar to those involved in the 2006 Brins Fire. One storm, on August 6<sup>th</sup>, 2006, produced three small-volume ( $\sim < 3000 \text{ yd}^3$ ) debris-flows that deposited sediment immediately at the base of the steep slopes with very limited impacts. Even though these are among the highest ranked debris-flow risk corridors in the County, the potential for severe debris-flows may be less due to the vegetation and geology. Generally, these watercourses are well defined and the delineated debris-flow corridors may also be an overestimation of the risk.

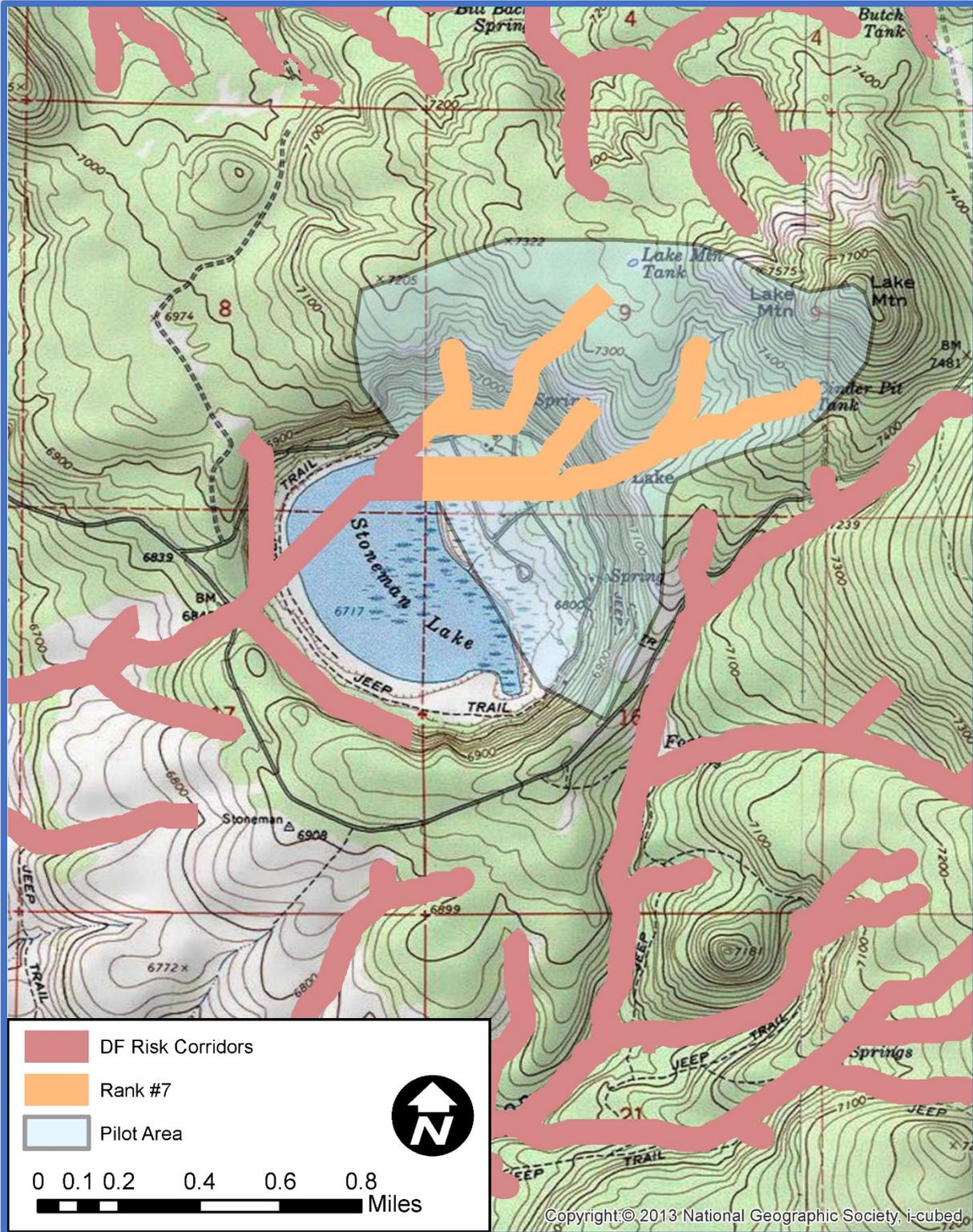
## *Sedona Flooding Risk*

There are many structures that may be at risk for post-wildfire flooding within each of the corridors. Although the proposed pilot area is large in size, each of the individual watersheds are relatively small and generally the watercourses are very channelized until they spread out near Oak Creek. A wildfire within the watershed could increase the flooding along these watercourses as well as increase the discharge in Oak Creek.



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## Pilot Area #5 – Stoneman Lake





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## *Stoneman Lake Pilot Area Description*

The pilot study area will focus on the east side of Stoneman Lake in the vicinity of the Ponderosa Paradise subdivision. Debris-flow Risk and flooding impacts will be analyzed within the area identified above.

## *Stoneman Lake Debris-flow Risk*

The Ponderosa Paradise neighborhood is at risk from debris-flows originating on the steep eastern slopes of the Stoneman Lake basin and Lake Mountain. The debris-flows may directly impact many homes and the area was ranked high in Task 1.

## *Stoneman Lake Flooding Risk*

The east side of the Stoneman Lake basin and the Ponderosa Paradise neighborhood is at risk for post-wildfire flooding. The extent of the flooding may be limited due to the channelized nature of the watercourses and the lack of structures once the grade flattens out into the lake bed.



## Recommended Pilot Areas

Several meetings were held by the project team to select 2 pilot areas for further study. After discussing the potential pilot study areas and considering the pros/cons for studying each area, the team decided upon 2 pilot study areas to move forward towards a detailed study.

*Table 6. Conceptual Alternative Selection Results*

Pilot Area	Name	Advance (Yes/No)
1	Williams	Yes
2	Fort Valley	Yes
3	Spruce Avenue Wash	No
4	Sedona	No
5	Stoneman Lake	No

### *Pilot Area #1: Williams*

The Williams Pilot Area was selected for the following primary reasons:

- The watershed has a high potential to burn.
- Potential for debris-flows to directly impact homes is high.
- Two drainages have reservoirs and are used as a source of city water and debris-flows and flooding may negatively impact the drinking water.
- There is a large number of structures that may be inundated after a fire.
- Bill Williams Mountain has undergone modeling by the Kaibab National Forest to develop burn scenarios that can be used to generate proxy burn severity maps.
- This is an area that has been scheduled for forest treatments on the north side of Bill Williams Mountain but delayed indefinitely.
- The study and community outreach may be a cooperative effort with the City of Williams.

### *Pilot Area #2: Fort Valley*

The Fort Valley Pilot Area was selected for the following primary reasons:

- FLO-2D mapping has been done for the area. Since the base mapping is complete, there is a possibility to model pre and post thinning burned conditions.
- Since the IEA was recently completed for this area, this would be the next logical step in modeling flooding impacts and the benefit of mitigation.
- Fort Valley is in the County so planning/mitigation measures do not need to be coordinated with any other towns or cities.



- Fort Valley is similarly situated to the San Francisco Peaks as Timberline is to Schultz Peak. Timberline was severely impacted from post-wildfire floods and debris-flows following the 2010 Schultz Fire. Fort Valley would likely see similar impacts if a similar wildfire and rainfall occurred on the slopes above this community.

#### *Pilot Area #3: Spruce Avenue Wash*

The Dry Lake Hills/Mount Elden area was *not* selected for the following primary reasons:

- The area is currently being studied by the City of Flagstaff and USFS. The area is included within the Flagstaff Watershed Protection Project and forest thinning is in progress.
- Most people are generally aware of the fire/flood risks in the area.

#### *Pilot Area #4: Sedona*

The Sedona Pilot Area was *not* selected for the following primary reasons:

- The potential for severe debris-flows may be less due to the vegetation and geology.
- No critical infrastructure is affected.
- Flooding and debris-flows from the Brins Fire and Slide Fire were limited which may prove similar in these watersheds.
- Generally, these watercourses are well defined and the delineated debris-flow corridors may be an overestimation of the risk through the most densely populated areas.

#### *Pilot Area #4: Stoneman Lake*

The Stoneman Lake Pilot Area was *not* selected for the following primary reasons:

- All hazards are in a privately owned area.
- No critical infrastructure is affected.
- There is a small population that will benefit if only one drainage is studied.

## **Summary**

The recommended Pilot Study Areas are Williams and Fort Valley. Study of these areas will provide the County with tools to implement mitigation strategies and a useful template to study additional areas in the future.

It is important to note that this is a planning level study that selection of the pilot areas does not value one area over another. The recommended pilot study areas appear to exhibit risk for post-wildfire debris-flow and flooding, and the results developed can be used as guidance for studying other areas of risk identified in this memorandum.



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