

The Economic Impact of Post Fire Flooding: Bill Williams Mountain



Prepared for:

**Lucinda Andreani
Coconino County Flood Control District**

Prepared by:

**Thomas Combrink and Wade Rouse
The Alliance Bank Economic Policy Institute
The W.A. Franke College of Business
Northern Arizona University**

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Overview

Potential damages from a catastrophic wildfire and the post-fire flooding in the Bill Williams Mountain watershed are estimated to be between \$379 million and \$694 million. This study estimates the post-fire flood impacts on the City of Williams located directly north of the Bill Williams watershed. The US Forest Service Bill Williams Ranger District has completed the NEPA process to conduct fuel reduction forest treatments in the watershed, which is critical to the City of Williams and was a recommendation from the *Coconino County Post-Wildfire Debris-Flow and Flooding Assessment*. By thinning unnaturally dense vegetation and using prescribed fire in the watershed, the risk of intense wildfire and post-fire impacts will be significantly reduced.

The primary risks of wildfire are two-fold: damage from the fire and damage from resulting floods. Severe, uncharacteristic fire destroys trees, wildlife and recreation values and threatens homes and infrastructure in its path. Because forest soils are baked during catastrophic wildfire the soils become hydrophobic, and thus temporarily unable to absorb water. As a result, floods occur in areas downstream of burns and cause severe damage to areas located at a distance from the fire itself. Research from the University of Wyoming College of Agriculture and Natural Resources indicates that increased runoff and erosion after intense wildfires on steep hillsides can increase peak runoff by up to 100 times the average flow¹. This happens after moderate to severe fires that burn the soil to the point that it is hydrophobic and can no longer absorb water. After the 2010 Schultz Fire, that burned adjacent to the City of Flagstaff, flooding caused millions of dollars of damages to properties downstream of the watershed. The study concluded that post-fire flows would be up to 5 times the pre-fire flows through the City of Williams. A small (2-year) storm on a burnt Bill Williams watershed has the potential to produce flows similar to the 100-year pre-fire conditions.

This study assumes that post-fire impacts would be similar to a 100 year flood in the drainages below Bill Williams Mountain after a fire of similar intensity and coverage. The Bill Williams Mountain Watershed is located south and uphill from The City of Williams' cultural, tourist, retail, residential and

governmental core. The watershed is heavily used for outdoor recreation including a ski area, residential housing, and summer camps. It is also unnaturally dense with ponderosa pine and mixed-conifer forests and characterized by steep slopes, making this area vulnerable to an intense catastrophic wildfire and post-wildfire flooding that would devastate its scenic and recreation value as well as devastating the City of Williams water supplies. Based on the example of the Schultz Fire, hydrophobic soils are likely to impair the slopes ability to retain moisture, funneling previously unseen amounts of storm runoff through downtown Williams. The runoff would threaten the heart of Williams' tourist industry including retail shops, government buildings, schools, residential neighborhoods, critical infrastructure, hotels and the signature Grand Canyon Railway. The floods could potentially exacerbate the potable water supply issues for Williams as the town depends on both City and Dogtown Reservoirs for surface water. The lack of a constant potable water supply has plagued the City especially during times of drought and any interruption of the water supply could be very costly to the city, its businesses and residents. Burned hillsides would no longer absorb monsoon rains, polluting both reservoirs waters with silt, ash, debris and mud, and reducing storage capacity. The City Reservoir is also subject to debris flows according to the Arizona Geological Survey (AZGS) as discussed in the Coconino County Post-Wildfire Debris-Flow and Flooding Assessment. The result would be a water supply no longer useable until the reservoir is dredged to remove sediment and debris, and the water treatment plant is re-engineered/upgraded to handle the known chemical changes in the water itself. Both of these processes would be expensive. An immediate solution could be the costly process of drilling new wells. However, previous drilling attempts in Williams have proven to be a difficult process. Several efforts to drill new water wells have failed.

This study uses data from the Army Corps of Engineers' *Rio De Flag, Flagstaff, Arizona, Economic Reevaluation Report*², The Ecological Restoration Institute's *Full Cost Accounting of the 2010 Schultz Fire*³, and the *Coconino County Post-Wildfire Debris-Flow and Flooding Assessment*⁴, JE Fuller Hydrology & Geomorphology, Inc., and the Arizona Rural Policy Institute's *Flagstaff Watershed Protection Project Cost Avoidance Study*⁵.

Methods

The *Coconino County Post-Wildfire Debris-Flow and Flooding Assessment* by JE Fuller provides the platform for the analysis of the costs to properties, content and structures within the City of Williams resulting from post-fire flooding events. The JE Fuller analysis examines the impacts of post-fire flooding by developing non regulatory risk zone maps analyzing the potential impacts of post-fire flooding and debris flow in the City. The risk zones are summarized below:

“Existing Condition Flood – Areas which will potentially be inundated by floodwaters greater than 1 foot if the event occurred in the watershed in its current condition.

Potential Post-Fire Flood – Areas which will potentially be inundated by floodwaters greater than 1 foot in depth if the flooding occurs after the watershed burns with the forest in its current condition.

Post-Fire Debris Flow – Areas which may be produce post-fire debris flows. Debris flows erode and scour channels as they travel downslope, releasing sediment for additional transport by hyperconcentrated flows and sediment-laden flood flows. Downstream areas will see a significant increase in flooding and sedimentation after wildfires.

Post-Fire Hyperconcentrated Flow – Areas downstream of debris flows which may experience severe erosion, and transport the sediment, water and debris from the base of the flow to the flood inundation area.

The Williams 100 year risk zone map (Figure 1) is the basis for calculating the costs to structures and properties in this analysis. JE Fuller provided a file of potential flood depths by square meter for the entire risk zone to the Coconino County GIS division. JE Fuller also developed a flood depth map Figure 2, which indicates estimated flood depths within the identified zone. The flood depth layer was then joined to Appraiser Parcel Numbers and the County Assessor’s Office provided the Economic Policy Institute with a final database containing parcel numbers, square footage of parcels and improvements, and flood depths that was used for all flood damage related calculations. Other data sources were provided by the United States Forest Service, local businesses, the City of Williams sales tax collections and the Corps of

Engineers and FEMA documents. Where necessary descriptions of the data used and the methods applied will be included with the cost estimates.

Cost Summary

Table 1 lists the high and low estimated damages that may occur from catastrophic fire and post-fire flooding in the Williams watershed. The estimates are in 2018 dollars and include a majority of costs for the events summarized. Potential financial damages range from \$379 million to \$694 million. Details for each cost estimate is discussed below.

Table 1. Summary of Potential Impacts

	Low	High
Remediation	\$74,000,000	\$93,000,000
Flood Damages	\$93,000,000	\$124,000,000
BNSF Railroad Damages	\$12,000,000	\$23,000,000
I-40 Freight Delays (6 flood events/3 years)	\$27,000,000	\$53,000,000
Lost Property Value	\$24,000,000	\$27,000,000
Williams Water Supply	\$5,000,000	\$10,000,000
Mexican Spotted Owl	\$100,000	\$3,400,000
Communications Towers and structures	\$39,000,000	\$94,000,000
Revenue Loss - Fire event	\$1,200,000	\$11,900,000
Revenue Loss - Flooding events	\$13,000,000	\$72,000,000
Tourism Revenue Losses - reduced tourism demand	\$85,000,000	\$170,000,000
Sales Tax Revenue lost to all events	\$5,000,000	\$12,000,000
Total	\$379,000,000	\$694,000,000

Figure 1. Williams Risk Zones (100 Year Flood)

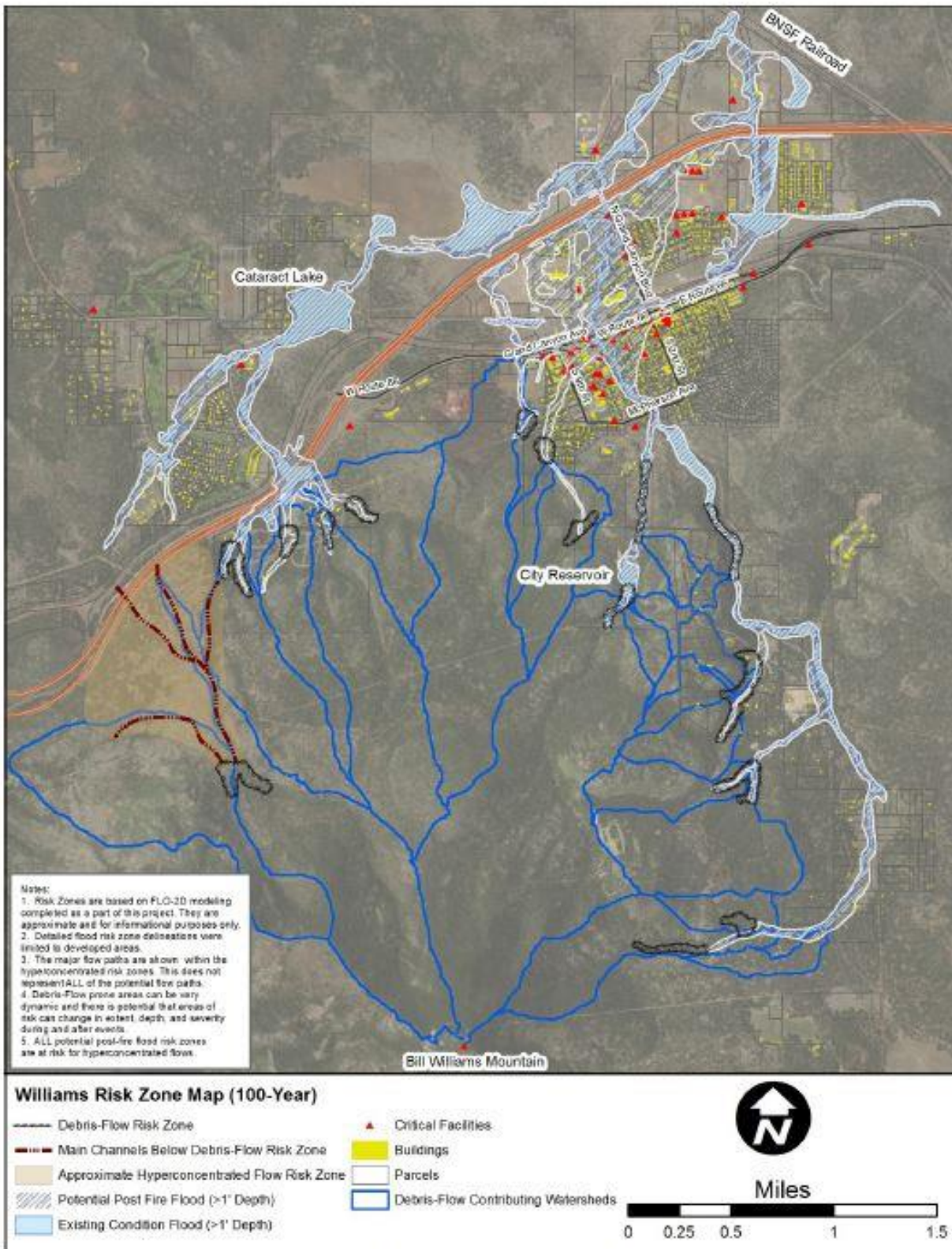
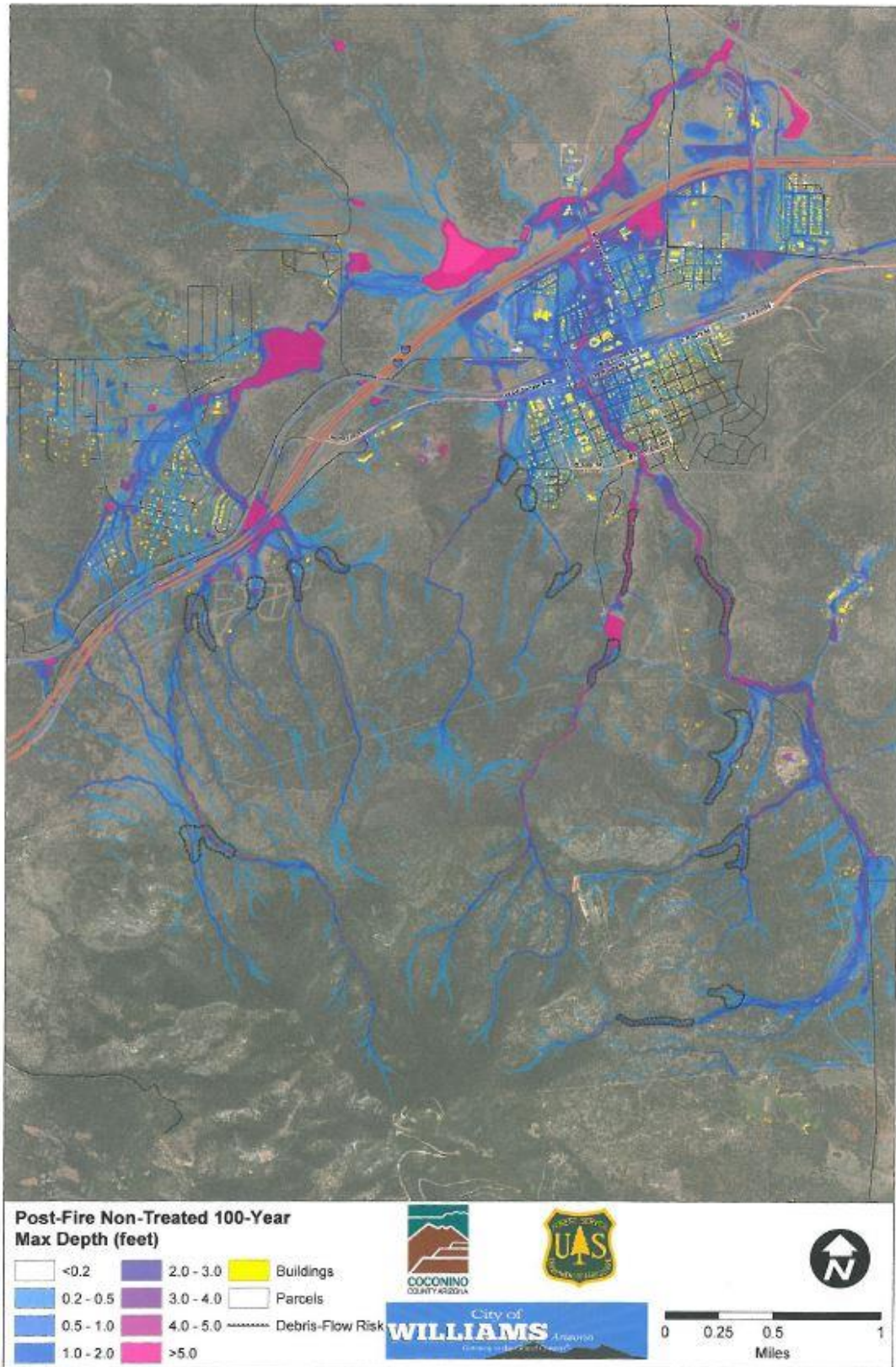


Figure 29 – Williams 100-Year Risk Zone Map

Figure 2. Williams Flooding Depths Post-Fire (100 Year Flood)



Response & Remediation Costs

The response to a fire would incur immediate expenses, including suppression, post-fire rehabilitation, evacuation, and repair costs. This analysis uses as a proxy the costs incurred during the Schultz Fire of 2010. The figures in Table 2 shows the expenditures by state, county, city, and federal government agencies and a variety of utilities after the Schultz Fire and flood. The costs include actual expenditures for suppression and flood mitigation in 2010-2012: mitigation went through 2015 and totaled \$30 million. This did not include response costs. The fire modeling of a catastrophic wildfire on Bill Williams closely approximates the scope and size of the Schultz Fire and are therefore used as a proxy. All costs in Table 2 are adjusted to 2018 dollars.

Table 2. Response and Remediation Costs, based on the Schultz Fire 2010.

Funding Agency	Low Estimate	High Estimate
City of Flagstaff	\$6,000,000	\$7,000,000
Coconino County	\$16,000,000	\$17,000,000
Arizona Division of Emergency Management (ADEM)	\$2,000,000	\$3,000,000
Arizona Department of Transportation (ADOT)	\$4,000,000	\$5,000,000
Fire Department	\$1,000,000	\$2,000,000
Natural Gas Utilities	\$1,000,000	\$2,000,000
Electrical Utilities	\$2,000,000	\$5,000,000
Water Utilities	\$3,000,000	\$9,000,000
Federal Emergency Management Agency (FEMA)	\$7,000,000	\$8,000,000
US Forest Service (USFS)	\$16,000,000	\$17,000,000
Natural Resources Conservation Service (NRCS)	\$9,000,000	\$10,000,000
Federal Highway Administration (FHWA)	\$7,000,000	\$8,000,000
Total adjusted to 2018 dollars	\$74,000,000	\$93,000,000

(Based of FWPP, 2014)

The actual costs estimates related to items in Table 2 may differ significantly from those of the Schultz Fire on which the table is based. Flooding effects in Williams may be quite different as the topography of the two sites differ greatly. The topography of the Schultz Fire allowed for a relatively long gradient that

dispersed flooding over a wider area and limited scour and other effects. On the other hand the potential flooding and debris flow from the Williams watershed is considerably steeper and shorter potentially affecting the velocity and reach of the water. The Schultz Flood affected many houses that were on large lots whereas the flood path in Williams goes directly through built up residential neighborhoods and the developed downtown increasing damage and remediation costs. The impact of flooding is likely to be considerably larger in Williams as the central business district, hotels and the Grand Canyon Railway properties will be directly impacted, when compared to the Schultz flood where virtually no commercial property was damaged.

Assets at Risk

All assets falling within the 100 year flood zone depth map were aggregated to provide the basis for the evaluation of risk. There are 947 buildings in total in the flood zone, a majority (80%) are residential, followed by retail (5%) and accommodations (4%). Residential properties have the highest full cash value (\$135 million), whereas accommodations have the highest full cash value (\$91 million) for the fewest properties. Retail (\$24 million) also has a high full cash value compared to a small number of establishments.

Table 3. Structures and Full Cash Value in 100 Year Flood Zone.

Type of structure	Structures	Total full cash value of parcels
Residential	756	\$135,000,000
Office	22	\$12,000,000
Retail	46	\$24,000,000
Services	14	\$8,000,000
Restaurants/Food	25	\$10,000,000
Industrial-Agricultural	31	\$7,000,000
Public	13	\$6,000,000
Accommodations	40	\$91,000,000
Structure Full Cash Value	947	\$293,000,000

Source: Coconino County Assessor, J.E. Fuller

The total value of structures in the 100 year flood zone was estimated to be approximately \$293 million in 2018 dollars. Maps showing the flood zone are included in the Appendix.

Structure and Content Damage

The projected flood damages in these areas were calculated using the Army Corps of Engineers' Flood Damage parameters of damage to properties and structures resulting from specific levels of flood inundation. Property and content damage were assessed to properties based on the flood depth levels from the JE Fuller map. Parcels with structures that fell within the flood zone were assigned the level of damage based on the actual anticipated height of the flood waters. This method is somewhat more conservative than applying one property and structure damage factor across the flood zone. This figure also represents expectations during one flood event. To provide a range the low estimate assumes that only 75% of the calculated damages actually occur while the high estimate assumes 100% of the damages occur. The figure in the table are for both content and structure losses adjusted by flood water height. Market value of properties is used as opposed to full cash value from assessor parcels. This is consistent since market value is the true potential value that will be damaged by the floods. Market value is considered to be 35% higher than assessor's full cash value.

Table 4. Expected Damages to Structures in the 100 Year Flood Zone.

Expected Damages	Low (75% damages)	High (100% damages)
Residential	\$49,000,000	\$65,000,000
Office	\$4,000,000	\$5,000,000
Retail	\$11,000,000	\$15,000,000
Services	\$3,000,000	\$4,000,000
Restaurants/Food	\$4,000,000	\$5,000,000
Industrial-Agricultural	\$2,000,000	\$3,000,000
Public	\$2,000,000	\$2,000,000
Accommodations	\$21,000,000	\$28,000,000
Total	\$93,000,000	\$124,000,000

Railroad Damages

The ACE Economic Reevaluation Study for Flagstaff projected costs incurred by the Burlington Northern Santa Fe Railway if its tracks were damaged volume and flow of floodwater. Between physical damages and the cost of delayed rail traffic, a total financial impact to the BNSF was estimated between \$11 million and \$22 million. These numbers were estimated by a consultant hired by the City of Flagstaff (for publication in the Economic Reevaluation Study). These numbers are used as a proxy for Williams. The calculation of such estimates is beyond the scope of this analysis.

Table 5. Expected Damages and Interruptions to BNSF railroad operations (inflation adjusted).

	Low Estimate	High Estimate
Railroad Damages	\$12,000,000	\$23,000,000

Source: Army Corps of Engineers

As with many other figures borrowed from the Army Corps of Engineers', this range indicates expectations during one flood event. Experience suggests that following catastrophic fires, such events would occur sporadically and with high-intensity during the monsoon season.

I-40 Damages and Transportation Delays

The potential exists for a 100 year post-fire flood to overtop Interstate 40 west of the Country Club Exit. The extent of the damage to I-40 will depend upon the depth and strength of the water flow as it comes off the mountain and tries to find a path to Cataract Lake via Cataract Creek and the BNSF Railway underpass. The flood zone models indicate a depth between 1 and 2 foot of potential water which will inundate both east and westbound lanes of the Interstate, ponding depths adjacent to the pavement is greater. A study 2007-2008 study by Washington State University titled "Storm-Related Closures of I-5

and I-90: Freight Transportation Economic Impact Assessment Report,” studied the impact of flooding in Washington in the winter of 2007. Both I-5 and I-90 were closed for 4 days each as the result of winter snow melt flooding, and avalanche dangers. As a result of truck traffic disruption and truck delays in the two corridors total loss was almost \$75 million. More than \$47 million of the total loss is attributable to the I-5 closure, with almost \$28 million attributable to the I-90 closure. Sales tax revenues lost are estimated at \$3.81 million, and reduction in personal income is estimated at \$23.15 million⁶. While this study was instructive in producing comparable metrics for I-40 the scale of the I-5 and I-90 closure (20 miles of I-5 under water) is far larger and more complex than the potential closure of I-40 from post-fire flooding.

Using an alternative method also originating in the Washington State report, the first task is to determine the number of trucks passing east and westbound of the flooded area. It is estimated from Arizona Department of Transportation Traffic Counts that there are 8,558 trucks per day that will be potentially impacted by the flooding. Next calculate the mileage of a detour around the closure for both east and west bound truck traffic, the most direct route for eastbound traffic is from Ash Fork to Prescott Valley to I-17 and back to Flagstaff to carry on eastbound on I-40. Conversely, westbound traffic would reverse the route going back to Flagstaff, down I-17 to Prescott Valley and back to Ash Fork. Using Google Maps it was determined that the average roundtrip was 153 miles. The WDOT study estimated the value of time cost for the Washington detours as \$500 per truck per-detour. This yields a total loss of \$4,280,000 per day, and making the assumption that the interstate will stay closed for two days the total cost for the first post-fire flood event is \$8,600,000. Based on the Schultz Fire it is estimated that the first post-fire year will have 3 flood events, year 2 will have 2 flood events and year 3 will have 1 flood event. There are no anticipated damages after year 3 as a result of remediation efforts. The table below presents the cumulative losses due to disruption of truck traffic three years after the fire.

Table 6. Expected Damages and Interruptions to I-40 Resulting from Flooding.

Flood Events	Low (1 Day)	High (2 Days)
3 100 year events year#1	\$13,000,000	\$26,000,000
2 100 year events year#2	\$9,000,000	\$18,000,000
1 100 year events year#3	\$5,000,000	\$9,000,000
Total 100 year flood events years 1-3	\$27,000,000	\$53,000,000

Loss of Property Value

Perhaps the largest financial consequence of a wildfire in the Bill Williams watershed would be the subsequent loss of property values. Residents, businesses, and governments would feel these impacts and losses throughout the city. Multiple factors, ranging from water damage to the loss of a forested backdrop, would depress the existing property market. The resulting loss in property owners' personal wealth would be staggering. For many residents, home equity is a major portion of net worth and the same is true of many businesses. The impact of flooding on government assets is also important, impacting cost of borrowing and the ability to acquire new assets. Because Williams' property values include a premium based on intangibles such as natural beauty and access to adjacent forest land, all parcels in the city would likely see some loss of property value. In the study of the impact of the Schultz Fire the overall percentage of loss is conservatively assumed as 6.7%. The rate was calculated using the drop experienced by homeowners in the neighborhoods north of Flagstaff affected by the 2010 Schultz Fire floods. It is an average built both on properties inundated and damaged, and those in the region that lost value due to intangible commodities such as degraded views and buyer uncertainty.

According to records supplied by the Coconino County Assessor's Office (2018), the aggregate full cash value (FCV) for properties in the flood zone is \$293 million. As stated above, decreases within all city properties are very likely. However, to provide a more conservative comparison, impacts are only calculated on the smaller footprint that will be inundated in the 100 year flood. Within that reach are

1,707 parcels, 947 of which have structures, and 760 parcels without structures. The lost market value is only calculated for those parcels in the flood zone that have structures, as the value of undeveloped parcels should not be affected by property loss.

The county reports the FCV of properties for tax purposes. However, these figures are usually lower than actual market value. According to the County Assessor the market value of properties is approximately 135% of their full cash value. The expected drop in property value was taken from the 2010 Schultz Fire. The study estimated that property in selected neighborhoods north of Flagstaff had lost an average of 6.7% of their value after the fire and subsequent flooding. The 6.7% decline in market value is considered conservative, since the area damaged by the Schultz flooding was exclusively residential, whereas the potential area affected by the Bill Williams watershed contains a mix of residential and business properties. The low estimate is calculated only for structures with flood damage and the high estimate is calculated with all parcels including those without improvements.

Table 7. Estimate of lost Market Value

	FCV	Market Value	Loss (6.7%)
Low estimate (parcels with structures)	\$259,000,000	\$350,000,000	\$24,000,000
High estimate (parcels with structure and undeveloped land)	\$294,000,000	\$396,000,000	\$27,000,000

Williams Water Supply

The primary motivation for the watershed improvements on Bill Williams Mountain is the protection of the Williams water supply. The main surface water supplies for Williams is the City Reservoir (116.6 acre feet) and Dog Town Reservoir (1037.3 acre feet). A burdensome side effect of many fires in recent years has been the pollution of water sources by post-fire runoff and loss of reservoir storage capacity.

For example, the aftermath of two Colorado wildfires – 1996’s Buffalo Creek Fire and 2002’s Hayman Fire – sent over 1 million cubic yards of sediment into Strontia Reservoir, a major municipal water source

for the cities of Denver and Aurora. Dredging the reservoir in order to restore it to a useable state cost the City of Denver \$26 million. According to Brad Hill, City of Flagstaff Utilities Director, a fire in the Upper Lake Mary Watershed would require either drilling 11 new wells, dredging Lake Mary as well as expanding the capacity of water treatment facility, or both⁴. The cost estimates for the redesigning the water treatment facility are based on adjustments made by the Salt River Project after the Rodeo-Chideski fire in 2002. Then, many cities in Maricopa County were forced to make design changes in their filtration processes.

Table 7. Cost to William’s Water Supply

Low	\$ 5,000,000
High	\$ 10,000,000

(Source: FWPP)

These costs are conservative; they do not reflect the time required to make the changes, borrowing costs, or increased production costs (pumping costs). Drilling new well sites in Williams has not always been successful in prior years (personal conversation, Joe Loverich, J.E. Fuller).

Mexican Spotted Owl

A value is placed on the habitat of the Mexican Spotted owl. The treatment area on Bill Williams Mountain includes all or portions of one protected activity centers (PAC’s), for a total of approximately 1,018 acres of protected habitat within the project area. Economists use various methods to attach dollar amounts to habitat loss. The two methods referenced here are found on page 19 in a Full Cost Accounting of the 2010 Schultz Fire. The first is funds spent in conservation efforts. If the United States Fish and Wildlife Service (USFWS) will spend \$100 million on spotted owl recovery projects, and 1,000 units of owl habitat exist, then the value per unit of owl habitat according to the USFWS is \$100,000. A second method used is willingness to pay, from a random survey of American households Loomis and Ekstrand⁵

solicited respondents willingness to pay on an annual basis for conservation efforts specific to the Mexican spotted owl was \$3.6 million (\$3.8 million in 2018 dollars).

Assuming the loss per PAC is between \$100,000 and \$3,843,000, and assuming that damage to any portion of a PAC incurs these losses, the total cost of one lost Mexican spotted owl PAC's would be between \$100,000 and \$3,843,000.

Table 8. Estimated Value of Mexican Spotted Owl Habitat

Estimate	Low	High
Bill Williams Mountain	\$100,000	\$4,000,000

(Source: USFS, Kaibab National Forest, Loomis et.al.)

Estimated Loss of Communications and Communication Tower Infrastructure

The communication towers located atop Bill Williams Mountain are vulnerable to uncharacteristic, stand replacing wildfires. A precedent for the destruction of these facilities was set in June 1977, when the Radio Fire burned on Mount Elden's peak, destroying millions of dollars' worth of communication equipment and interrupting regional communications. The top of Bill Williams Mountain holds an array of towers and buildings. Among the users of these facilities structures and their contents are television stations, FM radio broadcasters, cellular phone service providers, 2-way radio users (including county law enforcement), telephone and internet providers. Kelly Cullen, President of the Bill Williams Mountain Users' Group, estimates that the cost per day for data transmission alone from their group is \$3 million. Replacement costs for the buildings are assumed to be similar to those in the cited in the Flagstaff Watershed Protection Project Cost Avoidance Study⁴ where low cost estimate to replace towers and buildings contents and structure range from a low estimate of \$3 million to a high estimate of \$8 million per structure.

Table 9. Estimated loss of Communications and Replacement Cost of Facilities

Location	Buildings/ Towers	Low (5 days, \$3 million /structure)	High (10 days, \$8 million/structure)
Loss of communications/day	\$3,000,000	\$15,000,000	\$30,000,000
Bill Williams Mountain	8	\$24,000,000	\$64,000,000
Total		\$39,000,000	\$94,000,000

However, this range does not reflect the impacts of communications losses in the area. Were these facilities to burn, many services including cell phone service, internet, radio, and public safety (law enforcement, fire, emergency medical services) communications would be severely impacted. The results would be disastrous across the community, from business operations to fire suppression and emergency services.

Revenue Loss Resulting from Fire & Post-Fire Flooding

Retail sales, especially sales to tourists are critical for the City of Williams, providing both much needed employment and sales tax revenues. Williams is one of three gateway cities to Grand Canyon National Park (GCNP) a world renowned crown jewel in the US National Park system. The City of Williams is a tourist destination as well, with several renowned attractions including the Grand Canyon Railway, Bearizona, and a revitalized tourist dependent downtown. In order to account for tourism losses from fire and flooding the analysis needs to consider the entire regional tourism economy. Economic losses to the tourism economy occur in the form of reduced expenditures and sales taxes collections occur at varying levels depending upon the post-fire timeline. This study will examine business revenue losses at three specific points in time:

- losses during the fire event,
- losses during flood events

- reductions in tourism expenditure post fire and flooding in Williams resulting from reduced GCNP visitation based on uncertainty caused by news reports and perceptions of fire and flooding.

Business Revenue – Catastrophic Fire Event

The first losses to be examined are the loss of tourism revenue and sales tax resulting from a catastrophic fire on Bill Williams Mountain. Based on fire behavior models and the 2010 Schultz Fire it is assumed that the fire will take between 5 to 10 days to contain. Estimating fire behavior is difficult but based on the Schultz Fire and a geographic and topographic similarity the Schultz Fire took 10 days to contain. Therefore, the length to containment will be 5 days at the low estimate and 10 days at the high estimate.

The next step in the process of estimating impacts is to determine a daily estimate of tourist expenditure from City of Williams’ tax data. Averaging daily estimated expenditures over a 5 month period from April to August (these are the months with the highest fire potential) yields daily tourism revenues of \$1,200,000, and sales tax revenues of \$42,000. Extrapolated over the low estimate of 5 days to contain the fire, the estimate of revenues lost is \$6,000,000 while the estimate for a 10 day fire (the norm based on the Schultz Fire) is \$11,900,000. Lost sales tax revenues range from \$42,000 per day to \$416,000 for ten days.

Table 10. Retail business Revenue at Risk from the Fire Event

	Revenues Lost	Sales Taxes Lost
1 day Fire	\$1,200,000	\$42,000
5 days Fire	\$6,000,000	\$208,000
10 days Fire	\$11,900,000	\$416,000

Source: City of Williams

Business Revenue Loss – Post-Fire Flooding Event

Using the same estimates for losses as the previous section, assuming that the economic loss from a flood event would approximate the losses from a fire event. Assuming that the duration of the flooding events would be shorter than that of a fire it is assumed that each flooding event and the impact would last 5 days for a low estimate and 10 days for a high estimate. Based on the Schultz Fire, there were three 100 year flood events in year one, followed by two 100 year flood events in year 2 and one event in year three before remedial actions were taken. Cumulative losses from post-fire flooding account for \$13 million at the low end of the estimate and \$72 million at the high estimate.

Table 11. Retail business Revenue at Risk from Flooding Events

Flood Events	Revenue Lost Low Estimate (5 Days)	Revenue Lost High Estimate (10 Days)
3 100 year events year#1	\$8,000,000	\$36,000,000
2 100 year events year#2	\$3,000,000	\$24,000,000
1 100 year events year#3	\$2,000,000	\$12,000,000
Total 100 year flood events years 1-3	\$13,000,000	\$72,000,000

Tourism Revenue Loss Resulting from Post Fire and Flooding Effects

Finally, the analysis needs to consider the post wildfire and flooding outcomes on the Williams' long term tourist economy. There are numerous articles in the tourism academic literature that examine the impacts of natural disasters such as hurricanes and flooding on tourism communities. None of the literature however, has examined the impacts of these disasters on gateway communities or the impact of fire and post-fire flooding in the west. An analog for what may happen in Williams is the examine the effects that the Slide Fire which burned a large portion of the western slope of Oak Creek Canyon in May 2014, had

on the tourist economy of Sedona. According to a presentation from the Sedona Chamber of Commerce and Tourism Bureau, \$7.6 million in visitor spending was lost during the 10 days of the fire. After the fire when the press was concentrating on stories about the Slide Fire the official Sedona Visitor Center saw a 40% reduction in visitors in June and July. At the same time the community saw a 14% decrease in restaurant and bar sales, and a 25 % reduction in retail taxes. The Chamber estimates that reduced tourism resulted in \$3.4 million in lost tax revenues during June and July and an overall loss of \$100 million dollars in total visitor spending over the period May to July. Visitor volumes for Sedona returned to normal by the end of August, 2014 four months after the fire. The Slide Fire and its impact on Sedona is therefore a reasonable analog to use for estimating potential impacts on Williams. The impacts are also likely to occur in the summer months which coincide with Williams' peak tourist season. The following section estimates the potential impact of visitors who will not travel to Grand Canyon National Park because of the spill-over effects of the fire and perceptions that the Park may not be open.

Williams, Flagstaff and Tusayan all benefit as gateway communities to Grand Canyon National Park (GCNP), providing lodging, transportation and tourism services to visitors traveling by road to the GCNP. Almost four-fifths (79%) of visitors to GCNP arrive at the south entrance with 75% of vehicles entering the park from I-17 and Williams on State Route 64, and 25% traveling from Flagstaff on Highway 180⁷. In 2017, official NPS statistics indicate that 4,918,710 visitors that entered the park through the south entrance in 2017, with 79% arriving via SR64 and Williams (3,689,032 visitors). Some portion of these 3.7 million visitors stay in Williams during, before or after their trip to GCNP and therefore might not go to the park because of the fire and flood.

The monthly average of GCNP visitors was calculated from entrance statistics and per-person, per-car statistics from GCNP were used to convert vehicles to visitors. In order to be conservative in developing the estimates, the potential lost visitation is based on the average visitation from May to August multiplied by average per-person per-trip expenditures of (\$292) from the GCNP from the NPS Money Generation Model⁸. The estimates of loss are reported as a range from 20% to 40% for the four months

and are similar to those of the Slide Fire impacts. It is assumed that after 4 months that visitation will return to its normal pattern based on previous NPS entrance counts.

Table 12. Estimates of Lost Retail Sales and Tax Collections Post Fire and Flooding

	Low Estimate	Sales Tax Revenue	High Estimate	Sales Tax Revenue
Reduction in tourism	20%	20%	40%	40%
Average Tourist Revenue Loss per month	\$21,200,000	\$800,000	\$42,400,000	\$1,500,000
Total losses (May to August)	\$84,800,000	\$3,000,000	\$169,500,000	\$6,000,000

Tax Revenue Lost From All Events

The City of Williams will see a reduction in anticipated tax revenues resulting from all fire, post-fire flooding and reduced tourism scenarios. Sales tax revenues are very important to the City and help to fund city programs, departments and services. The reduction in potential sales taxes are determined by estimating the sales tax portion of the event costs. Sales taxes for the County are also calculated. Sales taxes are not estimated on damages and their repairs but only on potential retail sales during the flood and fire and tourist losses thereafter. The tax estimates are outlined in the tables below.

Table 13. Estimates of Lost Retail Sales Tax Collections all Events

	City of Williams		County	
	Sales Tax Lost Low Estimate	Sales Tax Lost High Estimate	Sales Tax Lost Low Estimate	Sales Tax Lost High Estimate
Events Resulting in Sales Tax losses				
5 day and 10 day fire estimated sales tax loss	\$208,000	\$416,000	\$78,000	\$155,000
3 100 year events year#1	\$280,000	\$1,260,000	\$104,000	\$468,000
2 100 year events year#2	\$105,000	\$840,000	\$39,000	\$312,000
1 100 year events year#3	\$70,000	\$420,000	\$26,000	\$156,000
Total tourism losses (May to August)	\$2,967,000	\$5,933,000	\$1,102,000	\$2,204,000
Total Sales Tax Losses	\$3,630,000	\$8,869,000	\$1,348,000	\$3,294,000

It is estimated that \$5 million in combined city and county potential sales taxes are lost for the low estimate and \$12 million dollars of sales taxes are lost for the high estimate.

Conclusion

While the potential damages from a catastrophic wildfire and the post-fire flooding identified in this study range from \$379 million to \$694 million, some costs have not been accounted for, therefore the estimate is **conservative**. Several omissions that would surely carry costs include:

- Lost payroll for retail and tourist attractions, during both fire & flooding and post fire events
- Damage to utilities (electric, sewer, etc.)
- Health problems, both physical and mental
- Evacuation costs during both fire and flooding
- Negative impacts on outdoor recreation
- Negative impacts on air quality
- Damage to residential streets
- Vehicles damaged or destroyed by flooding
- Increased travel time for residents and visitors

These costs and others could be calculated if the data were readily available and added to the total.

Regardless, the impact as shown in this study to thin the forest on Bill Williams Mountain makes the case for such a restoration. It is estimated to cost between \$4 and \$8 million to thin this forest. This seems like a small investment compared to even the lower end of the potential damage estimate of \$379 million.

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