Alluvial Fan Mapping and Risk Assessment

Project Report:
Big Wood, Lower Boise, Payette, Teton and Upper Spokane Watersheds

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I. PROJECT MANAGEMENT PLAN

Project Summary

The Alluvial Fan Mapping Project Report for the five funded watersheds—Big Wood, Lower Boise, Payette, Teton and Upper Spokane—was designed to map alluvial fans from existing data sources such as geologic maps and flood insurance rate maps as specified in the Alluvial Fan Mapping CTP (Cooperating Technical Partners) Project Proposal (Idaho Department of Water Resources [IDWR] 2012). Further work on this project includes techniques for identifying potential alluvial fans from existing data sources, such as slope models and geologic data.

The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP) and the Risk Mapping, Assessment and Planning (Risk MAP) program throughout the United States and is authorized to identify and characterize flood hazards, particularly in Idaho. Idaho has only 11 counties with Digital Flood Insurance Rate Maps (DFIRMs), 26 counties and 14 cities with paper Flood Insurance Rate Maps (FIRMs). Mapping flood hazards in Idaho includes riverine flood sources and one of the most dangerous geologic features associated with riverine flooding, alluvial fans. Heavy rain events such as micro-bursts and thunderstorms can deliver significant amounts of water anywhere in Idaho. These heavy rain events create flash flooding that produces significant water flows through streams and rivers that often emerge onto alluvial fans. These sheet flow areas are designated as Zone AO on FEMA maps. This proposed mapping activity seeks to attain funding to map alluvial fans using existing data as the state match to identify potential AO zones for future inclusion in Idaho flood hazard maps.

Alluvial fans are made of sediments that are deposited where a stream or river leaves a defined channel and enters a broader and flatter floodplain. These deposits are fan-shaped on account of the coarse- and fine-grain material that the stream or river deposits. As the flow path spreads out, conveyance is reduced and active erosion, sedimentation, deposition and unpredictable flow paths inundate the low-lying areas. Alluvial fans are especially dangerous and convey high flood risk. When the stream or river repeatedly deposits sediment into its floodway and channel bed, the conveyance capacity of the cannel is quickly exceeded resulting in overbank flooding, erosion and the formation of a new channel. Alluvial fans are also dangerous because the stream or river channel will slowly erode the soft sediments and meander outside of the mapped .01% annual chance flood zone. FEMA designates Zone AO as the .01% annual chance flood zone for shallow flooding, sheet flow or areas with high flood velocities on alluvial fans. Idaho Department of Water Resources (IDWR) intended to map these alluvial fans in Idaho.

Project Benefits

Mapping Idaho alluvial fans develops quality risk assessment data, increases risk awareness, enables additional mitigation actions at the local level, and validates existing flood studies while informing future flood studies.

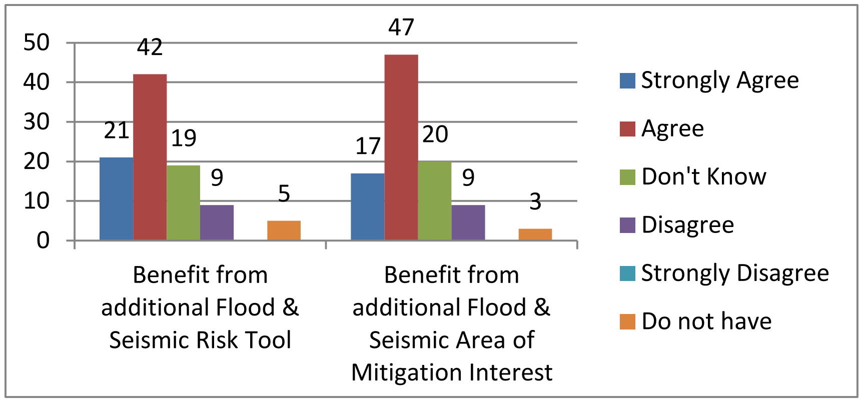

Table 1. Survey results from local communities

In the Idaho Flood and Seismic Risk Portfolio, IDWR asked local communities if they believed developing additional flood and seismic risk assessment tools was beneficial. IDWR also wanted to discover if communities believed they would benefit from tools to help mitigate flood and seismic risks. As Table 1 indicates, local Idaho communities wanted to better understand their flood and seismic risk.

Benefits of Mapping Alluvial Fans

- Supports future DFIRM production
- Useful in identifying AO Flood Zones
- Supports Mass A Zone DFRIM production
- Functions as a non-regulatory Risk MAP product
- Informs county and city land use planning
- Informs flood risk assessments
- Constitutes, quantifies and qualifies substantive Areas of Mitigation Interest
- Informs county All Hazard Mitigation Plans
- Informs State All Hazard Mitigation Plan
- Informs Disaster Preparedness, Response and Recovery
- Informs Fire Management Program
- Supports NRCS soil protection initiatives
- Informs USACE and BOR reservoir sedimentation patterns
- Informs Idaho Geological Survey research

Deliverable

Vector and attribute data were created and stored in the geodatabase deliverable

Project Phasing

The project was designed to be phased by watershed. Study watersheds include Big Wood, Lower Boise, Payette, Teton and Upper Spokane.

Acknowledgement

The State of Idaho sincerely thanks FEMA Region Ten for funding and supporting this project.

II. ALLUVIAL FAN IDENTIFICATION

Definition

Many different definitions exist for the term alluvial fan, although most include some description of the overall shape of the feature, the location of where sediment deposition occurs and the process by which the fan forms (Rachocki, 1981). This report will defer to the definition created by the National Research Council (NRC), as tasked by FEMA: a sedimentary deposit located at a topographic break, such as the base of a mountain, escarpment, or valley side, that is composed of stream flow and/or debris flow sediments and that has the shape of a fan either fully or partially extended.

Alluvial fans receive their name from the material from which they are made, alluvium. As defined by Bates and Jackson (1984), alluvium is "A general term for deposits made by streams on river beds, flood plains, and alluvial fans. The deposits are typically made of up of loose rock and mineral material produced by mechanical means (disintegration or abrasion)." Therefore alluvial fans are geologic features with distinct physical properties that can be identified using the Geographic Information System (GIS).

Formation

Alluvial fans form at the topographic apex (the point where a stream exits the mountain slope and enters the valley floor, Figure 2), due to the stream's inability to move material, due to an increase in channel width, a reduction in channel slope or an increase in sediment load to the stream (Bull, 1977; National Research Council, 1996; Rachocki, 1981). Alluvial fan formation, and periodic flash flooding, is particularly common in arid and semi-arid regions where a lack of vegetation and extensive root systems minimize the total cohesive strength (binding together) of the soil. However, they may also form in humid regions (Harvey *et al*. 2005) or on glaciers, where the glacial-melt run off deposits sediment and forms outwash fans in front of the glacier (Boggs, 1995). When multiple alluvial fans at the base of the mountain front grow large enough to combine, the resulting continuous spread of sediment is commonly called a "bajada" (Bates & Jackson, 1984), although the term "apron" is often used interchangeably.

Alluvial fans are divided into three general types based on their depositional features or the process by which the alluvium was transported and deposited: **stream flow fans, debris flow fans** and **composite fans** (FEMA, 1989; National Research Council, 1996; Lancaster et al., 2010). It should be noted that the Association of Flood Plain Managers have reviewed information regarding alluvial fan flooding and recommend a further subdivision of alluvial fans (ASFPM, 2011).

> **Stream flow fans** are those that have been built up by water floods. Stream flow events are characterized by high speed water flows with sediment concentrations of 20% or less by volume (FEMA, 2012).
>
> **Debris flow fans** are those that have been built up by hyper-concentrated (20-40% sediment by volume), transitional or debris flow events. Debris flow events are characterized by slow to moderate velocities of moving objects which may include boulders, rocks and sediments with concentrations of 55% or more by volume (FEMA, 2012).
>
> C**omposite fans** combine the characteristics of stream flow and debris flow fans. They are built up through water floods (stream flow fans) but also by hyper-concentrated, transitional or debris flow events (Lancaster et al., 2010).

Visual Identification

The alluvial fan's three-dimensional shape is described as an outspread fan or segment of a cone when viewed in plan-view (Figure 1, Part A). A cross-section perpendicular to the river valley, from which the flow emanates, shows the fan's convex-upward profile (Figure 1, Part B); whereas a cross-section parallel to the mountain valley from which the flow emanates shows the fan's concave-upward profile similar to a riding saddle (Figure 1, Part C; Boggs, 1995; Bull, 1977). The far boundary of a fan, or toe, is commonly marked by an obstacle that intersects the fan, such as a stream, lake or alluvial plain. The toe of a fan may be identified by increases and decreases in slope as evidenced by Digital Elevation Models (DEMs), contour lines, IFSAR or LiDAR data. The lateral boundary of a fan may be marked by a trough, channel or swale at the lateral limits of deposition (National Research Council, 1996).

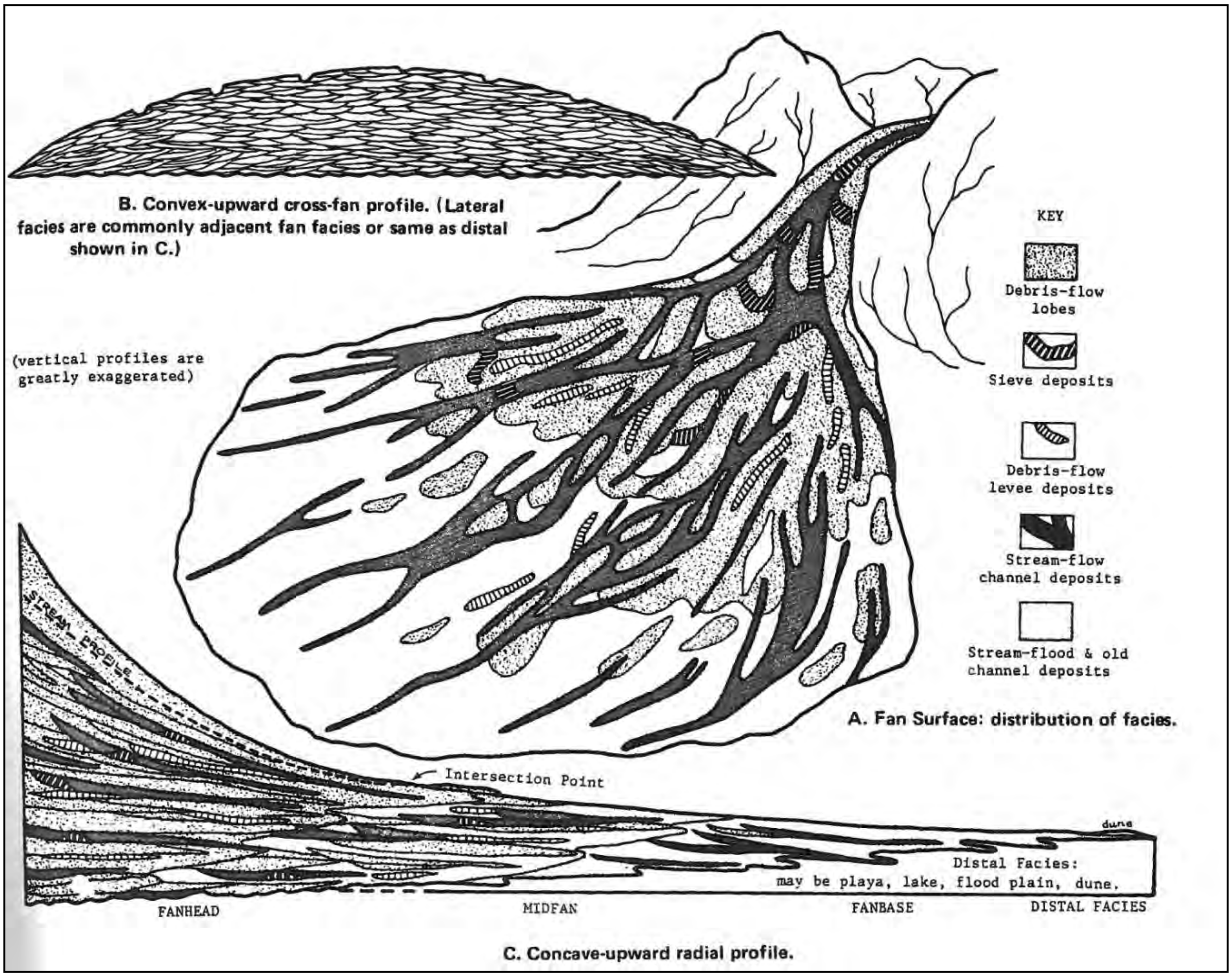

Figure 1. Cross-sectional profiles and generalized fan surfaces. Boggs, 1995.
A. Fan surfaces. B. Cross-fan profile oriented parallel to mountain front. C. Longitudinal profile oriented perpendicular to mountain front.

Based on the aforementioned fan types, alluvial fans can be divided into more specific sections (Figure 2). The topographic apex is the highest point on an alluvial fan and is typically located where the stream exits the mountain slope. The hydrographic apex is the highest point on an alluvial fan where the flow is last confined. The inactive portions of an alluvial fan are those for which evidence of recent flooding cannot be found. The active portions of an alluvial fan are those where flooding, deposition and erosion are possible.

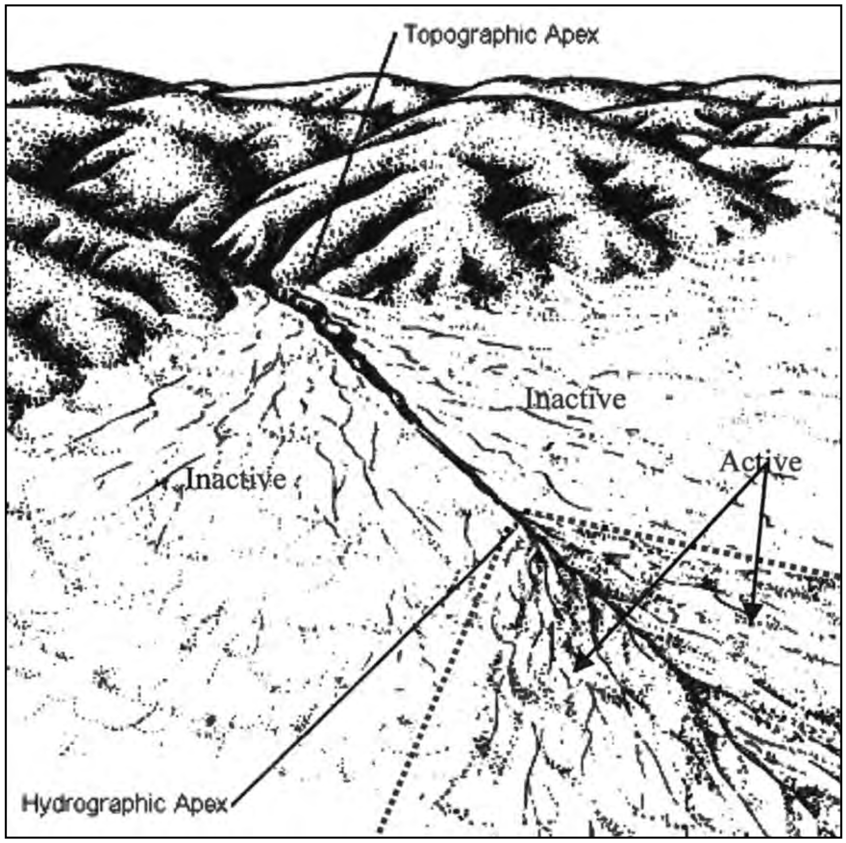

Figure 2. Alluvial fan zones. Bull, 1977; FEMA, 2003(a).

A typical alluvial fan can be broken down into three distinct zones, each having unique hydraulic, sediment transport, deposition processes and flood hazard levels. These zones possess several different names. However, this report will acknowledge the terms established by Boggs (1995) and FEMA (2012): upper fan, mid fan and distal fan, as illustrated in Figures 1 and 2.

The **upper-fan zone** is identified by the following characteristics:

- Also known as the channelized zone, proximal fan, or fan head
- Begins at the topographic apex and ends at hydrographic apex
- Typically flanked by inactive portions of the fan
- Steepest slope
- Coarsest sized sediment
- Flow confined to single or few deeply entrenched channels
- Rare shifting of channel may occur due to clogging with sediment or debris
- Flood hazard due to high flow velocities, boulder/debris impact and channel scour

The **mid-fan zone** is identified by the following characteristics:

- Also known as the braided zone
- Begins at the hydrographic apex and ends where the hydraulic regime shifts to sheet flow and lack of defined channels
- Considered to be within the active portion of the alluvial fan
- Gentler slope
- Intermediate sized sediment
- Unstable flow paths resulting in numerous interlacing and shifting shallow channels
- Flood hazard due to flood inundation and sediment deposition

The **lower-fan zone** is identified by the following characteristics:

- Also known as the sheet flow zone, distal fan or fan toe
- Begins down-slope of the mid fan and ends at the toe of the alluvial fan
- Considered to be within the active portion of the alluvial fan
- Gentlest slopes
- Finest size sediment
- Lack of well defined channels
- Flood hazard due to inundation by low velocity floodwater

Land Surface Identification

In some cases, current or potential alluvial fans can be identified in the field using visual observation. This is usually done by professional geologists or engineers who are trained to look for both obvious and subtle indicators. In other cases, however, indicators such as slope and fan size may not be recognized in the field (FEMA, 1989). Therefore, potential alluvial fans may be identified using historic aerial photographs, topographic maps or geologic maps produced by entities such as the United States Geological Survey (USGS), state geological surveys, soil conservation districts and universities. When viewing maps or photographs, alluvial fans can be identified by their location at the mouth of the mountain valley and characteristic fan shape. This shape is characterized by semi-circular arcs of concentric contour lines emanating from the topographic apex and bowing downstream, like ripples on the surface of water. If a potential alluvial fan is identified using maps or photographs, it is recommended that a final confirmation be accomplished in the field by professionals trained at alluvial fan identification.

III. HAZARDS AND MITIGATION

Hazards and Hazard Factors

The main hazard associated with alluvial fans is flooding. As defined by Title 44, Code of Federal Regulations, Part 59 (2013), alluvial fan flooding is "flooding occurring on the surface of an alluvial fan or similar landform which originates at the apex and is characterized by high-velocity flows, active processes of erosion, sediment transport and deposition and unpredictable flow paths." The mouth of the water source is the topographic apex of the fan, or the highest point on an alluvial fan where flow is last confined (National Research Council, 1996). In other words, the fast-moving flow most commonly associated with alluvial fan flooding is highly dangerous and destructive. The high velocities result in deep scour that moves large sediments, boulders, vegetation and deposits these objects elsewhere; resulting in damage to people, property and structures.

Three of the most common types of alluvial fan flooding are stable channel flooding, sheetflow flooding, and debris flow flooding (FEMA, 2003).

> **Stable channel flooding** usually occurs in the upper fan where the channel(s) is typically deeply entrenched and has definable banks that contain the floodwaters. This stable channel is located between the topographic and hydrographic apex. Stable channel flooding risks include channel migration and subsequent erosion of stable bank material, which may result in a shift in the location of the channel, called avulsion. Stable channel flooding may also cause erosion of bank material adjacent to existing structures, such that the structure is undermined and at risk of partial or full collapse.
>
> **Sheetflow flooding** occurs below the hydrographic apex and is characterized by shallow waters that carry large amounts of sediment not confined to a channel. Sheetflow flooding mainly causes inundation of structures by the flood water and deposits sediments. These deposits form natural barriers, redirecting the floodwaters, creating internal and external structural damage or burying low-lying surface features.
>
> **Debris flow flooding** can occur on any portion of the fan given correct weather and watershed characteristics. Due to debris flows' high sediment to water ratio, they move slowly and heavily, like cement, and even at low speeds cause major damage due to sheer force and momentum. Debris flows can deposit massive amounts of sediment and organic debris that dam up and force the avulsion of stable channels.

When assigning risk for flood insurance purposes, it is important to determine which portions of the alluvial fan surface may or may not experience flooding. However, this determination is not exact. Given enough geologic time and extreme weather events, portions of the alluvial fan may suddenly experience flooding even if they have never done so before. For flood insurance purposes, however, the flood risk is determined using more well-known and likely probabilities. Criteria were developed to assign alluvial fan flooding risk with the recognition that not all portions of an alluvial fan are at equal risk of flooding (National Research Council, 1996). These criteria are based on whether or not the alluvial fan has experienced flooding at some reasonable point in the past: and if so, then it is likely to experience flooding at some reasonable point in the future. Therefore, the surface of the alluvial fan is divided into "active" and "inactive" portions (Figure 2). The "active" portions of the fan are those where flooding, erosion and deposition are possible within a determined timeframe, usually 100 years (National Research Council, 1996; FEMA 2003). FEMA determines the 1% annual chance, or 100 year, event as the statistically relevant period for setting Flood Insurance Rate Map (FIRM) thresholds, which are different from the flood hazard maps because 1) FIRMs are concerned with floods with a return interval of 100 years, and 2) evidence of alluvial fan flooding from events in the past 100 years is relatively easy to identify. Several factors are used by professionals to determine active and inactive portions of alluvial fans, including relative age indicators such as marker beds containing artifacts of human origin; morphology and weathering of fan surfaces; surficial geology and soils maps; and vegetation type and density (National Research Council, 1996; FEMA, 2003). All of these indicators of alluvial fan behavior and hazard were taken into account in this study.

Variables Contributing to Hazards

The shape and form of a landscape can be understood as a result of the interaction between of mass (sediment) and energy (gravity). For example when water from precipitation flows downhill, under the force of gravity, it exerts kinetic energy on the sediment. The sediment may then erode and be deposited at some other location, thereby altering the shape and form of the landscape. Only certain landscape components, or variables, are capable of adjusting to the changing energy of the environment. Bull (1991) identifies those variables that are capable of adjustment in human timescales as the "dependent" variables, and those that are considered incapable of adjustment as the "independent" variables (Table 4). A number of variables may combine to affect the severity of alluvial fan flooding. The recurrence interval for each of these variables takes a very long time to manifest.

Independent Variables	Dependent Variables
Climate	Drainage Basin Area
Total Landscape Relief	Hillslope morphology (slope)
Drainage Basin Base Level	Subsurface drainage pathways
Underlying lithology and geologic structures	Soil-profile development
Human activities	Vegetative type and density
	Fauna
	Watershed disturbances (wildfire, landslides, earthquakes)
	Human activities

Table 2. Examples of independent and dependent variables in a watershed

Independent Variables

The independent variables have little relation to the other variables in the watershed and exert primary control on the stream channel system. A primary example is climate, specifically precipitation. Changes in the amount and type of precipitation alter the extent and rates of weathering, erosion, transportation and deposition of sediment. These changes shape the hills and streams, which eventually form the alluvial fan (Bull, 1991). In wetter climates, more frequent and intense precipitation events occur resulting in increased streamflow and therefore an increased capacity to erode and transport sediment onto the alluvial fan. In dryer climates, the frequency and intensity of precipitation events is less, resulting in reduced streamflow, sediment deposition and fan development.

Drainage basin base level is the lowest point in the system to or through which the water flows. Drainage basin base levels contribute to alluvial fan formation and flooding. Water flows from higher gradients (elevations) to lower gradients and the base level is the low point of the gradient. Higher drainage basin base level can result in steeper hillslopes, channel slopes and bigger drainage areas. This equates to more energy, in the form of water flow, which acts upon the land surface. The opposite is true of lower drainage basin base level, where low hill and channel slopes equate to less energy.

The landscape's geology is another influence contributing to alluvial fan hazards. The underlying geology may be composed of rocks that erode easily are resistant to erosion or resist chemical/physical breakdown into sediment. How much and how long the underlying geology can resist the erosive stream energies affects the amount of sediment in the drainage system.

Dependent Variables

The dependent variables are typically interactions within the watershed between independent variables and sometimes other dependent variables, such as drainage basin areas. Larger drainage basin areas capture more precipitation, and when paired with the hillslope morphology (slope), may result in increased runoff and sediment transport through the stream network towards the alluvial fan. The shallow land surface has the ability to absorb and transport precipitation affects the amount of water and sediment available to flow across the land surface towards the alluvial fan. For example, if the shallow subsurface can absorb and disperse large volumes of precipitation, less water is available for sheetflow after most storms. However, each watershed is limited on how much water can be absorbed by the subsurface before surface flow starts.

A thick vegetative layer in the watershed can reduce flooding by minimizing sedimentation. Vegetation shields the ground from raindrop impacts and traps sediment at the base of the plant. The root structure of some plants enhances the strength of the shallow subsurface by stabilizing soil against erosion.

Watershed-scale disturbances, such as earthquakes or wildfire, can increase sediment volume in streams. Earthquakes can de-stabilize the alluvial fan, resulting in channel relocation or bank collapse, and causing inactive portions of the fan may become active again. Wildfire also increases alluvial fan flooding by removing vegetation, a frequent barrier to erosion. Without vegetation stabilizing the soil, less energy is needed to erode and move the soil down slope (Ragan, 2005). These bare landscapes, now highly prone to severe erosion, may re-activate inactive portions of the fan.

Reducing Risk of Alluvial Fan Flooding

Stopping the natural processes such as precipitation or earthquakes that have created the alluvial fans with alluvial fan flooding is *impossible*. However, it *is possible* for mankind to reduce the severity of inevitable flooding. Both FEMA (1989, 2012) and the United States Army Corps of Engineers (USACE, 1993) describe mitigation measures that may be applied to existing and future structures, as well as the land surface in the watershed and on the alluvial fan itself. Ideally, concepts and mitigation measures for retrofitting existing structures should be considered when designing a structure before it is built; the structure should be designed to be flood resistant, floodplain mindful and ecologically respectful from the inception of the project.

Structures

Upgrading, or retrofitting, existing structures can be accomplished by several different methods: elevating the structure, relocating the structure (if feasible), floodproofing the structure or constructing barriers around the structure.

Elevating an existing structure can be done by constructing solid perimeter foundation walls or open foundation systems such as piers, posts, columns and piles (Figure 3). In almost all cases, the existing structure is lifted using jacks, the method of elevation is installed and then the structure is lowered and attached. When elevating structures it is important to consider other hazards the structure and supports may encounter, including wind forces on walls and roofs, additional loading on existing footings, impact from debris and undermining (FEMA 2012).

Figure 3. Structure elevated on piles. FEMA, 2012

Relocating structures involves moving a structure to a location that is less prone to flooding or flood related hazards (FEMA, 2012). Ideally, the structure would be relocated outside the floodplain. However, this is not always possible. Costs associated with an undertaking of this scale involve moving the structure, preparing the new site and restoration of the old location. Relocating a structure may only be necessary if staying in the original location is highly hazardous.

Floodproofing a structure can be accomplished by either dry floodproofing or wet floodproofing techniques. Dry floodproofing involves making the structure watertight while strengthening the existing foundation and walls to withstand the forces exerted by the floodwaters. This can be done by applying wall coatings, waterproofing compounds, impermeable sheeting or cast concrete (FEMA, 2012). The anticipated duration of flooding is a critical factor to consider when choosing the appropriate materials to dry floodproof a structure. Some materials may deteriorate or fail with lengthy exposure to water. The anticipated depth of the floodwaters surrounding a dry floodproofed structure should also be considered. Water will impart an upward force (buoyancy), and if significant enough, may cause the structure to tilt, move off its foundation, or completely float away. Therefore, dry floodproofing a structure with a basement may not be appropriate (FEMA, 2012). Wet floodproofing is a method by which the structure is modified "to allow floodwaters to enter it in such a way that damage to the structure and its contents is minimized" (FEMA, 2012). Furnaces, water heaters and other appliances may need to be relocated to an area of the structure that will not be inundated by the floodwaters. According to FEMA (2012) wet floodproofing is typically the least expensive option.

Protective barriers, such as floodwalls and levees (Figure 4), may be constructed between the structure and the floodwater source. Typically six-feet tall or less and built using reinforced concrete, masonry, or earthen materials, these barriers keep the floodwaters from coming into contact with the structure (FEMA, 2012). They can encompass the entire structure or be strategically placed to protect weak areas such as doors, windows or basement entrances.

Figure 4. Earthen levee. NPR, 2011

Watershed and Alluvial Fan

Flood mitigation measures may also be used in the watershed above the alluvial fan and on the alluvial fan surface. These measures help reduce the flood risk by retaining some volume of flood water in the watershed, directing the floodwaters through the susceptible areas and allowing floodwaters to discharge in a controlled manner.

Enhancing and improving existing channels and stream banks allows them to withstand erosion caused by turbulent floodwaters and debris flows. Floodwaters may pass safely through the alluvial fan system if the existing channels and banks are protected. Flood stages are reduced, since floodwaters can now move efficiently, quickly and safely through an area. Lining a stream channel with rocks or concrete, concrete embedded with steel rails or steel grating appear to hold up very well against the flood waters and sediment impacts (USACE, 1993). A concrete lined channel also helps pass the sediment load efficiently through the system. If the channel banks are not lined with concrete, they need to be protected in some manner to prevent bank erosion and collapse. Lining material and methods include pipe and wire fence, riprap (dumped rock), rock paving (hand placed), wire and lock mattress or gunite slope paving. The flood waters will find and exploit any weakness in the protective measures taken. Therefore, it is critical to identify and address potential weak points such as seams or joints in the concrete, concrete to rock transitions, bare soil under rock armor or where concrete transitions to bare soil when paving or lining channels and banks.

Detention storage basins and debris basins are storage structures designed to capture and hold both flood water and sediment. They intercept, capture and retain a portion of the total flood waters and sediment to help reduce flooding. This strategy helps reduce the amount of material making its way onto the alluvial fan. These retention structures are called detention storage basins or debris basins. They may be located upstream in the watershed or at the mouth of the stream valley where the flow is still confined (topographic apex). These structures function adequately within the limits of their capacity. However, once they fill, the floodwaters can pass over them. These basins are commonly used in combination with an improved channel on the downstream side of the basin. With this configuration, the basin retains sediment, therefore reducing sediment deposits and minimizing scour of the concrete lining. These basins require an outlet structure to discharge the water and fine sediment while retaining the large debris. The outlet structure must be designed in a manner which prevents clogging as the basin fills with sediment and debris. The United States Federal Highway Administration (FHWA) calls one such outlet a "debris riser" (Figure 5) and describes it as closed-type structure typically built of metal that cause deposition of flowing debris and sediment. These basins require maintenance to remove the accumulated sediment taking up storage volume. The maintenance schedule is based on the sedimentation rates for the watershed.

Figure 5. Debris riser. FHWA, 2011

Debris barriers stop or reduce the movement of debris down the channel system and onto the fan. Debris barriers may be a permanent structure in the watershed or constructed as temporary control measures after wildfires or landslides. Whether permanent or temporary, these structures allow flood waters and fine grained sediment to pass through but stop larger sediment, rocks and vegetative material from flowing downstream. These are not effective flood control measures however as they allow waters to pass through. However, by trapping larger material they can prevent damage that would be caused by this large debris. Also, by removing large debris, the potential is reduced for this debris to dam-up and clog the channel, leading to bank overtopping. Several types of debris barriers commonly used are debris fences, debris barrier walls, and crib barriers.

Debris fences (Figure 6) are constructed using vertical beams or poles and may come with or without connecting wire. Debris fences typically fail due to bending under the weight of debris, rather than sudden failure due to impacts. Fence placement is critical to the success of reducing debris movement. Placing multiple lines of fences in upper portions of the watershed is a better strategy then placing a single massive fence lower in the watershed, because the energies are lower where the flood waters begin to accumulate or where the debris begins to move down slope. Debris fences must be periodically inspected and maintained and cleared of debris to ensure full functionality at the time of the flood or debris flow.

Figure 6. Ring net debris fence. www.aisconstruction.com

Debris barrier walls are similar to debris fences with vertical beams but utilize wooden cross-beams.

Figure 7. Crib barrier, early phases of construction. FHWA, 2011

Crib barriers (Figure 7) are square-shaped structures built vertically to the desired height by laying down two beams parallel to each other but separated by the desired distance. Then, two more beams are stacked parallel to each other but oriented at right angles relative to, and atop, the first layer. Additional layers are added following the same right angle orientation to the underlying layer, similar to stacking logs to construct a log cabin. These cribs may be constructed of wooden beams, concrete beams or steel rails.

Diversions or bypasses constructed on the alluvial fan are also options for handling flood waters. These are man-made channels that provide additional flow capacity or re-direct floodwaters away from developed areas. These structures divert a portion of the flow with the intention of reducing peak flow discharge traveling downstream and ultimately reducing the flood stage (USACE, 1993). The diverted flow can be retained in a storage area, transported through a controlled channel system or allowed to discharge in an area that would result in less damage (USACE, 1993).

Dikes, levees or retaining walls can also be used for flood mitigation. These features are vertical walls or mounds constructed of earthen material or concrete parallel to the stream to prevent overflows into developed areas. These structures may also be oriented at various angles perpendicular to the stream in order to divert floodwaters into diversions, bypasses or detention storage basins. These features may be used to protect large areas or single structures. They are different from debris barriers in that they do not allow water or sediment to pass through.

Land Use Planning for Alluvial Fans

The Local Land Use Planning Act (LLUPA) requires every community in the state of Idaho to address natural disasters in the community land use plan. This study was conducted to provide a non-regulatory tool that Idaho communities would use to reduce their risk to life and property. By referencing the Alluvial Fan Mapping and Risk Assessment document by title in a community plan, the community can then use the data contained in this document in community land use planning and regulation: specifically in the Findings of Fact or Site Specific Conditions of Approval in a staff report or elected official determination for individual development applications, infrastructure projects or capital improvement plans.

Effective land use planning for alluvial fan flooding is a creative enterprise. Lands evidenced by alluvial fan deposits are at risk for flood, and have a different highest and best use than lands not subject to flood. Once a community identifies a threat and recognizes the risk to life and property it presents the planning process for the economic development of the land is unique to the natural character of the land. There are numerous highly desirable community assets that are effective at reducing the effects of alluvial fan flooding, and community and regional land use planners are skilled to place them appropriately. The function of suitable land uses, or land use policies, is intended to create safe areas for the wayward sediments of alluvial fans to collect while conveying the waters through the existing floodplains and waterways in an ecologically friendly and environmentally responsible manner. The following examples of land uses celebrate community assets through place-making and may be appropriate improvements on a confirmed alluvial fan, as determined on a case-by-case basis:

- Amphitheatre
- Golf course
- Athletic park
- Band shell
- Dog parks
- Formal gardens
- Plaza or community commons
- Campgrounds
- Archery range
- Monuments and memorials
- Places of worship
- Fine/cultural/performance arts venue
- Parks and recreation
- Fishery enhancement
- Nature reserve interpretive center
- Wildlife sanctuary or management area
- Equestrian exhibition facility
- Velodrome or skateboard park
- Motocross arena
- Cemetery

Undeveloped areas (i.e. natural bare land) have the most receptive areas to employ nonstructural floodplain management techniques because the land has not yet been improved with structures subject to the effects of flooding. Zoning and impact area plans are effective policies to protect life and property in undeveloped areas.

Moderately developed areas (i.e. rural urban transition, sporadic roads, outbuildings or irrigated fields) are also receptive to nonstructural floodplain management techniques because the land has not yet been fully improved. Annexation, zoning, infrastructure projects and building codes are effective policies to protect life and property in moderately developed areas.

Fully developed areas (i.e. urban and suburban) are already fully improved, and therefore a more skillful application of nonstructural floodplain management techniques must be applied. In areas where initial annexation, zoning and construction has already occurred effective floodplain management strategies become more complex and may include the use of subdivision or specific area plans, enhanced setbacks, transfer of development rights (TDRs), buyout program, elevating structures, proactive E911 implementation, flash flood warning sirens and other more drastic measures to protect life and property. The use of structural floodplain management practices that function to direct the flow of high water away from fully developed land is not recommended, but has become an alternative of last resort. When floodwalls, dikes and levees are utilized to constrain a floodway, the waters they convey accelerate velocity, volume and erosion processes that can actually make flooding more dangerous to others.

While it is ill-advised to intensively develop lands subject to flooding to the point where floodwalls, dikes and levees are sometimes used to mitigate the risk of flood damage. Areas exist that are already fully developed and near a flood hazard, so it is necessary to thoughtfully explore some appropriate structural methods as part of an overall plan. Structural floodplain management should not be the primary mitigation plan; it is what must be done after planning without sufficient information, a major environmental change or after the plan fails. The use of structures to protect from flooding is sometimes necessary and even desirable, but elected officials, planners, engineers and architects should carefully consider the use and application of the following objects to protect life and property:

- Roadway network patterns
- Elevated roadways, rail lines and multi-use pathways
- Detached sidewalks with planter boxes & center islands
- Porous, non-impervious construction materials
- Vertical curb, gutter and sidewalk
- Reverse-crown roadways
- Jersey barriers
- Swales
- Flumes
- Landscape architecture
- Parapets
- Municipal or county roadway aggregate storage
- Post and pile foundation construction
- Armoring channels
- Dry and wet floodproofing
- Trenching
- Emergency detention basins with armored spillways
- Storm water impoundment vaults
- Subsurface bioretention
- Floodplain, wildlife and riparian corridors
- Other mitigation activities mentioned elsewhere in this alluvial fan mapping and Risk Assessment.

IV. METHODOLOGY

For further detail or to replicate these methods and results, see Appendix II.

Alluvial Fan Mapping

Known alluvial fans were mapped from available sources per the mapping guidelines. These sources enhanced Flood Insurance Rate Maps (FIRMs), Digital Flood Insurance Rate Maps (DFIRMs) and Surficial Geologic Maps. The AO zones on FIRMs and DFIRMs indicate the presence of alluvial fans, as do alluvial soil types.

Alluvial Fan Risk Potential

Due to the lack of reliable geologic information in some watersheds, alluvial fan risk potential was analyzed to provide a starting point from which to analyze this risk, thereby reducing the workload for field analysis of alluvial fan extent. This methodology was adapted from the 2012 publication of Lancaster et al. An alluvial fan risk overlay was categorized by high, moderate and low hazard, based on the age of geologic deposits (USGS, 2005) following the hazard model depicted in Figure 8 (Johnson and Raines 1996). Quaternary soils are categorized as high hazard potential. Moderate hazard potential has been assigned to Late Pleistocene and Holocene deposits. Low hazard potential has been assigned to other Pleistocence deposits.

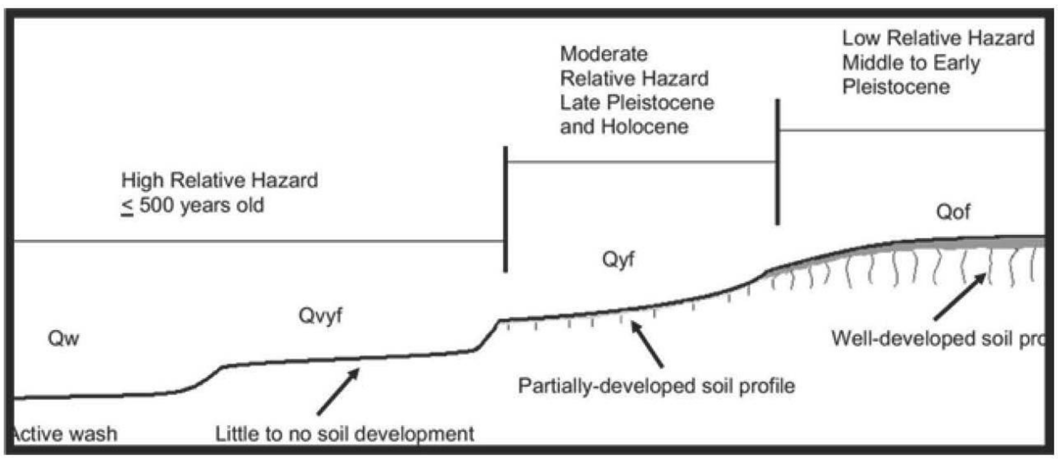

Figure 8. Geomorphic profile of relative hazard to alluvial-fan flooding. Lancaster et al, 2012.

Surficial units are classified as: Qw, active wash; Qvyf, latest Holocene alluvial fan; Qyf, late Pleistocene and Holocene alluvial fan; Qof, Pleistocene alluvial fan. Surficial mapping nomenclature based on J. Matti and P. Cossette (USGS, unpub. data, 2010).

In order to create a slope overlay to assist in the alluvial fan detection, the best available LiDAR and digital elevation models (DEMs) were gathered. The 1/3-arc second National Elevation Dataset (USGS 2009) DEM was used as base data and was supplemented by local LiDAR derived DEMs. All DEMs were reprojected and resampled to a common projection and grid size. Then the DEMS were merged together to then create the slope model. A hillshade overlay was created by using the same merged DEM created for the slope model.

Potential Fan Mapping

Potential alluvial fans were mapped from developed data sources. These areas need further confirmation by professional geologists or engineers using site observation or other analysis techniques.

V. RESULTS

Big Wood

The Big Wood Watershed is located in south-central Idaho. This area includes portions of Blaine, Camas, Gooding and Lincoln Counties as well as the communities of Bellevue, Gooding, Hailey, Ketchum and Sun Valley. Estimated population in the watershed is 23,200. Four counties and five communities participate in the National Flood Insurance Program (NFIP) with total premiums of approximately $422,000 and $162 million of total coverage.

Data coverage

A total of 61% of the watershed is covered by DFIRMs (Table 3). There were no identified alluvial fans on the DFIRMs, suggesting that the data source may not have included this type of hazard in the original analysis. However, the surficial geologic data showed many previously mapped fans.

Dataset	Area (acres)	Area (sq. mi)	% of watershed
Big Wood Watershed	917,047	1,433	100
DFIRM	558,975	873	61
FIRM	0	0	0

Table 3. Flood insurance data source coverage by area for Big Wood Watershed.

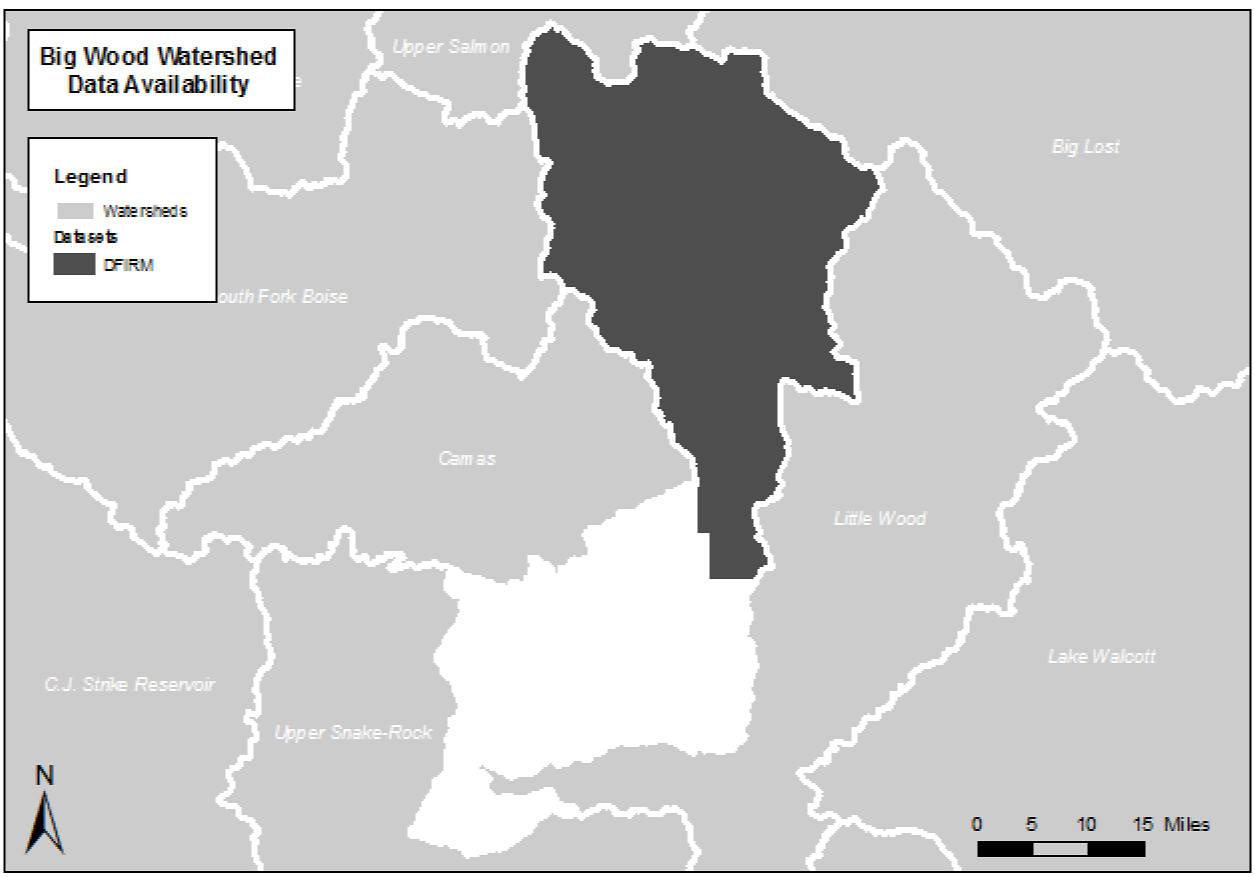

Figure 9. Flood insurance data source coverage for Big Wood Watershed.

Mapped Alluvial Fans

Two hundred three (203) mapped fans exist based on existing data sources in this watershed (Table 8). All of these fans are from the Surficial Geologic Map of the Wood River Valley Area, Blaine County, Idaho (Breckenridge et al 2006).

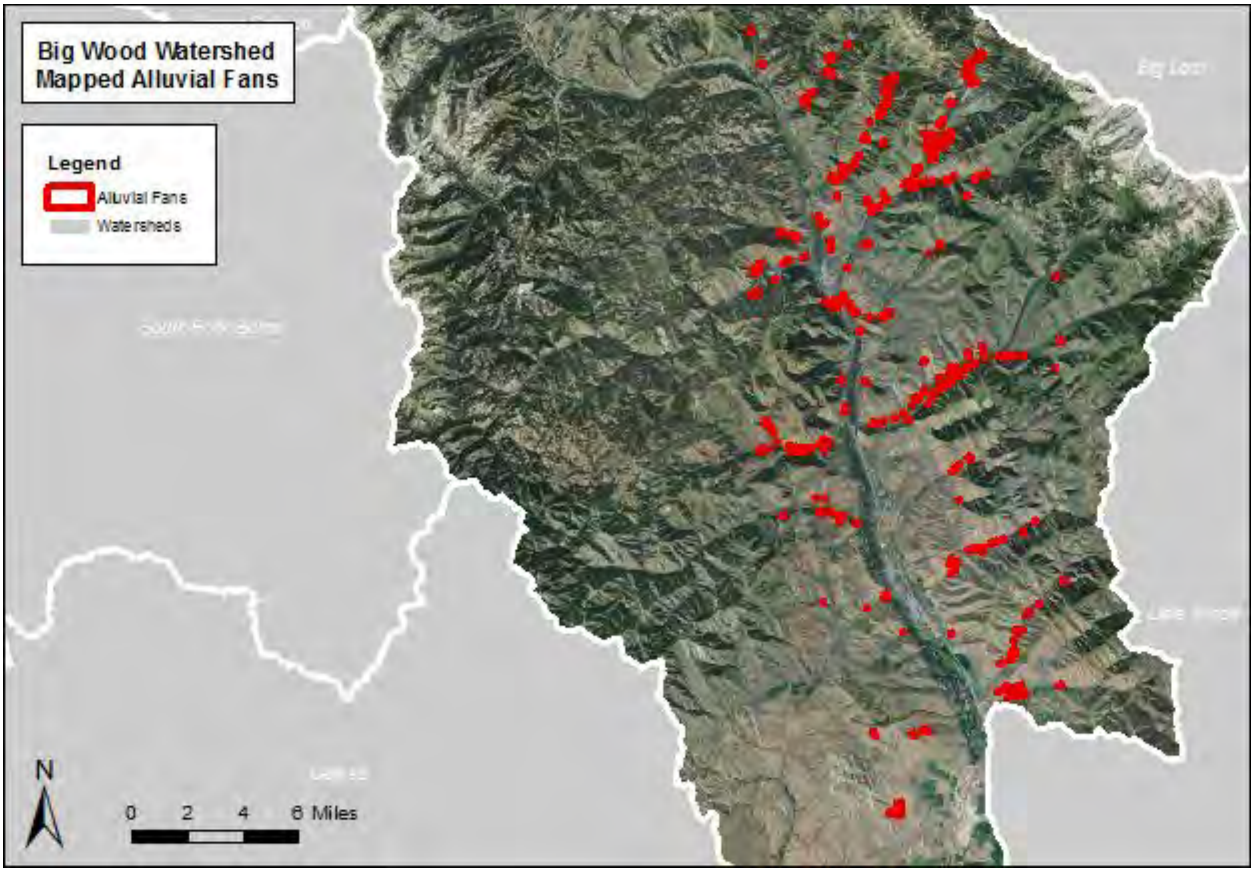

Figure 10. Mapped alluvial fans from existing data sources for Big Wood Watershed.

Alluvial Fan Risk Potential

Alluvial fan risk potential was mapped in this watershed using the methodology described in Section IV. The highest alluvial fan risk potential is only categorized for 6.5% of the watershed by area (Table 4) and is largely restricted to the highly incised river valleys in the northern half of the watershed (Figure 11) where the majority of the population is concentrated within the watershed.

Risk Potential	Area (acres)	% of watershed
Low	828,980	90.4
Moderate	28,114	3.1
High	59,953	6.5

Table 4. Alluvial fan risk potential summary for Big Wood Watershed.

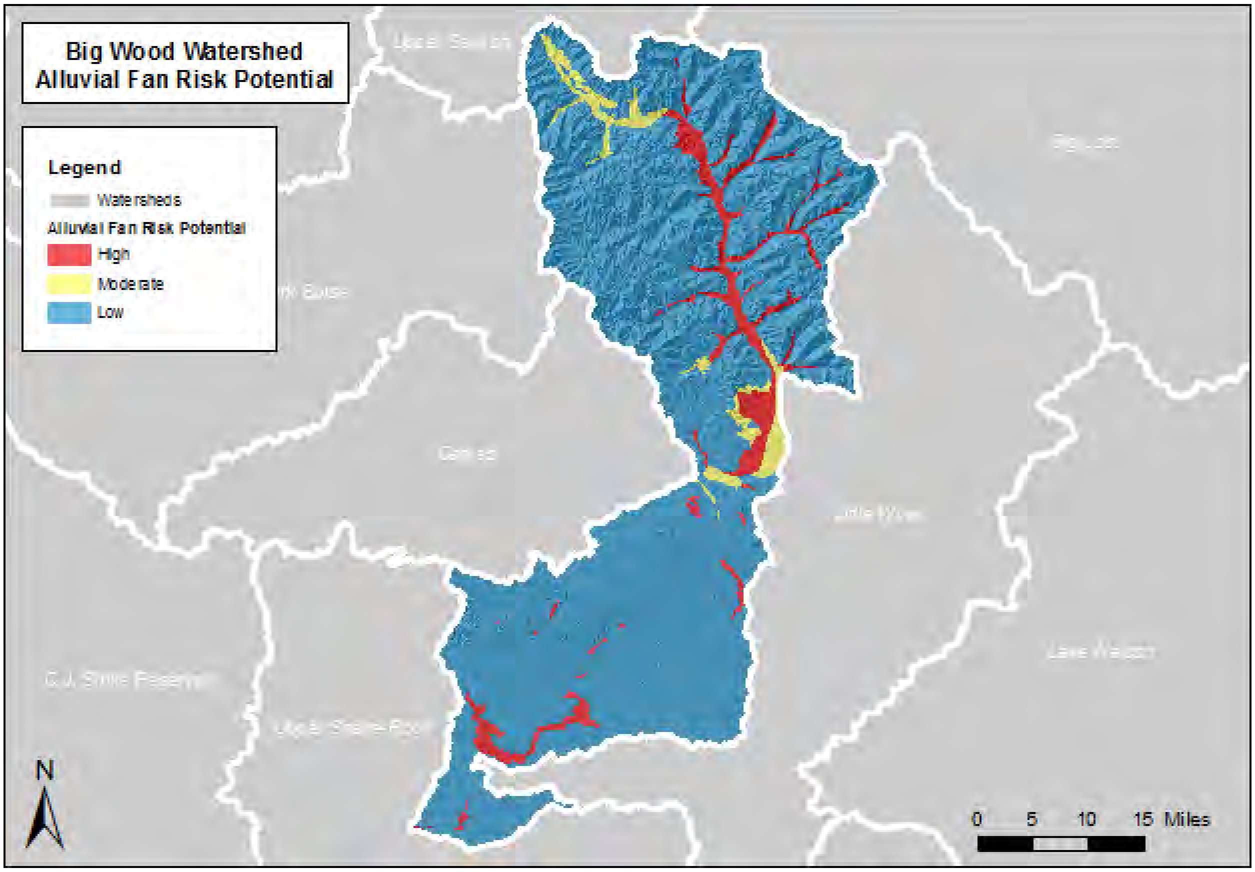

Figure 11. Alluvial fan risk potential for Big Wood Watershed.

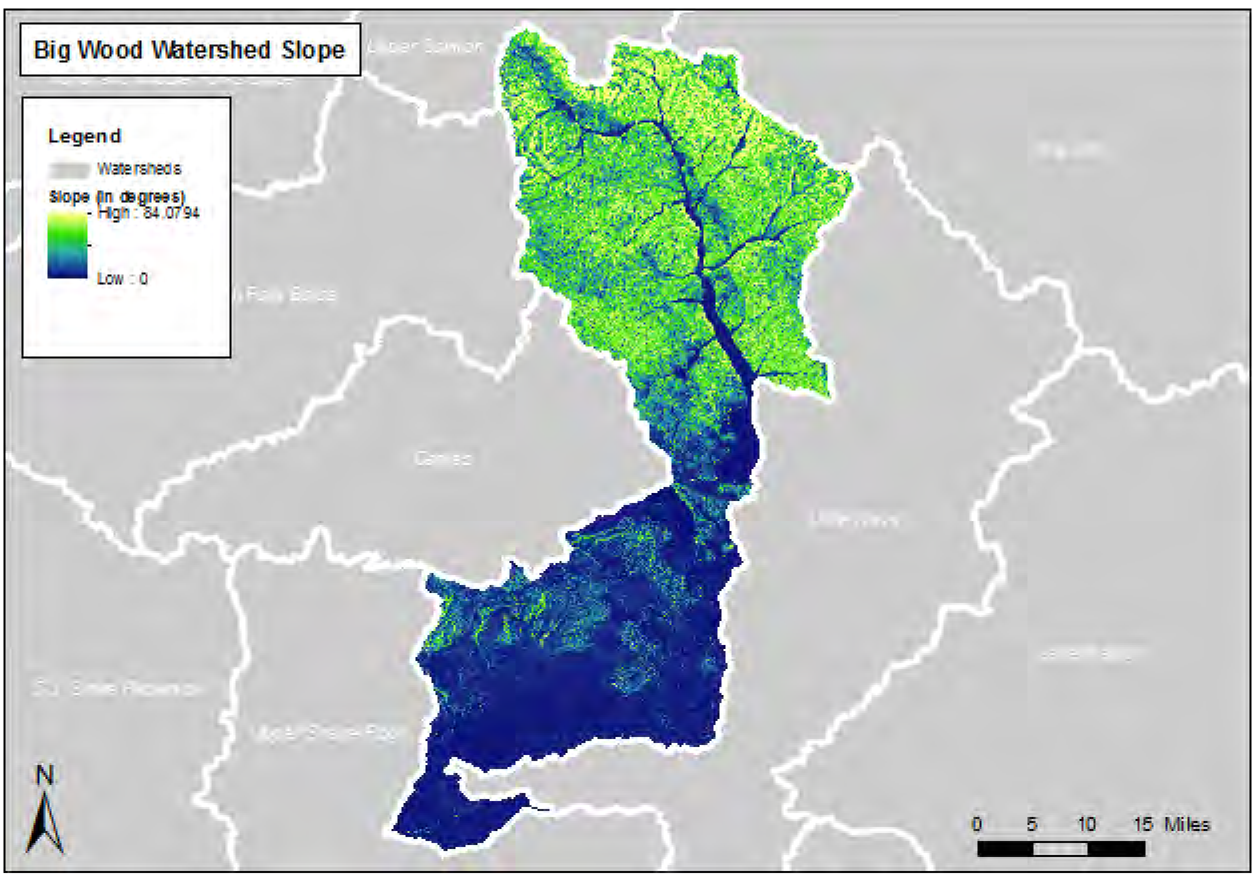

Figure 12. Slope analysis for Big Wood Watershed.

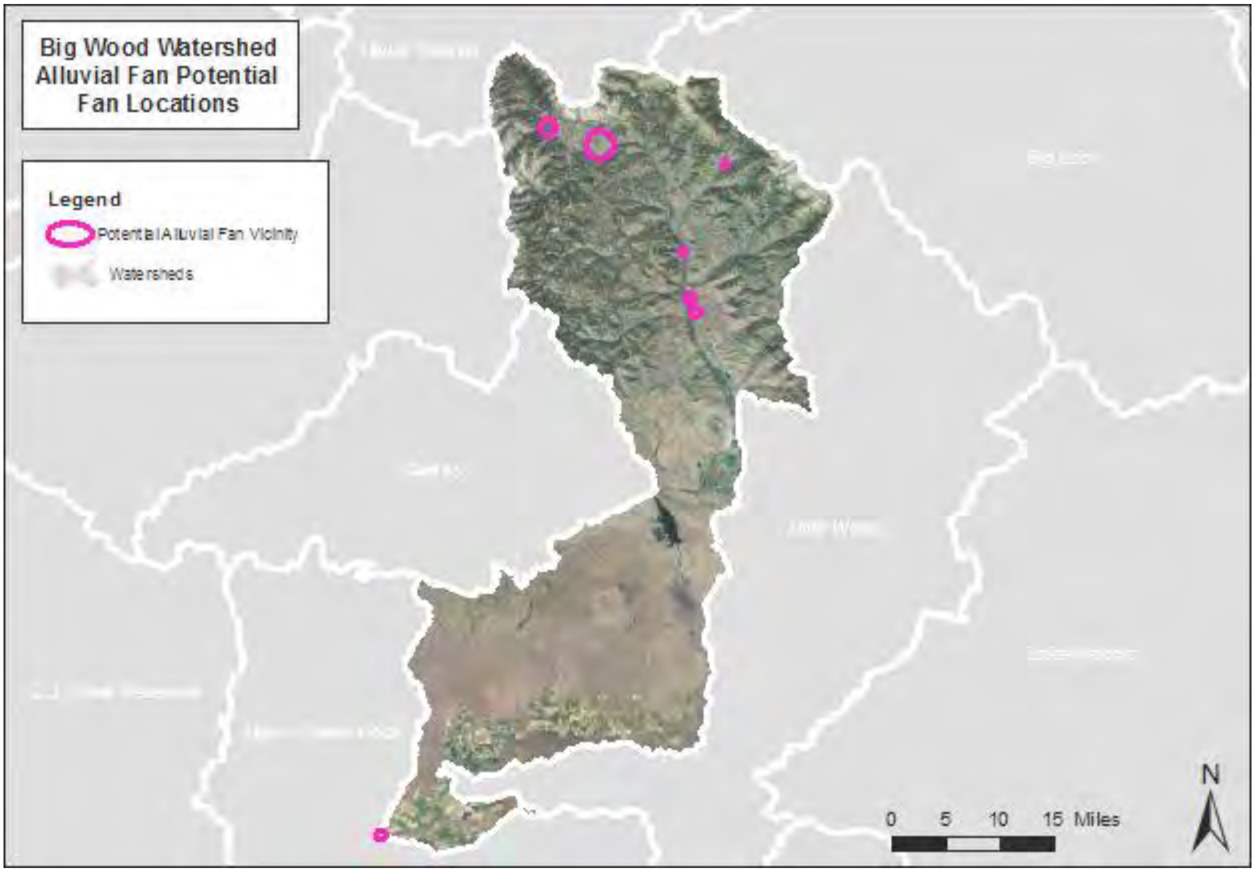

Figure 13. Potential alluvial fan locations for Big Wood Watershed.

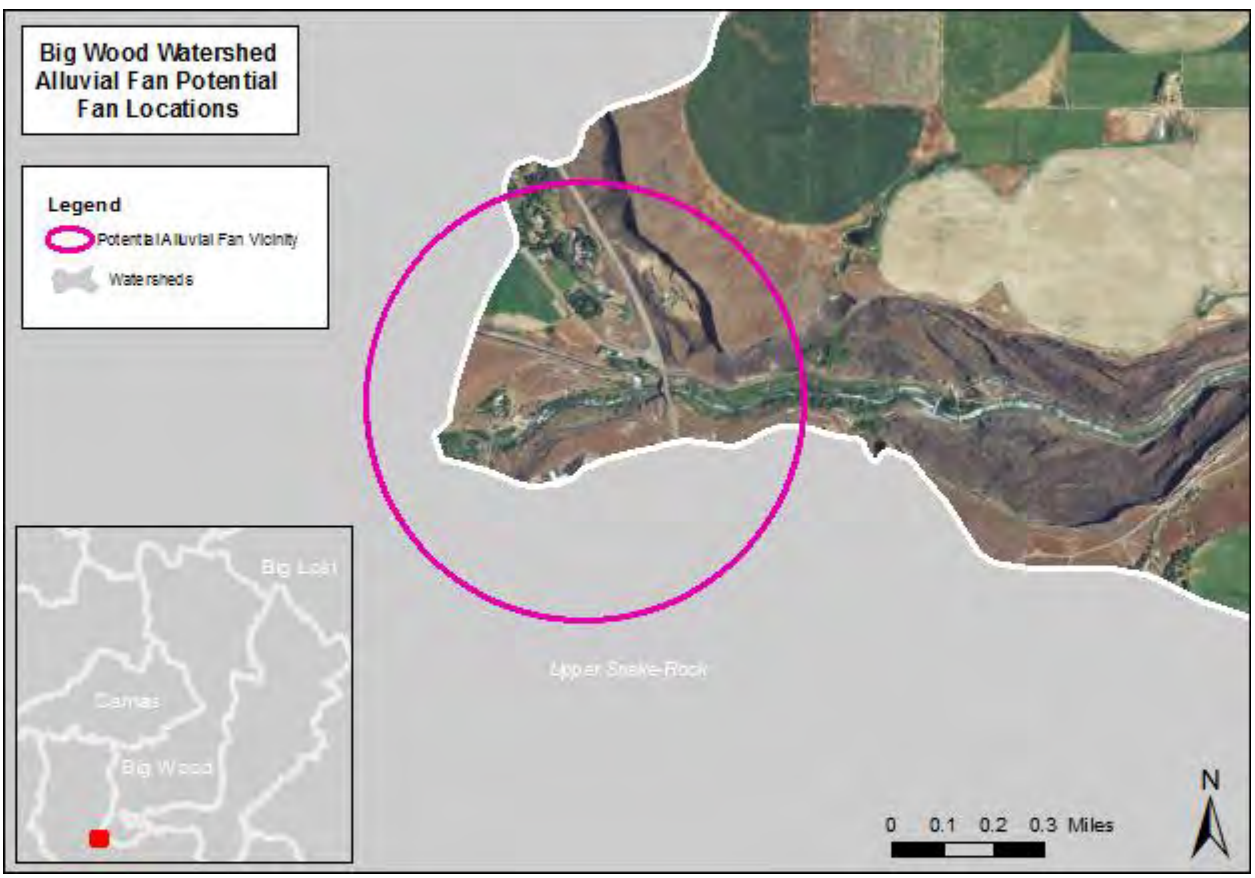

Figure 14. Potential alluvial fan vicinity #1 for Big Wood Watershed.

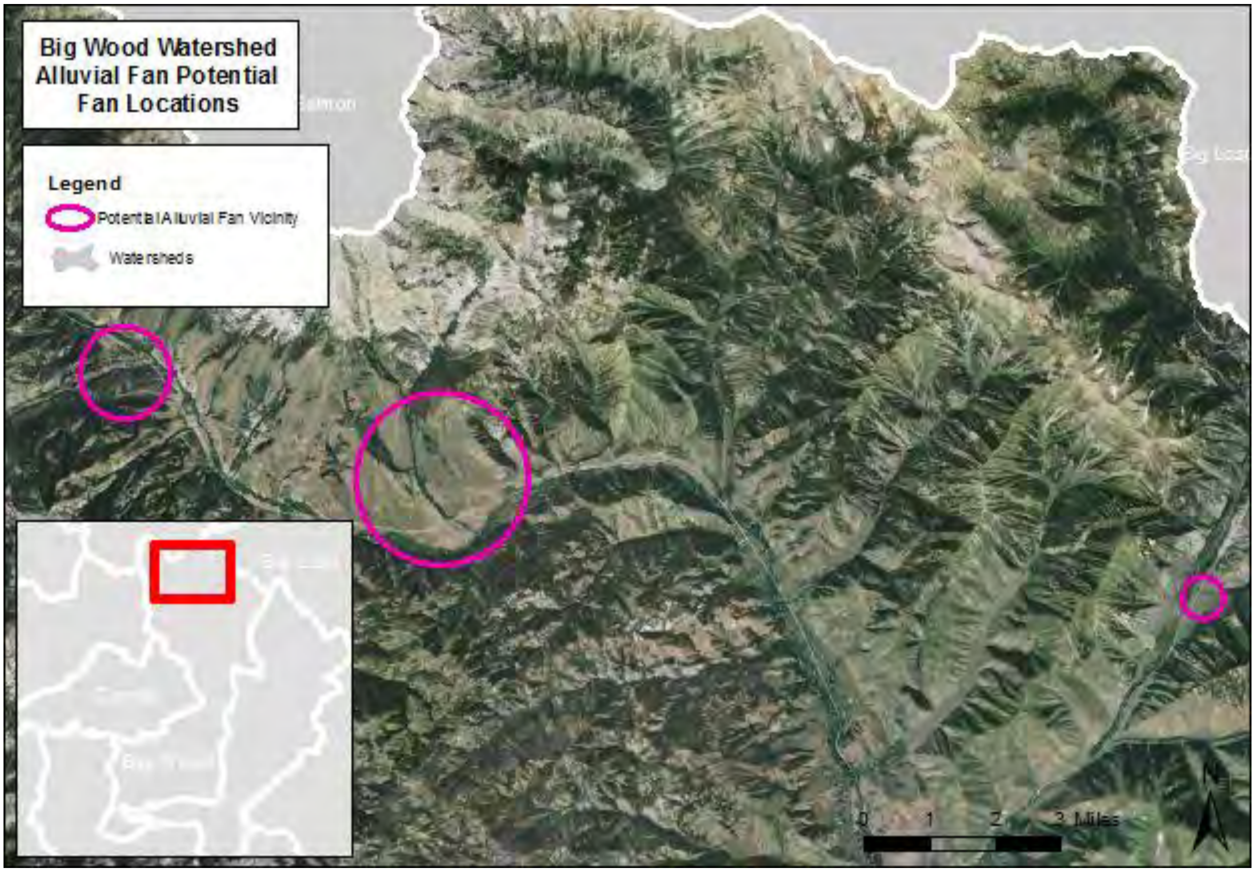

Figure 15. Potential alluvial fan vicinity #2 for Big Wood Watershed.

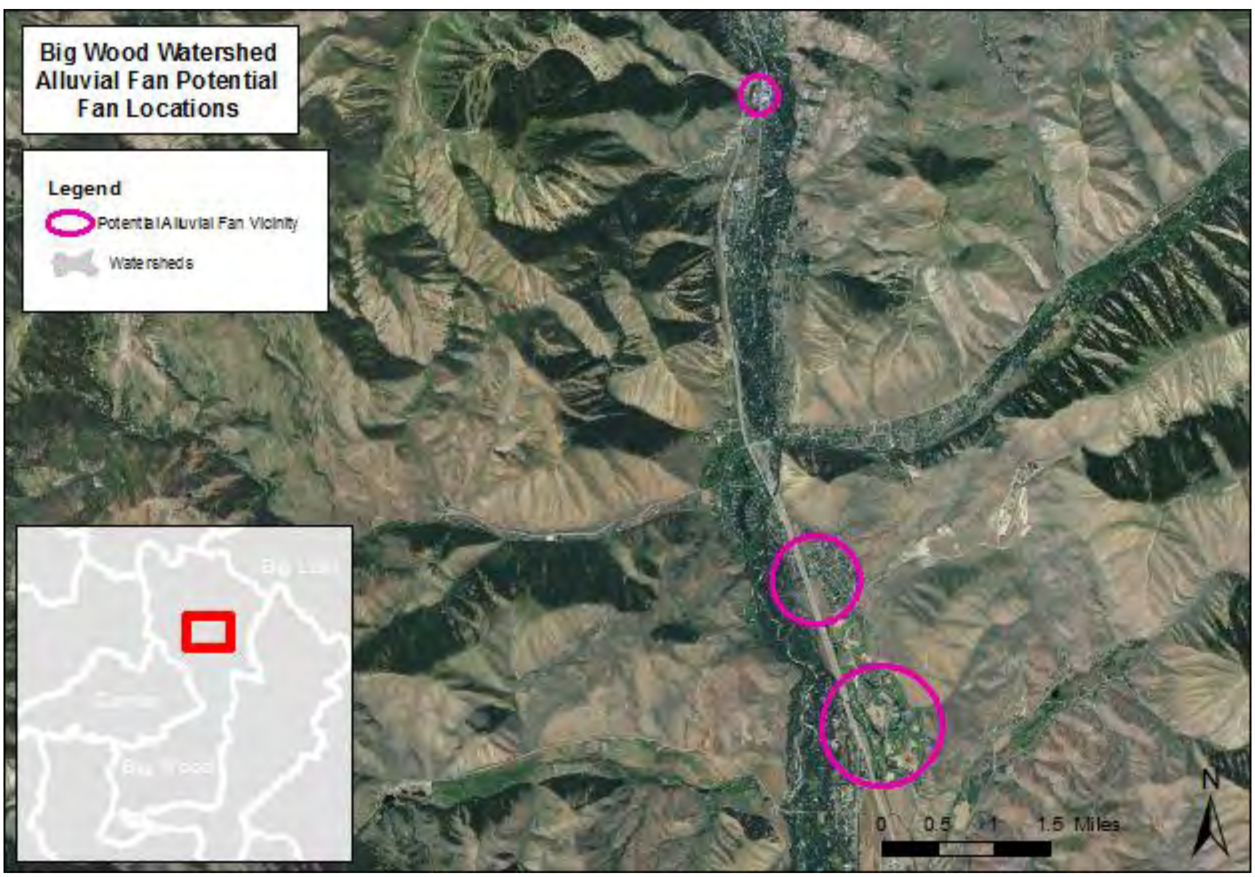

Figure 16. Potential alluvial fan vicinity #3 for Big Wood Watershed.

Potential Alluvial Fan Example 1

This potential alluvial fan site near Cathedral Pines, Idaho, demonstrates a number of characteristics that makes it likely for alluvial fan flooding. It is ranked as a moderate alluvial fan risk depicted in yellow in Figure 19. The slope broadens and flattens into the valley depicting a strong fan-shaped plain. The geologic age of these sediments is consistent with alluvial fan instability. Braided stream reaches (interlacing and shifting shallow channels) and the strong curve in the river below suggest instable soils, erosion and active meander. Slope modeling shows terracing, a step-like characteristic of specific types of alluvial fans. While there is little development in the area affected by this alluvial fan, Idaho State Highway 75 could be seriously impacted by any flood event on this alluvial fan. This highway supports travel between Ketchum and Stanley, both areas that depend on tourism.

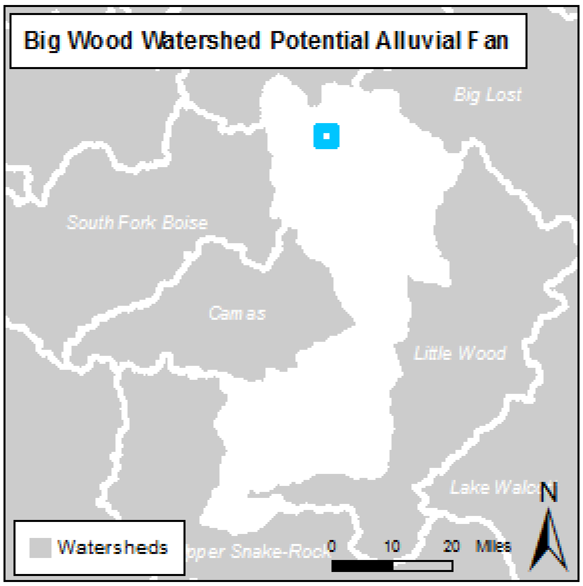

Figure 17. Extent of potential alluvial fan #1 in Big Wood Watershed.

Figure 18. Slope of potential alluvial fan #1 in Big Wood Watershed.

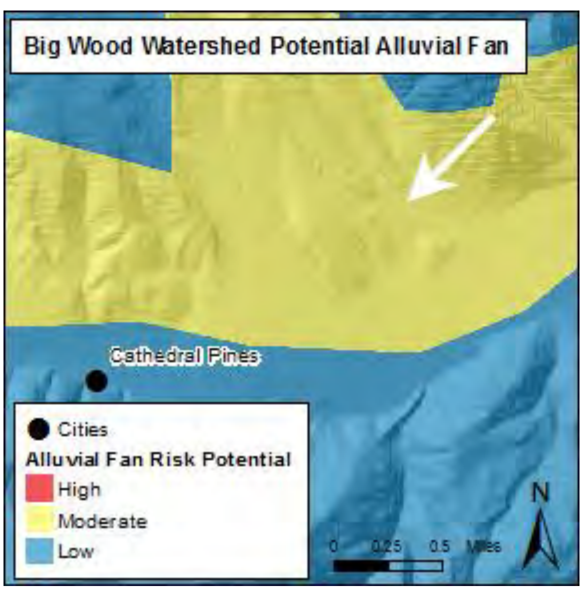

Figure 19. Alluvial fan risk of potential alluvial fan #1 in Big Wood Watershed.

Figure 20. Imagery of potential alluvial fan #1 in Big Wood Watershed.

Potential Alluvial Fan Example 2

This potential alluvial fan site northeast of Sun Valley, Idaho, demonstrates a number of characteristics that makes it likely for alluvial fan flooding. It is ranked as a high alluvial fan risk depicted in red in Figure 23. The slope broadens and flattens into the valley depicting a strong double fan-shaped plain suggesting two adjacent fans merging at the middle or toe sections. The geologic age of these sediments in consistent with alluvial fan instability. Braided stream reaches (interlacing and shifting shallow channels) suggest instable soils, erosion and active meander. While there is little development in the area affected by this alluvial fan, National Forest Development Road 51 could be seriously impacted by any flood event on this fan.

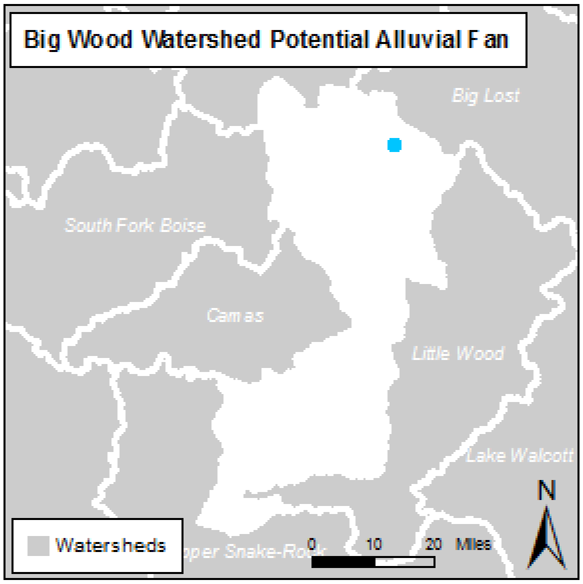

Figure 21. Extent of potential alluvial fan #2 in Big Wood Watershed.

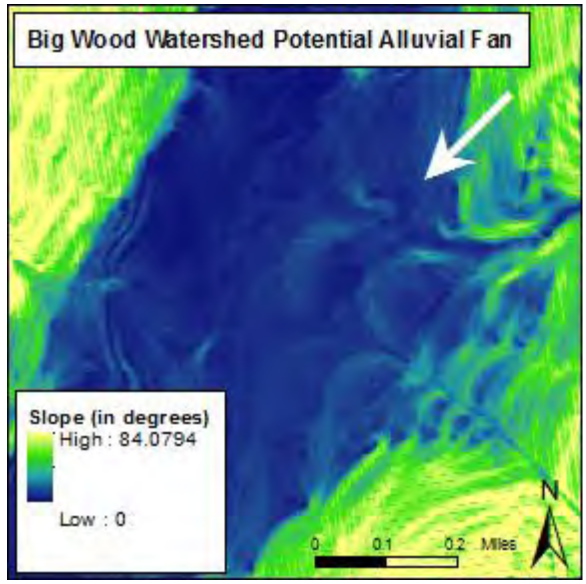

Figure 22. Slope of potential alluvial fan #2 in Big Wood Watershed.

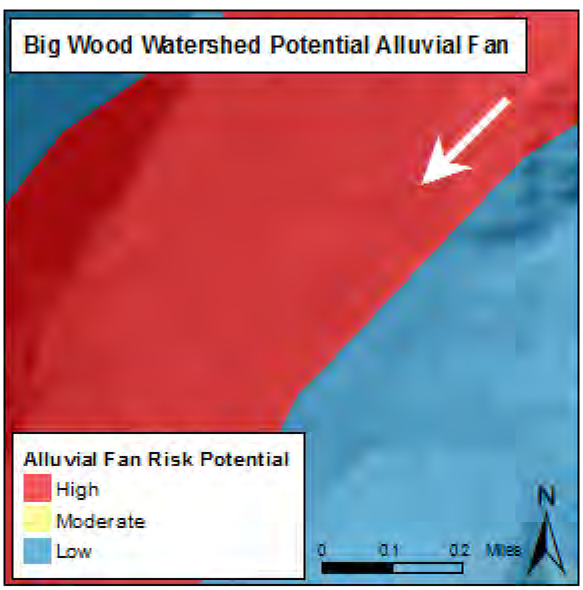

Figure 23. Alluvial fan risk of potential alluvial fan #2 in Big Wood Watershed.

Figure 24. Imagery of potential alluvial fan #2 in Big Wood Watershed.

Summary of Exposure to Alluvial Fans

Area	Average Parcel Value	High Parcel Value	Parcel Count
Big Wood (Watershed)	$465,000	>$1,351,000	19,731
Blaine (County)	$481,000	>$1,378,000	19,036
Camas (County)	$43,000	>$121,000	3,311
Gooding (County)	$99,000	>$365,000	8,512
Lincoln (County)	$91,000	>$427,000	4,263
Bellevue (City)	$292,000	>$483,000	1,029
Gooding (City)	$81,000	>$137,000	1,482
Hailey (City)	$354,000	>$607,000	3,590
Ketchum (City)	$866,000	>$1,835,000	3,834
Sun Valley (City)	$899,000	>$2,080,000	2,674

Area	Parcel Count in Potential Fans	Parcel Count in Mapped Fans	High Value Parcel Count in Fans
Big Wood (Watershed)	397	48	39
Blaine (County)	381	48	38
Camas (County)	0	0	0
Gooding (County)	17	0	0
Lincoln (County)	0	0	0
Bellevue (City)	0	0	0
Gooding (City)	0	0	0
Hailey (City)	0	0	0
Ketchum (City)	0	9	3
Sun Valley (City)	0	43	4

Area	% of Parcels in Potential Fan	% of Parcels in Mapped Fans	Total Value in Fans
Big Wood (Watershed)	2.01%	0.24%	$259,857,174
Blaine (County)	2.00%	0.25%	$257,751,452
Camas (County)	0.00%	0.00%	$2,126,157
Gooding (County)	0.20%	0.00%	$0
Lincoln (County)	0.00%	0.00%	$0
Bellevue (City)	0.00%	0.00%	$0
Gooding (City)	0.00%	0.00%	$0
Hailey (City)	0.00%	0.00%	$0
Ketchum (City)	0.00%	0.23%	$15,298,400
Sun Valley (City)	0.00%	1.61%	$47,882,960

Table 5. Alluvial fan property risk potential summary for Big Wood Watershed
2012 County Assessor taxlot data was used. Any parcel with a taxable amount less than 1 was disregarded. This eliminated most government owned facilities from data. High value parcels were defined as greater than 1 standard deviation above the mean value.

Risk Mitigation Strategy

There are eight potential alluvial fans identified in the Big Wood watershed. Several of them are located at the mouth of drainages, such as Prairie Creek, Boulder Creek and Wilson Creek (Figures 14 - 17). None of the locations have visible structures or dwellings built on them intended for permanent human occupation.

A potential alluvial fan exists at the mouth of Ohio Gulch, on which a subdivision and golf course are built. The narrow stream valley widens significantly approximately two miles upstream of the subdivision and golf course. This location would allow adequate room for the construction of detention storage basins or debris basins. Existing ponds or basins (for undetermined purposes) seen in aerial imagery may be used as detention basins in an emergency situation. Although the upper regions of this drainage have steep slopes, this potential fan poses low risk due to the length and width of the lower portion of the valley.

A second potential alluvial fan emanating from an unnamed drainage discharges onto the Valley Club Golf Course. A portion of the course has been built up into the drainage itself. The clubhouse and dozens of residential homes are interspersed in and around the golf course. The stream valley is narrow almost to the point where it meets the valley floor. The contributing area to this drainage is relatively small which will minimize the total volume of flood water flowing downstream. A combination of floodwalls built discretely into the landscaping surrounding the clubhouse and homes, combined with diversions, would allow for the floodwaters to flow safely onto the golf course.

A third potential alluvial fan emanates out of Cold Springs Gulch, at the mouth of which is St. Luke's Medical Center. The high relief in the valley and moderately sized drainage area contribute to the risk of alluvial fan flooding but the long valley length helps reduce this risk. The area at the mouth of the valley is conducive to a diversion which would pass the flood waters by the south end of the hospital into a small existing depression or pond. The hospital may also consider constructing a floodwall to help deflect the flood waters and debris towards this existing depression.

A fourth potential fan is located at the mouth of Deer Creek. This fan poses moderate to high risk due to the large drainage area, steep slopes and fire activity from the 2013 Beaver Creek fire. The lower valley widens and flattens approximately four miles upstream of the confluence with the Wood River, which may help to dissipate the flood waters. There are a series of ponds that exist within the flat valley bottom which will interact with the flood flow and help contain some of the water or sediment. Multiple structures in the upper portion of the valley adjacent to the Clarendon Hot Springs at Harp Creek Road may be at risk of flooding. A wave of flood water and sediment could enter the ponds and displace the existing water. These structures may be protected by constructing floodwalls or levees to divert the flow away from the structure and back downstream.

A final potential alluvial fan is located near Hagerman at the mouth of the Malad Gorge (Figure 12). This potential fan poses low risk for several reasons. First, the gorge is deeply entrenched into basalt which would contain any flood water or sediment traveling downstream. Secondly, the floodwaters traveling downstream would discharge directly into the Snake River within a short distance of the headwall of the gorge. The surrounding drainage area is very flat indicating that it contributes a very small portion of water and sediment to the stream.

Floodwalls, dikes and levees are structural floodplain management practices; and are therefore less popular, desirable and effective than nonstructural floodplain management practices, such as land use regulation. Land use planning is the application of fiscal and public policy to create orderly land use patterns, regulate development, improve infrastructure and provide public process whereby a community endeavors to create its preferred future, hopefully one with a reduced risk to natural disasters.

Lower Boise

The Lower Boise Watershed is located in southwest Idaho. This area includes portions of Ada, Boise, Canyon, Elmore, Gem and Payette Counties as well as the communities of Boise, Caldwell, Eagle, Garden City, Greenleaf, Kuna, Meridian, Middleton, Nampa, Notus, Parma, Star and Wilder. The estimated population in the watershed is 573,600. All six counties and twelve cities participate in the NFIP with total premiums of approximately $1.677 million and $690 million of total coverage.

Data Coverage

A total of 92.9% of the watershed is covered by DFIRMs and FIRMs (Table 6). These maps included a small number of mapped alluvial fans.

Dataset	Area (acres)	Area (sq. mi)	% of watershed
Lower Boise Watershed	850,353	1,329	100
DFIRM	729,257	1,139	85.8
FIRM	60,064	94	7.1

Table 6. Flood insurance data source coverage by area for Lower Boise Watershed.

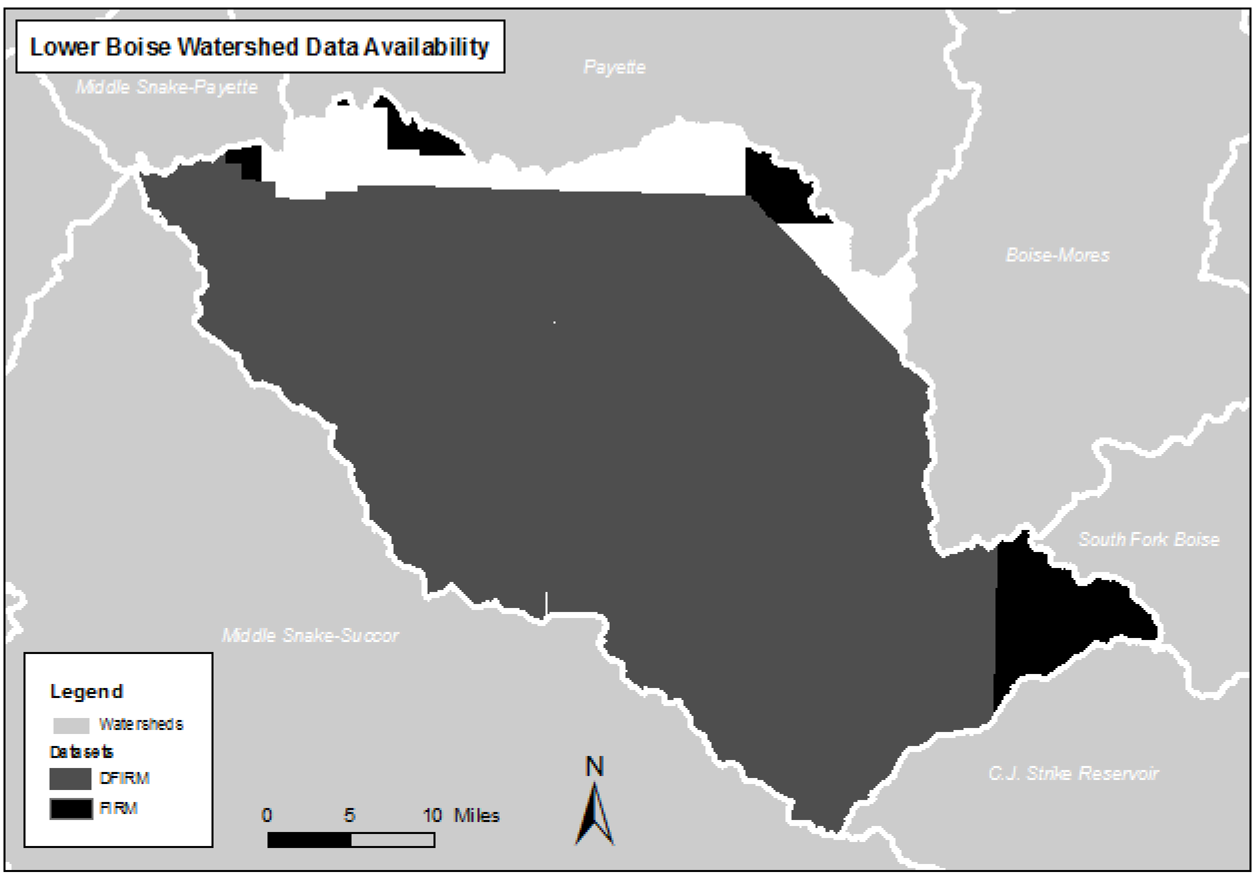

Figure 25. Flood insurance data source coverage for Lower Boise Watershed.

Mapped Alluvial Fans

Eighteen (18) mapped fans exist based on available data sources in the Idaho portion of this watershed (Figure 26). Sixteen of those fans are from the Ada County Digital Flood Insurance Rate Map (Federal Emergency Management Agency 2003). Two fans are from the Geologic Map of the Mayfield Area (Phillips et al 2012).

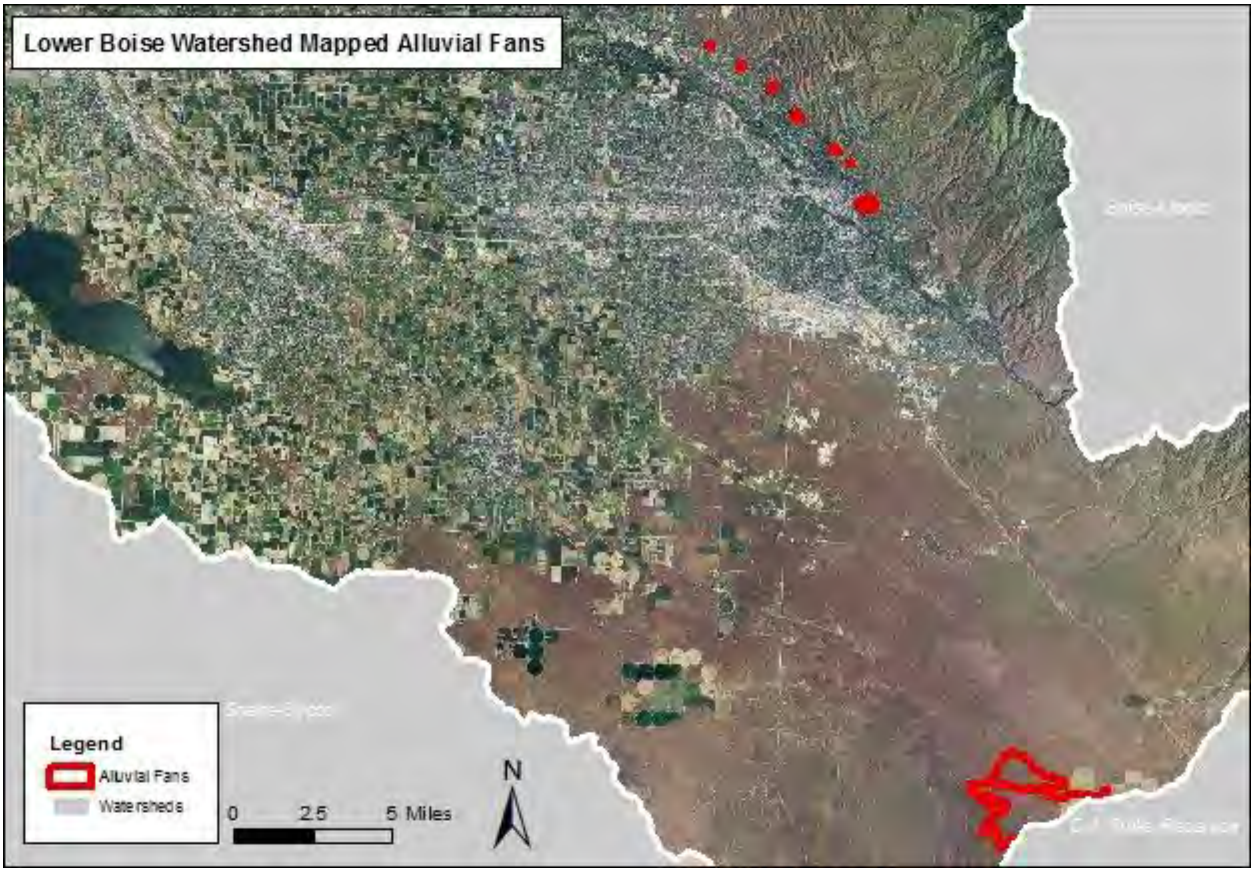

Figure 26. Mapped alluvial fans from existing data sources for Lower Boise Watershed.

Alluvial Fan Risk Potential

Alluvial fan risk potential was mapped in this watershed using the methodology described in Section IV.

Risk Potential	Area (acres)	% of watershed
Low	375,097	44.1
Moderate	387,684	45.6
High	87,284	10.3

Table 7. Alluvial fan risk potential summary for Lower Boise Watershed.

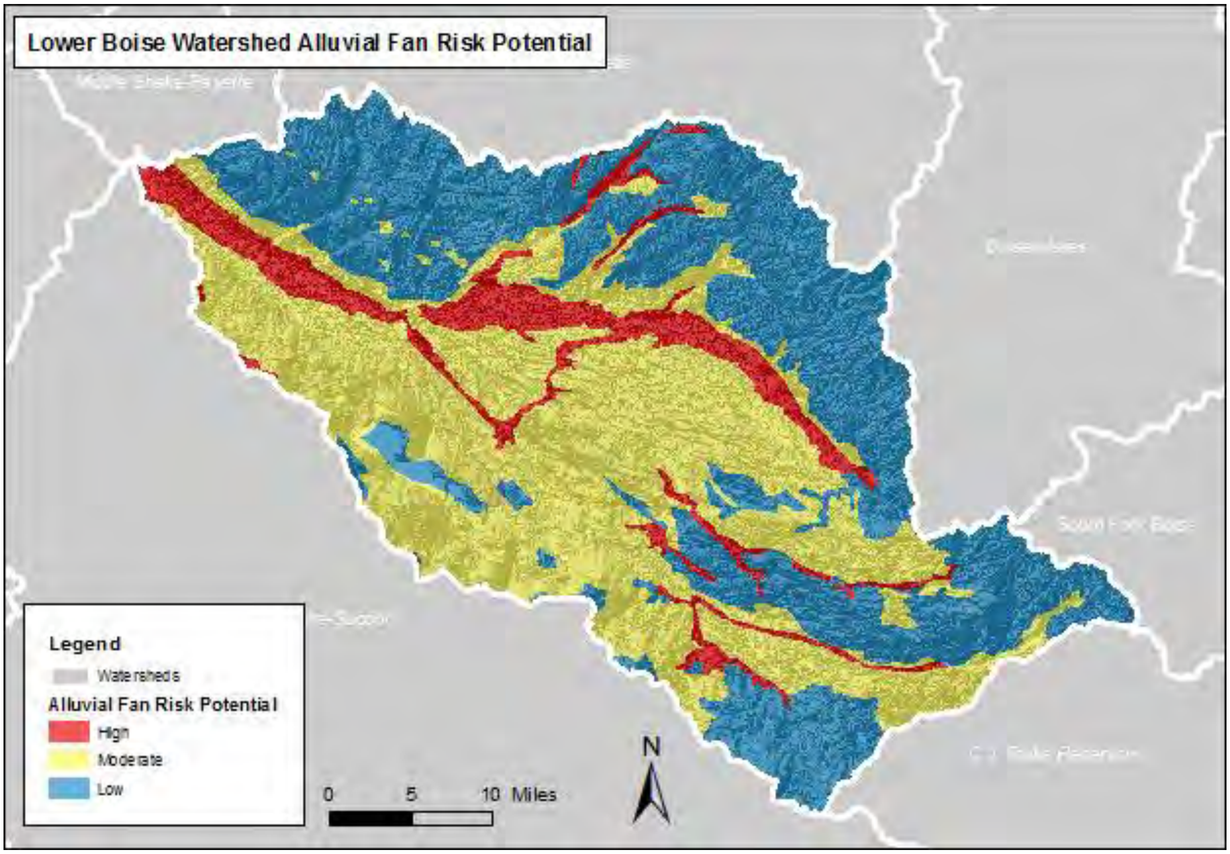

Figure 27. Alluvial fan risk potential for Lower Boise Watershed.

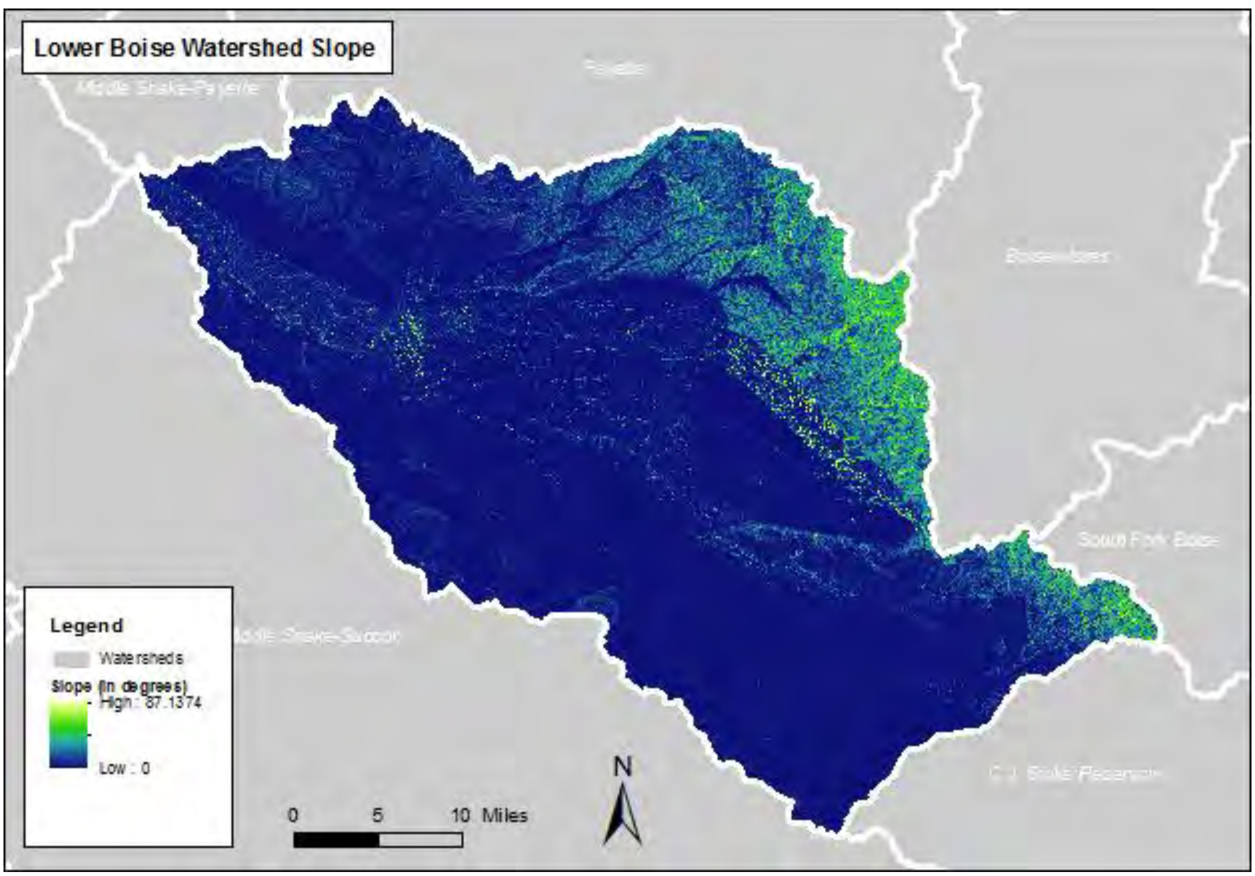

Figure 28. Slope analysis for Lower Boise Watershed.

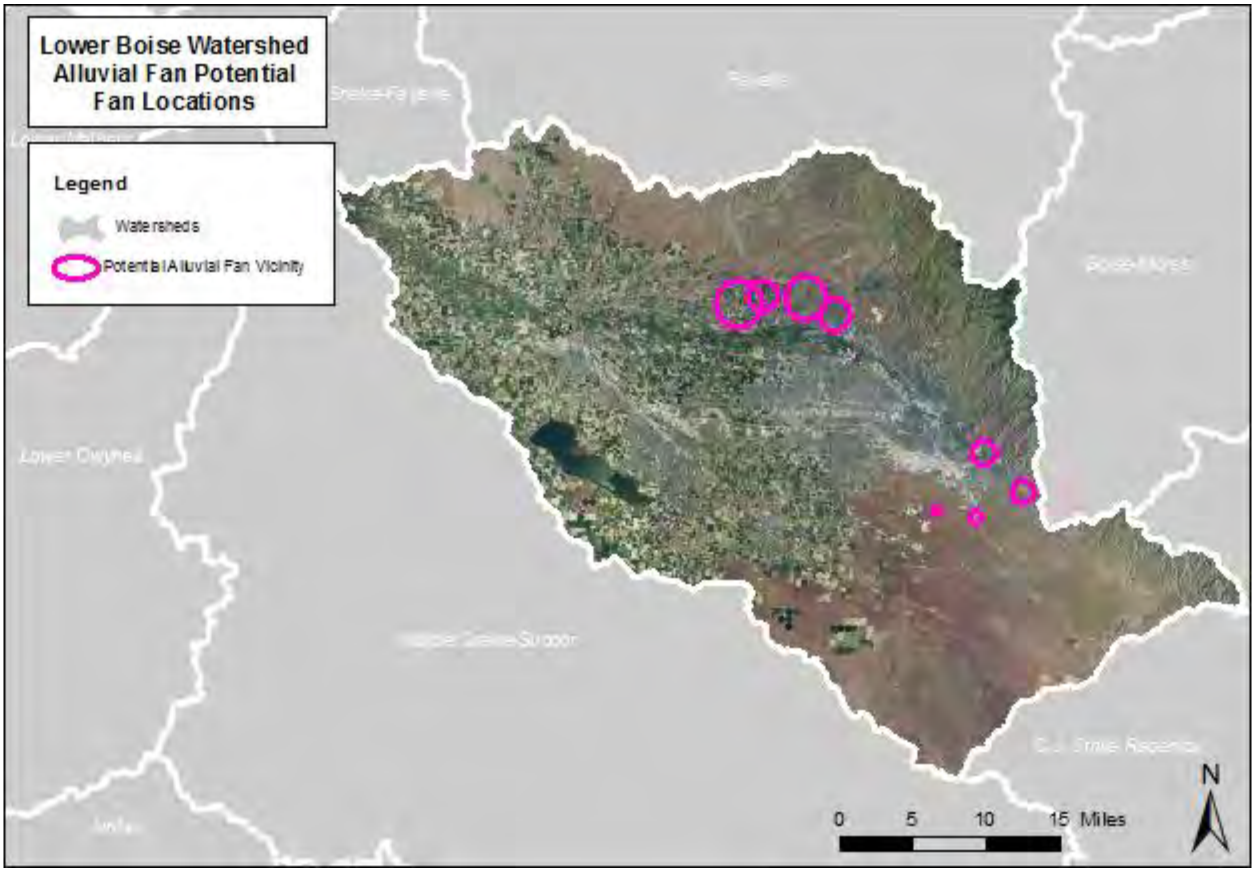

Figure 29. Potential alluvial fan locations for Lower Boise Watershed.

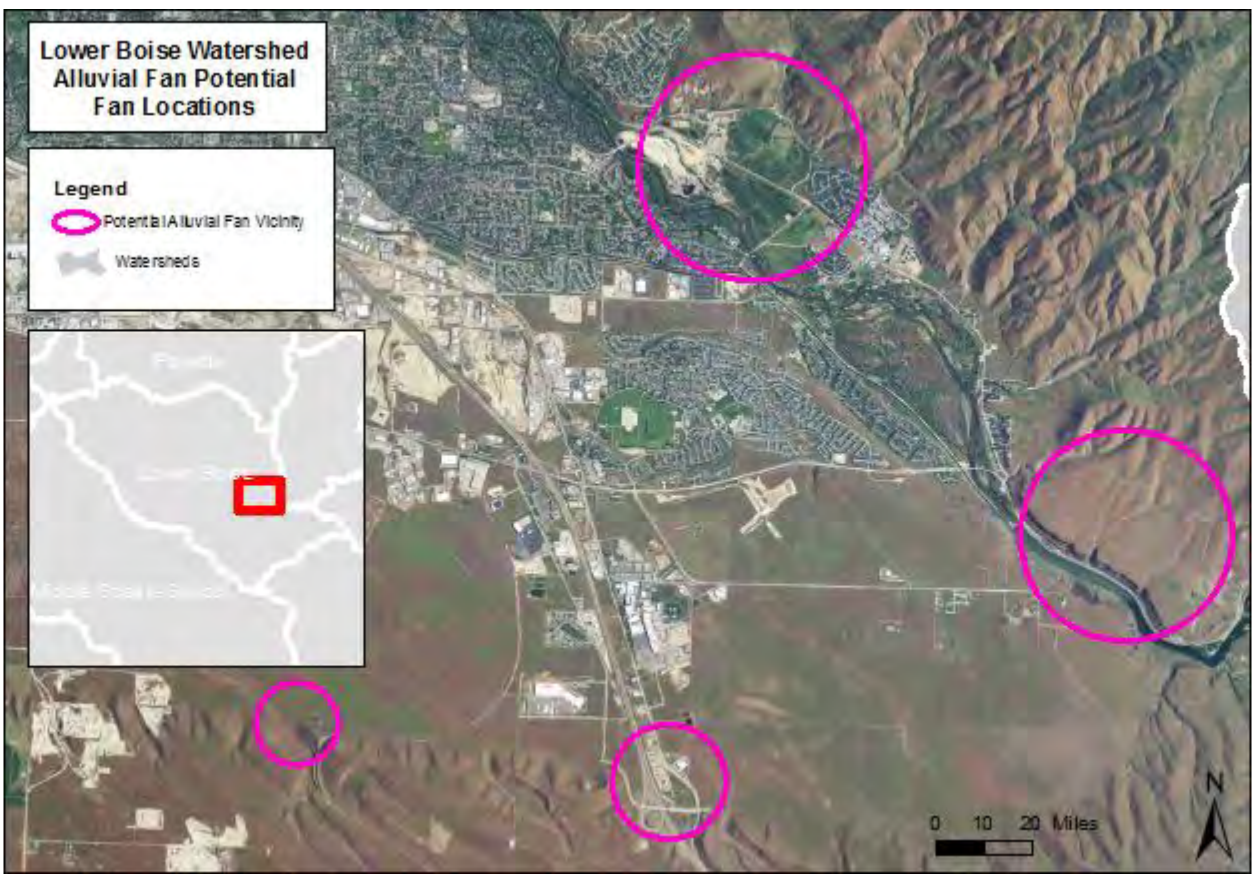

Figure 30. Potential alluvial fan vicinity #1 for Lower Boise Watershed.

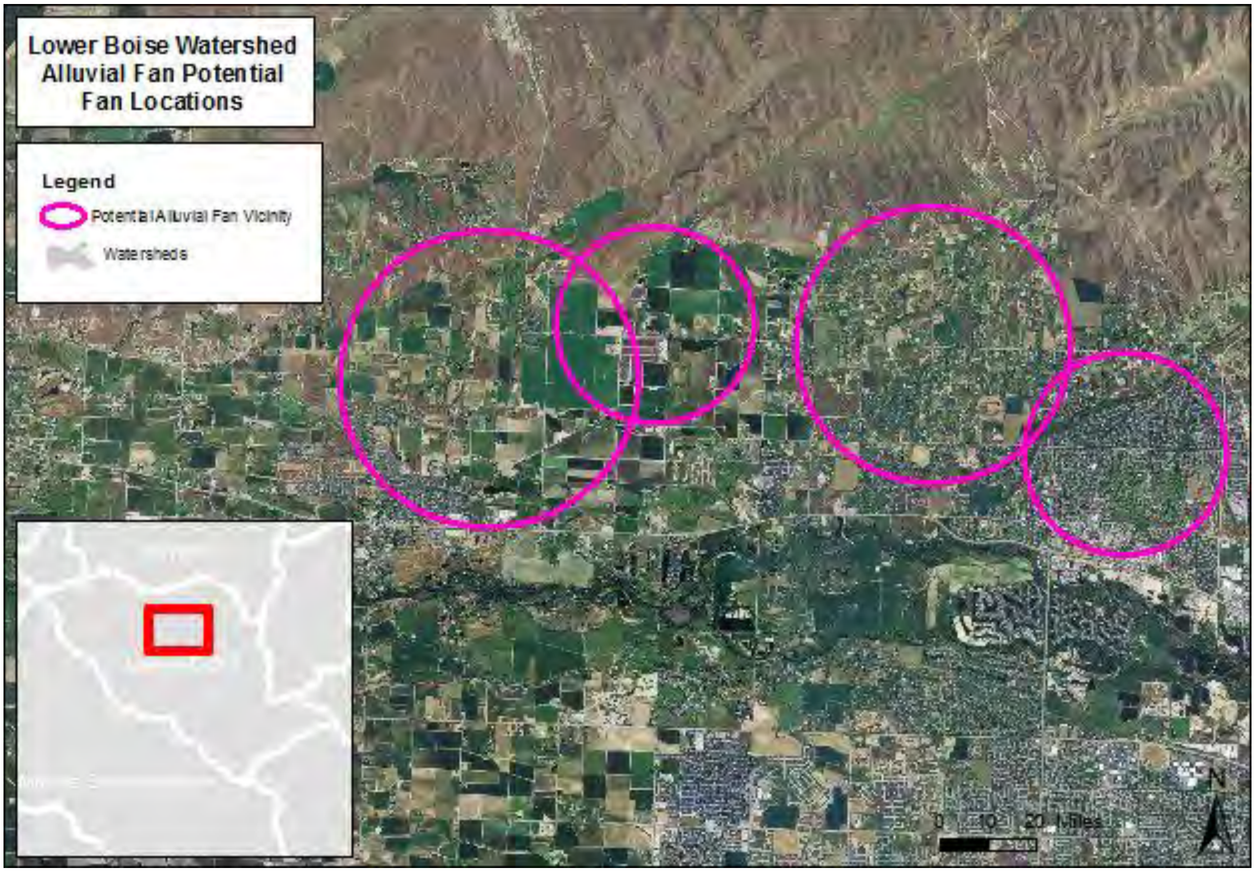

Figure 31. Potential alluvial fan vicinity #2 for Lower Boise Watershed.

Potential Alluvial Fan Example 1

This potential alluvial fan could be the convergence of two fans; the extensive development along this area makes it less obvious than other similar fans. The geologic age of these sediments is consistent with alluvial fan instability. Subdivisions and agriculture cover this possible fan. Agricultural development is a common occurrence on alluvial fans due to broad, low slopes and rich alluvial soils. Subdivisions are also often built on alluvial fans, because the fan's slope allows nearly every house to have a view.

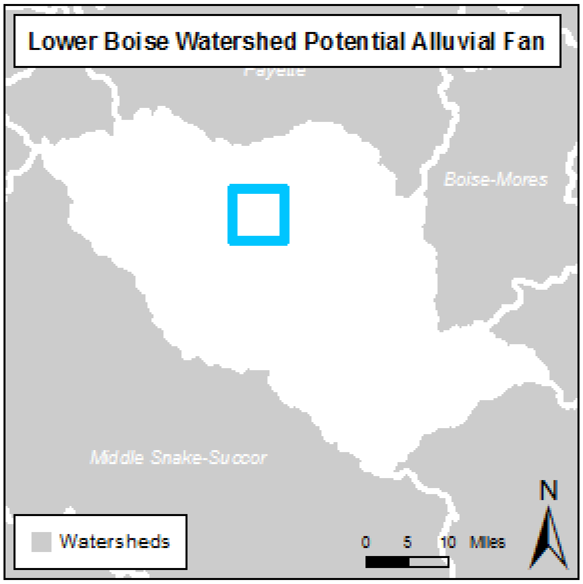

Figure 32. Extent of potential alluvial fan #1 in Lower Boise Watershed.

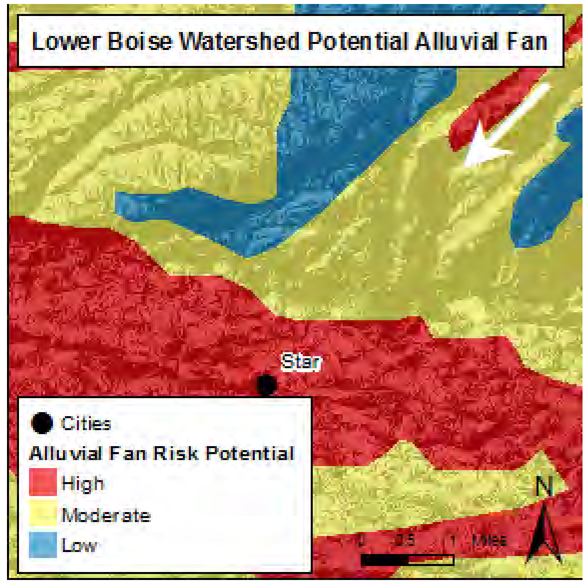

Figure 34. Alluvial fan risk of potential alluvial fan #1 in Lower Boise Watershed.

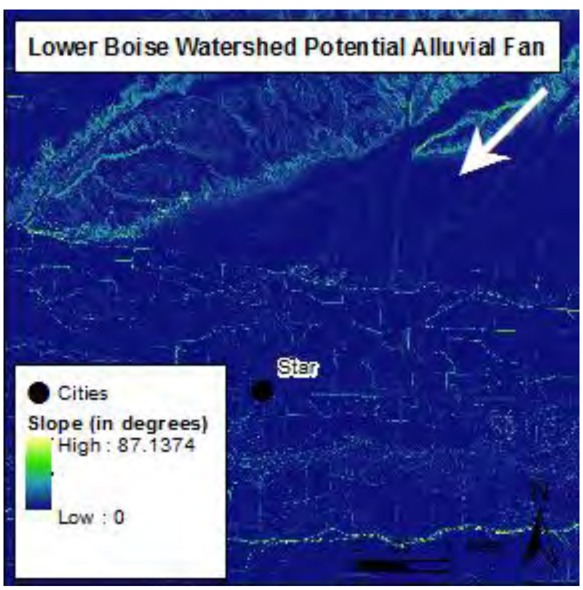

Figure 33. Slope of potential alluvial fan #1 in Lower Boise Watershed.

Figure 35. Imagery of potential alluvial fan #1 in Lower Boise Watershed.

Potential Alluvial Fan Example 2

This potential alluvial fan appears to have a very typical fan shape, despite the extensive development across the fan's extent, with the foot of the fan extending to the southeast. Similar to the previous example, this fan is mostly covered in agriculture due to broad, low slopes and rich alluvial soils. A canal near the apex of the fan may have been shaped by alluvial activity. However, the lower part of the fan appears to be well channelized and could be possibly deactivated due to the canals.

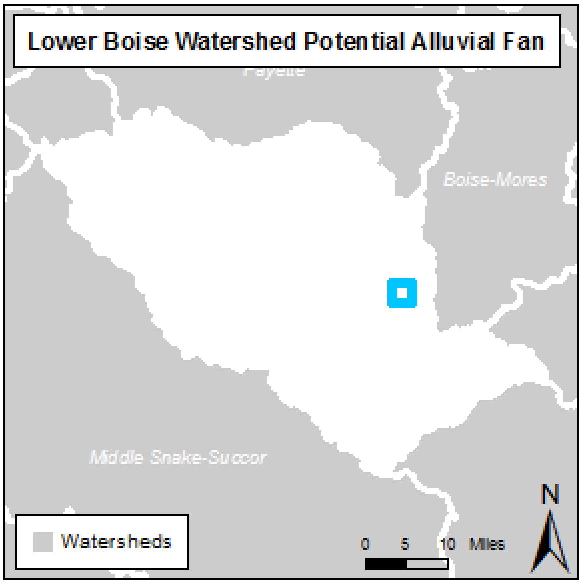

Figure 36. Extent of potential alluvial fan #2 in Lower Boise Watershed.

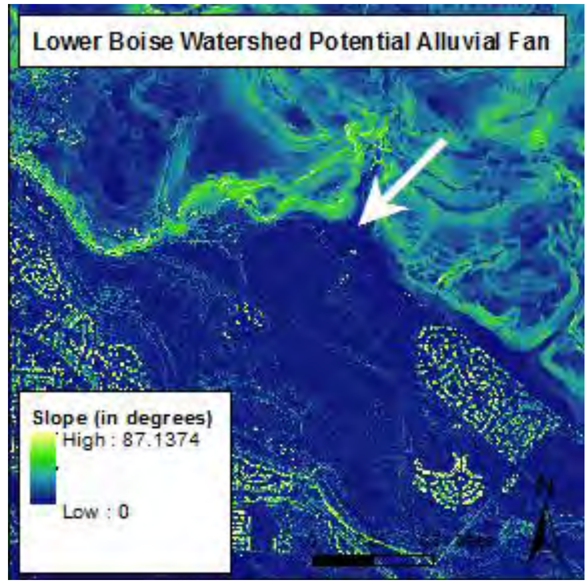

Figure 37. Slope of potential alluvial fan #2 in Lower Boise Watershed.

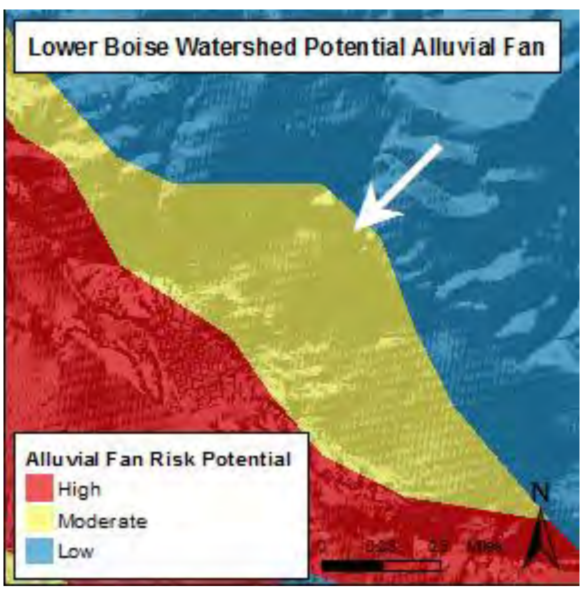

Figure 38. Alluvial fan risk of potential alluvial fan #2 in Lower Boise Watershed.

Figure 39. Imagery of potential alluvial fan #2 in Lower Boise Watershed.

Summary of Exposure to Alluvial Fans

Area	Average Parcel Value	High Parcel Value	Parcel Count
Lower Boise (Watershed)	$150,000	>$913,000	219,692
Ada (County)	$197,000	>$1,108,000	149,173
Canyon (County)	$48,000	>$259,000	74,833
Elmore (County)	$76,000	>$256,000	16,118
Boise (City)	$215,000	>$1,461,000	72,808
Caldwell (City)	$36,000	>$95,000	15,998
Eagle (City)	$269,000	>$562,000	8,231
Garden City (City)	$206,000	>$570,000	4,690
Greenleaf (City)	$20,000	>$35,000	358
Kuna (City)	$97,000	>$182,000	5,818
Meridian (City)	$1,904,000	>$2,396,000	28,176
Middleton (City)	$24,000	>$67,000	2,472
Nampa (City)	$72,000	>$407,000	28,271
Notus (City)	$28,000	>$58,000	221
Parma (City)	$18,000	>$39,000	766
Star (City)	$109,000	>$190,000	2,405
Wilder (City)	$13,000	>$26,000	321

Area	Parcel Count in Potential Fans	Parcel Count in Mapped Fans	High Value Parcel Count in Fans
Lower Boise (Watershed)	6807	220	36
Ada (County)	6807	366	25
Canyon (County)	178	0	0
Elmore (County)	0	0	0
Boise (City)	689	194	5
Caldwell (City)	0	0	0
Eagle (City)	3962	0	83
Garden City (City)	0	0	0
Greenleaf (City)	0	0	0
Kuna (City)	0	0	0
Meridian (City)	0	0	0
Middleton (City)	0	0	0
Nampa (City)	0	0	0
Notus (City)	0	0	0
Parma (City)	0	0	0
Star (City)	871	0	90
Wilder (City)	0	0	0

Area	% of Parcels in Potential Fan	% of Parcels in Mapped Fans	Total Value in Fans
Lower Boise (Watershed)	3.10%	0.10%	$1,608,392,560
Ada (County)	4.56%	0.25%	$1,604,207,500

Canyon (County)	0.24%	0.00%	$4,185,060
Elmore (County)	0.00%	0.00%	$0
Boise (City)	0.95%	0.27%	$243,836,600
Caldwell (City)	0.00%	0.00%	$0
Eagle (City)	48.14%	0.00%	$924,490,100
Garden City (City)	0.00%	0.00%	$0
Greenleaf (City)	0.00%	0.00%	$0
Kuna (City)	0.00%	0.00%	$0
Meridian (City)	0.00%	0.00%	$0
Middleton (City)	0.00%	0.00%	$0
Nampa (City)	0.00%	0.00%	$0
Notus (City)	0.00%	0.00%	$0
Parma (City)	0.00%	0.00%	$0
Star (City)	36.22%	0.00%	$100,536,100
Wilder (City)	0.00%	0.00%	$0

Table 8. Alluvial fan property risk potential summary for Lower Boise Watershed.
2012 County Assessor taxlot data was used. Any parcel with a taxable amount less than 1 was disregarded. This eliminated most government owned facilities from data. High value parcels were defined as greater than 1 standard deviation above the mean value.

Risk Mitigation Strategy

A total of nine potential alluvial fans were identified in the Lower Boise watershed. The incorporated cities of Eagle and Star having the first and second most numbers of parcels located in mapped potential alluvial fans, as shown in Table 8. These two cities are located adjacent to each other and sit at the base of the foothills, where streams flow in a south-westerly direction. The hillsides in the drainage basins have low to moderate slopes and lengthy valleys that are flat and wide.

The northern portions of the City of Eagle are located on two potential alluvial fans emanating from Goose Creek, Dry Creek, Woods Gulch and several smaller unnamed drainages. The Goose Creek drainage contains the Hidden Hollow Sanitary Landfill. The valley through which the stream flows is fairly wide and flat. The landscape and lack of structures makes it a suitable candidate for detention basins to capture the floodwaters. The Goose Creek and Dry Creek valleys converge at their mouths where numerous residences have been built on the flat land surface. The Dry Creek valley receives flows from several named creeks, the largest of which is Spring Valley Creek. The Dry Creek valley is very flat and wide in its lower portions and contains the community of Hidden Springs in the upper portions. The upper portions of Dry Creek may be suitable for detention basins to capture some of the flow prior to passing Hidden Springs. The Woods Gulch stream valley is also fairly wide with low relief compared to the surrounding hills, which will aid in reducing the effects of flood waters.

The northern portions of the City of Star are located on two potential alluvial fans emanating from Big Gulch Creek and Little Gulch Creek (Figures 28 - 32). The relief in these two drainages is low and the valleys are long, which will minimize the effect of flooding. Detention basins, which capture and retain flood waters, may be an effective mitigation strategy if constructed in the valleys. The main land use at the mouth of the valleys is agriculture and residential. However, commercial operations exist in the area, such as the River Birch Golf Course and a cattle feedlot. Mitigation strategies may also include constructing diversions. Flood waters would flow onto areas where the impact can be minimized.

Another potential fan with a moderate flood risk is located at the base of Warm Springs Creek (Figures 33 - 36). This drainage displays the typical characteristics associated with alluvial fan flooding risk: steep slopes in the larger drainage area and a confined valley that discharges directly onto a flat surface at the mouth. The confined valley does not allow the flood waters to dissipate their energy before exiting the valley channel. Both homes and agricultural fields are located at the base of this drainage. The existing homes may be protected by constructing architectural elements that may function as a floodwall, perhaps in between the homes and the valley mouth. Diversions may also be helpful to route the flood water onto the agricultural areas where it can spread out, slow down and deposit its sediment load as the waters flow towards the Boise River.

Floodwalls, dikes and levees are structural floodplain management practices; and are therefore less popular, desirable and effective than nonstructural floodplain management practices, such as land use regulation. Land use planning is the application of fiscal and public policy to create orderly land use patterns, regulate development, improve infrastructure and provide public process whereby a community endeavors to create its preferred future, hopefully one with a reduced risk to natural disasters.

Payette

The Payette Watershed is located in southwest Idaho. This area includes portions of Boise, Gem, Payette, Valley and Washington Counties as well as the communities of Emmett, Fruitland, Horseshoe Bend, New Plymouth and Payette. Estimated population in the watershed is 30,500. All six counties and three of the listed communities participate in the NFIP with total premiums of approximately $35,000 and $13 million of total coverage.

Data coverage

Despite covering nearly 70% of the watershed by area (Table 9), the FIRMs and DFIRMs identify no alluvial fans suggesting that the data source may not have included this type of hazard in the original analysis.

Dataset	Area (acres)	Area (sq. mi)	% of watershed
Payette Watershed	783,605	1,224	100
DFIRM	61,169	95.6	7.8
FIRM	488,772	763.7	62.4

Table 9. Flood insurance data source coverage by area for Payette Watershed.

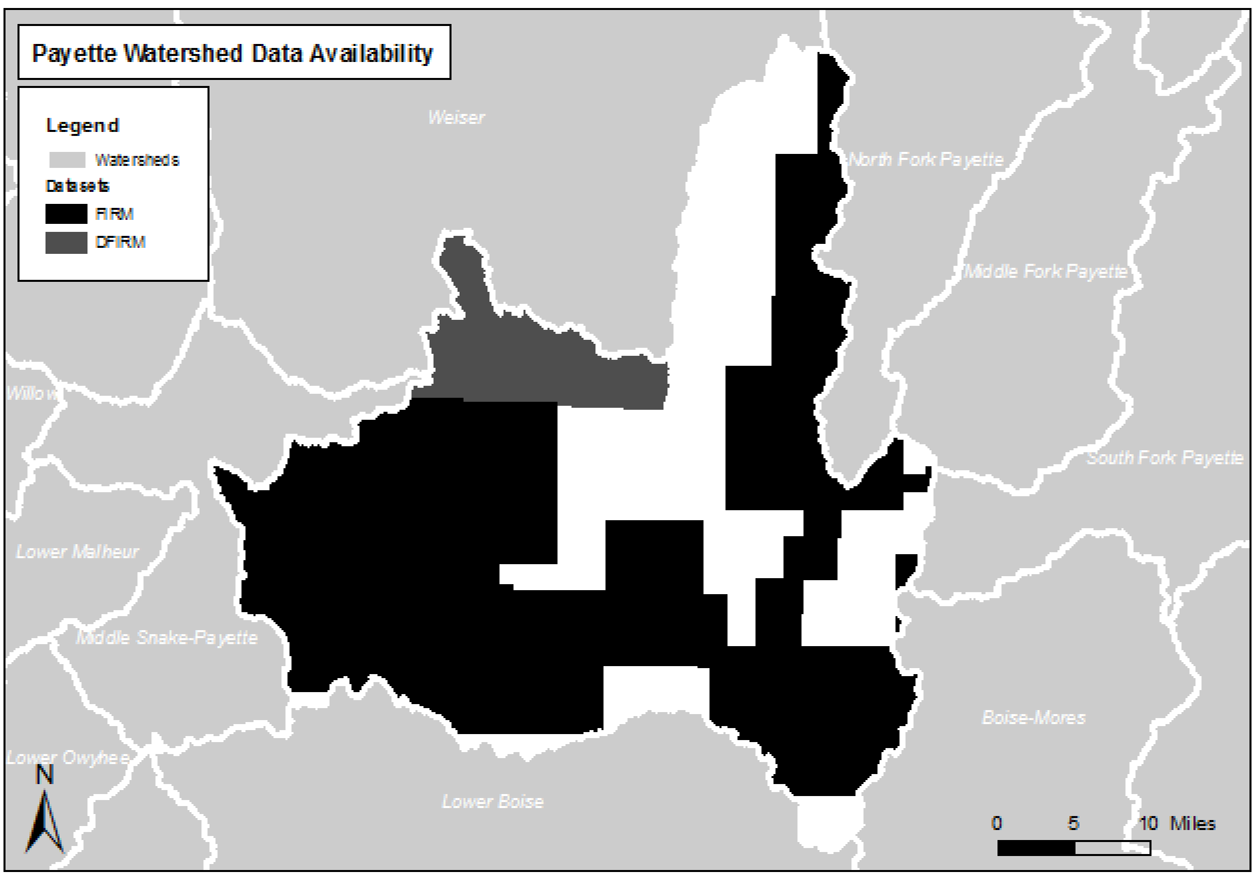

Figure 40. Flood insurance data source coverage for Payette Watershed.

Mapped Alluvial Fan

No mapped fans exist in this watershed based on existing data sources.

Alluvial Fan Risk Potential

Alluvial fan risk potential was mapped in this watershed using the methodology described in Section IV.

Risk Potential	Area (acres)	% of watershed
Low	672,097	85.8
Moderate	101,895	13.0
High	9,605	1.2

Table 10. Alluvial fan risk potential summary for Payette Watershed.

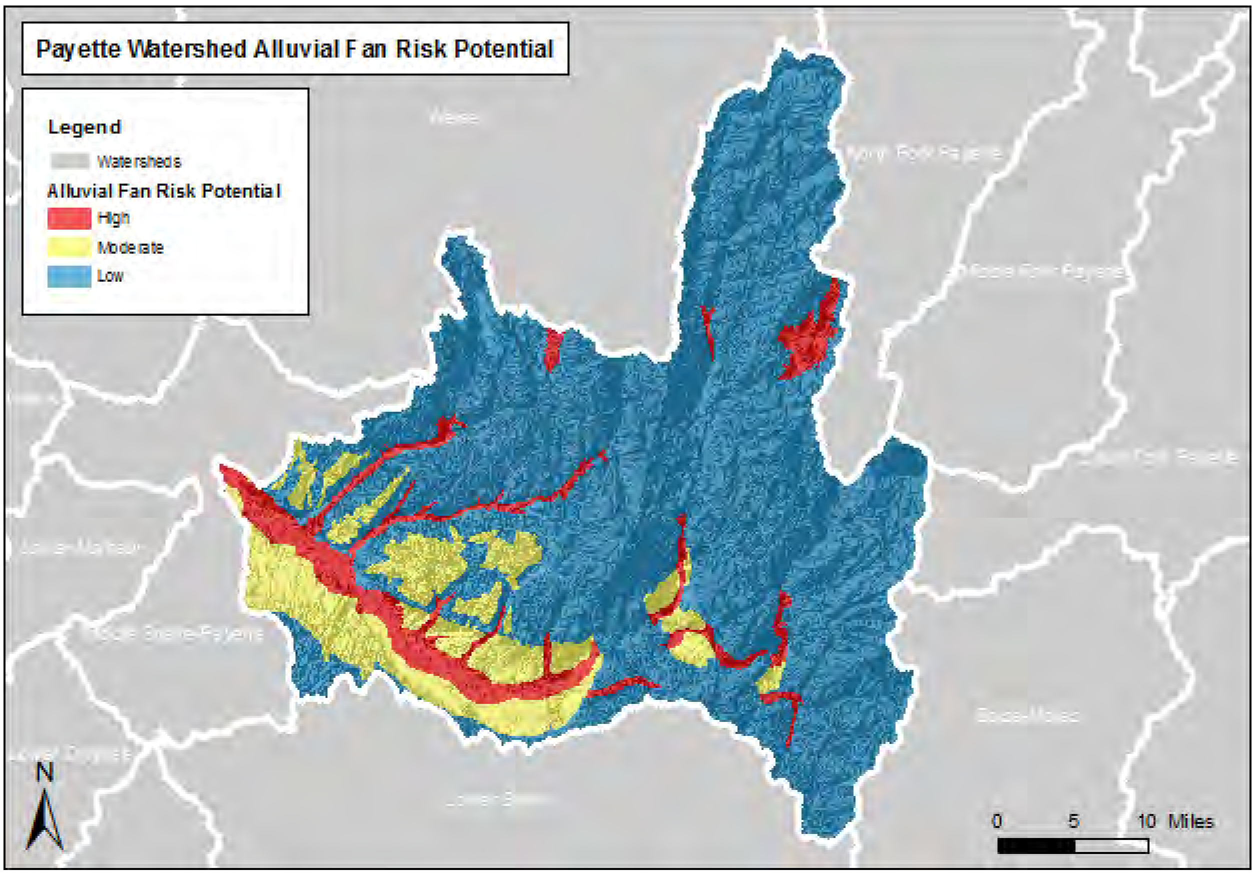

Figure 41. Alluvial fan risk potential for Payette Watershed.

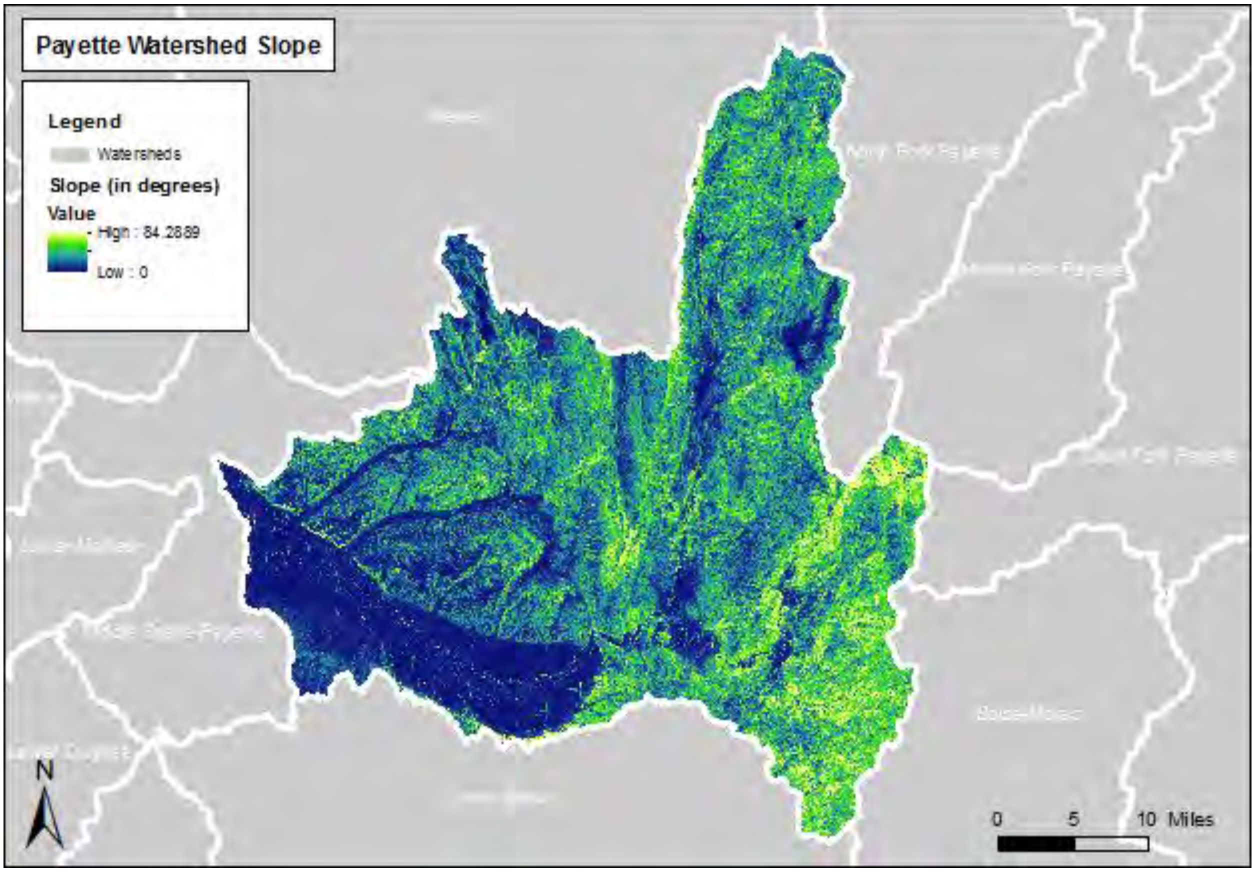

Figure 42. Slope analysis for Payette Watershed.

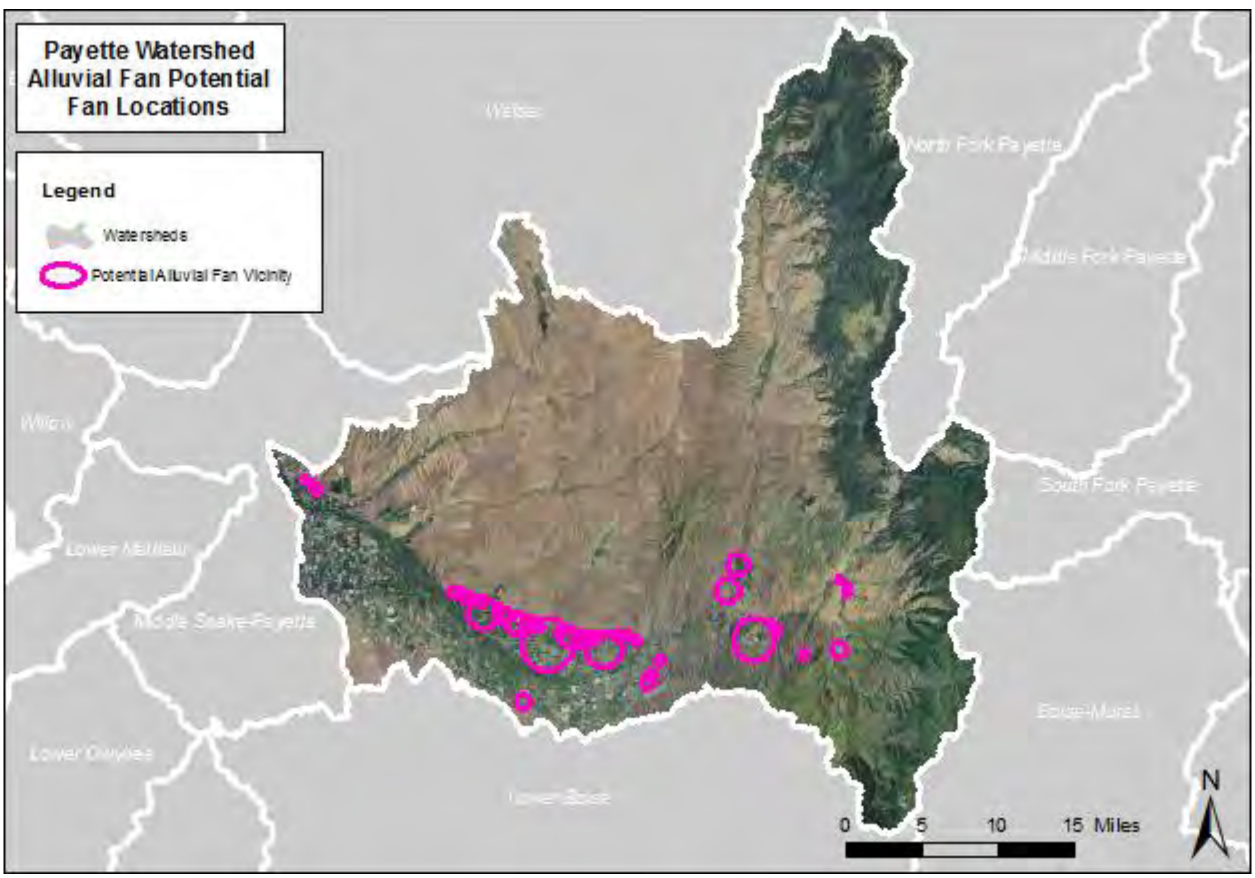

Figure 43. Potential alluvial fan locations for Payette Watershed.

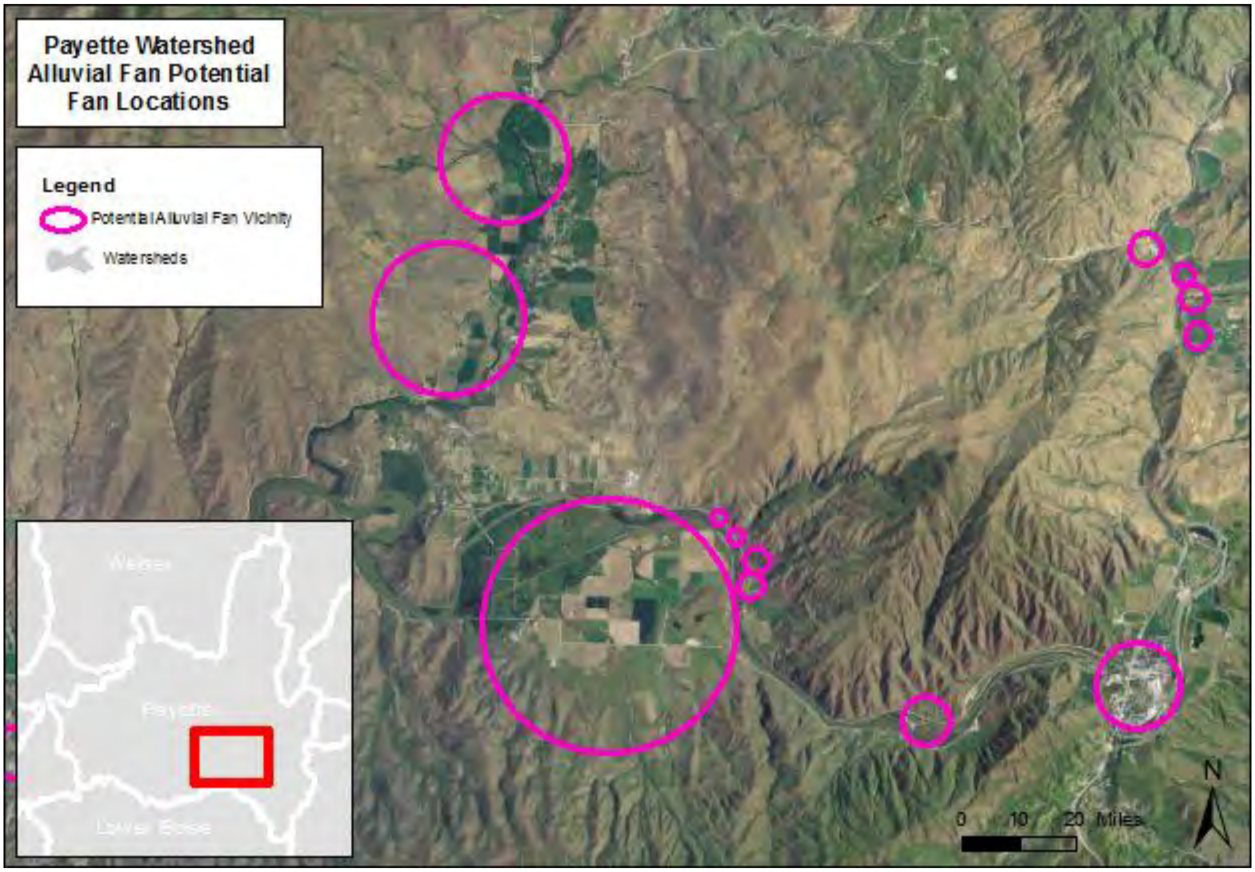

Figure 44. Potential alluvial fan vicinity #1 for Payette Watershed.

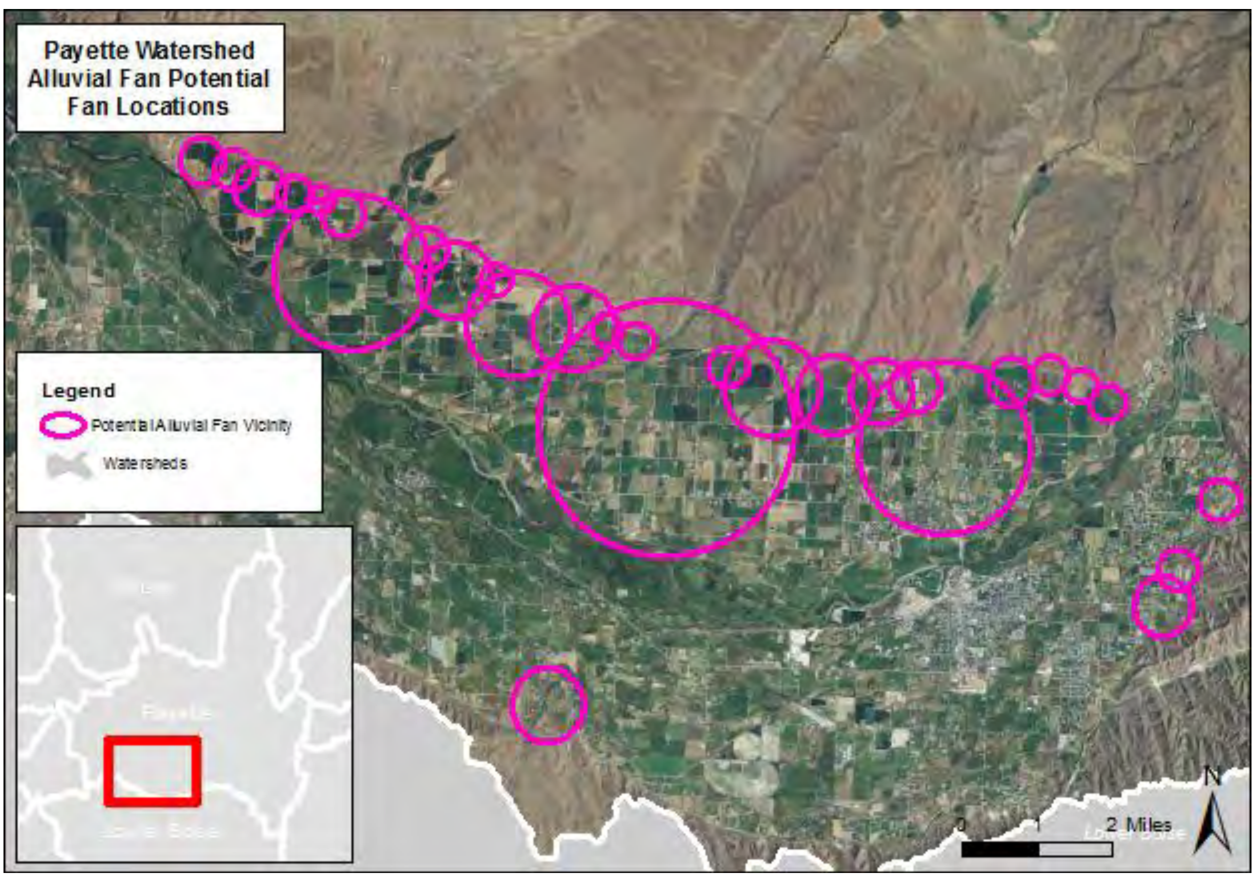

Figure 45. Potential alluvial fan vicinity #2 for Payette Watershed.

Figure 46. Potential alluvial fan vicinity #3 for Payette Watershed.

Potential Alluvial Fan Example 1

This potential alluvial fan site near Sweet, Idaho, demonstrates several characteristics that make it likely for alluvial fan flooding. Alluvial fan risk is high to moderate, as depicted in red and yellow in Figure 49. The slope broadens and flattens onto the valley depicting a strong fan-shaped plain. The geologic age of these sediments is consistent with alluvial fan instability. Braided stream reaches (interlacing and shifting shallow channels) suggest instable soils, erosion and active meander. Slope modeling indicates terracing, or a step-like surface, which is characteristic of specific types of alluvial fans.

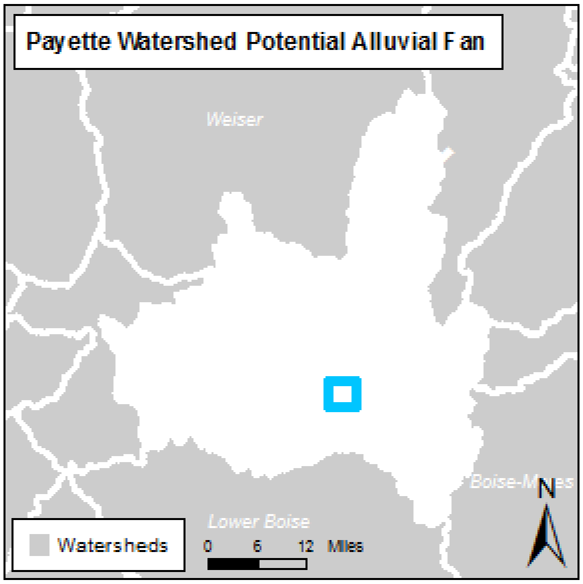

Figure 47. Extent of potential alluvial fan #1 in Payette Watershed.

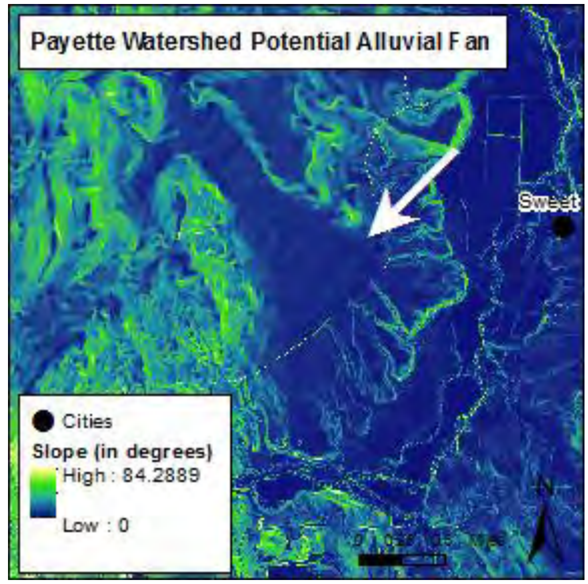

Figure 48. Slope of potential alluvial fan #1 in Payette Watershed.

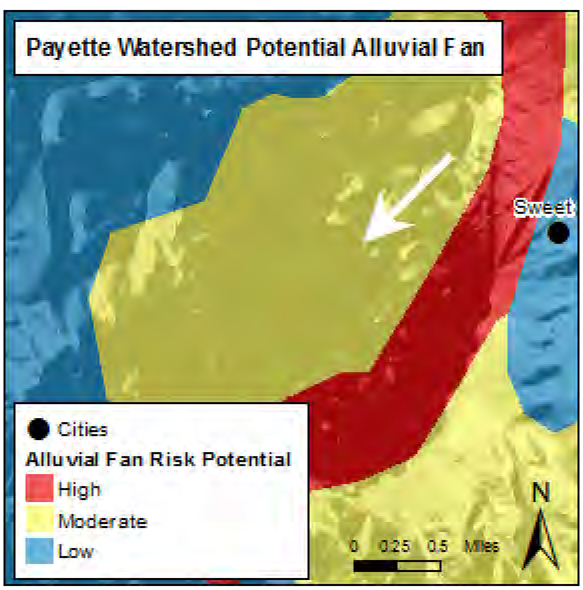

Figure 49. Alluvial fan risk of potential alluvial fan #1 in Payette Watershed.

Figure 50. Imagery of potential alluvial fan #1 in Payette Watershed.

Potential Alluvial Fan Example 2

This potential alluvial fan site stretching between Letha and Emmett, Idaho, demonstrates several characteristics that make it likely for alluvial fan flooding and is ranked as a high to moderate alluvial fan risk depicted in red and yellow in Figure 53. The slope broadens and flattens into the valley depicting a strong fan-shaped plain indicating the potential for several joined alluvial fans. The geologic age of these sediments is consistent with alluvial fan instability. Extensive agricultural development is also a common occurrence on alluvial fan due to broad, low slopes and rich alluvial soils.

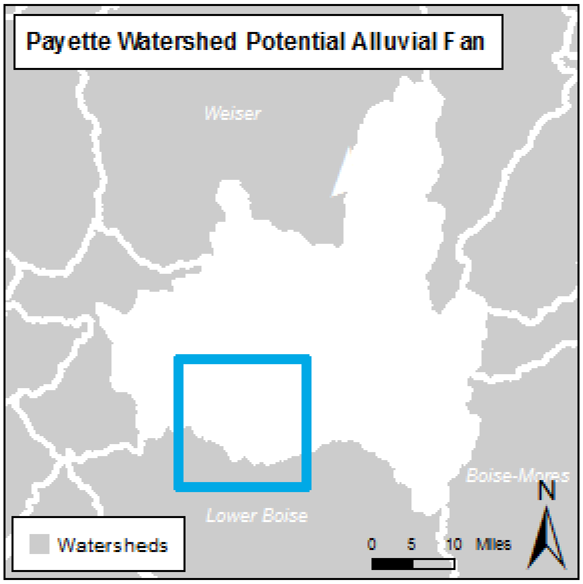

Figure 51. Extent of potential alluvial fan #2 in Payette Watershed.

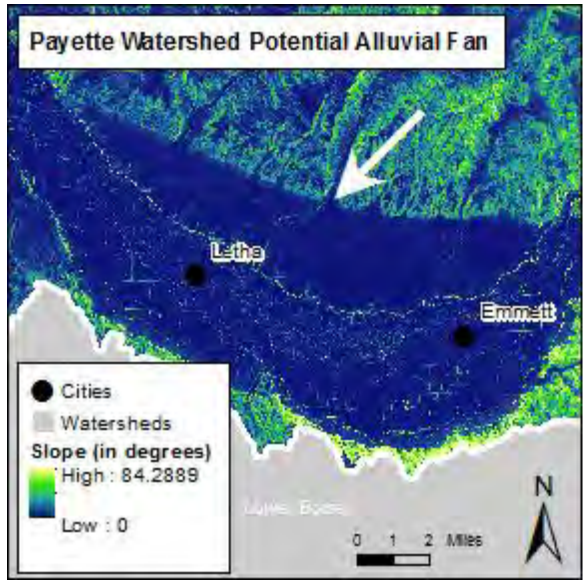

Figure 52. Slope of potential alluvial fan #2 in Payette Watershed.

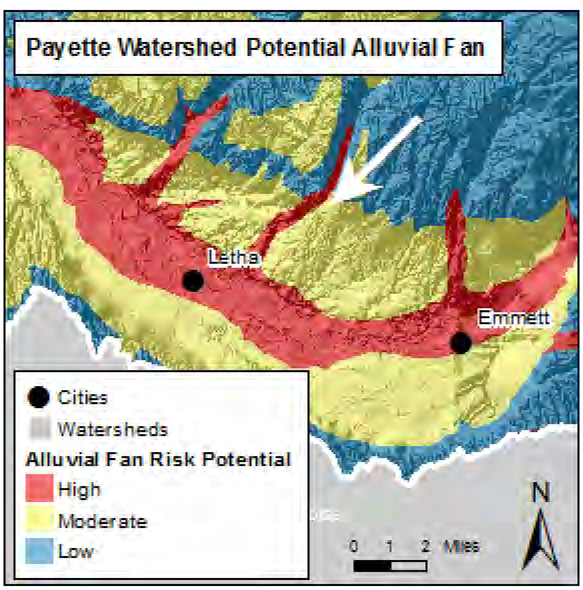

Figure 53. Alluvial fan risk of potential alluvial fan #2 in Payette Watershed.

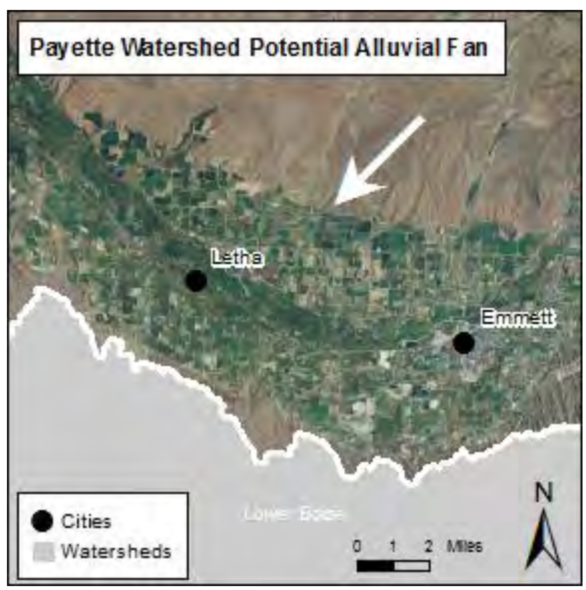

Figure 54. Imagery of potential alluvial fan #2 in Payette Watershed.

Summary of Exposure to Alluvial Fans

Area	Average Parcel Value	High Parcel Value	Parcel Count
Payette (Watershed)	$75,000	>$179,000	14,898
Boise (County)	$74,000	>$170,000	9,910
Gem (County)	$74,000	>$169,000	6,883
Payette (County)	$95,000	>$405,000	10,721
Valley (County)	$136,000	>$403,000	21,268
Washington (County)	$36,000	>$123,000	4,575
Emmett (City)	$45,000	>$153,000	2,437
Fruitland(City)	$105,000	>$270,000	1,765
Horseshoe Bend (City)	$57,000	>$129,000	389
NewPlymouth (City)	$72,000	>$178,000	639
Payette (City)	$82,000	>$202,000	2,914

Area	Parcel Count in Potential Fans	Parcel Count in Mapped Fans	High Value Parcel Count in Fans
Payette (Watershed)	1345	0	120
Boise (County)	296	0	9
Gem (County)	999	0	122
Payette (County)	50	0	0
Valley (County)	0	0	0
Washington (County)	0	0	0
Emmett (City)	0	0	0
Fruitland(City)	0	0	0
Horseshoe Bend (City)	280	0	14
NewPlymouth (City)	0	0	0
Payette (City)	0	0	0

Area	% of Parcels in Potential Fan	% of Parcels in Mapped Fans	Total Value in Fans
Payette (Watershed)	9.03%	0.00%	$118,618,356
Boise (County)	2.99%	0.00%	$16,038,306
Gem (County)	14.51%	0.00%	$97,307,300
Payette (County)	0.47%	0.00%	$5,272,750
Valley (County)	0.00%	0.00%	$0
Washington (County)	0.00%	0.00%	$0
Emmett (City)	0.00%	0.00%	$0
Fruitland(City)	0.00%	0.00%	$0
Horseshoe Bend (City)	71.98%	0.00%	$14,809,534
NewPlymouth (City)	0.00%	0.00%	$0
Payette (City)	0.00%	0.00%	0.00%

Table 11. Alluvial fan property risk potential summary for Payette Watershed.
2012 County Assessor taxlot data was used. Any parcel with a taxable amount less than 1 was disregarded. This eliminated most government owned facilities from data. High value parcels were defined as greater than 1 standard deviation above the mean value.

Risk Mitigation Strategy

A total of 45 potential fans were identified in the Payette Watershed. A number of potential alluvial fans have joined to form an apron of sediment (bajada) at the base of the foothills. The apron begins north of Emmett and just slightly west of Black Canyon Dam and ends approximately 13 miles west where Hillview Road crosses the Payette River at Freemont Road (Figure 41). The major drainages that contribute to this bajada are Haw Creek, Bissel Creek and Sand Hollow. The upper portions of Haw

Creek have fairly low relief with broad, gently sloping hills which transition into a wide valley bottom. There are also two existing ponds, one small and one large, that may act as detention basins. Diversions can be utilized, allowing the floodwater to flow onto non-residential or commercial lands. As with Haw Creek, the Bissel Creek drainage has hills with low relief, and slopes that merge with a wide valley floor in the upper portions of the drainage. The few residential structures at the mouth of Bissel Creek may utilize floodwalls to divert the floodwaters around the buildings. Sand Hollow has the largest drainage area, but combined with the low relief and long valley length of nearly seven miles from headwaters to mouth, any flood flows and sediment would likely remain in the valley. At the valley mouth, the width increases even more. Also, the agricultural land use makes it ideal for building diversions and bypasses into the stream channel. These structures can route floodwaters onto the flat land where it can slow down and deposit its sediment load.

A second potential alluvial fan stems from Yergenson creek (Figures 44 - 46) near Sweet, Idaho. The Yergenson Creek drainage basin is fairly large and receives additional flows from Wood Canyon and Minnis Canyon. The drainage basin has moderate relief throughout. However, steep slopes and semi-confined channels in its upper portions route floodwaters downhill towards the potential alluvial fan. This fan poses moderate risk due to the characteristics discussed above (relief, slopes and channel confinement) and the semi-confined nature of the upper and mid-fan zones. Several structures and residential buildings exist in the upper portions of the fan which may utilize flood walls to divert the flow around the structure and onto the surrounding flat, undeveloped land.

A third potential alluvial fan is located near Montour, Idaho, and receives flood waters from Stagecoach Canyon, Baltic Canyon, Deep Canyon, Church Creek and Snyder Canyon. The risk of alluvial fan flooding is moderate due to the steep slopes and confined channels in the upper portions of the drainages as well as the high number of drainages contributing to the potential fan. The high number of drainages increases the probability that a storm event, such as wildfire followed by normal precipitation may induce a mass movement (such as a landslide) in one of the drainages. The risk of alluvial fan flooding on Church Creek may be reduced if a diversion is constructed upstream where this creek comes very close to Deep Canyon. A floodwall or levee constructed on the upstream side of the one residential structure at the mouth of the stream may route the flood waters around onto the surrounding agricultural flatland. Several other residential structures located further down the fan may also utilize flood walls to divert floodwaters and sediment around the structure.

Floodwalls, dikes and levees are structural floodplain management practices; and are therefore less popular, desirable and effective than nonstructural floodplain management practices, such as land use regulation. Land use planning is the application of fiscal and public policy to create orderly land use patterns, regulate development, improve infrastructure and provide public process whereby a community endeavors to create its preferred future, hopefully one with a reduced risk to natural disasters.

Teton

The Teton Watershed is located in southeast Idaho and western Wyoming. This area includes portions of Fremont, Madison and Teton Counties as well as the communities of Bates, Driggs, Newdale, Rexburg, St. Anthony, Sugar City, Teton, Tetonia and Victor. Estimated population in the watershed is 27,700. All four counties and four of the listed communities participate in the NFIP with total premiums of approximately $73,800 and $28 million of total coverage.

Data coverage

Despite covering nearly 90% of the watershed by area (Table 12), the FIRMs and DFIRMs identified no alluvial fans suggesting that the data source may not have included this type of hazard in the original analysis.

Dataset	Area (acres)	Area (sq. mi)	% of watershed
Teton Watershed	528,130	825	100
DFIRM	0	0	0
FIRM	470,390	735	89

Table 12. Flood insurance data source coverage by area for Teton Watershed.

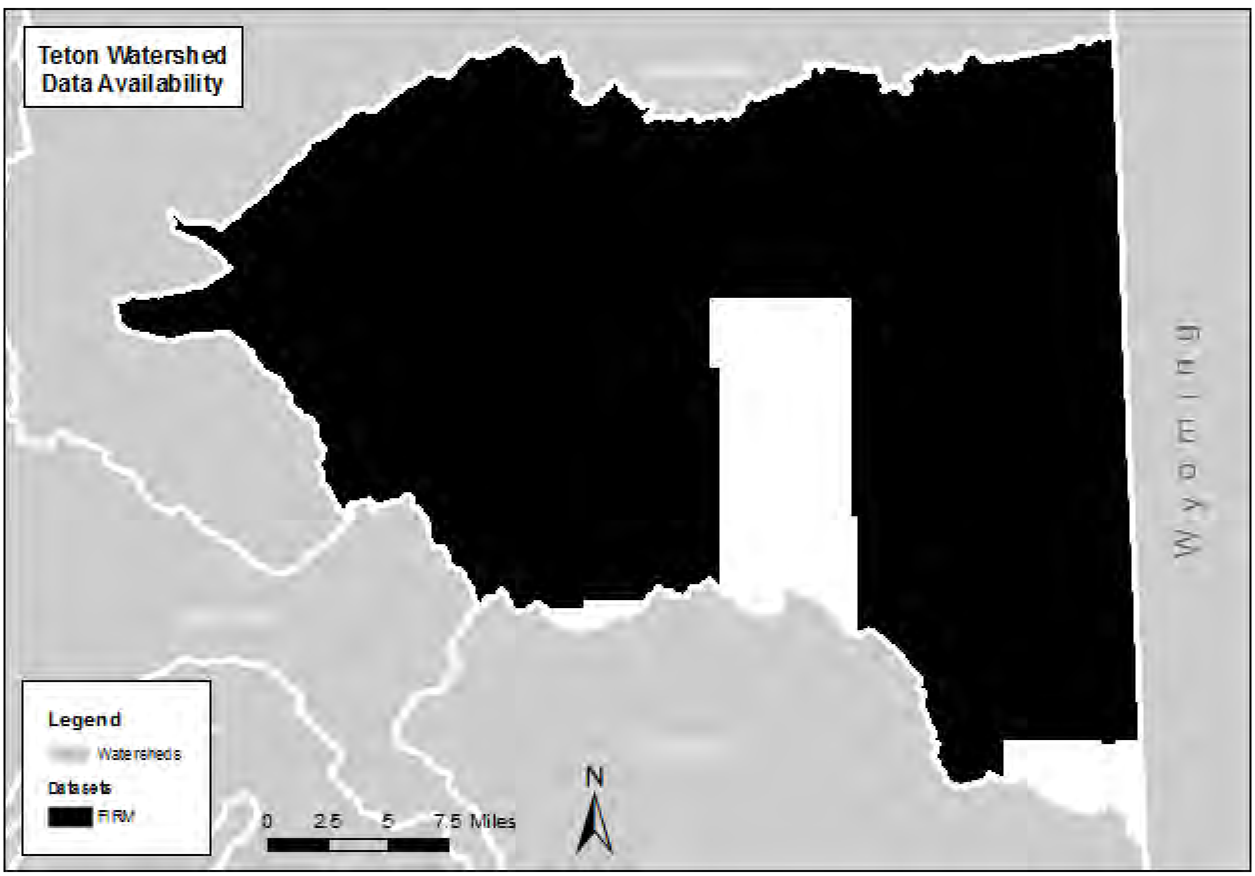

Figure 55. Flood insurance data source coverage for Teton Watershed.

Mapped Alluvial Fans

No mapped fans exist in this watershed based on existing data sources.

Alluvial Fan Risk Potential

Alluvial fan risk potential was mapped in this watershed using the methodology described in Section IV. The high risk potential category encompasses approximately 20% of the area of the Teton Watershed (Table 13).

Risk Potential	Area (acres)	% of watershed
Low	375,124	71.3
Moderate	43,922	8.3
High	107,044	20.3

Table 13. Alluvial fan risk potential summary for Teton Watershed.

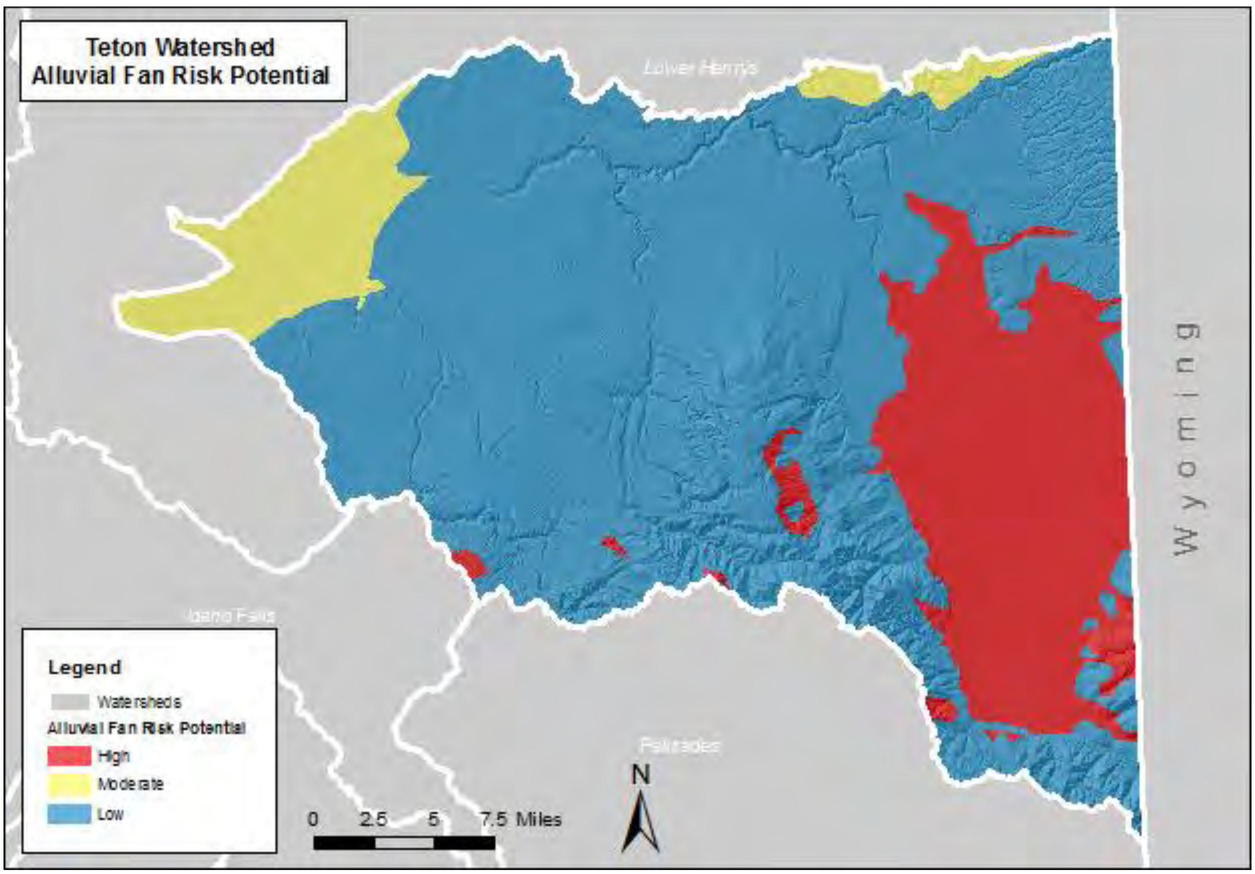

Figure 56. Alluvial fan risk potential for Teton Watershed.

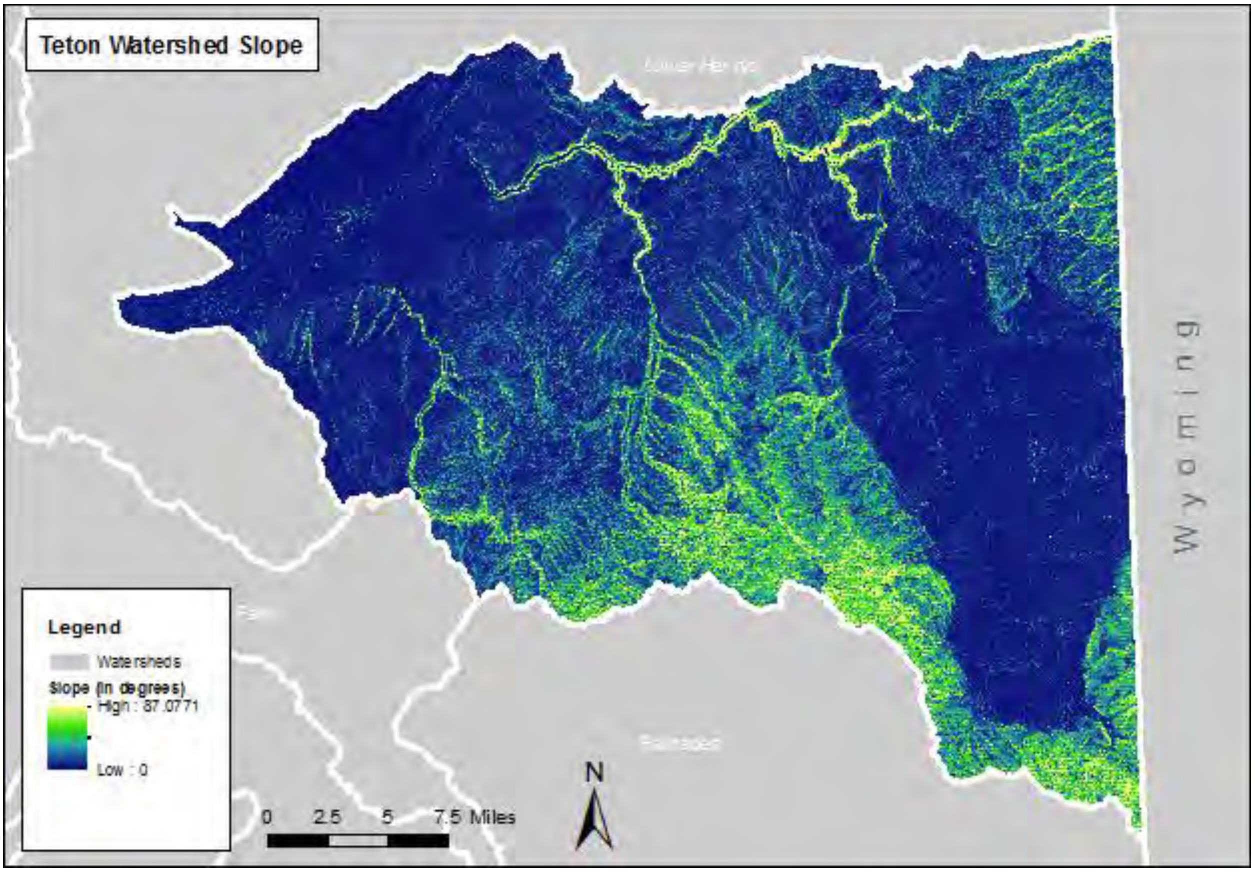

Figure 57. Slope analysis for Teton Watershed.

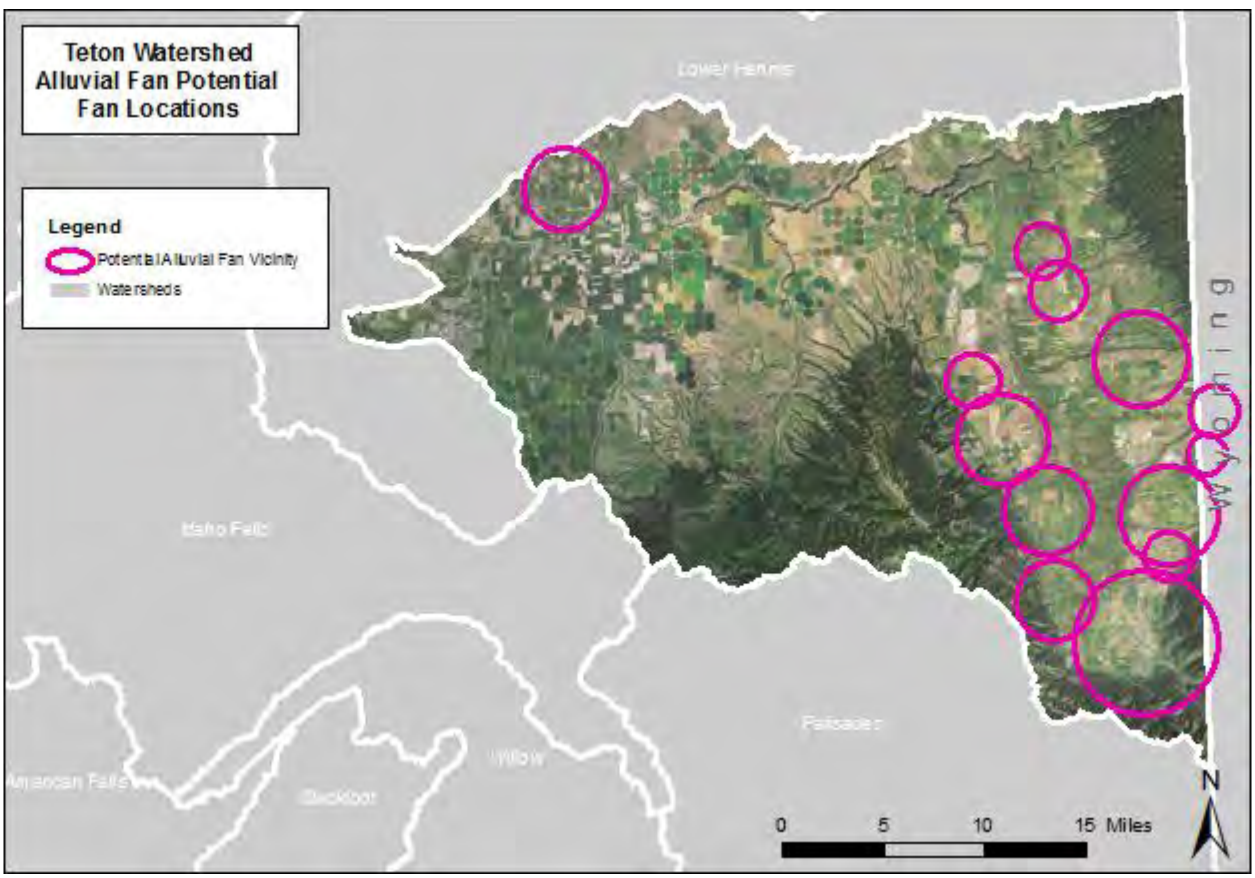

Figure 58. Potential alluvial fan locations for Teton Watershed.

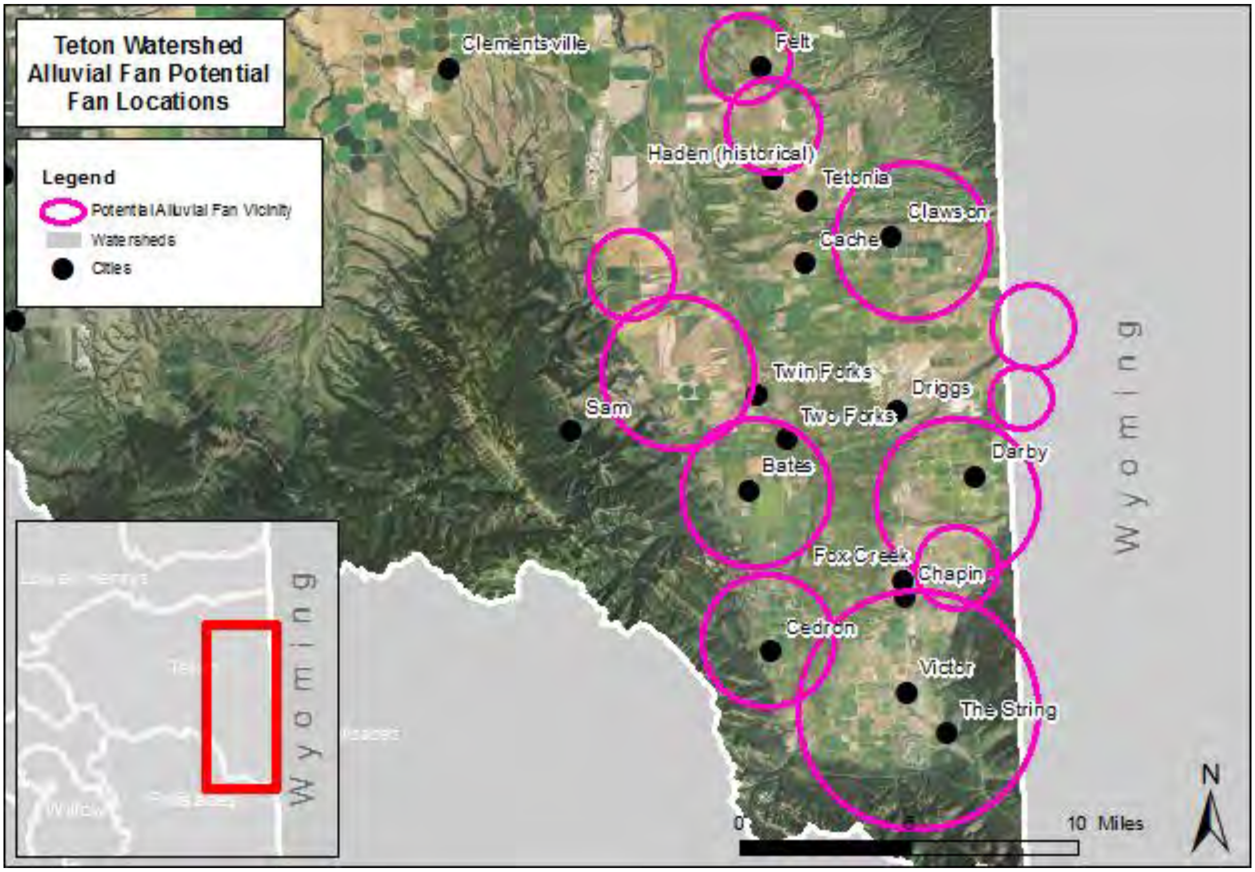

Figure 59. Potential alluvial fan vicinity #1 for Teton Watershed.

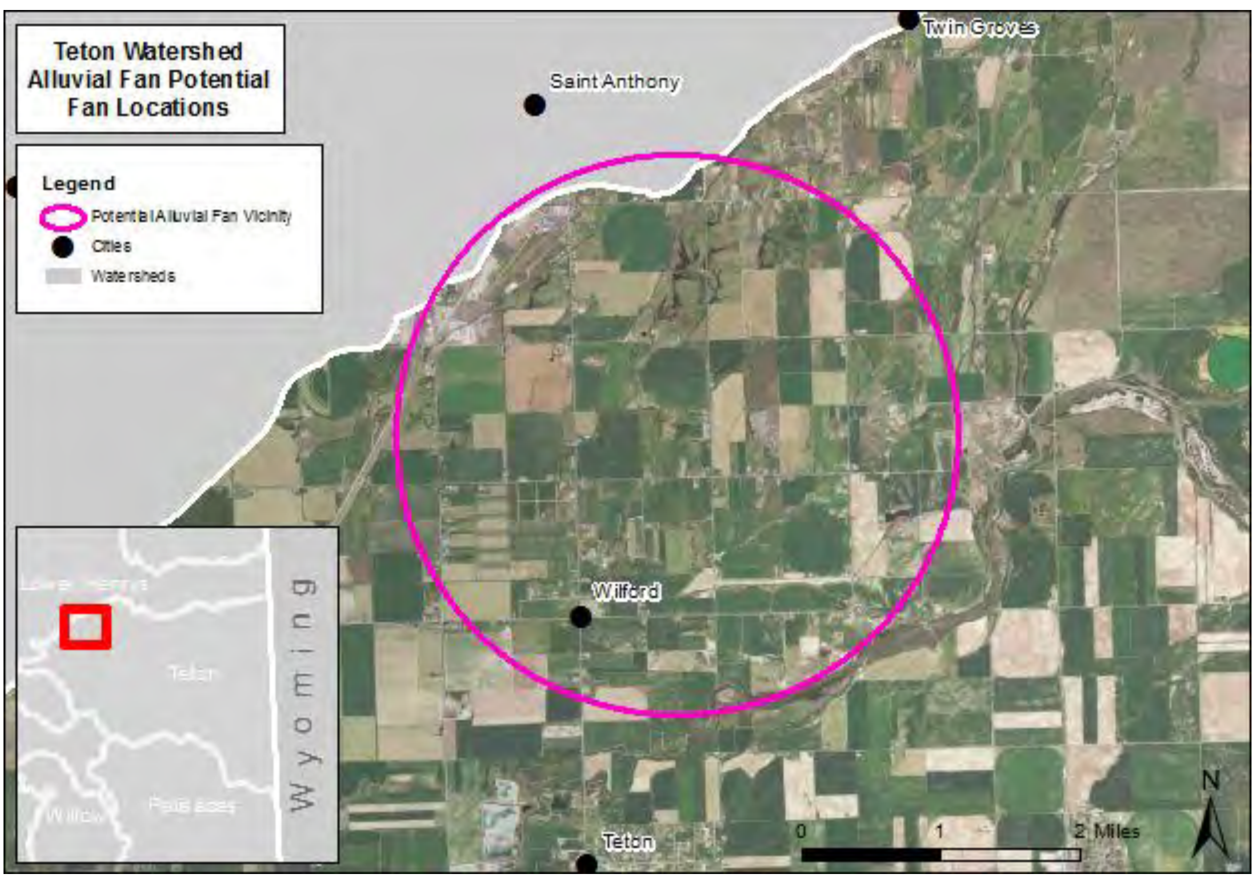

Figure 60. Potential alluvial fan vicinity #2 for Teton Watershed.

Potential Alluvial Fan Example 1

This potential alluvial fan site near Bates, Idaho, demonstrates several characteristics that make it likely for alluvial fan flooding. The alluvial fan risk is high, as depicted in red in Figure 63. The slope broadens and flattens into the valley depicting a strong fan-shaped plain. The geologic age of these sediments is consistent with alluvial fan instability. Braided stream reaches (interlacing and shifting shallow channels) suggest unstable soils, erosion and active meander.

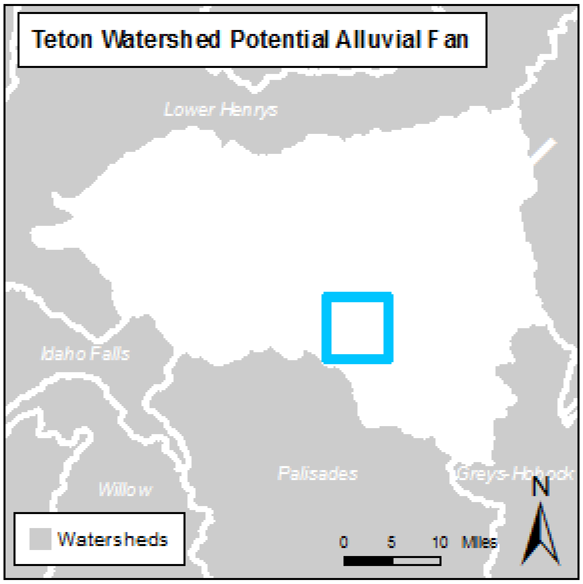

Figure 61. Extent of potential alluvial fan #1 in Teton Watershed.

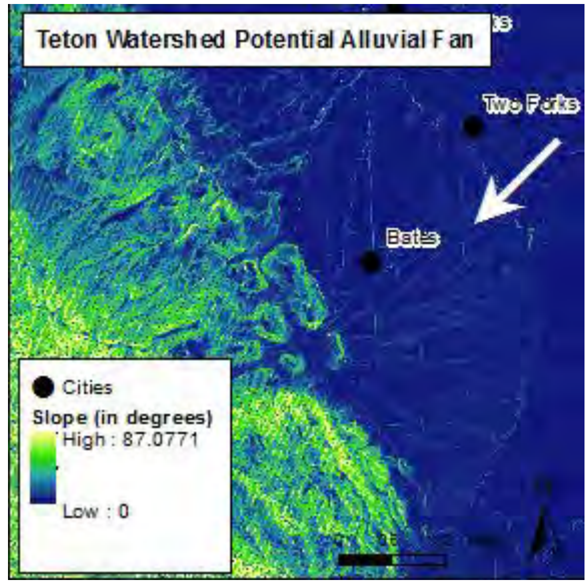

Figure 62. Slope of potential alluvial fan #1 in Teton Watershed.

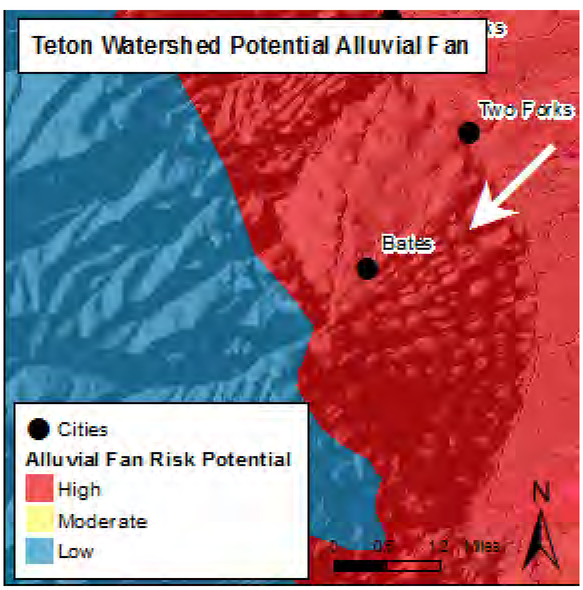

Figure 63. Alluvial fan risk of potential alluvial fan #1 in Teton Watershed.

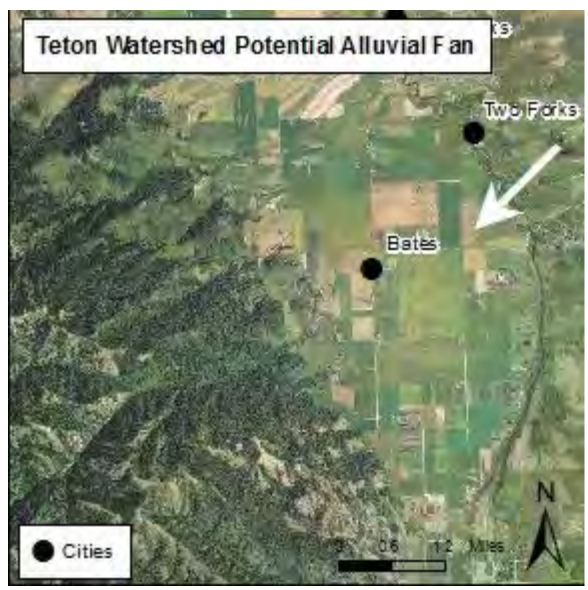

Figure 64. Imagery of potential alluvial fan #1 in Teton Watershed.

Potential Alluvial Fan Example 2

This potential alluvial fan site encompassing much of the community of Victor, Idaho, demonstrates several characteristics that make it likely for alluvial fan flooding. Alluvial fan risk is high, as depicted in red in Figure 67. The geologic age of these sediments is consistent with alluvial fan instability. Braided stream reaches (interlacing and shifting shallow channels) suggest instable soils, erosion and active meander. The slope broadens and flattens into the valley depicting a strong fan-shaped plain indicating the potential for several joined alluvial fans. Extensive agricultural development is also a common occurrence on alluvial fan due to broad, low slopes and good alluvial soils. The risk related to flooding could affect the nearly 2,000 citizens of Victor as well as agriculture and tourism in the area.

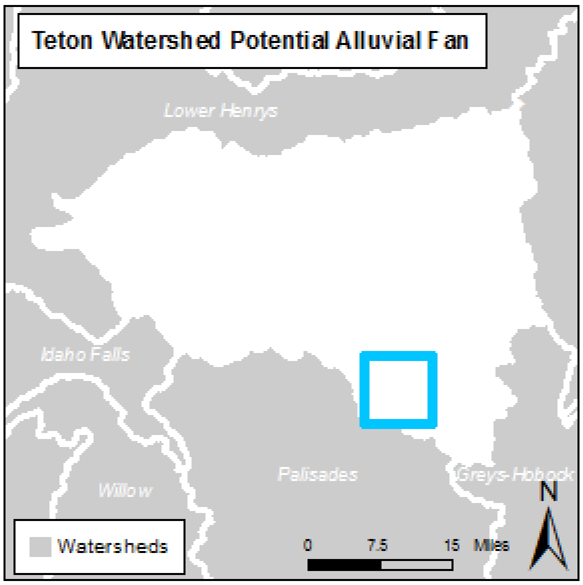

Figure 65. Extent of potential alluvial fan #2 in Teton Watershed.

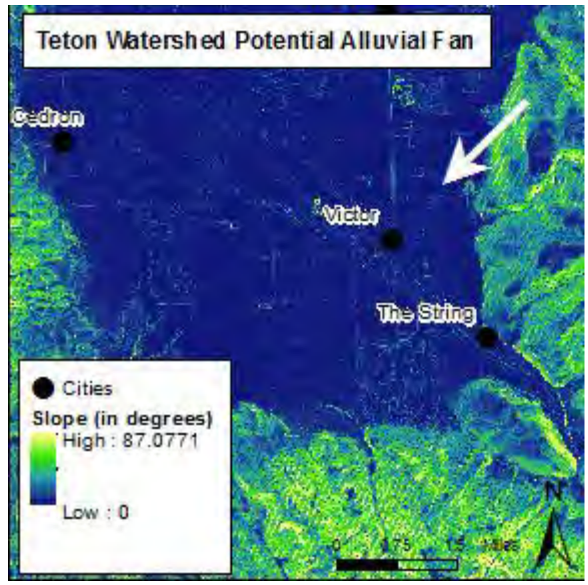

Figure 66. Slope of potential alluvial fan #2 in Teton Watershed.

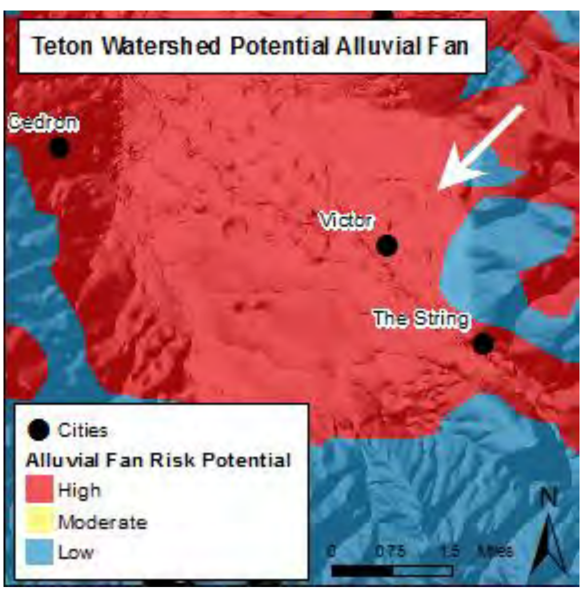

Figure 67. Alluvial fan risk of potential alluvial fan #2 in Teton Watershed.

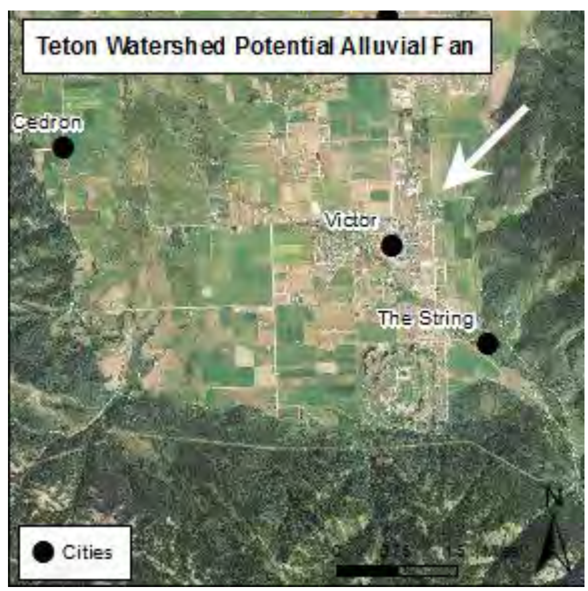

Figure 68. Imagery of potential alluvial fan #2 in Teton Watershed

Summary of Exposure to Alluvial Fans

Area	Average Parcel Value	High Parcel Value	Parcel Count
Teton (Watershed)	$127,000	>$666,000	22,117
Fremont (County)	$92,000	>$1,447,000	18,899
Madison (County)	$144,000	>$526,000	1,2027
Teton (County)	$130,000	>$780,000	14,104
Driggs (City)	$122,000	>$426,000	1,551
New Dale (City)	$70,000	>$143,000	165
Rexburg (City)	$206,000	>$770,000	4,794
St. Anthony (City)	$72,000	>$166,000	1,510
Sugar City (City)	$114,000	>$300,000	589
Teton (City)	$64,000	>$111,000	307
Tetonia (City)	$67,000	>$138,000	420
Victor (City)	$127,000	>$666,000	1,146

Area	Parcel Count in Potential Fans	Parcel Count in Mapped Fans	High Value Parcel Count in Fans
Teton (Watershed)	7836	0	73
Fremont (County)	609	0	0
Madison (County)	0	0	0
Teton (County)	7280	0	42
Driggs (City)	97	0	0
New Dale (City)	0	0	0
Rexburg (City)	0	0	0
St. Anthony (City)	64	0	4
Sugar City (City)	0	0	0
Teton (City)	0	0	0
Tetonia (City)	0	0	0
Victor (City)	1146	0	116

Area	% of Parcels in Potential Fan	% of Parcels in Mapped Fans	Total Value in Fans
Teton (Watershed)	35.43%	0.00%	$909,786,000
Fremont (County)	3.22%	0.00%	$43,982,000
Madison (County)	0.00%	0.00%	$0
Teton (County)	51.62%	0.00%	$868,777,000
Driggs (City)	6.25%	0.00%	$9,905,000
New Dale (City)	0.00%	0.00%	$0
Rexburg (City)	0.00%	0.00%	$0
St. Anthony (City)	4.24%	0.00%	$4,956,000
Sugar City (City)	0.00%	0.00%	$0
Teton (City)	0.00%	0.00%	$0
Tetonia (City)	0.00%	0.00%	$0
Victor (City)	100.00%	0.00%	$14,275,000

Table 14. Alluvial fan property risk potential summary for Teton Watershed.
2012 County Assessor taxlot data was used. Any parcel with a taxable amount less than 1 was disregarded. This eliminated most government owned facilities from data. High value parcels were defined as greater than 1 standard deviation above the mean value.

Risk Mitigation Strategy

A total of thirteen potential alluvial fans were identified in the Teton Watershed. Information from geologic and topographic maps indicates the entire eastern and western fringes of the Teton River valley are created by several joined alluvial fans (bajada). The characteristic outspread, fan-shaped lobes of sediment typical to alluvial fans and depicted as concentric contour lines are very apparent on the topographic map for this area. Due to the abundance of potential alluvial fans and high number of parcels on these fans, the entire valley has been mapped as high risk of alluvial fan flooding (Figure 56).

The entire incorporated area of the City of Victor is located on a potential fan with the main flow emanating from Trail Creek. Additional drainages contributing to the fan are Allen Creek, Nordwall Canyon, Pole Canyon and Warm Creek. The location and shape—high and steep—of the Teton Mountains directly to the east also contributes to the high risk. The main Trail Creek valley and smaller side drainages have relatively confined valleys, especially those on the southwestern side of Trail Creek. The confined channels contain the flows and do not allow the energies to spread out and dissipate.

Numerous residential structures exist at the mouth of Trail Creek, which is still fairly confined. Mitigation measures may be employed for each structure such as flood walls or dry floodproofing. However, it may be more appropriate to deploy mitigation measures in the watershed. Debris basins and debris barriers constructed in the side channels such as Sweet Hollow, Game Creek, Plummer Canyon, Sherman Canyon, Bear Canyon and Nordwall Canyon may be an effective strategy. A detention basin may be incorporated into the limited flat space on Moose Creek at the designated campground where Moose Creek and Nordwall Creek meet. Constructing a diversion near Mike Harris campground is another mitigation option. A diversion would route some of the floodwaters west along the utility right of way then discharge into the mouth of Pole Creek. Eventually the flow would spread over agricultural lands west of Teton Springs Resort and Club in this case.

Another potential alluvial fan, as shown in Figures 56 - 59, emanates from Mahogany Creek near Bates, Idaho. This fan displays the characteristic arch-shaped concentric contour lines originating at the mouth of the stream valley and radiating outwards, pushing the path of the Teton River eastward. The large drainage area has many smaller, confined stream channels surrounded by steep slopes, with a moderate elevation compared the Teton River valley floor. There are numerous residential structures on the fan surface. However, they are spread out amongst fields, allowing plenty of space to route the floodwaters. The structures closest to the mouth of the creek could utilize floodwalls or levees to provide protection and direct the flood waters back into the main portion of the channel.

Floodwalls, dikes and levees are structural floodplain management practices; and are therefore less popular, desirable and effective than nonstructural floodplain management practices, such as land use regulation. Land use planning is the application of fiscal and public policy to create orderly land use patterns, regulate development, improve infrastructure and provide public process whereby a community endeavors to create its preferred future, hopefully one with a reduced risk to natural disasters.

Upper Spokane

The Upper Spokane Watershed is located in Northern Idaho and includes areas of Eastern Washington. This area includes portions of Kootenai County as well as the communities of Athol, Coeur d'Alene, Dalton Gardens, Hayden, Hayden Lake, Huetter, Post Falls, Rathdrum and Stateline. Estimated population in the watershed is 99,000. Kootenai County and six of the listed communities participate in the NFIP with total premiums of approximately $161,500 and $46 million of total coverage.

Data coverage

Despite covering 100% of the watershed by area (Table 15) the FIRMs and DFIRMs identified no alluvial fans.

Dataset	Area (acres)	Area (sq. mi)	% of watershed
Upper Spokane Watershed	258,574	404	100
DFIRM	258,574	404	100
FIRM	0	0	0

Table 15. Flood insurance data source coverage by area for Upper Spokane Watershed.

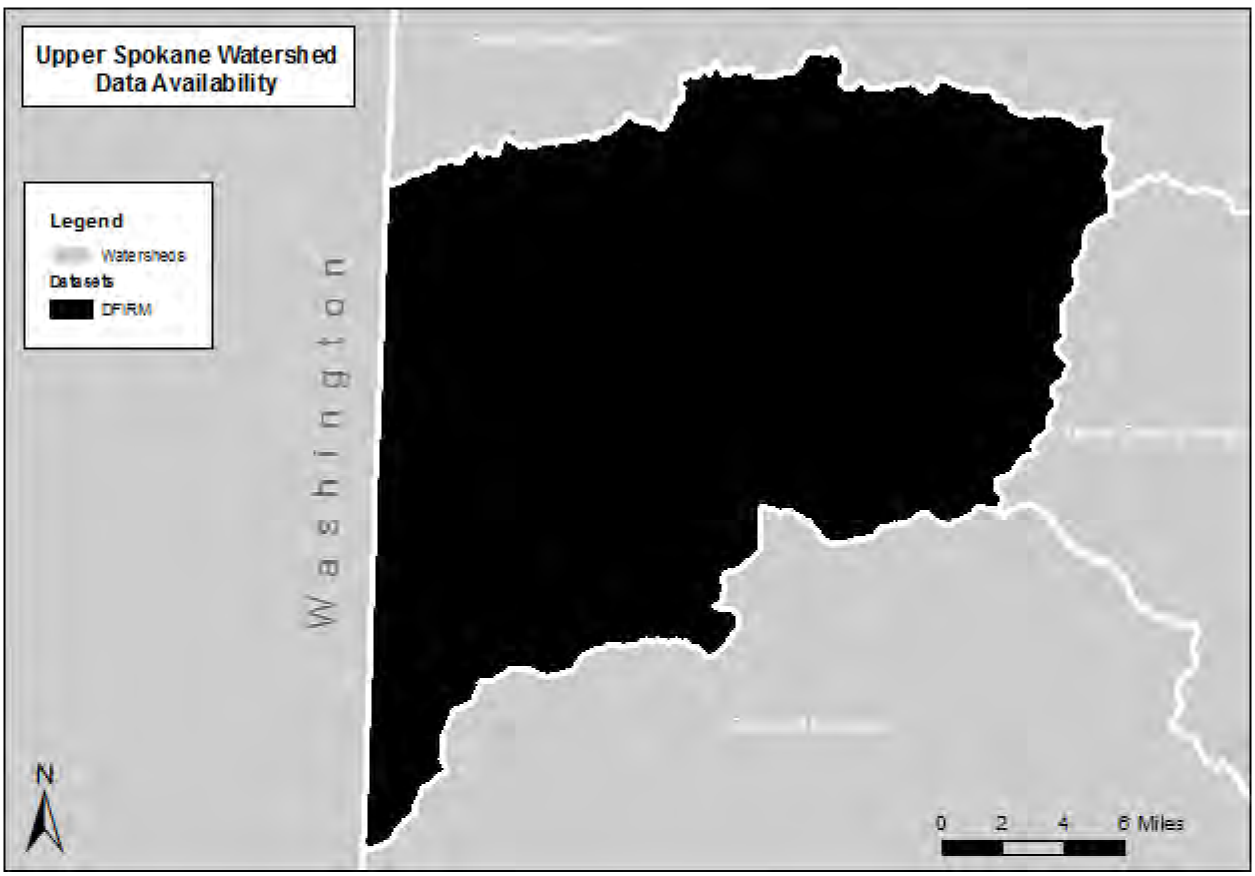

Figure 69: Flood insurance data source coverage for Upper Spokane Watershed.

Mapped Alluvial Fans

No mapped fans exist based on existing data sources in the Idaho portion of this watershed.

Alluvial Fan Risk Potential

Alluvial fan risk potential was mapped in this watershed using the methodology described in Section IV.

Risk Potential	Area (acres)	% of watershed
Low	123,200	51.9
Moderate	109,285	46.0
High	4,949	2.1

Table 16. Alluvial fan risk potential summary for Upper Spokane Watershed.

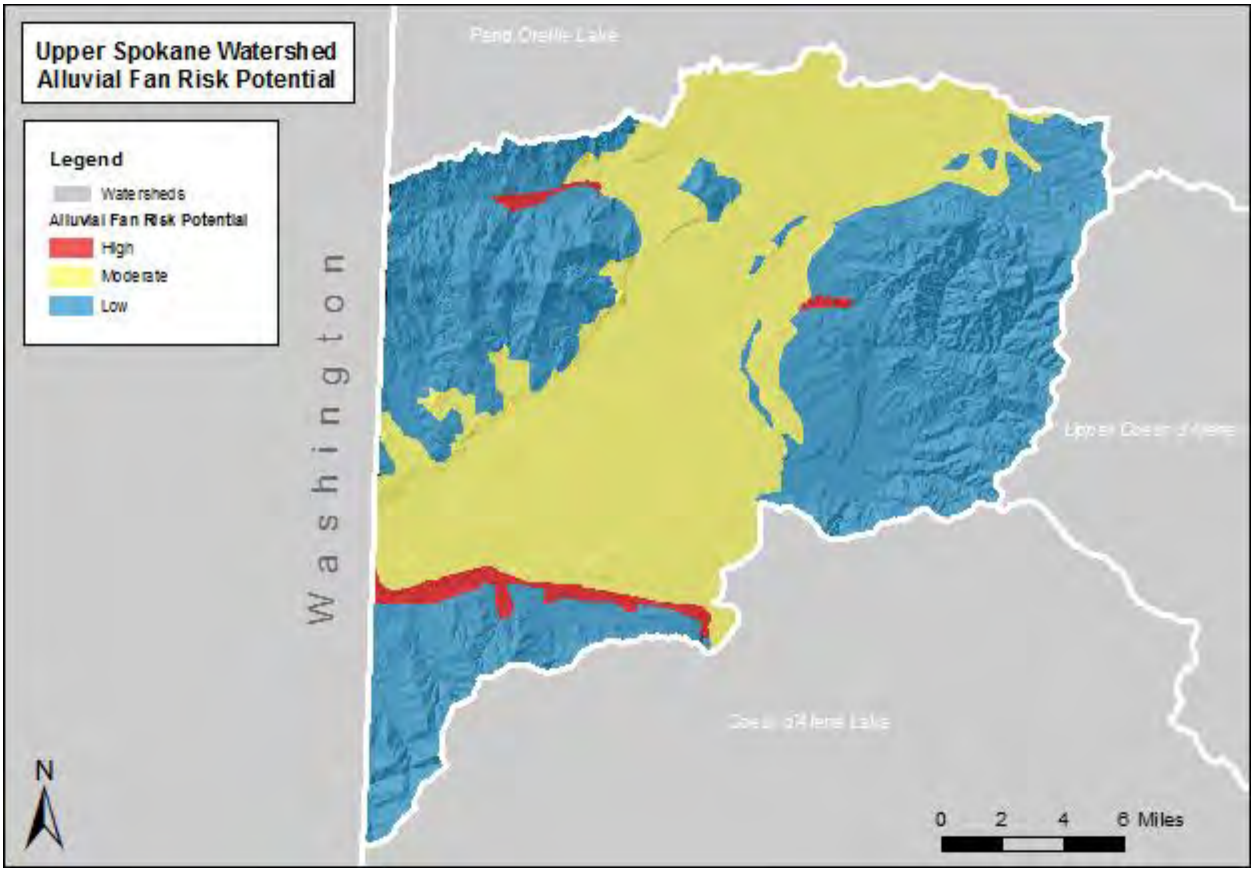

Figure 69. Alluvial fan risk potential for Upper Spokane Watershed.

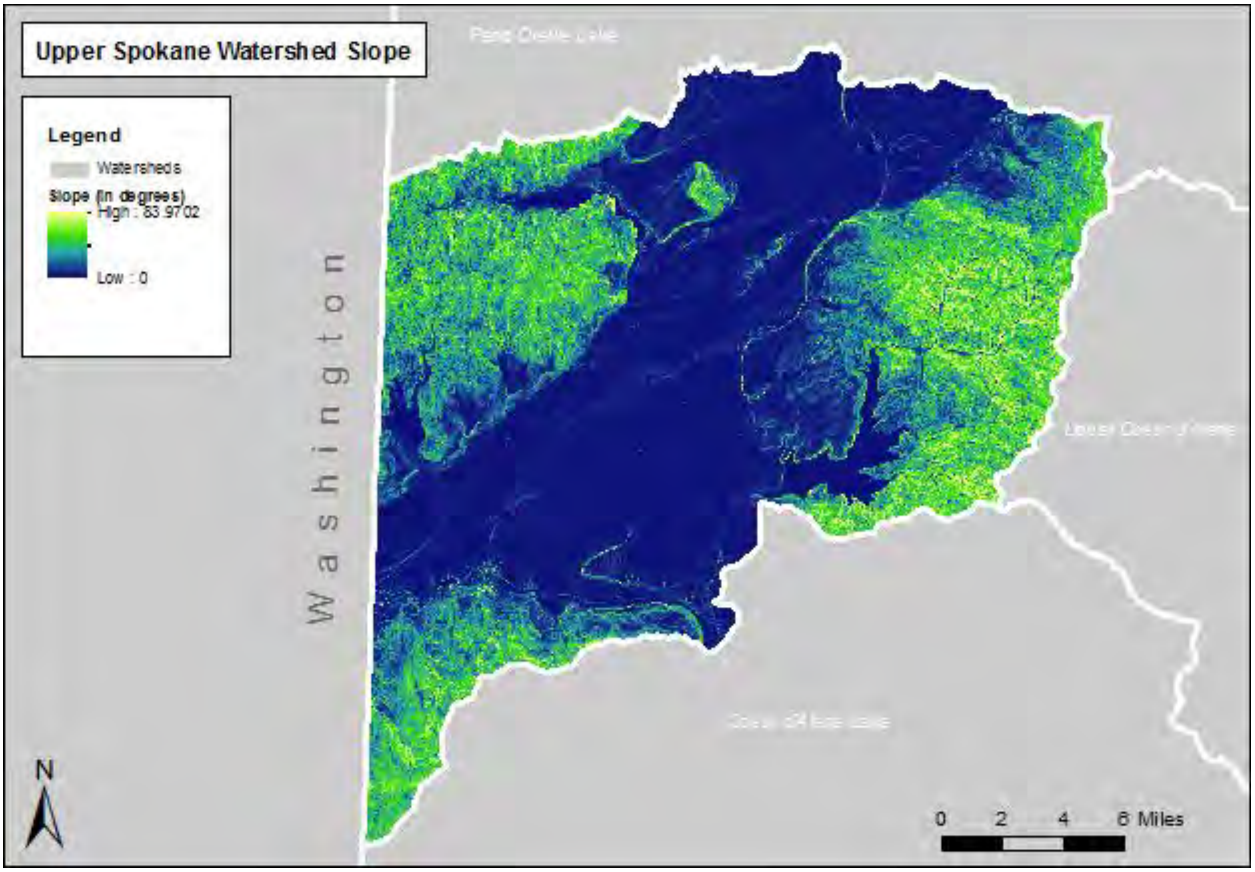

Figure 70. Slope analysis for Upper Spokane Watershed.

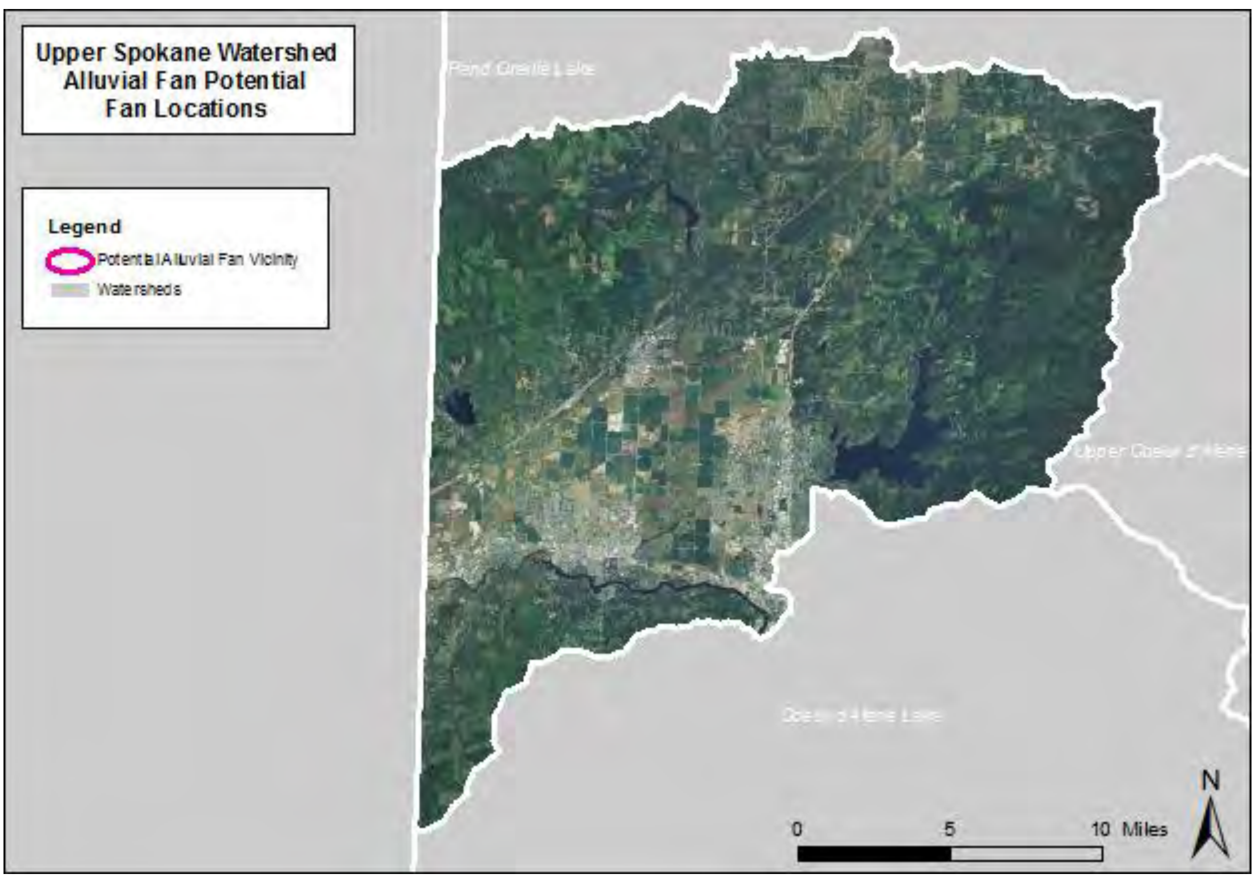

Figure 71. Potential alluvial fan locations for Upper Spokane Watershed.

Potential Alluvial Fans

Based on the available data for alluvial fan risk potential including geology and slope modeling (Figure 70) no apparent alluvial fans were identified. The areas depicted in Figure 69 as high and moderate risk areas will need to be examined in further detail to rule out any alluvial fan presence.

Summary of Exposure to Alluvial Fans

Area	Average Parcel Value	High Parcel Value	Parcel Count
Upper Spokane (Watershed)	$221,000	>$841,000	47,502
Kootenai (County)	$226,000	>$836,000	77,357
Athol (City)	$93,000	>$247,000	353
Coeur d'Alene (City)	$241,000	>$1,151,000	18,251
Dalton Gardens (City)	$257,000	>$465,000	1,124
Hauser (City)	$125,000	>$233,000	279
Hayden (City)	$201,000	>$593,000	6,050
Hayden Lake (City)	$427,000	>$968,000	451
Post Falls (City)	$208,000	>$831,000	11,483
Rathdrum (City)	$147,000	>$376,000	2,627

Area	Parcel Count in Potential Fans	Parcel Count in Mapped Fans	High Value Parcel Count in Fans
Upper Spokane (Watershed)	0	0	0
Kootenai (County)	0	0	0
Athol (City)	0	0	0
Coeur d'Alene (City)	0	0	0
Dalton Gardens (City)	0	0	0
Hauser (City)	0	0	0
Hayden (City)	0	0	0
Hayden Lake (City)	0	0	0
Post Falls (City)	0	0	0
Rathdrum (City)	0	0	0

Area	% of Parcels in Potential Fan	% of Parcels in Mapped Fans	Total Value in Fans
Upper Spokane (Watershed)	0.00%	0.00%	$0
Kootenai (County)	0.00%	0.00%	$0
Athol (City)	0.00%	0.00%	$0
Coeur d'Alene (City)	0.00%	0.00%	$0
Dalton Gardens (City)	0.00%	0.00%	$0
Hauser (City)	0.00%	0.00%	$0
Hayden (City)	0.00%	0.00%	$0
Hayden Lake (City)	0.00%	0.00%	$0
Post Falls (City)	0.00%	0.00%	$0
Rathdrum (City)	0.00%	0.00%	$0

Table 17. Alluvial fan property risk potential summary for Upper Spokane Watershed
2012 County Assessor taxlot data was used. Any parcel with a taxable amount less than 1 was disregarded. This eliminated most government owned facilities from data. High value parcels were defined as greater than 1 standard deviation above the mean value.

Risk Mitigation Strategy

There were no potential alluvial fans identified in the Upper Spokane Watershed, therefore without an example to analyze there are no risk mitigation strategies for alluvial fan flooding.

VI. REFERENCES

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APPENDIX I: COMMUNICATIONS

Community Meetings were scheduled for all five watersheds. Contacts were obtained from Discovery Meeting Minutes and from the IDWR list of Floodplain Administrators (IDWR 2012).

* from the Discovery Meeting Reports

Big Wood

Meetings

1. Introductory Meeting: Wednesday, March 20, 2013 at 10:30-11:30 am at City of Hailey
2. Follow-up Meeting:

Name	Jurisdiction	Email	Phone	Source
Nancy Cooley	Blaine County	ncooley@co.blaine.id.us	208-788-5570 x 1147	FPA/Disc
~~**Stacie Angelopoulos**~~	~~Custer County~~	~~sangelos@co.custer.id.us~~	~~208-879-6894~~	~~FPA~~
Ami Bennett	Gooding County	abennett@co.gooding.id.us	208-934-5958	FPA/Disc
Ray McClure	Lincoln County	rmcclure@lincolncountyid.us	208-886-9808	FPA/Disc
Mark Hofman	City of Sun Valley	mhofman@svidaho.org	208-622-4438	FPA
Joyce Allgaier	City of Ketchum	jallgaier@ketchumidaho.org	208-726-7801	FPA/Disc
Jim Zarubica	City of Hailey	jim.zarubica@haileycityhall.org	208-788-9830 x 17	FPA
Craig Eckles	City of Bellevue	ceckles@bellevueidaho.us	208-788-5351	FPA
Morri Hall	City of Gooding	mhall@goodingidaho.org	208-934-5669	FPA
Chris Corwin	Blaine County	ccorwin@co.blaine.id.us	208-578-3827	Jim Zarubica
Tom Bergin	Blaine County	tbergin@co.blaine.id.us		Nancy Cooley
Jeff Loomis	Blaine County	jloomis@co.blaine.id.us		Nancy Cooley
Fred Brossy	Water District			Ray McClure
Pete VanDerMeulen	Water District	vandermeulenpete@yahoo.com		Ray McClure
Jim Koonce	Retired	koonce_j@msn.com	208-788-9126	Jim Zarubica
William Trent	Magic Hydroelectric	william.trent@simplot.com	208-358-1247	?
Corey Loveland	NOAA	corey.loveland@noaa.gov	208-232-9306	?

Table 18. Big Wood Watershed Contacts

Contact Log

1. Blaine County
   a. Tom Bergin, FPA*
   b. Nancy Cooley, Zoning Specialist*
      i. 3/11/2013 message: invitation to meeting.
      ii. 3/11/2013 phone: will be attending and wants to invite Tom Bergin and Jeff Loomis.
   c. Jim Koonce, Engineer*
   d. Joel Hall, GIS Manager*
   e. Charles Turner, Emer. Mgr. *
   f. Chris Corwin, GIS Specialist*
   g. Jeff Loomis, Building Manager
2. Camas County
3. Gooding County

   a. Ami Bennett, FPA*
      i. 3/11/2013 phone: has a prior commitment, but will try to send a replacement and wants to be included on future outreach.
   b. Lori Capps, Disaster Services*
   c. Richard Bigelow, Building Inspector*
4. Lincoln County
   a. Ray McClure, P and Z Admin*
      i. 3/11/2013 phone: will attend. Will invite Mike Bright. Suggested to include Fred Brossy and Pete Van Der Meulen of the Water District.
   b. Mike Bright, Emer. Mgr. *
5. City of Sun Valley
   a. Diane Shay, Building Official*
   b. Mark Hofman, FPA
      i. 3/11/2013 phone: will attend.
6. City of Ketchum
   a. Joyce Allgaier, FPA*
      i. 3/11/2013 phone: unable to attend, but wants to be included in all future correspondence.
7. City of Hailey
   a. Tom Hellen, PW Director/Engineer*
   b. Jim Zarubica, FPA
      i. 3/4/2013 message: requested call back on hosting
      ii. 3/5/2013 phone: Jim offered to host the meeting
8. City of Bellevue
   a. Bruce Tidwell, FCD#9*
   b. Craig Eckles, FPA
      i. 3/11/2013 message with receptionist.
9. City of Gooding
   a. Morri Hall, FPA
      i. 3/11/2013: Unable to attend, may send building official. She wants to be included on future correspondence.
10. Delivery: Monday, September 30, 2013

Lower Boise

Meetings

1. Introductory Meeting:
2. Follow-up Meeting:

Name	Jurisdiction	Email	Phone	Source
Crash Marusich	ACCEM	pmarusich@adaweb.net		Disc
Darrin Carroll	ACHD	dcarroll@achdidaho.org	208-387-6183	Disc
~~**Jim Farrens**~~	~~No longer with Ada~~			~~Disc~~
Mark Perfect	Ada County	dsperfma@adaweb.net		FPA list
Jerry Hastings	Ada County	jhastings@adaweb.net		Disc/FPA
Rora Canody	Boise County	rcanody@co.boise.id.us		FPA
~~**Keri Sigman**~~	~~No longer with Canyon P&Z~~			
Dan Hunter	Canyon County	dhunter@canyonco.org		FPA
Bob Winterfeld	Elmore County	bwinterfeld@elmorecounty.org		FPA

Alan Christy	Elmore County	achristy@elmorecounty.org		FPA
Brad Clark	Gem County/City of Emmett	bclark@co.gem.id.us	208-365-2499	FPA
~~**Lindsey Royston**~~	~~Payette County~~	~~lroyston@payettecounty.org~~	~~208-642-6018~~	~~FPA~~
Russell Brooks	City of Parma	rbrooks@pharmereng.com		FPA
Ginny Lindmann	City of Notus	notuscityclerk@gmail.com		FPA
~~**Dave Freelove**~~	~~?? still with Middleton~~			
Amy Woodruff	City of Middleton	amy@civildynamics.net		FPA
Darin Taylor	City of Middleton	dtaylor@middletonidaho.us		web
Mike Williams	City of Eagle	mwilliams@cityofeagle.org	208-939-0227 x205	FPA
~~**Shawn Nickel**~~	~~City of Star??~~		~~208-794-3013~~	~~Disc~~
Justin Walker	City of Star	jwalker@kellerassociates.com		FPA
Lee VanDeBogart	City of Caldwell	lvandebogart@ci.caldwell.id.us		FPA/Disc
Lee Belt	City of Greenleaf	greenleafclerk@cableone.net		FPA
Jim Wyllie	City of Boise City	jwyllie@cityofboise.org		FPA
Rob Bousfield	City of Boise City	rbousefield@cityofboise.org		FPA
Jenah Thornborrow	City of Garden City	jthorn@gardencityidaho.org		FPA
~~**Rob Flaner**~~	~~?? with Meridian~~			
~~**Kyle Radek**~~	~~City of Meridian~~	~~kradek@meridiancity.org~~		~~Disc~~
David Miles	City of Meridian	dmiles@meridiancity.org		FPA/Disc
Mollie Mangerich	City of Meridian	mmangerich@meridiancity.org		FPA
Daniel Badger	City of Nampa	badgerd@cityofnampa.us	208-468-5469	Disc
Lenard A Grady	City of Nampa	gradyl@cityofnampa.us		FPA
~~**Mike Borzick**~~	~~City of Kuna~~		~~208-922-5274~~	~~Disc~~
Steve Hasson	City of Kuna	steve@cityofkuna.com		FPA

Table 19. Lower Boise Watershed Contacts

Contact Log

1. Ada County
    a. Crash Marusich, Public Education and Mitigation*
    b. Darrin Carroll, ACHD Stormwater*
    c. Jim Farrens, FPA/County Engineer*
    d. Jerry Hastings, County Surveyor*
    e. Mark Perfect, FPA
2. Boise County
    a. Rora Canody, FPA
3. Canyon County
    a. Keri Sigman, FPA/Planner*
    b. Dan Hunter, FPA
4. Elmore County
    a. Bob Winterfeld, FPA
    b. Alan Christy, FPA
5. Gem County
    a. Brad Clark, FPA
6. Payette County
    a. Lindey Royston, FPA
7. City of Parma
    a. Russell Brooks, FPA
8. City of Notus
    a. Ginny Lindmann, FPA
9. City of Middleton
    a. David Freelove, FPA Building Official*
    b. Amy Woodruff, FPA

10. City of Eagle
    a. Mike Williams, FPA/Planning Supervisor*
11. City of Star
    a. Shawn Nickel, Engineer (Land Consultants)*
    b. Justin Walker, FPA
12. City of Caldwell
    a. Lee VanDeBogart, FPA Project Engineer*
13. City of Greenleaf
    a. Lee Belt, FPA
14. City of Wilder
15. City of Boise City
    a. Jim Wyllie, FPA
    b. Rob Bousfield, FPA
16. City of Garden City
    a. Jenah Thornborrow, FPA
17. City of Meridian
    a. Dave Miles, FPA*
    b. Rob Flaner, Plan Update Coordinator (Tetra Tech)*
    c. Kyle Radek, Assistant City Engineer*
    d. Mollie Mangerich, FPA
18. City of Nampa
    a. Daniel Badger, Staff Engineer*
    b. Lenard A Grady, FPA
19. City of Kuna
    a. Mike Borzick, GIS Specialist*
    b. Steve Hasson, FPA
20. Delivery: Monday, September 30, 2013

Payette

Meetings

1. Introductory Meeting: Thursday, Dec. 6, 2012 at 10-11am at Emmett City Hall
2. Follow-up Meeting:

Name	Jurisdiction	Email	Phone	Source
Cynda Herrick	Valley County	cherrick@co.valley.id.us	208-382-7116	
Rora Canody	Boise County	racanody@co.boise.id.us	208-392-2293x150	
Kerri Pattee-Krosh	City of Horseshoe Bend	hsbcity@hsb-idaho.com	208-793-2219	Discovery
Bob Fry	Boise County	fryrobert47@gmail.com	208-793-2585	Discovery
Brad Clark	Gem County/City of Emmett	bclark@co.gem.id.us	208-365-2499	Discovery
Don Dressen	Payette County	ddressen@payettecounty.org	208-642-6018	Discovery
~~**Lindsey Royston**~~	~~Payette County~~	~~lroyston@payettecounty.org~~	~~208-642-6018~~	
Bobbie Black	City of Payette	bblack@cityofpayette.com	208-642-6024	Discovery
Rob Dickerson	Washington County	wcrdickerson@co.washington.id.us	208-414-3631	
Patti Nitz	Payette County	pnitz@payettecounty.org	208-642-6018	Lindsey Royston

Table 20. Payette Watershed Contacts

Contact Log

1. Boise County

a. Bob Fry – phone message not returned, invited via email
b. Rora Canody – planning on attending
2. Gem County
a. Brad Clark – hosting the meeting
3. Payette County
a. Lindsey Royston – message not returned
b. Don Dressen– invited via email
4. Valley County
a. Cynda Herrick – planning on attending
5. Washington County
a. Rob Dickerson – not attending, this area of their county is not highly populated and not a concern
6. City of Payette
a. Bobbie Black – planning on attending, she mentioned that the Discovery Meeting material was beyond her expertise and job description
b. Jamie Couch – message not returned, Bobbie will forward the meeting invitation to Jamie
7. City of Fruitland – no FPA here
8. City of New Plymouth – no FPA here
9. City of Horseshoe Bend
a. Kerri Krosch – planning on attending
10. City of Emmett - see Gem County
11. Delivery: Monday, September 30, 2013

Teton

Meetings

1. Introductory Meeting: Tuesday, March 19, 2013 at 1-2pm at Madison County Commissioners Hall
2. Follow-up Meeting:

Name	Jurisdiction	Email	Phone	Source
Gregory Newkirk	Fremont County	gnewkirk@co.fremont.id.us	208-624-4429	FPA
~~**Stephen Loosli**~~	~~Fremont County~~	~~sloosli@co.fremont.id.us~~		~~FPA~~
Brent McFadden	Madison County	bmcfadden@co.madison.id.us	208-359-6260	FPA/Disc
Greg Adams	Teton County	gadams@co.teton.id.us	208-354-2703	Ryan contact
Angie Rutherford	Teton County	arutherford@co.teton.id.us	208-354-2593	FPA
Patty Parkinson	City of St. Anthony	cclerk@cityofstanthony.org	208-624-3494	FPA
Glen Dalling	City of Sugar City	mayor@sugarcityidaho.gov	208-356-7561	FPA
John Millar	City of Rexburg	johnm@rexburg.org	208-359-3020 x2329	FPA/Disc
Val Christensen	City of Rexburg	valc@rexburg.org	208-359-3020 x 2324	FPA/Disc
Ashley Koehler	City of Driggs	pz2driggs@ida.net	208-354-2362 x105	FPA
Rob Heuseveldt	City of Victor	roberth@victorcityidaho.com	208-787-2940	FPA/Disc
Cameron Stanford	Madison County Sheriff's Office	cstanford@madisonsheriff.com	208-356-4437 x8318	Brent McFadden
Tom Cluff	Fremont County	tcluff@co.fremont.id.us	208-624-4643 x2266	Greg Newkirk
Craig Rindlisbacher	Madison County	craigr@rexburg.org	208-372-2317 208-359-3020 x2317	Greg Newkirk
Rob Marin	Teton County	rmarin@co.teton.id.us	208-354-2593 x5	Greg Newkirk
Keith Richey	Fremont County	krichey@co.fremont.id.us	208-624-1535	FPA
Mike Clements	IBHS	mclements@bhs.idaho.gov	208-589-0754	?
Dave Walrath	Madison County	dwalrath@co.madison.id.us	208-356-3101	?
Keith Davidson	City of Rexburg	keithd@rexburg.org	208-716-1320	?
Bruce Bowler	Madison County	bbowler@madisonsheriff.com	208-356-5426	Cameron Stanford

	Sheriff's Office			
Corey Loveland	NOAA	corey.loveland@noaa.gov	208-232-9306	?

Table 21. Teton Watershed Contacts

Contact Log

1. Fremont County
    a. Keith Richey, Emer. Mgr. *
        i. 3/5/2013 message (out of office until 3/11/2013): Invitation to meeting
    b. Gregory Newkirk, GIS Administrator
        i. 3/4/2013 phone: Plans on attending and gave me the name of new FPA, Tom Cluff. Also, will send along UI study data that may help.
    c. Tom Cluff, FPA
        i. 3/5/2013 message with Greg: Invitation to meeting
2. Madison County
    a. Brent McFadden, FPA, P and Z Admin. *
        i. 3/1/2013 phone/email: Coordinated meeting room.
    b. Craig Rindlisbacher, GIS Coordinator*
    c. Shawna Ringel, Assistant Planner*
        i. 3/5/2013 phone: does not need to attend (both Craig and Brent should attend)
    d. Cameron Stanford, Sherriff's Office Lieutenant
        i. 3/6/2013 message: Invitation to meeting
3. Teton County
    a. Tom Davis, Building Official*
    b. Arnold Woolstenhulme, (Teton County-Victor Trail Creek Irrigation)*
    c. Rob Marin, GIS Analyst
        i. 3/6/2013 phone: Sending data to me.
    d. Angie Rutherford, FPA
        i. 3/5/2013 message: Invitation to meeting
    e. Greg Adams, Emergency Management Coordinator
        i. Message left 3/1/2013 at 3pm regarding meeting date availability
        ii. 3/4/2013 phone: will be able to attend the meeting.
4. City of St. Anthony
    a. Patty Parkinson, FPA
        i. 3/4/2013 phone: Not able to attend and Fremont County takes care of all their FPA issues. CC on emails, but no need to participate.
5. City of Newdale
6. City of Teton
7. City of Sugar City
    a. Glen Dalling, Mayor*
    b. Lamont Merrill, FPA, Councilmember*
    c. Sharon Bell, FPA
        i. 3/6/2013 phone: indicated that the mayor is the rightful FPA.
8. City of Rexburg
    a. John Millar, PW Director*
        i. 3/6/2013 phone: will attend and will have staff attend
    b. Val Christensen, FPA*
        i. 3/6/2013 phone: plans on attending

        c. Chad Hinckley, GIS Analyst*
        d. Joel Gray, Assistant Engineer*
9. City of Tetonia
10. City of Driggs
    a. Ashley Koehler, FPA
        i. 3/6/2013 message: Invitation to meeting.
11. City of Victor
    a. Robert Heuseveldt, City Engineer*
        i. 3/6/2013 message: Invitation to meeting.
        ii. 3/11/2013 phone: plans on attending.
    b. Cari Golden, Assistant Planner*
12. Delivery: Monday, September 30, 2013

Upper Spokane

Meetings

1. Introductory Meeting:
2. Follow-up Meeting:

Name	Jurisdiction	Email	Phone	Source
Sandy Von Behren	Kootenai County	svonbehren@kcgov.us	208-446-1775	Ryan
Ben Tarbutton	Kootenai County	btarbutton@kcgov.us	208-446-1070	FPA
Justin Seier	Kootenai County	jseier@kcgov.us	208-446-1040	FPA
Glen Miller	City of Rathdrum	glenn@rathdrum.org	208-687-0261	FPA
Jill Sixt-Bowes	City of Hayden	jbowes@cityofhaydenid.us	208-209-1079	FPA
Cindy Espe	City of Hayden	cindyespe@hotmail.com	208-818-9053	FPA
John Manley	City of Post Falls	jmanley@postfallsidaho.org	208-773-3511	FPA
Marcia Wingfield	City of Dalton Gardens	marcia.wingfield@daltongardens.com	208-772-3698	FPA
Tami Stroud	City of Coeur d'Alene	tamis@cdaid.org	208-686-1800	FPA
Gordon Dobler	City of Coeur d'Alene	gordon@cdaid.org	208-769-2216	FPA

Table 22. Upper Spokane Watershed Contacts

Contact Log

1. Kootenai County
    a. Ben Tarbutton, FPA
    b. Justin Seier, FPA
        i. 3/6/2013 message: ask for a callback
    c. Sandy Von Behren, Emer. Mgr.
        i. 3/6/2013 phone: Not interested in meeting unless there is a known hazard. Will attend if Justin wants a meeting.
        ii. Henry Allen, (hallen@spokanevalley.org) Development Engineer, City of Spokane Valley, 11707 E. Sprague Ave, Ste. 106, Spokane Valley, WA 99206, (509) 720-5319
2. City of Athol
3. City of Rathdrum
    a. Glen Miller, FPA
4. City of Hayden
    a. Jill Sixt-Bowes, FPA
5. City of Hauser
    a. Cindy Espe, FPA

6. City of Hayden Lake
7. City of Post Falls
    a. Jon Manley, FPA
8. City of Dalton Gardens
    a. Marcia Wingfield, FPA
9. City of Coeur d'Alene
    a. Tami Stroud, FPA
    b. Gordon Dobler, FPA
10. City of State Line
11. City of Huetter
12. City of Spokane Valley (not in this watershed)
13. Delivery: Monday, September 30, 2013

APPENDIX II: METHODOLOGY DETAIL

Alluvial Fan Mapping

Alluvial fans were mapped from available sources per FEMA guidelines. Copy shapes from existing datasets such as DFIRM and Surficial Geologic Maps.

A. Digitize shapes from georeferenced datasets such as FIRMs.

B. Attribute all available alluvial fan shapes.
   a. Unique identifier for each alluvial fan shape [FanID]
   b. Name of flood source from NHD or DRG [FloodSource]
   c. Perennial or intermittent from NHD [FCode]
   d. Active/inactive/unknown status from data source or NAIP (USDA-FSA 2011) [Active]

Code	Active Status
Y	Alluvial fan appears to be active
N	Alluvial fan appears to be inactive
U	Unknown activity status using available data

Table 23. Key for Active Status for Alluvial Fans

   e. Area in square meters [Shape_Area]
   f. Source of alluvial fan data references L_Source_Cit table [Source]
   g. Hydrologic Unit Code, 8th field [HU8_Name] from NHD

C. Geoprocess alluvial fan shapes for interaction attributes such as NFIP statistics.
   a. Highest elevation in feet from DEM [HighElev]
   b. Lowest elevation in feet from DEM [LowElev]
   c. % private ownership from BLM Statewide Ownership [PerPriv]
   d. # NFIP policies from NFIP points [NFIPPolicies]
   e. # NFIP claims from NFIP points [NFIPClaims]
   f. Insurance in force ($) from NFIP points [NFIPInsurance]
   g. Developed status from NAIP [Developed]

Code	Development Status
Y	At least one building structure visible
N	No building, road or agriculture visible
R	Only roads with or without agriculture visible
A	Only agriculture visible

Table 24. Key for Developed Status for Alluvial Fans

   h. Jurisdiction from Incorporated Areas and Counties [Jurisdiction]

Alluvial Fan Risk Potential

This methodology was adapted from the 2012 publication by Lancaster et al. Due to the lack of reliable geologic information in some watersheds, alluvial fan risk potential was analyzed to provide a starting point from which to analyze this risk, thereby reducing the workload for field analysis of alluvial fan extent.

a. Geologic age and type (Johnson and Raines 1996): Alluvial fan risk categorized by high, moderate and low based on the age of geologic depositions (USGS 2005) following the hazard model depicted in Figure 72. Quaternary soils categorized as high hazard potential. Moderate hazard potential assigned to Late Pleistocene and Holocene deposits. Low hazard potential assigned to other Pleistocence deposits.

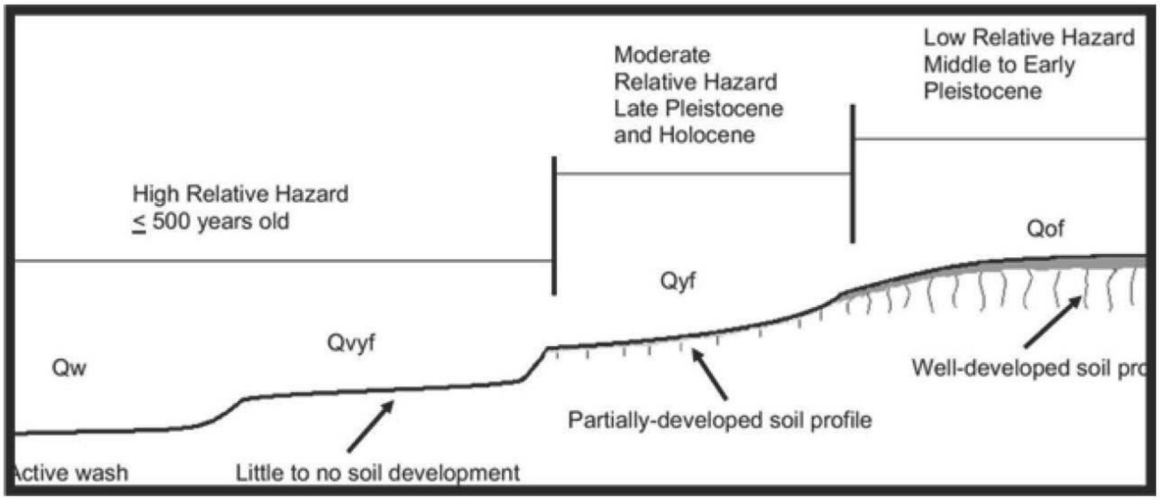

Figure 72. Illustrative geomorphic profile of the relative hazard to alluvial-fan flooding. Surficial units are classified as: Qw, active wash; Qvyf, latest Holocene alluvial fan; Qyf, late Pleistocene and Holocene alluvial fan; Qof, Pleistocene alluvial fan. Surficial mapping nomenclature based on J. Matti and P. Cossette (USGS, unpub. data, 2010). This figure excerpted from Lancaster et al. 2012.

b. Slope overlay: Download 1/3-arc second National Elevation Dataset (USGS 2009) digital elevation model (DEM). Re-project all layers to Idaho UTM NAD 83 projection with vertical units in meters. Resample using cubic convolution to 1 or 2 meter grid based on the scale of the available LiDAR-derived DEMs. Teton and Payette are based on 2-meter grid while Big Wood, Lower Boise and Upper Spokane are based on 1-meter grid. Merge with higher quality 1- or 2-meter LiDAR-derived DEM (see below). Derived slope in degrees. Slope overlay examined for fan-shaped low gradient transition zones.
   i. Big Wood datasets: none
   ii. Lower Boise datasets: 10 and 15 Mile Creeks 2003 (BOR 2004), Boise River (IDWR 2009), Dry Creek 2007 (University of Idaho 2010), Middleton 2011 (City of Middleton 2012)
   iii. Payette datasets: Gem Valley 2011 (FEMA 2012)
   iv. Teton datasets: Madison 2009 (Jefferson County 2009), Henrys Fork 2011 (FEMA 2011)
   v. Upper Spokane datasets: Mica (Coeur d'Alene Tribe 2005)

c. Hillshade: Re-project 1/3 arc second dataset (USGS 2009) to Idaho UTM NAD 83 projection with vertical units in meters. Run hillshade tool on this dataset for display purposes.

Potential Fan Mapping

Potential alluvial fans were mapped from developed data sources. These vicinities require further confirmation by geologic or engineering experts using site observation or other accepted analysis techniques.

A. Identify potential alluvial fan vicinities using visual analysis of alluvial fan risk potential, slope and NAIP imagery.
B. Digitize shapes of approximate potential alluvial fan shapes using circles.
C. Attribute all available alluvial fan shapes.
    a. Unique identifier for each alluvial fan shape [FanID]
    b. Hydrologic Unit Code, 8^{th} field [HU8_Name] from NHD
D. Geoprocess alluvial fan shapes for interaction attributes. These attributes could be largely affected by the defined extent of the alluvial fan in later analysis steps.
    a. Developed status from NAIP [Developed]. See **Error! Reference source not found.**.

Jurisdiction from Incorporated Areas and Counties [Jurisdiction]

APPENDIX III: PROJECT TIMELINE

Proposed

Project Initiation: 1 Sept 2012 – 30 Sep 2013
Big Wood: 1 Jan 2013 – 31 Aug 2013
Lower Boise: 1 Jan 2013 – 31 Aug 2013
Payette: 1 Jan 2013 – 31 Aug 2013
Teton: 1 Jan 2013 – 31 Aug 2013
Upper Spokane: 1 Jan 2013 – 31 Aug 2013

Production Schedule: Actual

Project Initiation (Payette Prototype): 1 Sep 2012 – 31 Mar 2013
Consult with IGS: 12 Nov 2012
Payette Watershed Meeting: 6 Dec 2012
Incorporate Feedback: 10 Dec 2012 – 14 Dec 2012
Build Payette dataset inc. attributes: 17 Dec 2012 – 31 Dec 2012
Payette Documentation: 1 Jan 2013 - 28 Jan 2013

Project Execution: 21 Jan 2013 – 26 Aug 2013
Research and build draft products: 28 Jan 2013 – 15 Feb 2013
Contact and schedule Watershed Meetings: 19 Feb 2013 – 22 Feb 2013
Conduct Watershed Meetings: 25 Feb 2013 – 20 Mar 2013
Incorporate Meeting Feedback: 8 Mar 2013 – 5 Apr 2013
Research data sources: 5 Apr 2013 – 14 Jun 2013
Build databases: 17 Jun 2013 – 8 Jul 2013
Geoprocessing and attributing: 8 Jul 2013 -26 Jul 2013
Documentation: 29 Jul 2013 – 9 Aug 2013
Showcase Silver Jacket National Conference Presentation: 21 Aug 2013
Develop final project reports: 26 Aug 2013 – 23 Sep 2013

Project Closing:
Cease project production, remove draft status from deliverable: 23 Sep 2013
Send all final project reports to stakeholders: 23 Sep 2013 – 27 Sep 2013
Send all final geodatabase, reports and deliverables to FEMA: 30 Sep 2013