

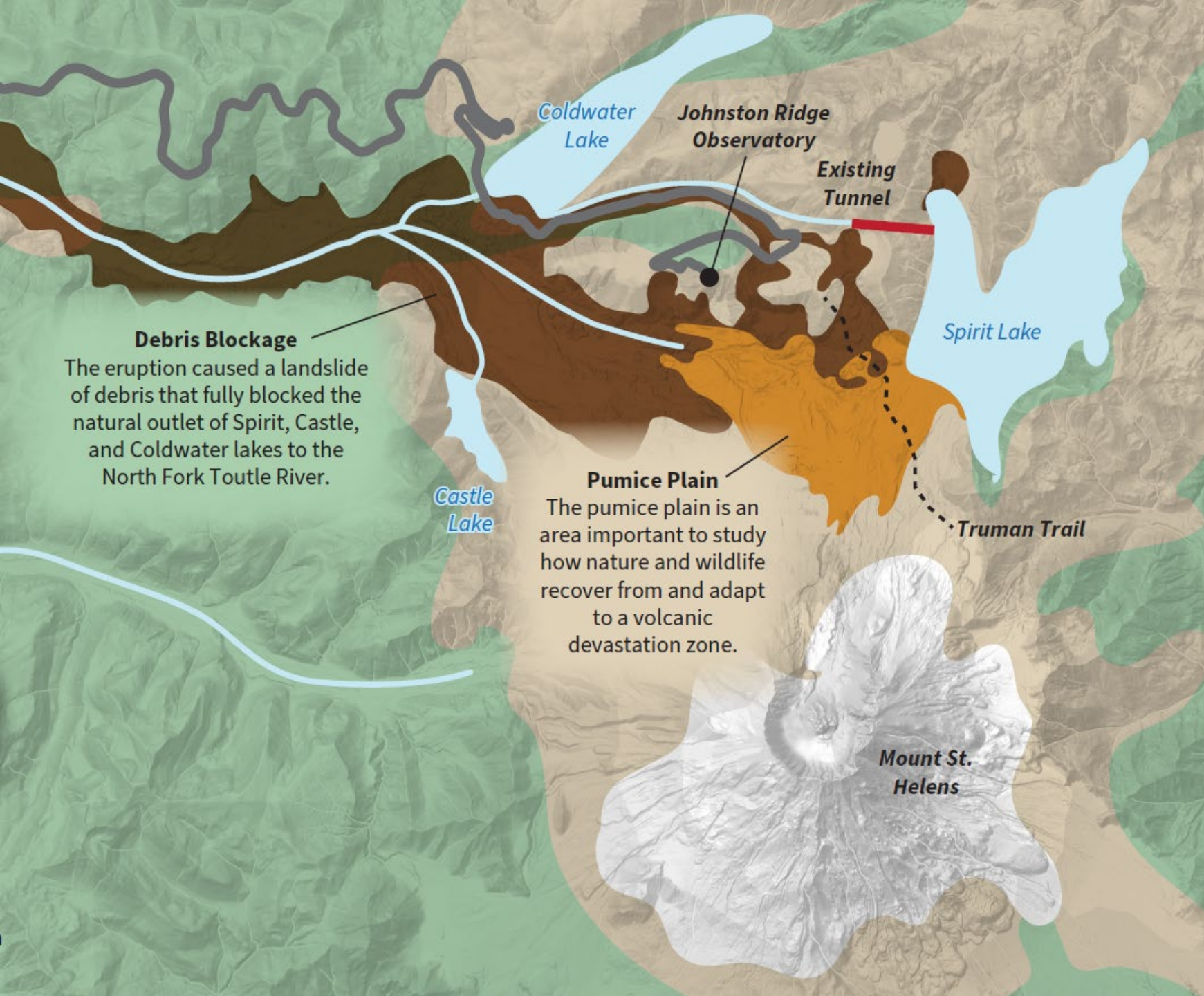
Smoking Mountain at the Head of the Watershed:

Spirit Lake Outflow Improvement at Mount St. Helens National Monument

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River Restoration Northwest 4 February 2025



Debris Blockage
The eruption caused a landslide of debris that fully blocked the natural outlet of Spirit, Castle, and Coldwater lakes to the North Fork Toutle River.

Pumice Plain
The pumice plain is an area important to study how nature and wildlife recover from and adapt to a volcanic devastation zone.

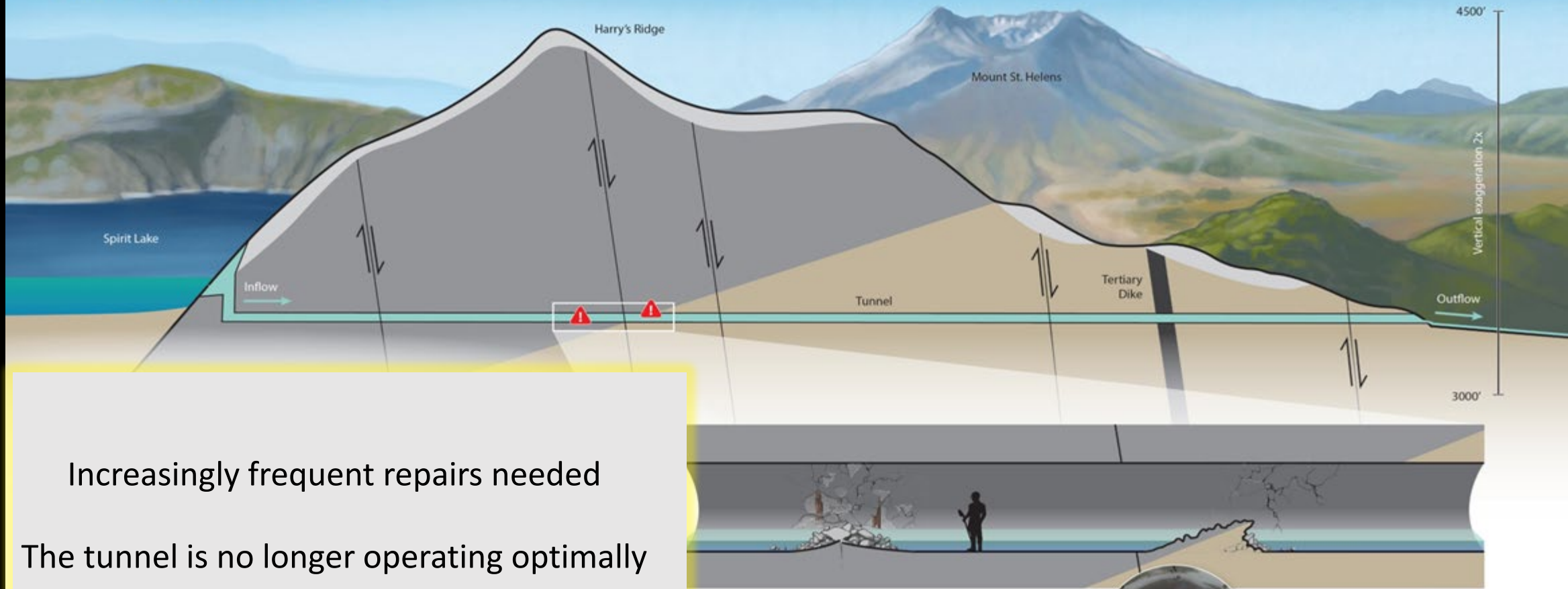
Spirit Lake Outflow Safety Improvement Project

at

Mount St. Helens National Volcanic Monument

URGENT NEED TO ACT:

Deferred maintenance and local geological stress have increased the risk of tunnel failure



Increasingly frequent repairs needed
The tunnel is no longer operating optimally
Increasing probability of tunnel failure

1995/1996:
Large sections of shotcrete had pulled away from the tunnel walls and the floor had heaved and cracked. Some supportive ribs had buckled.

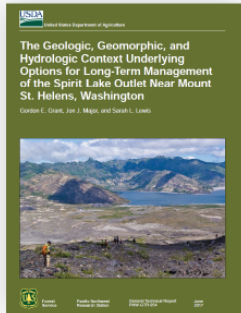


2015/2016:
Significant floor heave from high ground pressure reduced the tunnel diameter from 11 feet to 7 feet, restricting flow capacity.

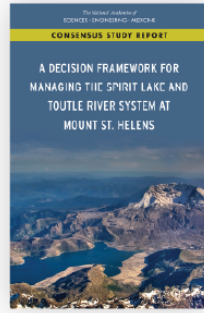
Legend:

- Predominantly tuff
- Predominantly basalt/andesite
- Overburden and debris avalanche
- Shear zone or normal fault

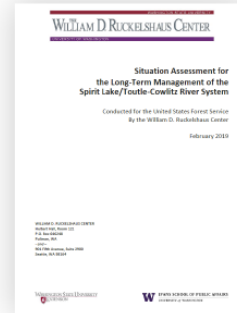
Building on Foundational Work



2017: The **USFS Pacific Northwest Research Station** publishes a semiquantitative risk assessment that explores the three principal regional hazards (floods, earthquakes, and eruptions) as they relate to the Spirit Lake debris blockage and potential tunnel solutions.



2018: Inspections of the outflow tunnel indicate a need for millions of dollars in repairs to avoid failure. The **National Academies of Sciences, Engineering, and Medicine (NASEM)** publishes a comprehensive report proposing decision-making processes to address the long-term safety and management issues related to the Spirit Lake tunnel and the Toutle River system.



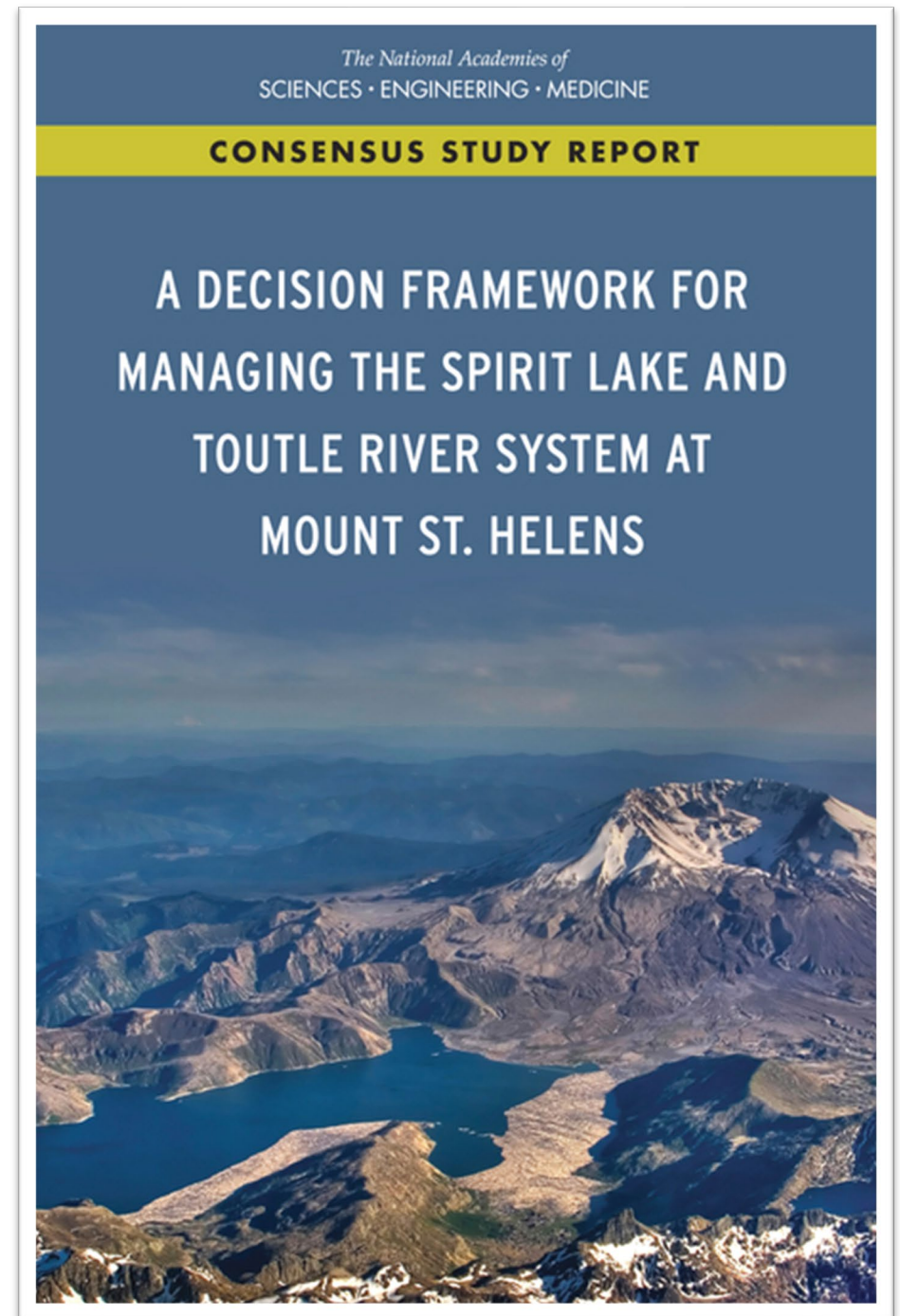
2019: The USFS commissions the **William D. Ruckelshaus Center** to draft a Situation Assessment for the "Long-Term Management of the Spirit Lake/Toutle-Cowlitz River System". Interviews are conducted with stakeholders from public, private, tribal, and nonprofit entities. Common themes and sub-themes are identified in values and preferences for how to manage the challenging system.

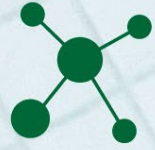


2021-2024: USFS conducts stakeholder engagement in parallel with engineering feasibility analysis of potential outflow options prior to beginning the NEPA compliance process. Based on the NASEM Report recommendations, the **Spirit Lake, Toutle/Cowlitz River Collaborative** was created as a system-level entity to lead a collaborative multi-agency, multi-jurisdictional effort with the goal of addressing sediment management and risks associated with catastrophic flood in the Spirit Lake and Toutle/Cowlitz River system.

Multi-Criteria Decision Analysis: Balancing Science, Engineering, Stakeholder Values

1. Provide a firm foundation for agency decisionmakers to develop a Proposed Action and draft alternatives for a resilient Spirit Lake Outflow.
2. Integrated effort including public and stakeholder values and adjacent management and regulatory agency missions identified through the PPP implementation.
3. Balance scientific values, engineering objectives and constraints, and input from interested parties, agency, and government





Stakeholder Engagement

USFS will engage stakeholder groups to seek input on potential outflow options. This will be done through working group sessions, questionnaires, and videos/presentations.



Outflow Options Development

Outflow options development plays a key role in the NEPA process. All feasible outflow options will be considered in formulation of draft alternatives for NEPA.



Engineering Feasibility Analysis

USFS is developing an Engineering Feasibility Assessment during the stakeholder engagement phase to capture stakeholder input and carry potential outflow options forward into the design phase.



The Enhanced Outreach Process

Gifford Pinchot National Forest has hosted many discussions, identified values, and explored ideas and solutions.

This is an iterative process which relies on continued engagement.

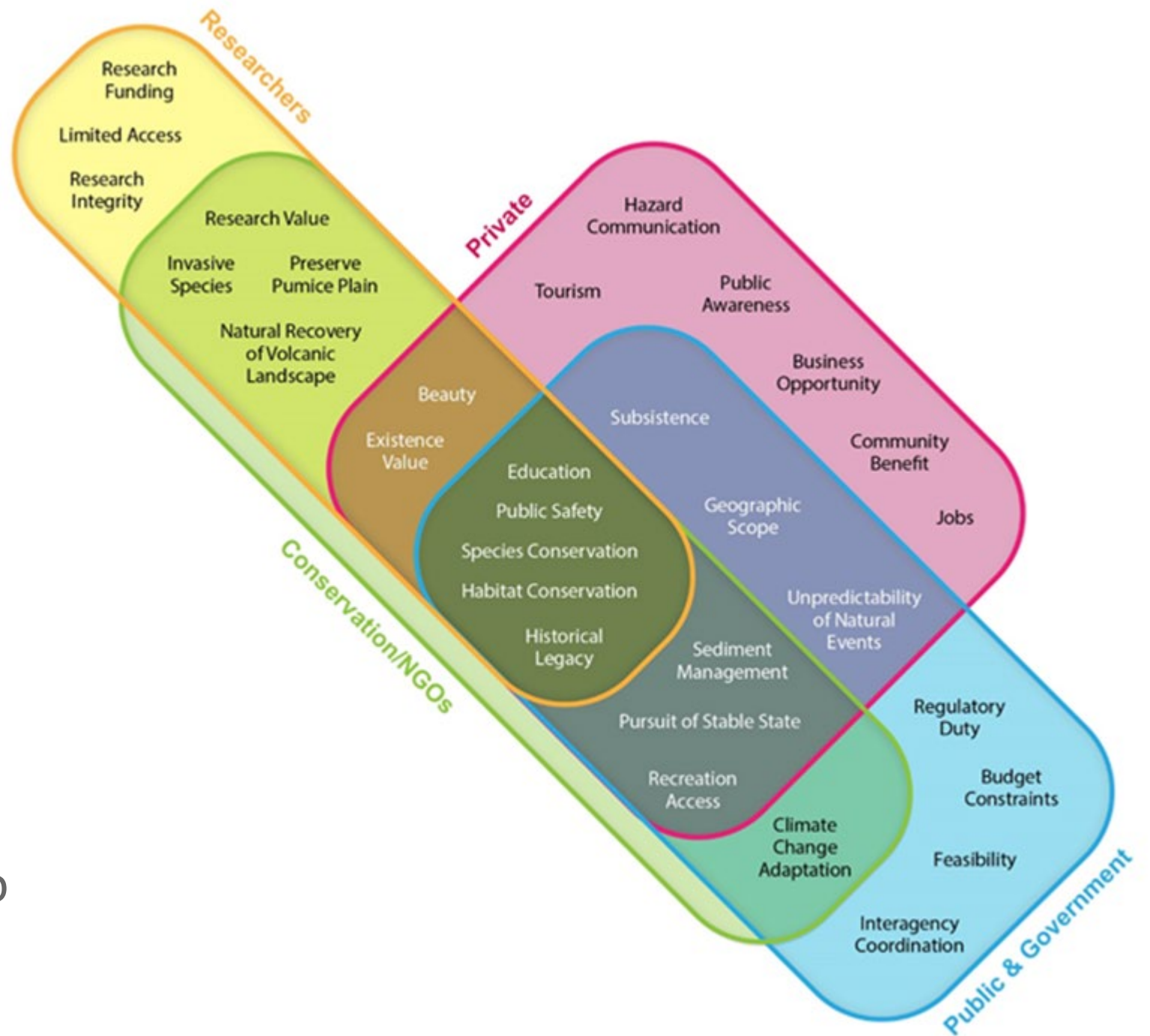
These efforts will inform the decision-making process

1. Community Dimension:

Values and preferences overlap to varying degrees: from no overlap to complete overlap

Work from areas of broad agreement out to concerns of specific groups

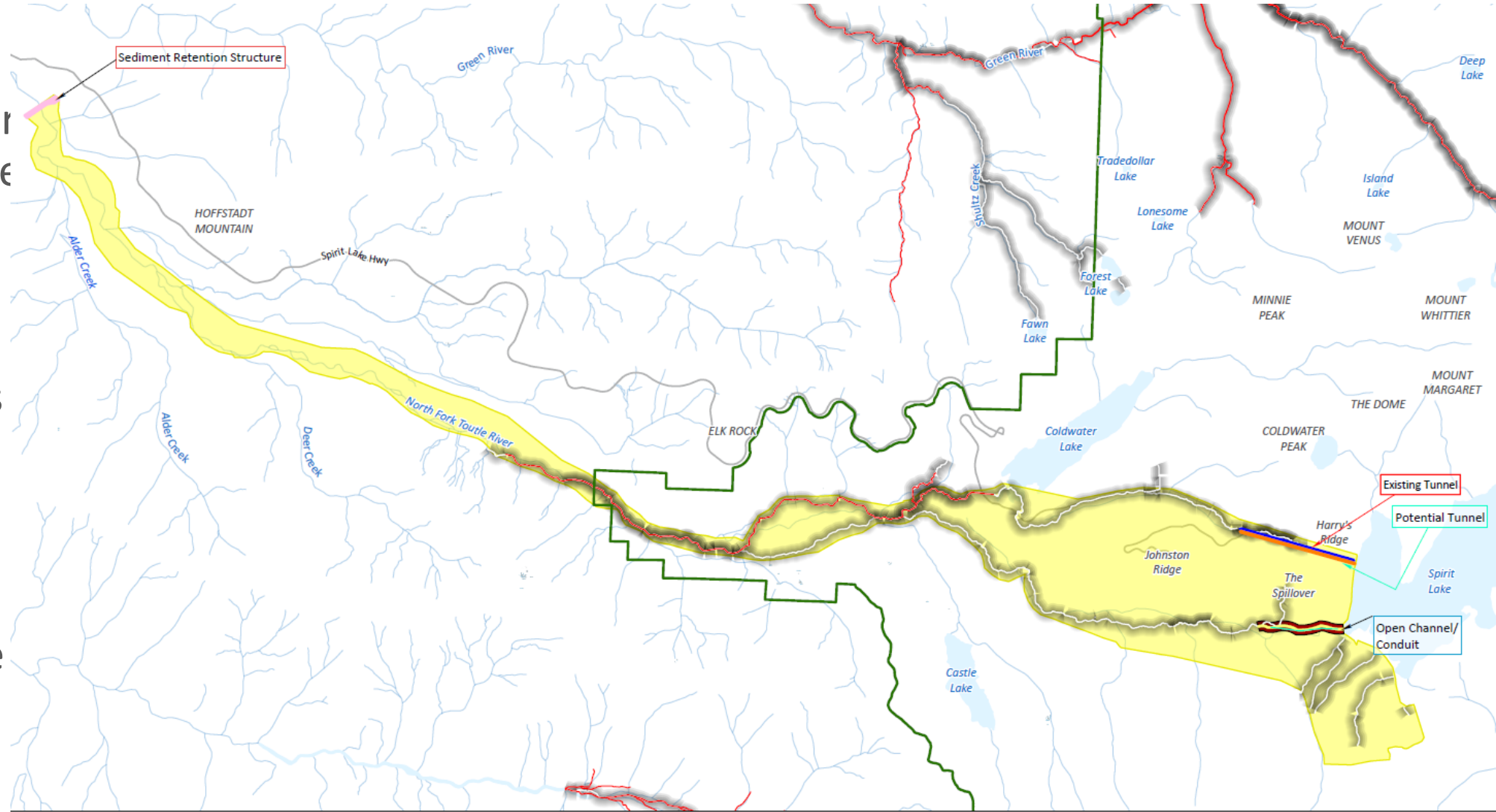
Updating this 2017 picture to reflect current views



2. Environmental Dimension

The affected area for each resource will be analyzed at a scale appropriate to the resource.

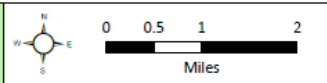
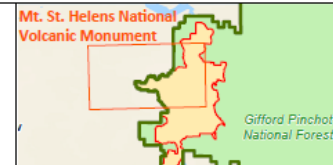
For example, effects from sediment mobilization could extend to the Corps Sediment Retention Structure and to the Columbia River for some alternatives



Legend
 Gifford Pinchot National Forest
 Sub-watersheds
 Fish Distribution
 Resident
 Anadromous

Existing Tunnel
 New Tunnel
 Open Channel
 New Conduit

Open Channel Excavation Extent
 Sediment Retention Structure
 Action Area



SPRIT LAKE OUTFLOW SAFETY IMPROVEMENT PROJECT ACTION AREA

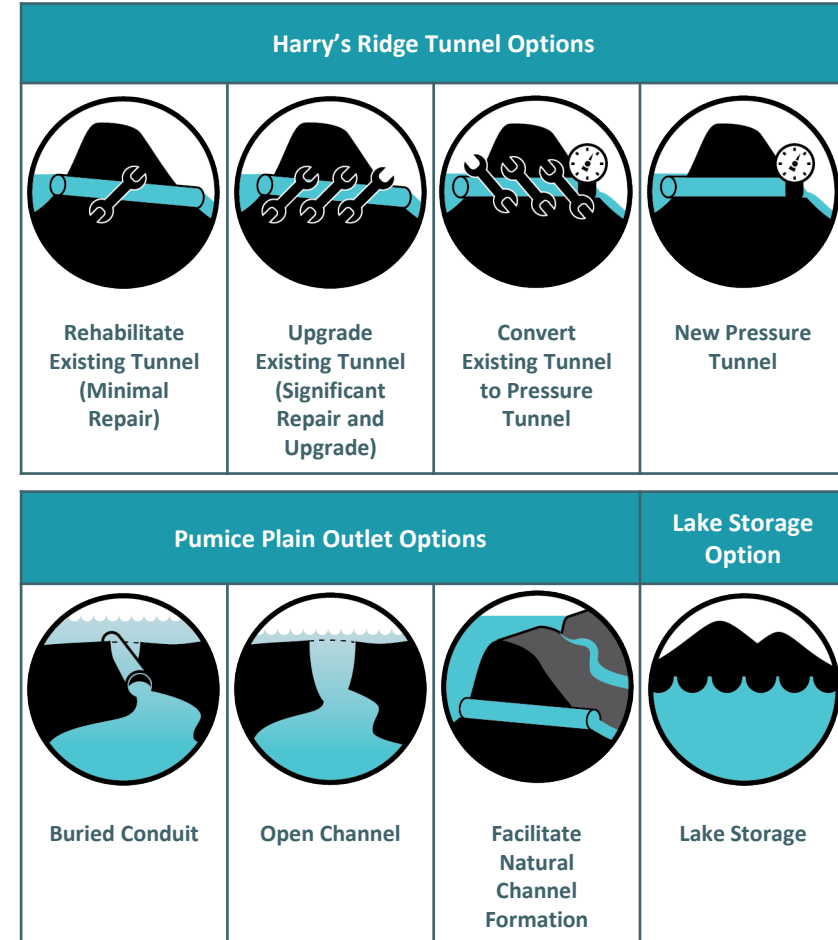
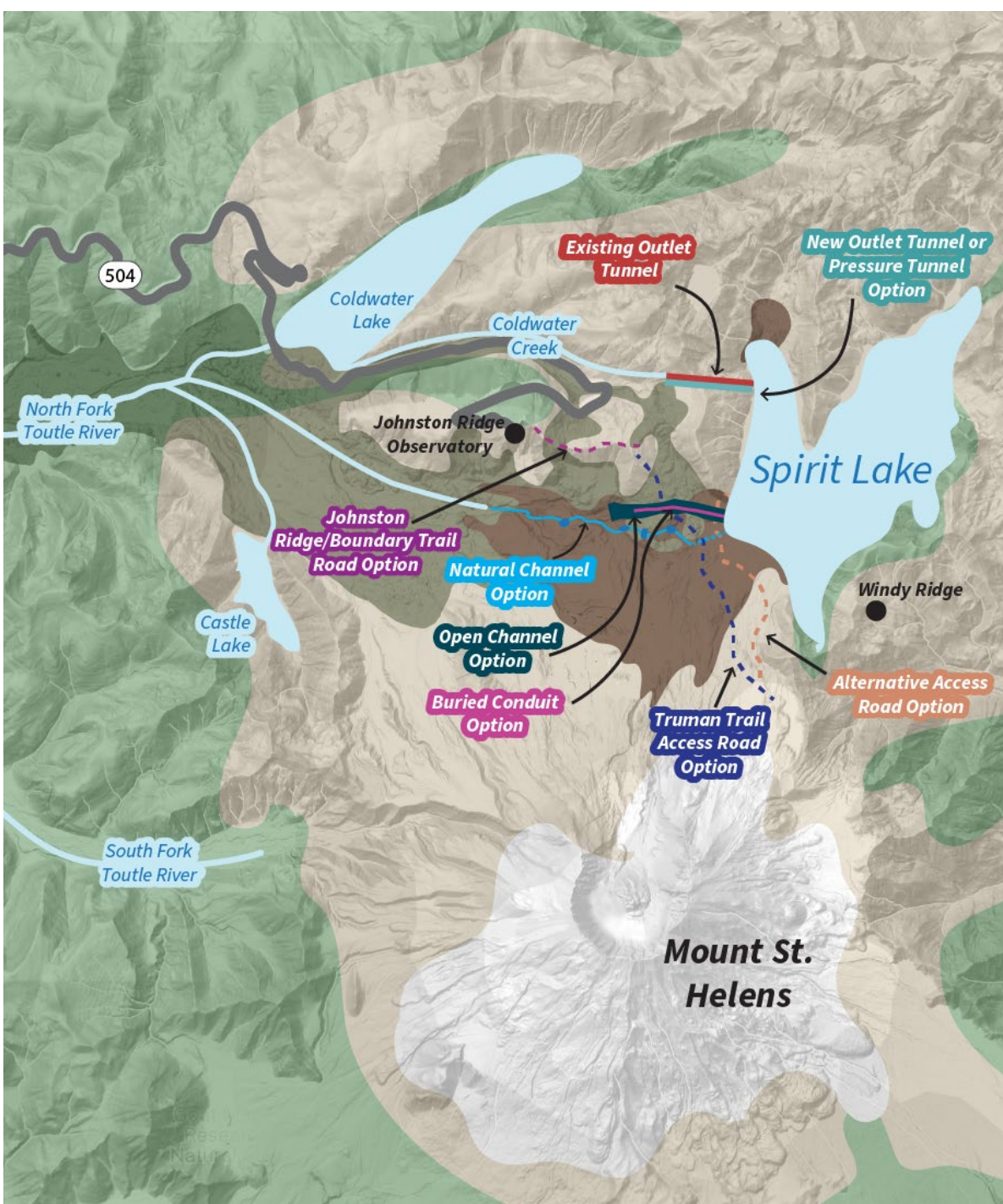
2. Engineering Dimension: Feasibility Analysis

- Assess options by their ability to enhance the reliability and resiliency of the outflow
- Develop additional features or analysis to improve an option
- Develop new options during enhanced outreach
- Analyze in sufficient detail to support environmental analysis



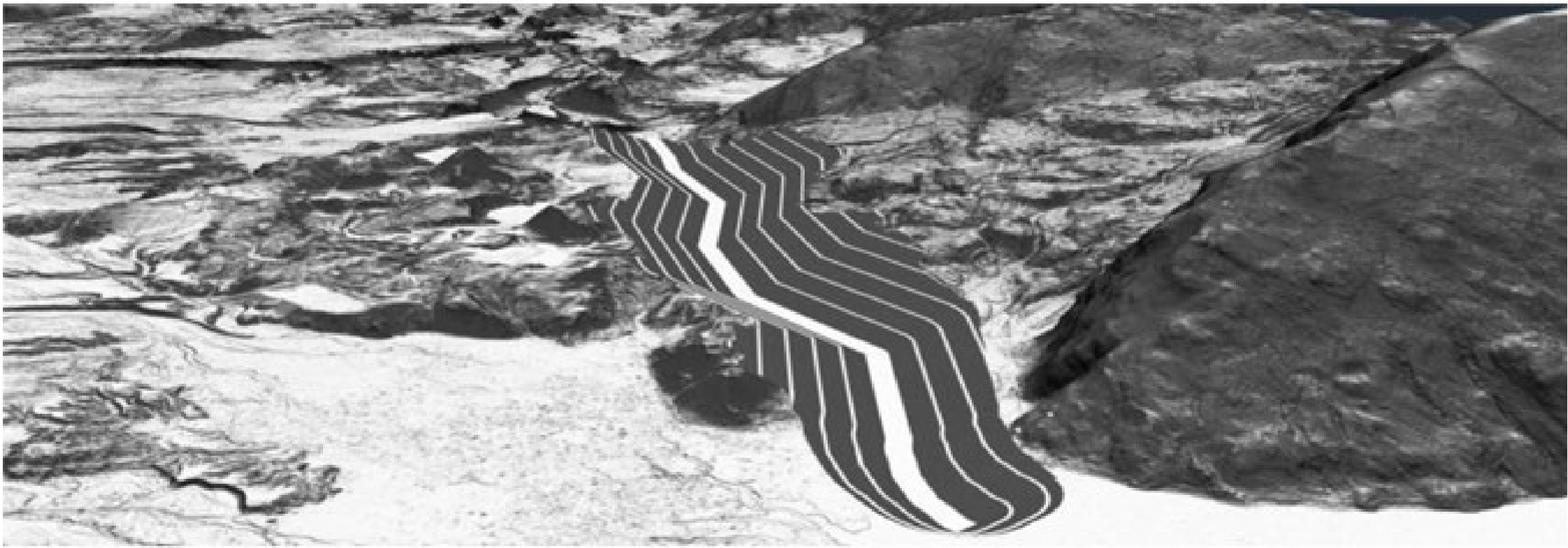
Spirit Lake Outflow Tunnel

Lake Level Control Options



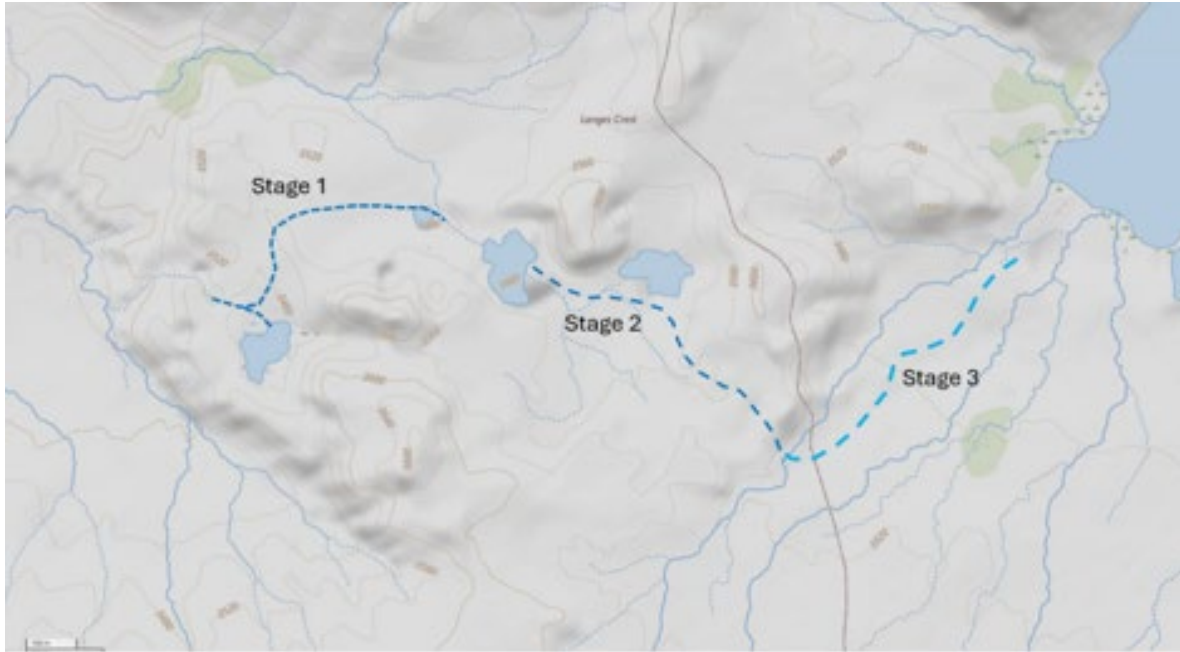
Note: all options require a permanent access road and temporary haul roads through the pumice plain.

A proposed action has not yet been selected for the project; however, the lake level control options shown below will be analyzed to identify a preferred alternative (for NEPA) which will be a combination of two of the below options. For example, rehabilitating the existing tunnel through the ridge could be combined with a buried conduit in the pumice plain as the redundant measure.



Open Channel Option

Engineered cut slopes and channel stabilization
Lake level control measures during construction
Excavated materials disposal



Natural Channel Option

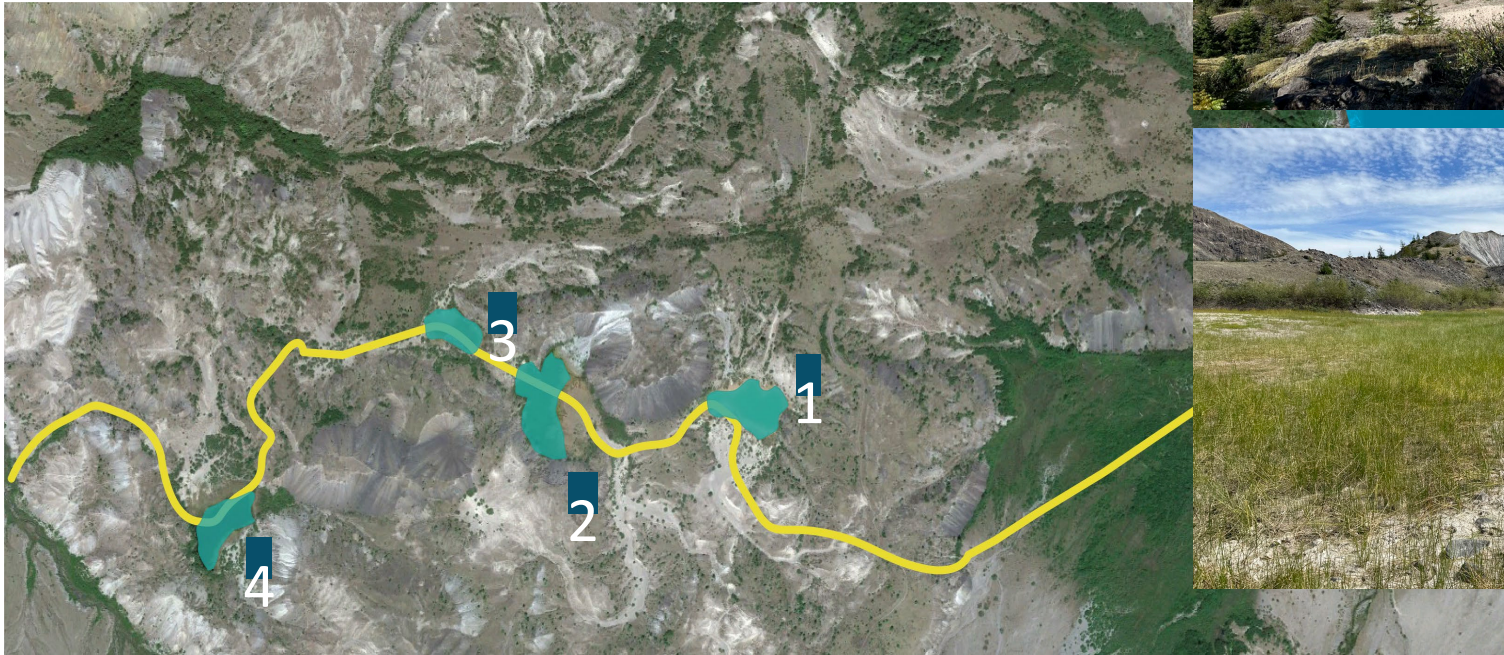
Staged development timeline
Variable water supply sources
Adaptive management for channel development



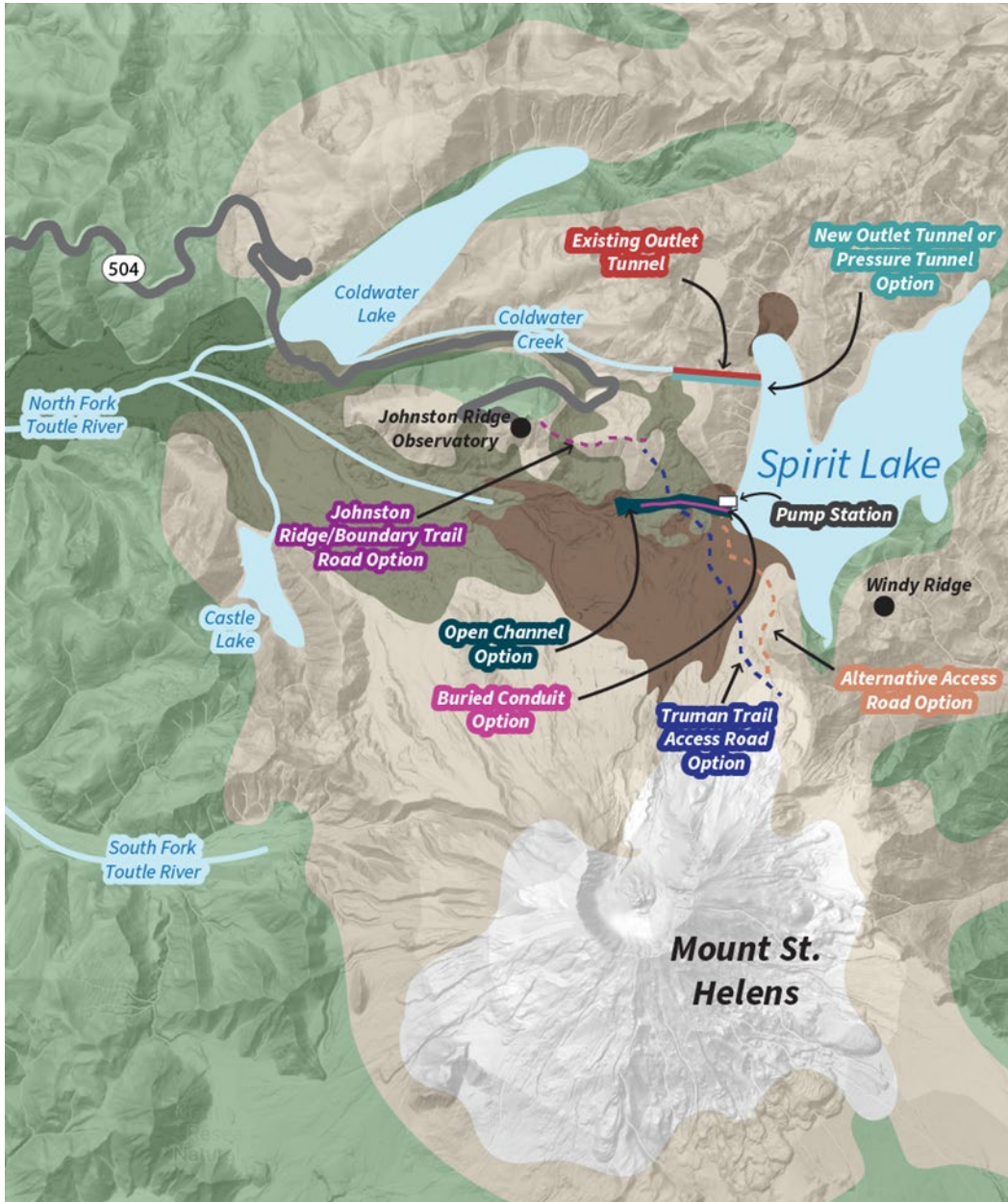
Boardman River Dams Ecosystem Restoration Project (dam removal, Traverse City, Michigan)
(<https://www.lre.usace.army.mil/Media/Images/igphoto/2002067168/>)



*With **lowered tunnel inlet and a pressure tunnel**, the stage is set for safer breaching of the debris avalanche by a developing new channel through adaptive management of lake levels*



Preliminary Combinations of Options Under Consideration: Leads to a **Proposed Action**



Option	Primary Lake Level Control Measure	Redundant Lake Level Control Measure
A	Open Channel Outlet , maintain current lake elevation	Rehabilitate Existing Outlet Tunnel
B	Lower intake with New Pressure Tunnel or Modified Existing Tunnel	Facilitate Natural Channel Development
C	Repair Existing Outlet Tunnel in shear zones	Permanent Pump Station
D	New Pressure Tunnel	Rehabilitate Existing Outlet Tunnel
E	Fully Rehabilitate Existing Outlet Tunnel	Buried Conduit in debris blockage
F	Convert Existing Outlet Tunnel into a pressure tunnel	Lake Storage with updated maximum sage lake level
-	The No Action Alternative would mean that no outflow improvement is selected, but repair of the existing tunnel will be unavoidable in the future	