Chapter 5 Programmatic Section 4(f) Evaluation

Chapter 5 contains the full and complete text of the *Programmatic Section 4(f) Evaluation and Approval for FHWA Projects That Necessitate the Use of Historic Bridges – Lake Keechelus Snowshed Bridge*.

5.1 Introduction

This document sets forth the basis for a Federal Highway Administration (FHWA) Programmatic Section 4(f) approval that there are no feasible and prudent alternatives to the use of certain historic bridge structures to be replaced or rehabilitated with federal funds, and that the project includes all possible planning to minimize harm resulting from such use. This approval is made pursuant to Section 4(f) of the Department of Transportation Act of 1966; 49 United States Code (USC) 303; Section 18(a) of the Federal-Aid Highway Act of 1968, 23 USC 138; 23 CFR Part 774, the Section 4(f) Evaluation); and 73 CFR 774.3(d), the Programmatic Section 4(f) Evaluation.

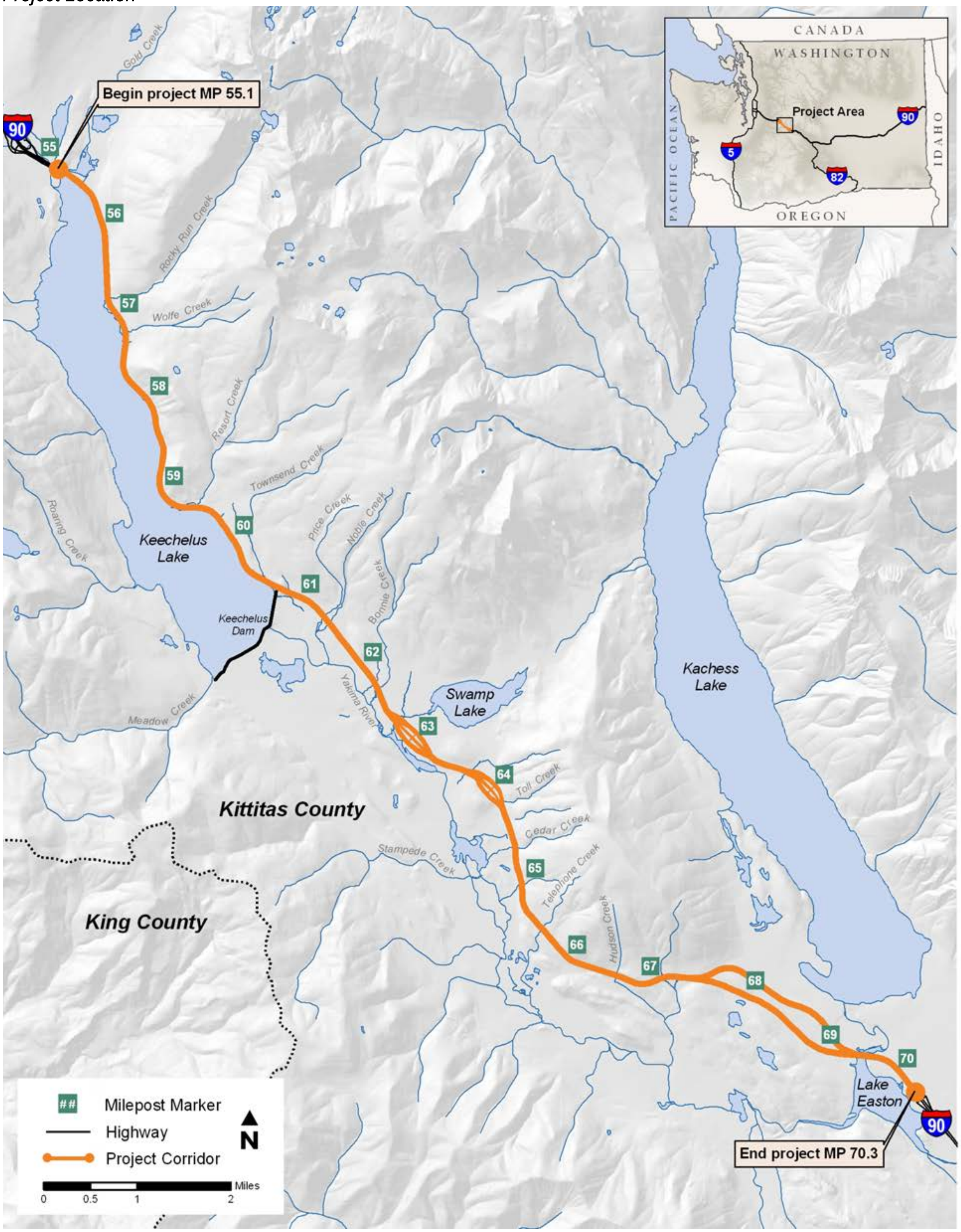
This document also includes additional background information on project setting and temporary occupancy of Section 4(f) resources.

Background

Project Setting

The Interstate 90 (I-90) Snoqualmie Pass East Project begins on the east side of Snoqualmie Pass at Hyak, in Kittitas County, Washington, at milepost (MP) 55.1 and ends approximately 15 miles to the east near the west Easton Interchange (MP 70.3) (Exhibit 5-1).

Exhibit 5-1
Project Location

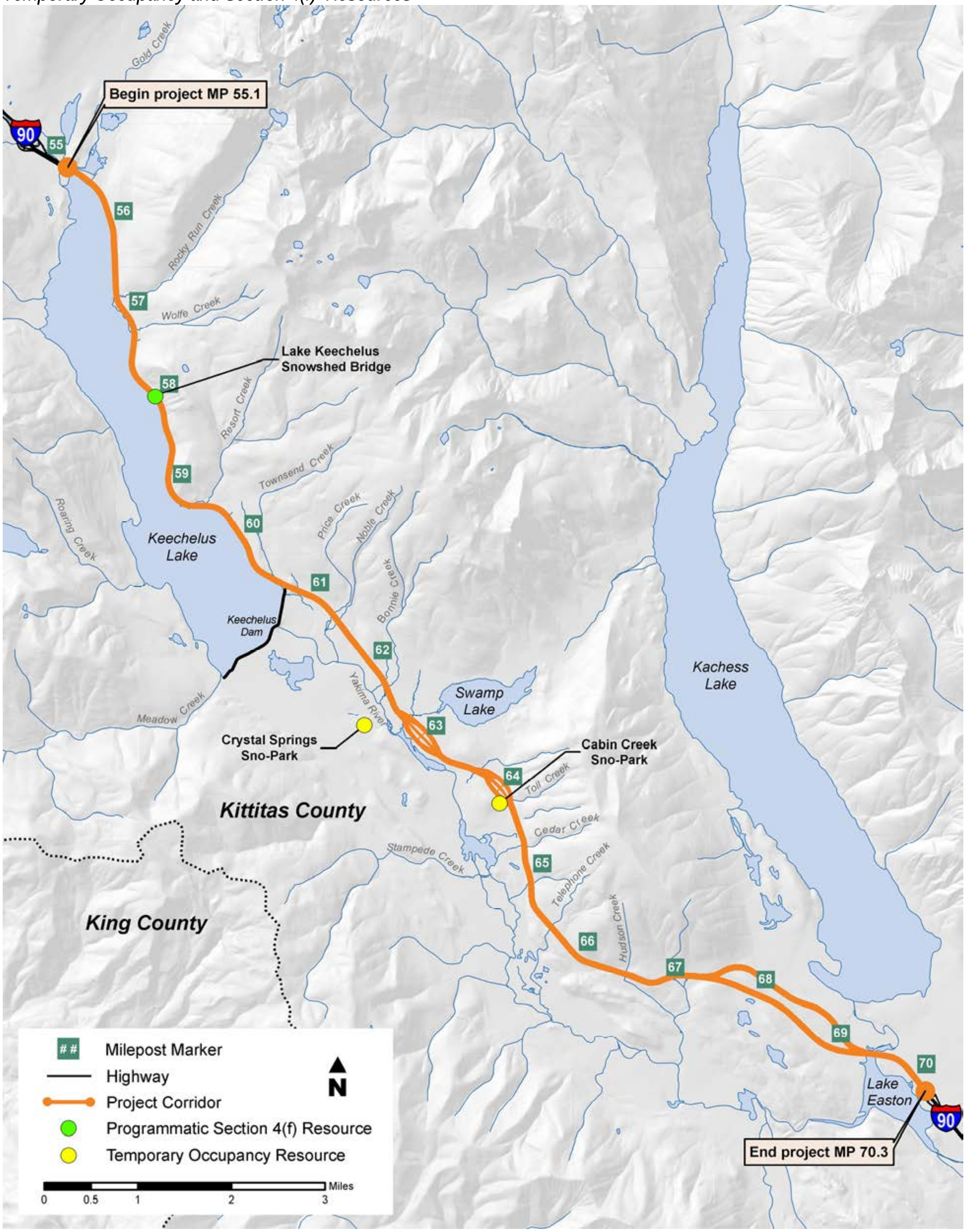


The existing highway is located within a glacially formed valley, which includes Keechelus Lake, the headwater of the Yakima River. The highway crosses Gold Creek near the western end of the project boundary and runs adjacent to the northeastern shore of Keechelus Lake to MP 60.5. The Lake Keechelus Snowshed Bridge (snowshed) is located near MP 58.1 (Exhibit 5-2). From MP 60.5 eastward, I-90 parallels the Yakima River for the remainder of the project area either along the valley floor or cut into the slope above the river. The project spans an area that transitions from rugged, forested mountainous terrain to rolling foothills, with roadway elevations ranging from approximately 2,550 feet near Hyak to 2,190 feet near Easton. Keechelus Lake is part of the United States Bureau of Reclamation (USBR) Yakima Project, and is used as a water storage facility for irrigated agriculture and flood control throughout much of the middle and lower portions of the Yakima River Basin.

The majority of the project is located on public land within the Okanogan-Wenatchee National Forest, which is managed by the United States Forest Service (USFS). The western end of the project corridor connects with a major winter recreation area at Snoqualmie Pass. Other land uses within the project corridor include rural residential; commercial forest land owned by Plum Creek Timber Company; and public recreation areas including trails, lakes, and sno-parks. Land use in the immediate vicinity of the snowshed is forest land, which is managed by the USFS.

The improvements to the 15 miles of highway between Hyak and Easton would widen I-90 to a six-lane highway, reduce avalanche closures and rock fall hazards, replace deteriorated pavement, straighten curves, increase capacity, improve safety and sight distance, lengthen truck climbing lanes, and build wildlife crossing structures. This would improve safety for drivers and reconnect wildlife habitat throughout the project corridor. Additionally, ecological connectivity improvements would enhance hydrologic, habitat, and species movement along this portion of the I-90 corridor.

Exhibit 5-2
Temporary Occupancy and Section 4(f) Resources



Cultural Resources in the Project Corridor Eligible for the National Register of Historic Places

The Washington State Department of Transportation (WSDOT) retained historians and archaeologists that met the Secretary of the Interior's Professional Qualification Standards to identify any historic or archaeological resources within the project's area of potential effect (APE) listed on or eligible for the National Register of Historic Places (NRHP). Resources eligible for the NRHP include prehistoric or historic districts, sites, buildings, structures, or objects that are defined under criteria in 36 Code of Federal Regulations (CFR) 60.4. The historian/archaeologist also determined whether the project would have an adverse effect on any NRHP-eligible or -listed resources.

As required under the Section 106 process described in 36 CFR Part 800 of the National Historic Preservation Act (NHPA), the historian/archaeologist submitted the initial cultural resource survey to WSDOT. The survey included an evaluation of all NRHP-eligible or -listed resources and project effects determinations (WSDOT 2003a). WSDOT conducted additional archaeological testing in 2004 on 11 of the archaeological sites to further determine eligibility status. These findings were reported in *Evaluative Testing of Eleven Sites for the Washington State Department of Transportation's I-90: Snoqualmie Pass East Project*, and the historian/archaeologist determined that none of these sites would be affected by the project (WSDOT 2004). WSDOT in turn submitted the evaluation to the Washington State Department of Archaeology and Historic Preservation State Historic Preservation Officer (SHPO) and applicable Tribal Historic Preservation Officers. WSDOT obtained eligibility and effect concurrence from SHPO in October 2005.

Under the NHPA Section 106 criteria defined in CFR 800.5(a)(1), an action is considered to have an adverse effect when the effect may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association of a historic property eligible for the NRHP. Impacts to cultural resources eligible for the NRHP may be direct or indirect.

The archaeologist/historian identified 58 cultural resources in the APE, located within 400 feet on either side of the I-90 edge-of-pavement. Of the 58 cultural resources identified, the snowshed, which is listed as the "Lake Keechelus Snowshed Bridge" on the NRHP Registration Form, is the only NRHP-listed resource. Six other resources are eligible for the NRHP, including three Rocky Run Cabins that were included in the cultural resource section of the project's Draft Environmental Impact Statement (EIS). However, the analysis in the Archaeological and Historic Survey Report (WSDOT 2003a) and *Evaluative Testing of Eleven Sites for the Washington State Department of Transportation's I-90: Snoqualmie Pass East Project* (WSDOT 2004) determined that the project would not adversely affect the Rocky Run Cabins or any other NRHP-eligible resources.

The archaeologist identified 37 archaeological resources in the APE. Two historic dumps and one prehistoric campsite were determined eligible for the NRHP, but the analysis in the Archaeological and Historic Survey Report (WSDOT 2003a) determined that the project would not adversely affect these sites.

WSDOT analyzed 14 areas as material source sites, staging areas, pit sites, or storage areas for the project in the *I-90 Snoqualmie Pass East Project Materials and Staging Report* (WSDOT 2006a). The report analyzed these areas for certain criteria in order to determine which were the least problematic in terms of environmental issues, and WSDOT ranked these areas as "preferred" or "acceptable." WSDOT ranked an area as "unfavorable" if it was in proximity to known archaeological/cultural resources, which was considered a "fatal flaw."

Traditional Cultural Properties

From 1998 to the present, WSDOT has met with Native American Tribes in a government-to-government coordination effort to discuss concerns regarding potential project impacts to traditional resources. These tribes include the Colville Confederated Tribes, Muckleshoot Tribe, Snoqualmie Nation, Tulalip Tribes, Wanapum Tribe, and the Yakama Nation. WSDOT, in consultation with the Tribes, did not identify any traditional cultural resources in the project area that would be adversely affected by the project.

Temporary Occupancy of Section 4(f) Resources in the Project Corridor

The FHWA Section 4(f) regulations define the circumstances when a temporary occupancy is not considered a Section 4(f) use as when:

> *"A temporary occupancy of land is so minimal that it does not constitute a use within the meaning of section 4(f) when the following conditions are satisfied:*
> *(i) Duration must be temporary, i.e., less than the time needed for construction of the project, and there should be no change in ownership of the land;*
> *(ii) Scope of the work must be minor, i.e., both the nature and the magnitude of the changes to the section 4(f) resource are minimal;*
> *(iii) There are no anticipated permanent adverse physical impacts, nor will there be interference with the activities or purpose of the resource, on either a temporary or permanent basis;*
> *(iv) The land being used must be fully restored, i.e., the resource must be returned to a condition which is at least as good as that which existed prior to the project; and*
> *(v) There must be documented agreement of the appropriate Federal, State, or local officials having jurisdiction over the resource regarding the above conditions."*
> *23 CFR 774.13(d), formerly 23 CFR 771.135(p)(7)*

The project would result in the temporary occupancy, but not the use, of two Section 4(f) recreation resources: the Crystal Springs Sno-Park and the Cabin Creek Sno-Park (Exhibit 5-2).

Crystal Springs Sno-Park

The Crystal Springs Sno-Park is located south of I-90 at the south end of Keechelus Lake, and is accessible from Exit 62. The Washington State Parks and Recreation Commission (State Parks) owns and manages the Crystal Springs Sno-Park, and a permit is required for parking. State Parks has jurisdiction over the sno-park and has determined that it should be provided protection as a Section 4(f) resource. Under the Preferred Alternative, WSDOT would temporarily occupy a portion of the site. This activity would constitute a temporary occupancy rather than a Section 4(f) use of this resource, according to Section 4(f) "use" and temporary occupancy criteria.

Since there is no summer recreation activity at this location, WSDOT plans to temporarily occupy the areas of the Crystal Springs Sno-Park not currently used for parking for the following activities:

- Stockpiling raw gravel and rock material
- Processing raw materials, rock crushing, screening, and asphalt and concrete production
- Staging, which would include equipment parking, a mobile office, and tool and equipment storage

In a letter to State Parks dated April 25, 2007, WSDOT requested permission to temporarily occupy the Crystal Springs Sno-Park for staging and stockpiling. State Parks responded in a letter to WSDOT October 15, 2007 (Appendix A), which states:

> *1. "WSDOT's temporary occupancy of the Crystal Springs Sno-park would begin during the first phase of construction of the I-90 Snoqualmie Pass East project, which is currently funded and may begin in 2009. It is anticipated to be used for future phases of construction, which are unfunded.*
> *2. WSDOT anticipates that actions associated with staging and stockpiling would occur while temporarily occupying the Crystal Springs Sno-park.*
> *3. WSPRC understands that this temporary use will have minimal effects to winter use and will be beneficial in the long term. WSPRC will review and approve a summer management plan of the site along with a conceptual site plan. WSPRC will identify the condition that the site must be*

reclaimed to for each winter recreation season, as well as the end of the I-90 project.

4. WSDOT and WSPRC are working together to develop a Memorandum of Agreement that will further outline the protocols and details for the temporary occupancy which should be finalized in late 2007 or early 2008."

WSDOT has determined that there would be no change in ownership of land at the Crystal Springs Sno-Park, and any changes at the sno-park would be improvements, with no permanent adverse physical impacts. WSDOT and State Parks will jointly develop restoration measures to meet State Parks' future objectives for the site.

Cabin Creek Sno-Park

The Cabin Creek Sno-Park is located south of I-90 and is accessible from Exit 63. The USFS has jurisdiction over the sno-park, has designated it as a developed recreation site, and determined that it should be provided protection as a Section 4(f) resource. The USFS Cle Elum District manages the sno-park and a permit is required for use. Under the Preferred Alternative, WSDOT would temporarily occupy the site during construction. This activity would constitute a temporary occupancy rather than a Section 4(f) use of this resource, according to Section 4(f) "use" and temporary occupancy criteria.

Since there is no summer recreation activity at this location, WSDOT plans to use the Cabin Creek Sno-Park as a temporary stockpiling and staging area for equipment, tools, and a job shed. During construction, WSDOT will be required to vacate the sno-park each winter to avoid temporary or permanent interference with the activities of the sno-park.

WSDOT's temporary occupancy of the Cabin Creek Sno-Park could occur during Phase 1 of the project, but would likely occur during a later phase of the project that involves reconstructing the Cabin Creek Interchange at Exit 63. WSDOT's temporary occupancy of the Cabin Creek Sno-Park would be less than the duration of construction of the project.

In a letter to the USFS dated April 25, 2007, WSDOT requested permission to temporarily occupy the Cabin Creek Sno-Park for staging and stockpiling. The USFS responded in a letter to WSDOT dated July 13, 2007 (Appendix B). The letter stated that a Special Use permit would be required for temporary occupancy when WSDOT occupies the sno-park for staging and stockpiling. WSDOT and the USFS are currently meeting to specify the temporary operation, environmental protections, long-term reclamation, and communication protocol during the time WSDOT is temporarily occupying the Cabin Creek Sno-Park.

WSDOT has determined that there would be no change in ownership of land at the Cabin Creek Sno-Park, and any changes at the sno-park would be improvements, with no permanent adverse physical impacts occurring.

WSDOT expects that constructing Phase 1 of the project could last five to six years, and estimates that the remaining 10 miles of the project would take seven or more years to complete.

Programmatic Section 4(f) Resource Use in the Project Corridor

Constructing the project would result in removing the snowshed. Removing the snowshed is considered an adverse effect under NHPA Section 106, and is a FHWA Programmatic Section 4(f) "use" of an historic bridge. The project would not adversely affect any other NRHP-eligible or -listed historic, archaeological, or cultural resources.

The Lake Keechelus Snowshed Bridge is located in the westbound lanes of I-90 adjacent to Keechelus Lake near MP 58.1 (Exhibit 5-3). The existing alignment was constructed in the most logical location in this corridor, which has served as a travel corridor since pre-historic times. This corridor was originally a Native American trail over the Cascade Mountains, which was eventually used by non-Native traders and settlers, becoming wider with additional use. It eventually became known as the Snoqualmie Pass Road. The Sunset Highway, later known as US Route 10, was built in the 1920s to replace the older, unpaved road. In 1951, the existing snowshed was constructed to replace a wooden snowshed built near MP 58.0, which had been in service for many years (Exhibit 5-4). During the late 1950s and early 1960s, US Route 10 was increased to four lanes from Hyak to Cle Elum, either by widening the existing highway, or by constructing an additional roadway parallel to the existing roadway. The snowshed continued to protect the westbound lanes, but no structure was added to protect the eastbound lanes in this avalanche-prone area.

Exhibit 5-3
Lake Keechelus Snowshed Bridge Vicinity

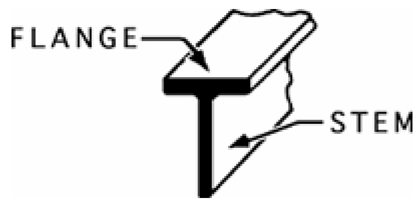
In the late 1960s and early 1970s, the parts of US Route 10 that did not meet interstate design standards were re-aligned, and US Route 10 became part of America's Interstate Highway System (I-90).

Exhibit 5-4
Lake Keechelus Snowshed Bridge Construction in 1951

WSDOT owns the snowshed, which was listed on the NRHP in 1995.

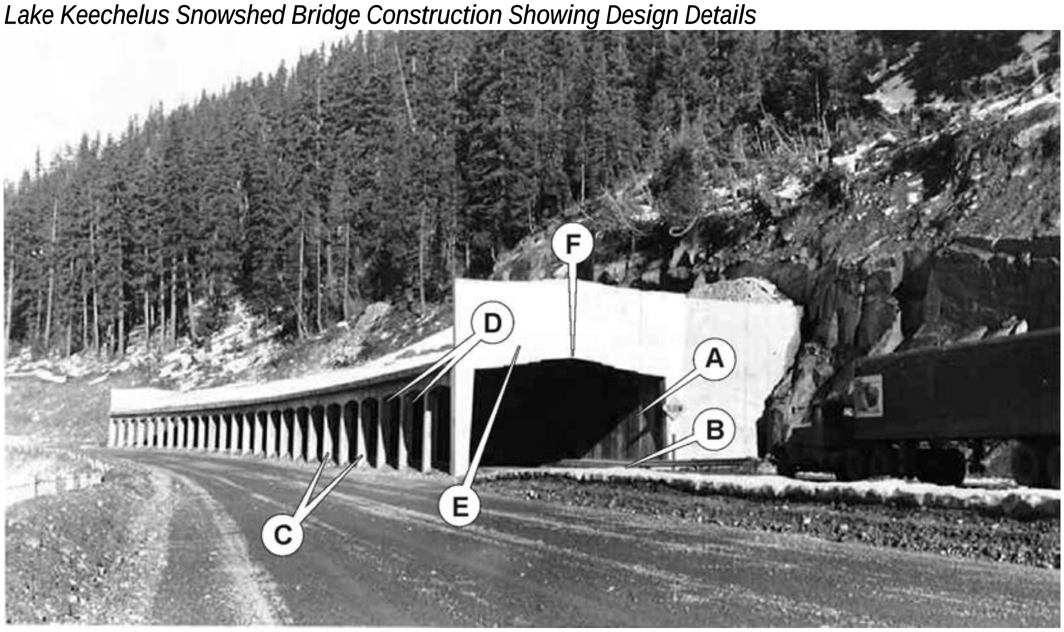
The snowshed consists of a pre-cast concrete girder-slab roof (A in Exhibit 5-4) supported by a counterforted retaining wall (a type of buttress that sticks out at right angles from a wall) on the uphill side (A in Exhibit 5-5), and a continuous open spandrel column and parabolic beam support on the downward side (B in Exhibit 5-4). The structure is 500 feet long and has a uniform cross-section.

The roof span, which has a 3 vertical to 1 horizontal (3V:1H) slope, is 34 feet wide and is made up of 200 pre-cast concrete T-beams (A in Exhibit 5-4). Each T-beam section has a stem that is nine inches thick and 21 inches deep below the flanges. The beam flanges are five inches thick and form the roof (A in Exhibit 5-4). Because the snowshed is located on a curve, the majority of flanges taper slightly in width. Both ends of these beams were thickened and recessed so that they could be secured over the top of the retaining wall and over the support at the lower end.

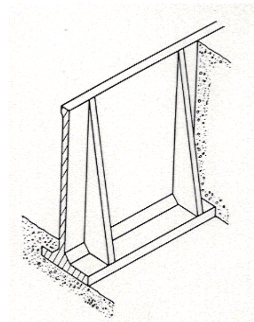


T-Beam

Exhibit 5-5
Lake Keechelus Snowshed Bridge Construction Showing Design Details



The counterforted retaining wall is 28 feet, 3 inches high and 15 inches thick (C in Exhibit 5-4). The counterforts, which provide extra strength to the wall, are 2 feet thick and positioned at 10-foot 2-inch centers (A in Exhibit 5-5). The wall rests on a reinforced concrete footing (B in Exhibit 5-5), which varies in thickness according to the nature of the foundation. The foundation is 19 feet wide in rock formations, and 23 feet wide in sand and gravel.



Counterfort

The downhill side support for the roof consists of a series of 2-foot columns on 20-foot centers (C in Exhibit 5-5), connected by segmental-arched beams of the same thickness, forming a series of 20-foot open bays (D in Exhibit 5-5). This open construction was designed to allow both ventilation and visibility, eliminating the need for artificial ventilation.

The structure is adorned at either end by two portals bearing Art Deco detailing (E in Exhibit 5-5). A series of raised concrete panels rise upwards toward the center of the portal in the shape of a flattened pointed arch (F in Exhibit 5-5). The central panel is incised with vertical parallel grooves, which accentuates its height. The retaining wall, like the utilitarian roof, is similarly disguised with panels. The overall visual effect is an entranceway that both complements the arched bays of the lower support and echoes “the precipitous sweep of the surrounding landscape” (US Department of the Interior 1993).

The snowshed is the only remaining concrete snowshed in Washington State. It is an early example of a structure built through the use of an innovative technique that involved combining both pre-cast and cast-in-place elements. It was designed to provide permanent protection from snow slides for what is one of the most heavily-used mountain passes in the United States (US Department of the Interior 1993). It was built at the same time as a similar snowshed for the rail line on the west side of Snoqualmie Pass, which was demolished in the early 1980s. Both snowsheds were conceived as forerunners of what was intended to be a huge program to cover 6,000 feet of Snoqualmie Pass. However, the other snowsheds were never built.

5.2 Use

The snowshed falls under the definition of Programmatic Section 4(f) "use" found in the Programmatic Section 4(f) Evaluation and Approval for FHWA Projects that Necessitate the Use of Historic Bridges (FHWA 1983), which states:

> *"The historic bridges covered by this programmatic Section 4(f) evaluation are unique because they are historic, yet also part of either a Federal-aid highway system or a state or local highway system that has continued to evolve over the years. Even though these structures are on or eligible for inclusion on the NRHP, they must perform as an integral part of a modern transportation system. When they do not or cannot, they must be rehabilitated or replaced in order to assure public safety while maintaining system continuity and integrity. For the purpose of this programmatic Section 4(f) evaluation, a proposed action will 'use' a bridge that is on or eligible for inclusion on the NRHP when the action will impair the historic integrity of the bridge either by rehabilitation or demolition. Rehabilitation that does not impair the historic integrity of the bridge as determined by procedures implementing the national Historic Preservation Act of 1966, as amended (FHWA), is not subject to Section 4(f)"*

5.3 Applicability

This Programmatic Section 4(f) evaluation may be applied by FHWA to this project because it meets the following criteria:

- The bridge is to be replaced or rehabilitated with federal funds
- The project will require the use of a historic bridge structure which is on or is eligible for listing on the NRHP
- The bridge is not a National Historic Landmark

- The FHWA Division Administrator determined that the facts of the project match those set forth in the sections of this document labeled Alternatives, Findings, and Mitigation

- Agreement between FHWA and the SHPO has been reached through procedures pursuant to Section 106 of the NHPA (Appendix C)

5.4 Alternatives

The alternatives described in Section 5.5, *Findings* avoid any use of the historic (snowshed) bridge, based on the guidance in the Programmatic Section 4(f) Evaluation and Approval for FHWA Projects that Necessitate the Use of Historic Bridges (FHWA 1983), which states:

> *"The following alternatives avoid any use of the historic [snowshed] bridge:*
> - *Do nothing*
> - *Build a new structure at a different location without affecting the historic integrity of the old bridge, as determined by procedures implementing the NHPA*
> - *Rehabilitate the historic bridge without affecting the historic integrity of the structure, as determined by procedures implementing the NHPA"*

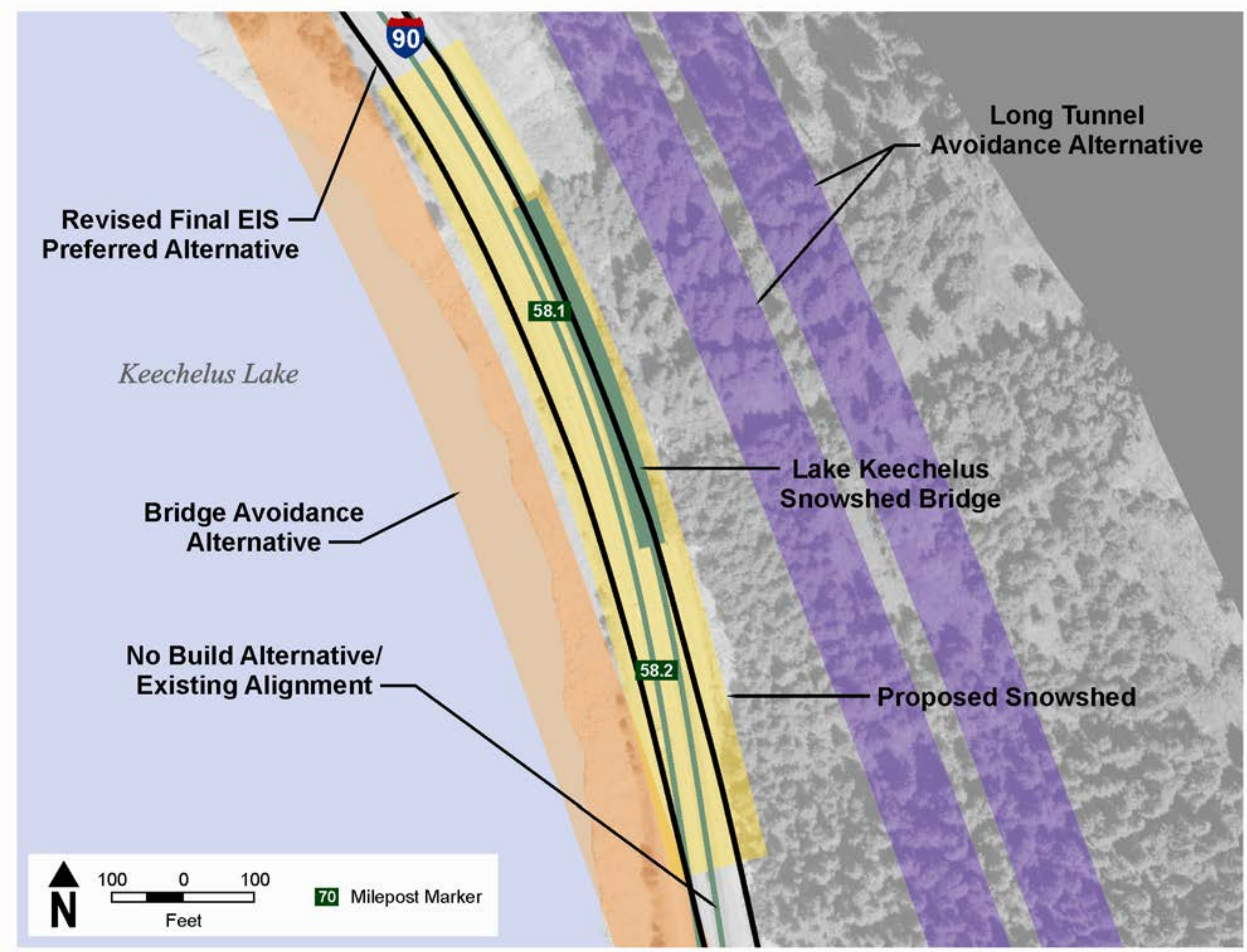
5.5 Findings

In order for this Programmatic Section 4(f) evaluation to be applied to a project, the findings for each alternative must be supported by the circumstances, studies, and consultations on the project.

Do-Nothing or No-Build Alternative

Under this alternative, which is required as part of the Programmatic Section 4(f) process, no new construction would occur, and the existing highway would be maintained and repaired as needed (Exhibit 5-6). Although the snowshed would remain in place under this alternative, it would not eliminate design deficiencies based on current American Association of State and Highway and Transportation Officials (AASHTO) and WSDOT design geometric guidelines for height and shoulder width.

Exhibit 5-6
Lake Keechelus Snowshed Viaduct Bridge Avoidance Alternatives, Existing Alignment, and Preferred Alternative



Maintenance

The Do-Nothing or No-Build Alternative does not correct the situation that causes the snowshed to require an increasing number and intensity of repairs.

WSDOT's December 12, 2005, Bridge Inspection Report (Appendix D) lists areas of cracking and spalling; scattered de-laminations along the north retaining wall, which acts as an abutment; a diagonal crack at the north, bottom corner of the east retaining wall; and cracking on the 26 southern columns. Several of the 200 40-foot-long concrete girders forming the roof are spalled and have transverse cracks. The 1996 Inspection Report stated: "There are cohesion cracks between the poured rubber and the pre-cast concrete T-beams. Leakage is visible underneath due to the adhesion failure between poured rubber and concrete panels. Monitor the progress of the adhesion cracks… if cracks get worse then roof should be coated with a new coat of asphalt." As of 2005, either snow or moss has prevented inspectors from viewing the roof in order to monitor the cracks. Subsequent reports simply restate the need to monitor the cracks, and WSDOT has not made repairs.

Although WSDOT will continue to provide general maintenance, the snowshed can be expected to deteriorate over time, and eventual failure cannot be ruled out. Additionally, general maintenance does not correct the situation that this structure is of inadequate length and width to protect the highway at all five avalanche chutes in the location of the snowshed. Under a Do-Nothing on No-Build Alternative, avalanches will continue to cause safety concerns and close the highway to traffic.

Safety

The Do-Nothing or No-Build Alternative would not correct the geometric deficiency of the snowshed. Although the snowshed met WSDOT design guidelines when it was constructed in 1951, it does not meet current AASHTO and WSDOT design guidelines for shoulder width (4 feet inside and 8 feet outside of travel lanes). The WSDOT Bridge Inspection Report from December 2005 states, "…there isn't a safe shoulder inside the shed, which is like a tunnel." The distance between the inside face of the columns and the inside of the retaining wall is 32 feet, 6 inches. The concrete roadway is 28 feet curb-to-curb. A safety walk and curb alongside the retaining wall form the exterior of a drainage duct that is 2 feet 6 inches wide and 3 feet high. According to AASHTO design guidelines for mountainous terrain, 8-foot-wide outside shoulders are recommended for highways with three or more lanes in each direction, and the inside paved shoulder should be a minimum of 4 feet wide. Shoulder width inside the snowshed should be consistent with adjacent highway shoulder widths. Snowshed design based on current AASHTO guidelines would create a total width of 96 feet for coverage of all six proposed lanes, or 48 feet wide for three lanes, rather than the existing width of 28 feet.

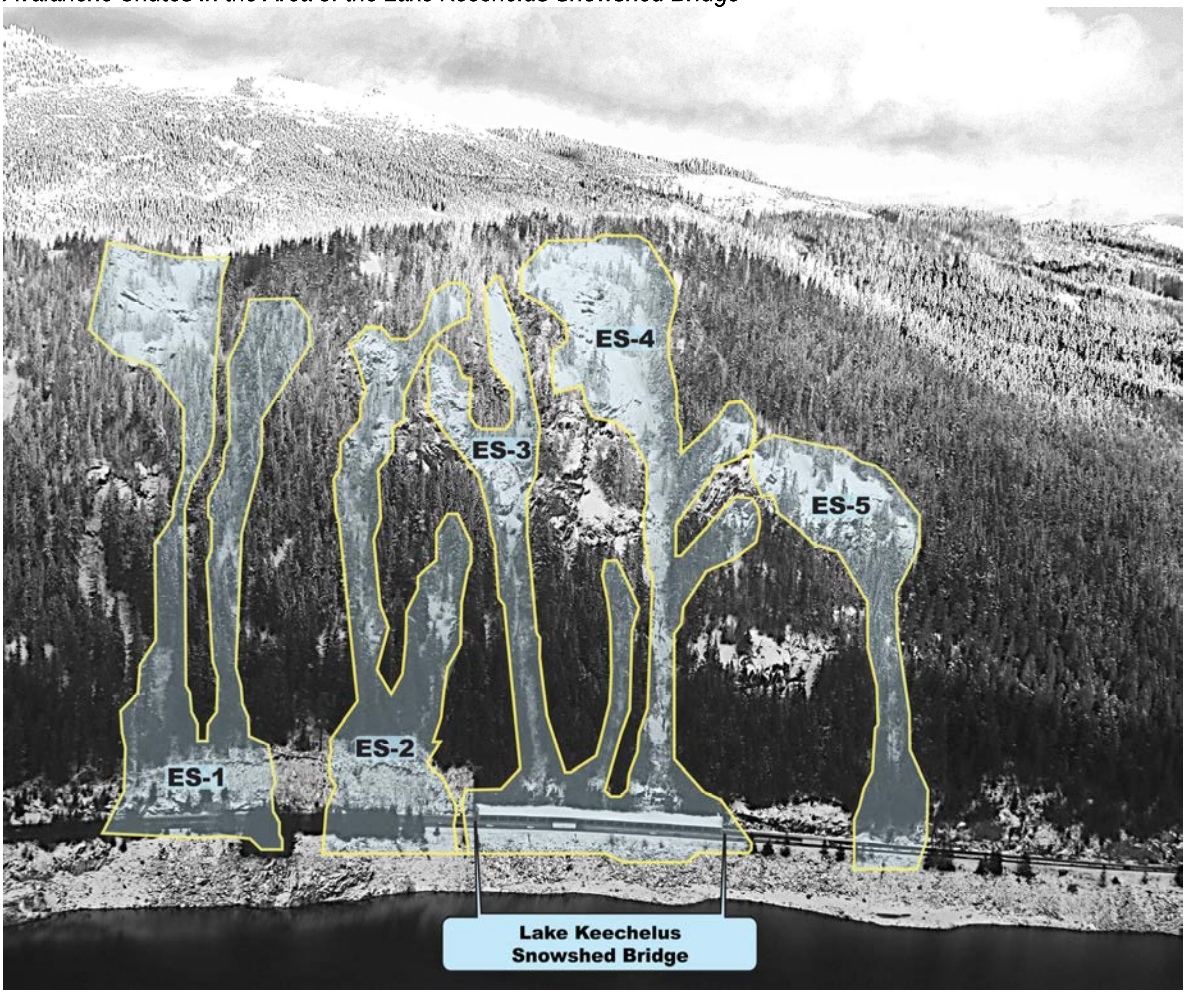
AASHTO guidelines for rural areas recommend 16 feet minimum vertical clearance under overhead structures, including over the paved shoulders. Tunnel vertical clearance is the same as under bridges. Horizontal clearance under a bridge shall be the *full paved width* of the rest of the road.

Because of the slight slant of the snowshed ceiling, large semi-tractor trailer rigs often try to drive through the center of the snowshed where there is the greatest clearance to avoid scraping the top edges of the truck or the containers on the snowshed ceiling. Superload tractor-trailer rigs are detoured around the snowshed, requiring temporary closure of the eastbound lanes (Washington State Patrol Ellensburg Trooper, personal communication).

The WSDOT Road Restrictions web site includes I-90 Ellensburg to Hyak, which states, “loads 16' 2" high restricted through Snowshed until further notice (Superloads). Note: This is a permanent restriction.” I-90 is a major freight corridor, with trucks accounting for over 17 percent (6,000 trucks) of the traffic volume on weekdays. An efficient, safe, and unobstructed roadway is economically vital to the movement of freight as traffic volumes continue to increase through this heavily-used corridor. The Do-Nothing or No-Build Alternative does not correct the restricted vertical clearance through the existing snowshed.

The Do-Nothing or No-Build Alternative does not reduce the risks of avalanches to the traveling public at this location. Five avalanche chutes are located along and at either end of the snowshed (Exhibit 5-7). The snowshed is located directly below avalanche chutes ES-3 and ES-4, and is constructed only over the westbound lanes. The snowshed does not protect the highway at all from avalanche chutes ES-1, ES-2 or ES-5, and does not protect the eastbound lanes. Because the snowshed covers only the westbound lanes along two of the five avalanche chutes, this section of I-90 is often closed in the winter when avalanches cover the eastbound lanes (or all lanes at both ends of the snowshed), or because of avalanche control and repair work (Exhibit 5-8).

Exhibit 5-7
Avalanche Chutes in the Area of the Lake Keechelus Snowshed Bridge



These closures result in substantial safety hazards to the traveling public due to the unanticipated nature of avalanche events, which strand motorists and freight on the pass, causing travel delays. Closures result in opportunity costs (the value of resources that would otherwise be productively employed, including time) to the regional economy due to freight transport disruption.

Exhibit 5-8
Lake Keechelus Snowshed Bridge and Avalanche

Between 1995 and 2002, Snoqualmie Pass was closed an average of 100 hours annually due to avalanches, avalanche control work, rock fall, and landslides. In the Draft EIS, WSDOT used two methods to calculate the cost of road closures due to these events: the Cross-Cascades Corridor Method and the WSDOT Method. For a 24-hour closure for freight trucks, the Cross-Cascades Method determined a total cost of $1,076,000, and the WSDOT Method determined a total cost of $806,000 (WSDOT 2003b). The traveling public and movement of goods remain at risk as long as the avalanche problem is not resolved. This risk will increase with an increase in traffic volumes.

Rock fall is another concern in the vicinity of the snowshed, both directly above and just beyond both ends of the snowshed. Because the existing alignment passes through areas of faulting, where cut slopes intersect fault gouge and loose soil materials, the potential for slope degradation has been and will continue to be a hazard to the traveling public. Rocks falling on the deteriorating roof of the snowshed are another safety concern.

Finding

Because of these deficiencies, the snowshed poses serious and unacceptable safety hazards to the traveling public, and places intolerable restriction on transport and travel. The Do-Nothing or No-Build Alternative would result in the continued use of the existing snowshed, and leaves the areas at both ends of the snowshed susceptible to avalanches and rock fall. Under this alternative, the present four-lane highway would be maintained and rehabilitated as needed. FHWA and WSDOT (the lead agencies) studied the No-Build Alternative in the Draft EIS, and found that the No-Build Alternative did not meet the project's purpose and need, including safety and capacity. For these reasons, the Do-Nothing or No-Build Alternative is not feasible and prudent.

Build on New Location without Using the Existing Snowshed Bridge

Throughout the development of the Draft EIS, FHWA and WSDOT investigated the possibility of constructing the project at a new location, away from the existing alignment. This section analyzes three alternatives that would avoid the snowshed. The lead agencies did not consider any of these alternatives to be feasible and prudent, because constructing the new alignment at another location to avoid the snowshed would:

- Result in extraordinary construction and engineering problems with tunnels or bridges
- Cause extraordinary disruption to established traffic patterns
- Cause substantial environmental impacts

In addition, the abandoned snowshed would no longer perform as an integral part of a modern transportation system, but would be an isolated structure, requiring State maintenance in perpetuity.

The following three avoidance alternatives were analyzed in the Draft EIS. The Draft EIS alternatives not evaluated in this Programmatic Section 4(f) Evaluation would have similar environmental, geotechnical, and economic constraints as the three avoidance alternatives evaluated here. The FHWA Programmatic Section 4(f) criteria do not require that all alternatives presented in the Draft EIS be evaluated in the Programmatic Section 4(f) Evaluation.

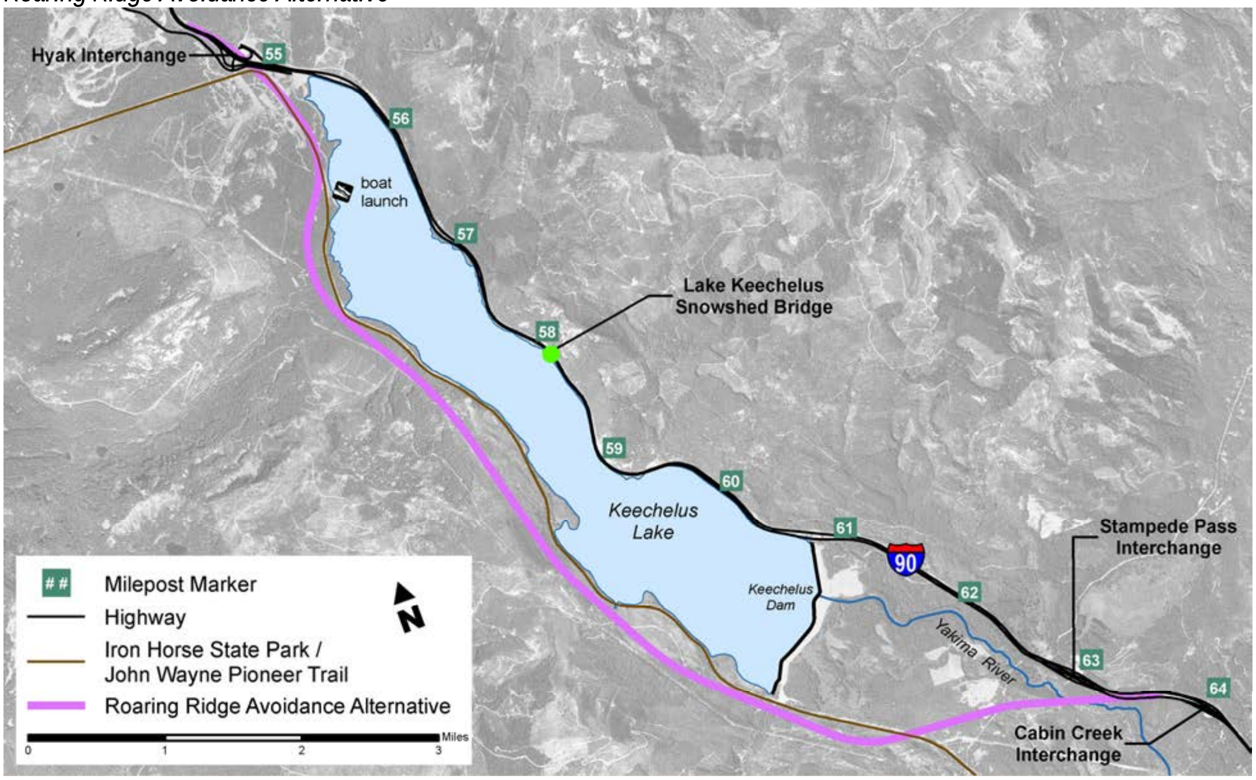
Roaring Ridge Avoidance Alternative, South End of Keechelus Lake

The Roaring Ridge Avoidance Alternative would construct a new six-lane highway west and south of Keechelus Lake from the Hyak Interchange to the Cabin Creek Interchange where none previously existed (Exhibit 5-9). This route would diverge from existing I-90 just east of the Hyak Interchange at MP 54.9, then turn south, passing through the Iron Horse State Park near the Keechelus Lake Boat Launch, then traverse the eastern-facing slopes of Roaring Ridge approximately 100 to 300 feet above the western shore of Keechelus Lake. South of Keechelus Lake, the route would veer east, crossing back through the Iron Horse State Park and crossing the Yakima River at Sawmill Flats, where it would rejoin I-90 at MP 64.0 just west of the Cabin Creek Interchange. From this point east, the route would approximately follow the existing alignment to the end of the project at the west Easton Interchange. Most of the existing alignment along the eastern shore of Keechelus Lake, including the snowshed, would be abandoned.

Terrain

The project area lies within the alpine zone on the east side of the Cascade Mountains. The general topography is one of mountainous ridges and peaks, with deep, glacially carved valleys. Most of the valleys exhibit geomorphology typically associated with glacial erosion. The highest elevations in the project area are generally less than 6,000 feet. Rampart Ridge, along the north end of the project alignment, reaches an elevation of 5,750 feet; Keechelus Ridge is just over 5,000 feet in elevation; and Amabilis Mountain is slightly higher than 4,500 feet (Plum Creek 1997). Keechelus Lake was formed when glacial moraines impounded the waters of melting ice at the end of the most recent glaciation.

Exhibit 5-9
Roaring Ridge Avoidance Alternative



The USBR built Keechelus Dam during the early 1900s, and continues to own and operate the dam. While the dam has raised the lake level by 97 feet, the lake is drawn down by approximately 70 feet during August and September each year to provide water for downstream irrigation use.

The western side of Keechelus Lake is steep, mountainous, and forested. The Iron Horse State Park-John Wayne Pioneer Trail (old Chicago-Milwaukee-St. Paul-Pacific Railroad grade) occupies the only logical location for a transportation route in this vicinity. The Iron Horse State Park is itself a Section 4(f) resource, and would need to be avoided. This alignment would need to be cut into the side of a steep hillside, approximately 100 to 300 feet above the lake shore, and would require additional snowshed construction. Bridges and culverts would be required for streams, ravines, and drainages.

Adverse Social, Economic, or Environmental Effects

Adverse Social Effects. Disadvantaged populations in Kittitas County represent a small portion of the community, with the minority population at 8.2 percent and the low-income population at 13.3 percent, according to 2000 US Census Bureau information (WSDOT 2005a). Neither the project nor the Roaring Ridge Avoidance Alternative would have a disparate or disproportionate impact on low-income or minority populations. WSDOT does not anticipate the project to increase the level of traffic volumes or development in the project corridor. Within the project area, the small amount of private land combined with existing zoning and access restrictions would prevent a proliferation of development sufficient to produce adverse effects to the social environment. Outside the project area, regional and statewide forces, which are independent of the project, are driving land use development and traffic volume increases.

Adverse Economic Effects. Relocating the alignment to avoid the snowshed could result in difficulty for businesses at the west end of the existing alignment that are generally supported by the traveling public, since they would lose visibility and convenient access. Other potential impacts on local businesses and private property owners include construction noise and dust.

Adverse Environmental Effects. Constructing this alternative to avoid the snowshed would create an entirely new highway corridor that would be six lanes wide, where none exists now, which would result in individual and cumulative environmental impacts of extraordinary magnitude. It would require new stream crossing structures and would disturb habitat areas that are currently undisturbed. FHWA and WSDOT determined that creating such a new highway would create substantial adverse impacts to ecological connectivity, special status species, wetlands and other waters of the US, and wildlife habitat. A United States Army Corps of Engineers (USACE) 404 permit to discharge dredged or fill material into waters of the US would be required for any water-crossing structures.

Engineering and Economy

While the difficulty associated with constructing a new highway under this alternative at this location is less extreme than with other alternatives analyzed in the Draft EIS, the Roaring Ridge Avoidance Alternative would not be feasible and prudent because the cost of constructing a new 10- to 15-mile-long alignment where a roadway does not currently exist would reach extraordinary magnitude. Factors supporting this conclusion include significant increased roadway and structure costs, and engineering difficulties associated with constructing a roadway approximately 100 to 300 feet above the Keechelus Lake shoreline in what has proven to be unstable geologic conditions along the shoreline elsewhere in the project area (WSDOT 2005b).

Because of these factors, project engineers did not estimate the cost of this alternative. However, they assumed the base cost would exceed that of the Long Tunnel Alternative, estimated at $832 million in 2006. This cost estimate does not include the escalation of cost to the year of construction including inflation, land values, and material costs; or the risk associated with design and construction, such as unstable rock or other unknown geotechnical concerns.

WSDOT estimated the cost of construction by using the following individual factors: engineering, right-of-way acquisition, roadway costs, surfacing, asphalt, and Portland cement concrete pavement, retaining walls, bridge structures, large culverts, cut and fill, traffic control, escalation and risk, on- and off-site mitigation, and all other work items required to construct the project.

As a result of moving the alignment to a new location, a portion of the existing alignment would need to be left in place for use as a frontage road for access to residences and businesses in the Hyak area at the west end of the project, and the Cabin Creek and Crystal Springs Sno-Parks at the east end of the project area. This would create additional road and winter maintenance for the State, in addition to the new alignment.

The Roaring Ridge Avoidance Alternative would construct a new six-lane highway where none previously existed. As a result, this alternative would generate additional direct and indirect impacts on environmental and Section 4(f) resources when compared to alternatives that use more of the existing alignment's footprint. For example, this alternative would require acquiring lands within the right-of-way of the Iron Horse State Park, including the John Wayne Pioneer Trail, both of which have been determined to be Section 4(f) resources, and which would constitute a Section 4(f) use of these resources. This avoidance alternative would then be trading the use of one historic Section 4(f) resource for the use of two recreation Section 4(f) resources. Indirect impacts would result from increased noise levels and decreased visual quality along the western shore of Keechelus Lake. While a portion of the existing highway's footprint would be reclaimed as part of the project, it is unlikely that it could be restored to pre-highway conditions.

Preservation of Existing Snowshed Bridge

The Roaring Ridge Avoidance Alternative would allow the snowshed to remain in place. The State would be required to maintain the snowshed in perpetuity at great cost, according to criteria set forth under the NHPA. It would no longer perform as an integral part of a modern transportation system, and would be isolated and unused. The public could view the snowshed only from the south side of Keechelus Lake. The State would need to maintain a portion of the existing highway between Hyak and the snowshed, or between Cabin Creek/Crystal Springs Sno-Park areas and the snowshed for WSDOT maintenance crews to reach the snowshed. The unused portion of the roadway would be rendered obsolete, removed, and reclaimed.

Finding

The Roaring Ridge Avoidance Alternative would construct a highway where no highway previously existed. It would result in numerous environmental impacts of extraordinary magnitude; excessive engineering difficulties; and construction, operational, and maintenance costs of extraordinary magnitude. This alternative would require the use of two recreation Section 4(f) resources.

Indirect impacts would result from increased noise levels and decreased visual quality along the western shore of Keechelus Lake. For these reasons, the Roaring Ridge Avoidance Alternative is not feasible and prudent.

Long Tunnel Avoidance Alternative

The Long Tunnel Avoidance Alternative would construct twin three-lane tunnels for a distance of approximately 1.9 miles through the hillside just east of the snowshed (Exhibit 5-6). This design would remove the sub-standard curves within this section of the project area, and re-align the highway to meet a 75 miles per hour (mph) design speed. This alternative bypasses all avalanche zones and unstable slopes along Keechelus Lake. A portion of the abandoned existing roadway would be removed and reclaimed.

Terrain

The general topography is one of mountainous ridges and peaks, with deep, glacially carved and eroded valleys (see the *Terrain* section on page 5-23). The slopes between the snowshed and Slide Curve exceed 100 percent (Plum Creek 1997). The snowshed is located adjacent to the eastern shoreline of Keechelus Lake, along a man-made cut in a 100 percent slope. The tunnel would be constructed through this hillside in poor to good quality rock for tunnel construction (Hatch Mott MacDonald, Inc. 2001).

Adverse Social, Economic, or Environmental Effects

Adverse Social Effects. Neither the project nor the Long Tunnel Avoidance Alternative would have a disparate or disproportionate impact on low-income or minority populations. WSDOT does not anticipate the project to increase the level of traffic volumes or development in the project corridor. Within the project area, the small amount of private land combined with existing zoning and access restrictions would prevent a proliferation of development sufficient to produce adverse effects to the social environment. Outside the project area, regional and statewide forces, which are independent of the project, are driving land use development and traffic volume increases.

Adverse Economic Effects. The Long Tunnel Avoidance Alternative would not impact businesses or access to private property, since this portion of the project is located on USFS and USBR land. However, in the remainder of the project corridor, this alternative could impact private property owners, including residential land owners and possibly a commercial business owner. Potential impacts include loss of property acquired by the State for the project. In the event that residents or businesses are relocated, WSDOT will comply with the terms of the federal Uniform Relocation Act of 1970, as amended.

Other potential impacts on local businesses and private property owners include construction noise and dust, temporarily impaired access to businesses, and loss of customers who would not be aware that businesses are open during construction. Because only a small number of businesses would be affected, constructing this alternative would have a minor impact on the economy of the area and the region.

Adverse Environmental Effects. By removing the existing highway at the location of the snowshed, the Long Tunnel Avoidance Alternative would decrease the exposed impervious surface between MP 56.6 and MP 59.9 from the existing 30.6 acres to approximately 22.0 acres. Most of the existing alignment would be restored with native vegetation; however, a section of the highway would be left in place so that WSDOT maintenance crews could access the snowshed. Short-term construction impacts such as increased turbidity could occur when the existing roadway is removed, but would be minimal if removal occurred during lake draw-down. However, these impacts would be offset by other benefits resulting from roadway removal. Wetlands are limited at the lakeshore near the snowshed; however, constructing the tunnel would cause severe and unavoidable loss to the wetlands located at the tunnel's southern portal near Resort Creek. This vicinity contains the largest complex of Category I and II wetlands, and represents some of the most valuable wetland habitat in the project area (WSDOT 2007a). Removing the existing highway along the shoreline of Keechelus Lake would result in a general improvement or recovery of lakeshore vegetation and habitat in the area of the snowshed.

Since construction would occur away from the shoreline, this alternative would not require in-water work in the vicinity of the snowshed. Constructing the tunnel would have little impact on fish species, amphibians, or aquatic habitat at this location.

The area around the snowshed is steep with nearly vertical outcroppings. Very few large species, except grizzly bear and wolverine (which are uncommon in this vicinity), will disperse over rugged terrain such as that found near the snowshed. Consequently, the tunnel would have little or no effect on larger species since the main limiting factors at this location are high road densities and lack of suitable habitat away from human disturbance (Garvey-Darda and Worthington 2003). Larger terrestrial species tend to travel across the highway at either end of Keechelus Lake.

FHWA and WSDOT concluded that even if funding could be obtained for the tunnel itself, the high cost of the Long Tunnel Avoidance Alternative would force the project to forego most of the proposed environmental benefits throughout the remainder of the project corridor if additional funding were not available.

Engineering and Economy

Although minimizing the cost of construction was not part of the project’s purpose and need, considerations for other alternatives should be made when the cost and engineering difficulties reach extraordinary magnitude. The current estimated cost of $832 million for building only the Long Tunnel Avoidance Alternative (excluding risk and escalation) exceeds the project’s Phase 1 funding allocation of $525 million to construct the first five miles of the project (including risk and escalation). The first phase of construction includes the entire area of the Long Tunnel Avoidance Alternative, the connectivity emphasis area improvements at Gold Creek and Townsend Creek, and advanced construction along portions of the Amabilis Grade.

The Long Tunnel Avoidance Alternative has substantial engineering constraints related to tunneling. The tunnel portal areas have the potential for rockfall hazard, especially the identified snow avalanche areas. The geotechnical report by Hatch Mott MacDonald, Inc. (2001) indicated that based on limited information, "the discontinuities of fresh rock are in good condition and typically fair condition for weathered rock at the tunnel portals." The long tunnel would start with good rock conditions on the east end, traverse through an area of poor to fair rock conditions, and encounter fair to good rock quality through the rest of the excavation to the west portal. Cut slopes could increase landslide hazards during construction of the long tunnel, especially where they intersect weak rock, and loose or marginally stable slopes at the tunnel portal locations. These areas include the rock slopes near Wolf Creek at MP 57.7 and near Resort Creek at MP 59.1.

Tunnel excavation could disturb nearby weak or marginally stable rock. Groundwater drainage from tunnel excavations also could affect high-erosion hazard areas. Areas most susceptible to erosion occur mainly along Keechelus Lake. Hazards associated with rock stability during tunneling would depend on 1) site-specific engineering design and construction techniques, as well as 2) the inherent site conditions, which have not been quantified at this stage and are not included in the $832 million estimate noted above.

Tunnels would eliminate the need for avalanche control; however, additional maintenance personnel would be required to maintain tunnel operations. When chains are required on Snoqualmie Pass in the winter, trucks and cars would cause excessive wear and damage to the snow-free road surface inside the tunnel. If chain removal was required prior to entering the tunnel, additional chain-up/chain-off areas would be necessary. Stalled vehicles in tunnels would be an additional hazard.

Additional considerations include higher maintenance costs compared to bridges or roads on-grade. Long-term maintenance and operation costs associated with a tunnel generate unique operational considerations. The State would need to employ between 30 and 50 full-time maintenance personnel, based on staffing requirements for tunnels of similar length in other states. Special maintenance activities would include cleaning, monitoring, fire suppression, and a tunnel maintenance facility. The Long Tunnel Avoidance Alternative would require a mechanical ventilation system, which would add to maintenance, operations, and repair costs, especially if the system were to break down, which could cause closure of the tunnel.

Fire suppression systems for tunnels would require specifically trained response personnel to be located nearby 24 hours a day, seven days a week. These systems also require large areas of dedicated water resources that would need to be available year-round. This would be difficult with winter weather conditions and the Keechelus Lake draw-down that occur October through April at this location. Other concerns are Emergency Medical Technician (EMT) response and emergency access into the tunnel.

Preservation of Existing Snowshed Bridge

The snowshed would remain in place under the Long Tunnel Avoidance Alternative. However, the existing roadway along Keechelus Lake east or west of the snowshed would be rendered obsolete, removed, and reclaimed. The State would be required to maintain the snowshed in perpetuity at great cost, according to criteria set forth under the NHPA. It would no longer perform as an integral part of a modern transportation system, and would be isolated and unused. The State would need to maintain a service road for WSDOT maintenance crews to reach the snowshed. The public could view the snowshed only from the south side of Keechelus Lake.

Finding

The base cost estimate for construction alone for the Long Tunnel Avoidance Alternative is approximately $832 million, which is without risk and escalation as described in the *Engineering and Economy* section on page 5-30. In addition, there would be operation, monitoring, and maintenance costs. The FHWA and WSDOT concluded that even if funding could be obtained for the long tunnel itself, the high costs of the Long Tunnel Avoidance

Alternative would force the project to forego most of the proposed highway and environmental improvements along the remainder of the project corridor if additional funding could not be obtained.

Constructing the Long Tunnel Avoidance Alternative would require WSDOT to provide dedicated tunnel fire-fighting equipment and personnel. Both would add additional ongoing costs. EMT response would be difficult inside the tunnel.

During the winter, chain use by trucks and cars would cause excessive wear and damage to the snow-free road surface inside the tunnel. If chain-removal was required prior to entering the tunnel, additional chain-up/chain-off areas would be necessary. Stalled vehicles in tunnels would be an additional hazard.

Cut slopes could increase landslide hazards during construction of the long tunnel. Groundwater drainage from tunnel excavations also could affect high-erosion hazard areas. Constructing the tunnel would cause severe and unavoidable loss to high-quality wetlands located at the tunnel's south portal near Resort Creek, and would require a USACE 404 permit to discharge dredged or fill material into waters of the US.

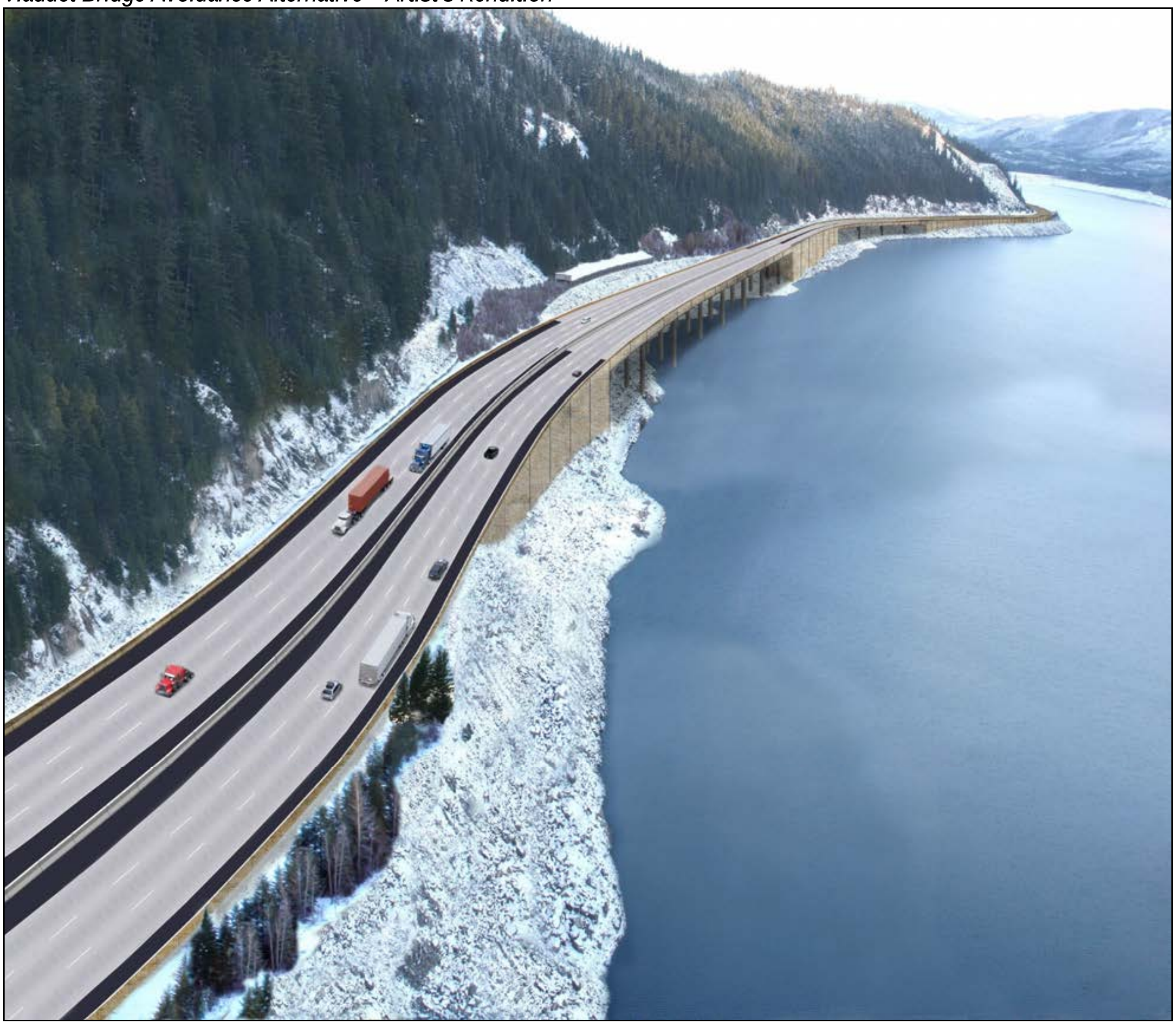
The Long Tunnel Avoidance Alternative would have engineering challenges and construction and maintenance costs reaching extraordinary magnitude, and would create safety concerns unique to tunnels, resulting in extraordinary operational or safety problems. For these reasons, the Long Tunnel Avoidance Alternative is not feasible and prudent.

Viaduct Bridge Avoidance Alternative

The Viaduct Bridge Avoidance Alternative was studied as Alternative 4 in the Draft EIS. Under the Viaduct Bridge Avoidance Alternative, WSDOT would reconstruct the highway to six lanes along Keechelus Lake, generally following the existing highway alignment (Exhibit 5-6 and Exhibit 5-10). The design would include two multiple-span bridges over Keechelus Lake to allow avalanches to pass beneath the bridges. The bridges would avoid the snowshed.

The eastbound bridge would be approximately 1,500 feet long and the westbound bridge would be approximately 1,200 feet long. Soldier pile tieback walls would retain the approach fills for both bridges. The average height above the Keechelus Lake reservoir high water level (pool) for both bridges would be 22 feet, with a maximum height of approximately 100 feet or more at low pool elevations.

Exhibit 5-10
Viaduct Bridge Avoidance Alternative – Artist's Rendition



The bridges would span an inlet and would be aligned mostly across the lake slope face, unlike a river crossing where bridges cross from one slope face to another. However, new geotechnical information revealed that the lake bed slopes are not favorable to stable bridge foundations, and that the rock slopes near the snowshed are stable enough to be safely cut back (WSDOT 2006b).

Substandard curves from just east of Rocky Run Creek to Resort Creek would be straightened. Additional measures to reduce accidents and injuries from rockfall would include slope netting, rock bolting, or slope flattening. Most of the abandoned portion of the existing roadway through the Keechelus Lake avalanche chutes would be removed and reclaimed.

Terrain

The general topography is one of mountainous ridges and peaks, with deep, glacially carved and eroded valleys (see the *Terrain* section on page 5-23). Glacial, alluvial, and lacustrine deposits are predominant from Hyak to Keechelus Dam, along with the rock fill on which the existing highway was constructed. The depth of the glacial materials varies throughout the project area. Keechelus Lake was formed when glacial moraines impounded the waters of melting ice at the end of the most recent glaciation. Consequently, the glacial materials and associated alluvium are the most extensive materials affected by the Viaduct Bridge Avoidance Alternative. WSDOT recently conducted geotechnical studies that found the area to be poor to good quality (stable) rock (WSDOT 2006b).

Adverse Social, Economic, or Environmental Effects

Adverse Social Effects. Neither the project nor the Viaduct Bridge Avoidance Alternative would have a disparate or disproportionate impact on low-income or minority populations. WSDOT does not anticipate the project to increase the level of traffic volumes or development in the project corridor. Within the project area, the small amount of private land combined with existing zoning and access restrictions would prevent a proliferation of development sufficient to produce adverse effects to the social environment. Outside the project area, regional and statewide forces, which are independent of the project, are driving land use development and traffic volume increases.

Adverse Economic Effects. The Viaduct Bridge Avoidance Alternative would not impact businesses or access to private property, since this portion of the project is located on USFS and USBR land. Potential impacts on local businesses and private property owners at the west end of the project include construction noise and dust, temporarily impaired access to businesses, and loss of customers who would not be aware that businesses are open during construction. Because only a small number of businesses would be affected, constructing this alternative would have a minor impact on the economy of the area and the region.

Adverse Environmental Effects. The Viaduct Bridge Avoidance Alternative would require drilled shaft pile piers and retaining walls in or near the lake to support the weight of the bridges that would support the six-lane bridges. This would affect approximately 26 acres of Keechelus Lake shoreline and riparian habitats associated with the lake and streams, and approximately 16 acres of wetland habitats throughout the corridor. The Viaduct Bridge Avoidance Alternative would require the most imported fill material by far (approximately 270,000 net cubic yards) of any of the alternatives discussed in this evaluation, which would cause a net reduction of up to 140 acre-feet of reservoir storage in Keechelus Lake. Because the USBR uses Keechelus Lake as a water storage reservoir, WSDOT would need to offset this reduction by removing materials from other parts of the lake.

Work along the shoreline and in Keechelus Lake has the potential to cause short- and long-term impacts to both aquatic species and habitats. The aquatic and shoreline impacts from this alternative to Keechelus Lake would be the greatest of all the alternatives discussed in this Programmatic Section 4(f) Evaluation, because of disturbance during construction and the alteration or loss of suitable habitat.

The Viaduct Bridge Avoidance Alternative would have the most extensive construction impacts on the Keechelus Lake shoreline and lakebed due to the proximity of the alignment to the lake. In addition, this alternative would have the greatest amount of roadway surface from which contaminants can enter Keechelus Lake without treatment. Blown snow, stormwater, snow melt, and snow storage would require a higher level of stormwater treatment, such as infiltration in rock slopes or snow catchment areas prior to discharge into the lake.

Constructing the piers and the retaining walls would require a USACE 404 permit to discharge dredged or fill material into waters of the US, since additional fill in the lake would be required for structure support.

Substantial technical difficulties limit opportunities for mitigating both short- and long-term environmental impacts associated with the Viaduct Bridge Avoidance Alternative.

Engineering and Economy

Constructing the Viaduct Bridge Avoidance Alternative would present engineering problems that approach the level of fatal flaws, which could make the alternative un-buildable. Some of the greatest concerns are related to the uncertainty of geological and geotechnical conditions, and bridge pier and abutment construction techniques in Keechelus Lake. WSDOT conducted geotechnical investigations in 2006 (WSDOT 2006b), which documented important conditions along the lake bottom, including:

- ***A steeply sloping lake-bottom surface.*** The lake bottom slopes down from the shoulder at an overall maximum slope of up to100 percent (1H:1V) before reaching the gently sloping lake bottom over 200 feet below the surface. The depth from the roadway to the top of bedrock would range from 30 feet to more than 170 feet, requiring building support structures more than 100 feet high on steep sub-aquatic slopes.

- ***Global stability.*** The steep sub-aquatic slopes have marginal safety factors with respect to global stability and could undergo movement as a result of an earthquake.

- ***Poor soils.*** The fill and native soil strata encountered in the lake would not provide adequate foundation support for piers and abutments, which would need to be driven into bedrock. In the area of the eastbound bridge, depth of soil over bedrock ranges from 0–81 feet thick, and from 0–47 feet thick in the area of the westbound bridge.

- ***Bedrock of poor to medium quality.*** Bedrock on the lake bottom generally consists of moderately to highly fractured or weathered andesite. Geotechnical investigation encountered vertical fractures at some test sites, with some samples being difficult to keep intact due to crumbling. This type of bedrock would not provide an adequately strong foundation. Additionally, bedrock is up to 150 feet from the water surface in certain locations and sub-surface ground profile under the bridge varies substantially.

This alternative would require constructing concrete and steel retaining walls, which would be anchored into bedrock at the base, and would be approximately 64 feet high and 2–10 feet wide. These walls would be difficult to build due to the same factors as the bridge piers. The base cost for Phase 1 of this alternative, including bridges in the lake, was approximately $241 million in 2006. This cost estimate is without risk and escalation and has the same limitations as those discussed in the *Engineering and Economy* section on page 5-25 and the *Finding* section on page 5-32.

Additionally, access to the work area during construction would be limited by the narrow eastbound road shoulders and steep embankment slopes. Finally, the construction period is limited to less than six months by the long winters in the area and by rapidly fluctuating water levels in Keechelus Lake of up to 70 feet due to annual reservoir draw-down during August and September each year for downstream irrigation.

WSDOT has identified and rated numerous unstable slopes in the project area. Rock slopes were re-assessed and re-rated in 2005 (WSDOT 2006b). Specific studies were conducted between MP 57.5 and MP 59.4 (Golder and Wyllie & Norrish 2005). Between MP 57.0 and MP 61.0, WSDOT identified 13 unstable slopes, including five sites that have already received mitigation treatment under the WSDOT Unstable Slopes Preservation Sub-Program. WSDOT has deferred mitigation for the remaining sites to coincide with this project. Three of these sites have been rated as relatively high-risk slopes.

The primary impact from the project at these sites would be the potential increase of rock slope instability at proposed rock cuts along the Keechelus Lake shoreline if the cuts and associated engineered stabilization measures are not properly analyzed, designed, and mitigated during construction. The highly jointed volcanic rocks along the alignment are vulnerable to rockfall where the proposed highway cut-slopes adversely affect the boundaries between rock types, weakening the rock, or where they are subject to construction activities such as blasting. The vulnerability of the rock slopes depends on the material strength, the character and geometric relations of discontinuities in the rock mass, and how these relate to the proposed project. Cut slopes also may increase unstable slope hazards by redirecting surface water run-off onto landslide areas or areas of high erosion hazard (WSDOT 2006c).

Avalanche chutes compose 11 percent of the slope failure features that have been mapped in the area. The steep slopes above Keechelus Lake are prone to avalanches, particularly at five avalanche chutes near the snowshed (Exhibit 5-7). The three avalanche chutes that have historically posed the greatest hazards are ES-3, ES-4, and an area at Slide Curve. ES-2, just west of the snowshed, is considered to be a hazard for the existing highway, and ES-5, just east of the snowshed, is considered to be an extreme hazard for the existing highway (Mears 2007).

The original intent of the Viaduct Bridge Avoidance Alternative was to allow avalanches to pass under the bridges into Keechelus Lake. Additional avalanche studies conducted in 2006 concluded that while snow would pass under the bridges, strong avalanches would nevertheless cause powder blast (white-out conditions) that would cause nearly zero-visibility driving conditions on the bridges, greatly reducing safety for drivers (Mears 2007).

Preservation of Existing Snowshed Bridge

The existing snowshed would remain in place under the Viaduct Bridge Avoidance Alternative; however, the existing roadway along Keechelus Lake north and south of the snowshed would be rendered obsolete, removed, and reclaimed. The State would be required to maintain the snowshed in perpetuity at great cost, according to NHPA criteria. It would no longer perform as an integral part of a modern transportation system, and would be isolated and unused. The State would need to maintain a service road for WSDOT maintenance crews to reach the snowshed. The public could view the snowshed only from the bridges constructed in Keechelus Lake in front of the existing snowshed or from the south side of Keechelus Lake.

Finding

When combined with the safety concerns associated with leaving the existing snowshed in place, the bridge design would involve engineering challenges, increase operations and maintenance costs and environmental impacts, and be substantially higher in cost.

Constructing the Viaduct Bridge Avoidance Alternative would involve geotechnical and engineering challenges that may be impossible to overcome. There are three strong engineering arguments against the Viaduct Bridge Avoidance Alternative:

- Avalanches would cause powder blast (white-out conditions) that would cause nearly zero-visibility driving conditions on the bridges, greatly reducing safety for drivers. It may not be possible to mitigate for these white-out conditions.

- The bridge would be aligned across a lake-bottom slope. The lake bottom slopes down from the roadway shoulder at an overall maximum slope of up to 100 percent (1H:1V) before reaching the gently sloping lake bottom over 200 feet below the surface. The depth from the roadway to the top of bedrock would range from 30 feet to more than 170 feet, requiring building support structures more than 100 feet high on steep sub-aquatic slopes.

- The lake-bottom slopes are steep and contain soils and rock of poor to competent quality for purposes of foundation design. The fill and native soil strata encountered in the lake would not provide adequate foundation support for piers and abutments, which would need to be driven into bedrock. In the area of the eastbound bridge, depth of soil over bedrock ranges from zero to 81 feet, and from zero to 47 feet thick in the area of the westbound bridge.

Additionally, this alternative would require substantial rock cuts south and east of the existing snowshed. A short work window, confined work space and limited access, and reservoir draw-down would be additional constraints for this alternative. Because the existing snowshed would be left in place, WSDOT would have ongoing costs for maintenance of the snowshed and an access road.

The Viaduct Bridge Avoidance Alternative engineering difficulties (including substantial construction risks) would likely increase project costs to an extraordinary magnitude. The base cost for Phase 1 of this alternative, including bridges in the lake, was approximately $241 million in 2006. This cost estimate is without risk and escalation and has the same limitations as those discussed in the *Engineering and Economy* section on page 5-25 and the *Finding* section on page 5-32.

The viaduct portion of this alternative has safety, constructability, and operational concerns of an extraordinary magnitude. For these reasons, the Viaduct Bridge Avoidance Alternative is not feasible and prudent.

Preferred Alternative from the Final EIS: Removal of the Lake Keechelus Snowshed Bridge

Since completing the Draft EIS, WSDOT has conducted additional geotechnical studies of the area near the existing snowshed to identify the geological integrity of the rock slopes and lake bottom slopes (WSDOT 2006b). These studies concluded that the rock faces in this area were sufficiently stable to allow the highway to be widened without moving the highway alignment over Keechelus Lake as proposed in the Viaduct Bridge Avoidance Alternative (Draft EIS Alternative 4), and that the stability of the lake bottom slopes may be marginal. This new information, along with the engineering and safety problems documented with building bridges in the lake, led FHWA and WSDOT to modify the Preferred Alternative in the Final EIS.

In November 2006, WSDOT convened a team of experts to conduct a value engineering study on the project. The WSDOT value engineering team developed 25 recommendations, of which nine were accepted by the WSDOT Professional Engineer. Of these nine recommendations, three are noteworthy because they reduce overall project costs. Two of the three recommendations also would reduce the area of ground disturbance, which could reduce effects to aquatic resources.

The first change recommended by the value engineering team was to the planned design speed of the new highway. The design speed for the Preferred Alternative was originally planned at 75 mph for the entire 15-mile corridor. The value engineering team recommended that design speed be reduced to 65 mph for the western six miles of the corridor along Keechelus Lake, and 70–75 mph for the remainder of the corridor, based on topographic constraints and safety concerns.

The second change recommended by the value engineering team was to eliminate the large viaduct bridges planned along Keechelus Lake. As originally envisioned, the highway would be shifted away from the existing alignment in order to avoid the avalanche slopes near MP 58.1. Two bridges would be built over Keechelus Lake: a 1,550-foot eastbound bridge and a 1,200-foot westbound bridge. A 600-foot bridge also would be constructed on the eastbound alignment at MP 58.6. The existing roadway at the avalanche chutes would be removed to create a large chute allowing avalanches to pass beneath the bridges. The existing snowshed would be left in place. The value engineering team recommended that these viaduct bridges be eliminated, based on findings from new technical studies conducted in 2006. For an extended discussion on these recommendations see the *Engineering and Economy* section on page 5-37.

FHWA and WSDOT accepted both of these recommendations. (See I-90 Snoqualmie Pass East Project Modifications to Recommendations and Project Description [WSDOT 2007b] for additional details.) Both of these recommended changes would result in reduced impacts to waters of the US and would allow the highway to remain closer to its existing alignment, eliminating the need for new fill in Keechelus Lake. Eliminating the bridges over the lake would eliminate the need for substantial amounts of in-water construction, along with bridge piers and other in-water structures.

Summary of Preferred Alternative Process

In May 2006, the Interdisciplinary Team (IDT) submitted recommendations to WSDOT for a Preferred Alternative based on Alternative 4 in the Draft EIS, which included bridges constructed on piers in Keechelus Lake in front of the snowshed. FHWA and WSDOT adopted those recommendations. After identifying the Preferred Alternative, WSDOT started detailed design work on the funded first phase of the project (WSDOT 2006d, 2006e, and 2007b).

In December 2006, WSDOT conducted a value engineering study (WSDOT 2006f). The value engineering team considered the results of new technical studies and thoroughly reviewed all of the design assumptions related to the project. The value engineering study (WSDOT 2006f) and associated recommendations (WSDOT 2007b) formed the basis for modifications to the Preferred Alternative. The value engineering study recommended two major changes to the Preferred Alternative.

The first recommended change was to the planned design speed of the proposed highway. The value engineering team recommended that the design speed be reduced to 65 mph for the western six miles of the corridor along Keechelus Lake, and 70–75 mph for the remainder of the corridor. FHWA and WSDOT accepted this change based on topographic constraints, consistency, safety, and improved transitions.

The second recommended change was to eliminate the two large bridges planned along Keechelus Lake, and to rebuild the highway along the existing alignment based on the following findings from new technical studies conducted in 2006 (WSDOT 2006b and 2007b):

- New geologic information indicated that the rock in the snowshed vicinity is stronger than was previously assumed, which would allow taller rock cuts

- Construction problems, access, and scheduling risks associated with building bridges in Keechelus Lake approach the magnitude of “fatal flaws”

- Updated avalanche modeling indicated that avalanche powder blast may cause white-out conditions on the proposed bridges, which would create safety problems for vehicles using the bridges

Both of these recommended changes would result in reduced environmental impacts. Both changes would allow the highway to remain more closely in its existing alignment, eliminating the need for new fill in Keechelus Lake. Eliminating the bridges over the lake would eliminate the need for substantial amounts of in-water construction, along with bridge piers and other in-water structures. These changes also would result in substantial cost savings and reduced construction risk.

Snowshed Removal

The Preferred Alternative, as modified, would require removing the snowshed in order to reconstruct a wider highway along the existing alignment. WSDOT would construct a longer, taller and wider snowshed that would cover all six proposed lanes, and protect the highway from four of the five avalanche chutes, including two avalanche chutes at the location of the existing snowshed. ES-1, which produces very little avalanche snow, will be contained by a ditch and a barrier.

Finding

At the time that the IDT provided their final recommendations for the Preferred Alternative, much of the information discussed in this section, including recommendations from the value engineering team, was not yet known.

The snowshed design and lower design speed recommended by the value engineering study (WSDOT 2006f) presented an opportunity to provide a safer highway at a lower cost along this stretch of the project corridor. The modified design would result in an alignment that more closely follows the existing alignment, reducing impacts on wetlands and the shoreline of Keechelus Lake. Furthermore, the modification would reduce the amount of new highway embankment or fill required within Keechelus Lake, which would reduce the impacts on lakeshore habitat and reservoir storage volumes.

The value engineering team recommended that a larger snowshed be constructed to address four of the five major avalanche chutes at this location. ES-1, which produces very little avalanche snow, will be contained by a ditch and a barrier. As a result of issues outlined in the *Build on New Location without Using the Existing Snowshed Bridge* section on page 5-22 and the *Preferred Alternative from the Final EIS: Removal of the Lake Keechelus Snowshed Bridge* section on page 5-41,the Final EIS Preferred Alternative design would require demolishing the existing Lake Keechelus Snowshed Bridge.

Rehabilitation without Affecting the Historic Integrity of the Snowshed Bridge

WSDOT has conducted studies on rehabilitation measures for the existing snowshed that would allow it to remain in place while expanding the highway to six lanes. This alternative is not feasible and prudent for the following reasons:

- The snowshed does not meet current AASHTO or WSDOT geometric design guidelines for height and shoulder width. AASHTO and WSDOT guidelines recommend three 12-foot lanes, 8-foot outside shoulders, and 4-foot inside shoulders in mountainous terrain; both for the highway and for the snowshed.

- The snowshed is not long enough, high enough, or wide enough to function as an integral part of the highway. Consequently, the snowshed would still require design improvements in order to safely perform as an integral part of the transportation system.

- The snowshed cannot be re-designed and modified to meet lane and shoulder width guidelines without completely rebuilding it, since there simply is not enough room. Because of the construction methods used to build the snowshed, it cannot be removed and reconstructed without damaging or destroying its character-defining features and historic integrity. Following such reconstruction, the snowshed would no longer meet Department of the Interior Standards and would not be eligible for the NRHP.

Additionally, there is an overwhelming argument against including the existing snowshed as part of a new snowshed design, besides the reasons that have already been discussed in the *Build on New Location without Using the Existing Snowshed Bridge* section on page 5-22 and the *Preferred Alternative from the Final EIS: Removal of the Lake Keechelus Snowshed Bridge* section on page 5-41. The existing snowshed roof and supports would collapse under the added snow load on the roof, so the existing snowshed would essentially need to be reconstructed in order to carry the extra weight.

5.6 Measures to Minimize Harm

In accordance with this Programmatic Section 4(f) Evaluation and Approval, the FHWA Division Administrator has ensured that the proposed action includes all possible planning to minimize harm to the Lake Keechelus Snowshed Bridge:

- The snowshed would be adversely affected due to removal. A Memorandum of Agreement between the SHPO and FHWA (Appendix C) has been reached through the Section 106 process of the NHPA on measures to minimize harm, including mitigation measures. Those measures will be incorporated into the project.

- Because the existing snowshed is to be demolished, FHWA has ensured that fully adequate records have been made of the snowshed (bridge) in accordance with the Historic American Engineering Record (HAER) standards. These records are on file at WSDOT Headquarters (US Department of the Interior 1993).

5.7 Procedures

This Programmatic Section 4(f) Evaluation applies to this project because the FHWA Division Administrator has:

- Determined that the project meets the applicability criteria set forth under Section 5.3, *Applicability*, of this evaluation

- Determined that all of the alternatives set forth in Section 5.5, *Findings*, have been fully evaluated

- Determined in Section 5.5, *Findings*, that there are no feasible and prudent alternatives to the use of the historic snowshed bridge

- Determined that the project complies with Section 5.6, *Measures to Minimize Harm*

- Assured that implementation of the Measures to Minimize Harm will be completed

- Documented in the project file that the Programmatic Section 4(f) Evaluation applies to the project on which it is to be used

5.8 Coordination

WSDOT conducted a cultural resource survey and Section 106 review for this project, and the SHPO was invited to comment. The SHPO has determined that the Lake Keechelus Snowshed Bridge, which is listed on the NRHP, would be adversely affected by its removal. In consultation with FHWA, WSDOT determined that removing the snowshed under this project would constitute a Programmatic Section 4(f) use.

Based on Section 4(f) guidelines, this statement may be coordinated with the US Department of the Interior.

As mitigation for removing the Lake Keechelus Snowshed Bridge, FHWA and WSDOT have been in consultation with the SHPO, and have developed a Memorandum of Agreement (Appendix C). The Memorandum of Agreement includes measures to minimize harm, requirements for historic documentation of the snowshed prior to removing it, and mitigation measures to be applied to the project. The measures include:

- Historic structures report for Travelers’ Rest
- Site assessment of current and potential uses of Travelers’ Rest, including mitigation options and needs
- Phase 1 environmental site assessment for hazardous materials
- Interpretive signs at Travelers’ Rest depicting historic travel including American Indians over Snoqualmie Pass, history of the Travelers’ Rest building and site, and history and engineering facts of the snowshed

5.9 Conclusion

Based on the new information and previous considerations, FHWA and WSDOT anticipate that the Preferred Alternative presented in the Final EIS would require removing the historic Lake Keechelus Snowshed Bridge. Removing the NRHP-listed snowshed resulted in a finding of adverse effect to the snowshed, which re-initiated Section 106 consultation with the SHPO.

While cultural and historical resources are recognized as important factors in preservation, FHWA and WSDOT believe that removing the Lake Keechelus Snowshed Bridge and constructing a larger, safer structure is both feasible and prudent, and best meets the project's purpose and need. There are no other alternatives that meet the project's purpose and need that can be constructed at reasonable expense and/or that do not present substantial environmental impacts and operational, constructability, and safety concerns.

5.10 References

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