CHAPTER 3.0 AFFECTED ENVIRONMENT

3.1 Introduction

This chapter describes environmental resources within the project area, as defined in Section 1.4.2 of this document. Descriptions of environmental resources are organized by sub-regions:

- The Alpine Lakes sub-region encompasses the mountainous region southwest of Leavenworth. The sub-region includes Square, Klonaqua, Eightmile, Colchuck, and Snow/Nada Lakes and the tributaries that connect these lakes with Icicle Creek;
- The Icicle Creek sub-region consists of the mainstem Icicle Creek floodplain and valley walls from the mouth of Leland Creek near the Icicle Creek headwaters at RM 26 to the confluence with the Wenatchee River; and
- The Wenatchee River Corridor sub-region lies within the Wenatchee River Valley and covers the Wenatchee River and adjacent areas from just upstream of the confluence of Icicle Creek to the confluence with the Columbia River.

Additionally, where applicable, an overview of resources for the entire area is provided in addition to the focused, sub-region descriptions.

3.2 Earth

This section describes Earth elements present in the project area, and conditions affecting proposed alternatives including topography, geology and soils, and geological hazards. Earth elements of the project area are first described in a regional context and followed by a detailed description by sub-region.

3.2.1 Regional Geology

The Icicle project area is located in the central and eastern portions of the Cascade Mountain Range. The Cascades were tectonically uplifted beginning in the late Eocene epoch (approximately 37 million years ago) as a result of the offshore collision of tectonic plates at the Cascadia subduction zone (CSZ). Coincident volcanism emplaced igneous rocks, including intrusives, lava flows, and ash, throughout the Cascades, which continues to modern times. Continued uplift of the region resulted in erosion and deposition of sedimentary rocks. More recent erosion from alpine glaciers and streams shaped the landscape to its current form while depositing unconsolidated sediments in low-lying areas. Figure 3-1 presents a geologic map of the Icicle project area based on mapping published online by Washington Department of Natural Resources (2017).

Figure 3-1. Surficial Geology

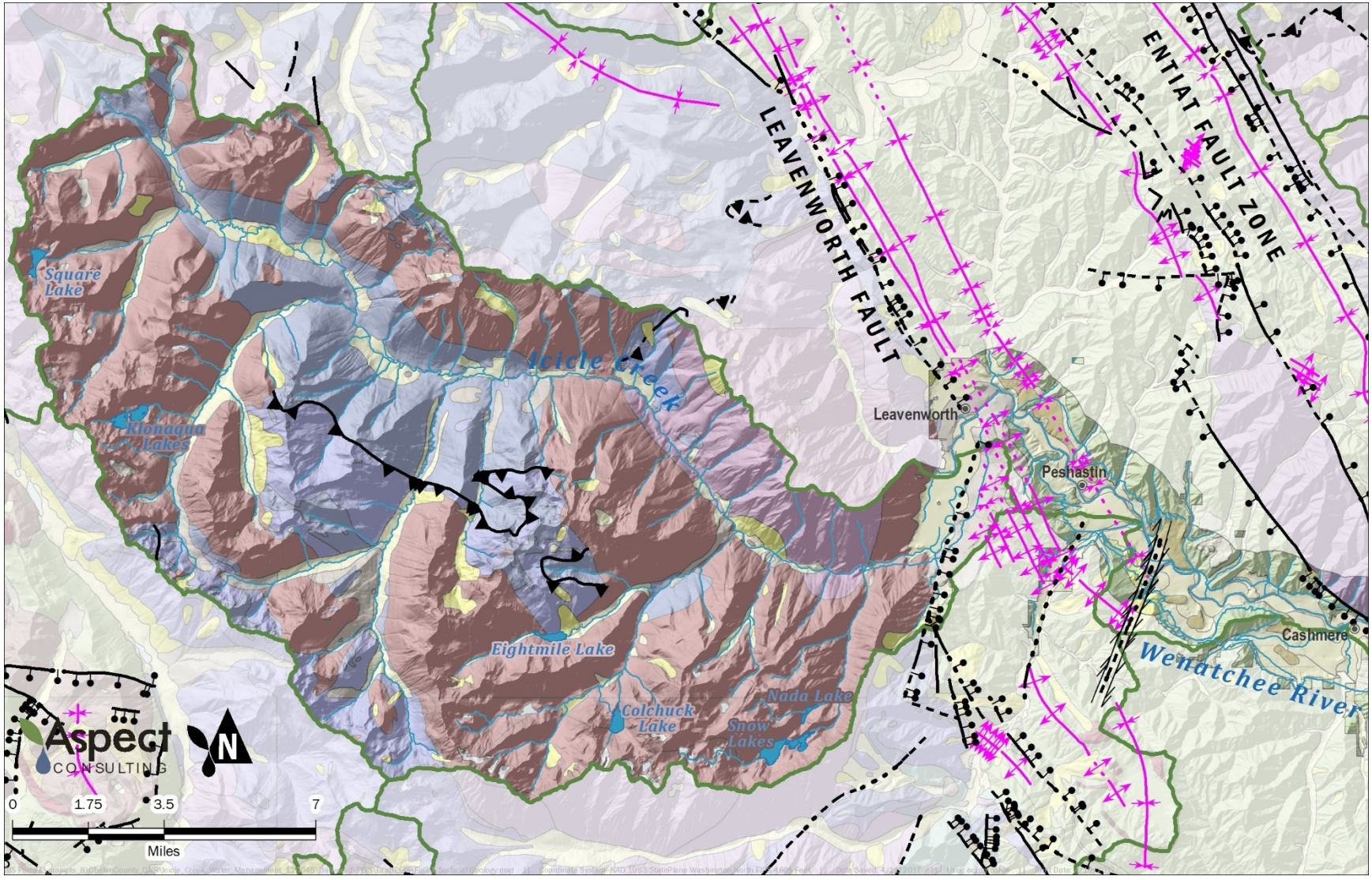
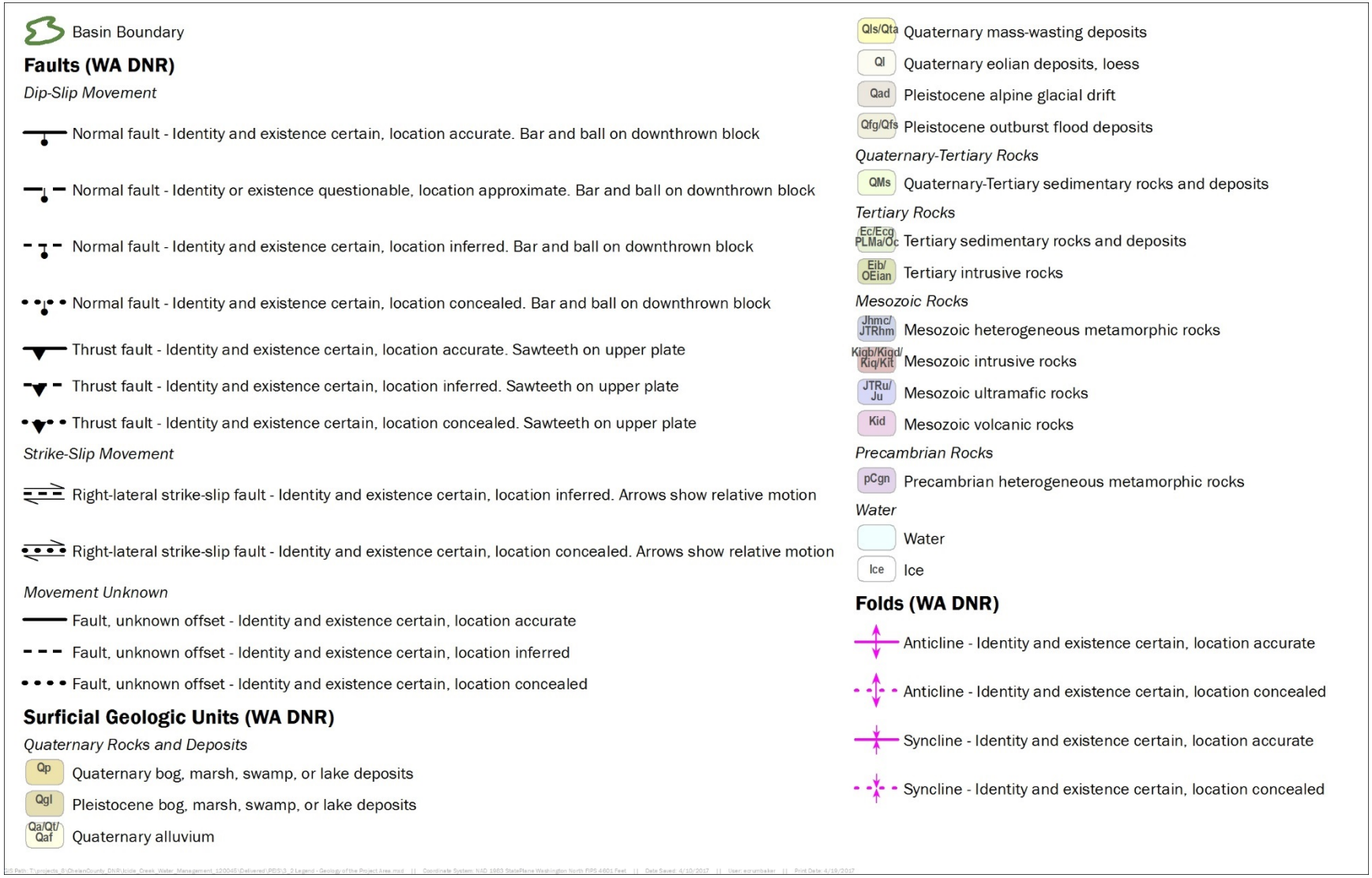


Figure 3-1. Surficial Geology (Legend)



3.2.1.1 Major Geologic Units

The oldest rocks in the Icicle project area are Mesozoic gneisses of the Mad River terrane that are confined to a small area in the southeast portion (map unit MZgn). The Mesozoic Ingalls Tectonic Complex occupies the southern and western portions of the project area. Geologic units associated with this ophiolite mélange are mapped locally as ultramafic serpentinite and peridotite (MZPZu) and metamorphosed rocks of the Chiwaukum Schist, including biotite schist and amphibolite (MZhm). These rocks were intruded by igneous rocks of the Mesozoic Mount Stuart batholith, which forms the Mount Stuart Range in the central and western portions of the project area. Geologic units associated with the Mount Stuart batholith are mapped as granodiorite, tonalite, and granite (MZi), and diorite (Kid). Subsequent regional uplift resulting in erosion of older rocks produced Tertiary continental sedimentary rocks in fault-bounded low-lying grabens. These rocks occupy the eastern portion of the project area. The predominant geologic unit associated with the Tertiary sedimentary rocks is mapped as sandstone, siltstone, and shale of the Chumstick Formation (Tc). Quaternary unconsolidated sediments mapped throughout the project area consist of alluvium (Qa); glacial drift and glacial deposits (Qad) from alpine glaciers consisting of till, gravelly outwash, lacustrine and bedded silts, and terrace gravels; and mass-wastage deposits (Qls).

3.2.2 Geologic Structures

Major geologic structures in the Icicle project area and vicinity include the north-south striking, strike-slip Evergreen fault (Dragovich et al., 2002) located 6 miles to the west, and the northwest-southeast-striking, high-angle Leavenworth fault zone (Tabor et al., 1982 and 1987) located in the western portion of the subbasin, and the Entiat fault (Tabor et al., 1987) located east of the project area about 3 miles east of Cashmere, Washington.

Internal thrust faults are present within the Ingalls Tectonic Complex, and several subsidiary faults and folds are present associated with the Leavenworth and Entiat fault zones.

The Leavenworth and Entiat faults bound the Wenatchee River Valley, a structural valley located at the western margin of the northwest-trending Chiwaukum structural low (Cheney, 2007), a fault-bounded tectonically subsided region (formerly known as the Chiwaukum graben [Gresens, 1983]).

3.2.3 Soils

Soils are formed slowly over time by the interaction between geology of the parent material, slope, climate, and natural vegetation of the area. Parent material consists of bedrock, alluvium, colluvium, loess, and volcanic ash, and soil is often a mixture of these. Soils in the project area are mapped and classified by the Natural Resources Conservation Service (NRCS) in its Soil Survey publications for mountainous regions, including Alpine Lakes and Icicle Creek sub-regions (NRCS, 2007) and the Wenatchee River Corridor sub-region (NRCS, 1975). Sub-region soil classifications are discussed below.

3.2.4 Regional Geological Hazards

Geological hazards, including seismic, mass wasting (landslides), and erosion, are present in the Icicle project area. The Chelan County Code, Chapter 11.86, Geologically Hazardous Overlay District (GHOD), uses published sources to identify areas having landslide and erosion hazards and also identifies hazards presented by snow avalanche. Where applicable, geological hazards present in the sub-regions are discussed in greater detail.

3.2.4.1 Seismic Hazards

The site is located within a region subject to earthquakes on shallow crustal faults and in the Cascadia subduction zone. Hazards associated with earthquakes include seismic shaking, surficial ground rupture, and liquefaction. Earthquakes can also trigger mass wasting events.

Large earthquakes in Washington and Oregon are associated with the CSZ, which lies approximately 150 miles to the west of the Icicle project area (Department of Natural Resources, 2008). Hazards associated with the CSZ include deep (Benioff zone) earthquakes and subduction zone earthquakes. Deep earthquakes generally originate during rupture of the sinking oceanic plate, have magnitude 7.5 or less, and occur approximately every 10 to 30 years. The subduction zone earthquakes occur because of rupture between the subducting oceanic plate and the overlying continental plate. These earthquakes have magnitude up to 9 and a recurrence interval on the order of 500 years.

A shallow earthquake within the Cascade Mountains occurred in 1872, east of the project area, near Entiat and had an estimated magnitude of 6.8 (Bakun, et al., 2002). Future earthquakes within the Cascades would likely be shallow and could exceed magnitude 7 (Noson and Qamar, 1988).

3.2.4.2 Mass Wasting

Mass wasting events include landslides, earthflows, mudflows, debris flows, slumps, creeps, and rock falls. Areas of existing or potential mass wasting are mapped in Chelan County's GHOD in all three sub-regions based on mapped slope failures and a combination of geologic, slope, and hydrologic conditions.

3.2.4.3 Erosion

Erosion hazards are identified in Chelan County's GHOD based on areas identified as "severe" erosion hazard according to the U.S. Department of Agriculture Soil Conservation Service Chelan County Soil Survey Manual (Natural Resources Conservation Service, 2017). The GHOD identifies the presence of erosion hazards in all three sub-regions of the project area. Erosion hazards increase in areas having steeper slopes.

3.2.5 Alpine Lakes

3.2.5.1 Geology and Physiography

The Alpine Lakes sub-region encompasses the mountainous region southwest of Leavenworth. The sub-region includes Square, Klonaqua, Eightmile, Colchuck, and Snow/Nada Lakes and the tributaries that connect these lakes with Icicle Creek.

Geology is characterized by steep bedrock mountains mapped as granites of the Mount Stuart batholith (MZi) and ultramafic/metamorphic of the Ingalls Tectonic Complex (MZPZu and MZhm). Alpine glaciation incised steep valleys, hanging valleys, and cirques that frequently encompass lake beds and stream channels. Several glaciers are still present. Glaciers and streams deposited thin layers of glacial drift and alluvium over bedrock in low-lying areas. Several large mass wastage deposits (Qls) are mapped.

The resistant granites of the intrusive Mt. Stuart batholith control topography. Elevations range from about 1,400 feet above sea level (asl) at the mouth of Snow Creek to 9,400 feet asl at Mount Stuart (WGS 84 datum). Slopes on glacially incised peaks and valley walls exceed 60 degrees, while the bottoms of valleys and cirques are generally less than 20 degrees.

3.2.5.2 Soils

Soils in the Alpine Lakes sub-region of the Icicle project area are broadly classified by NRCS as soils on mountains at middle elevations and soils in valleys and on mountains at high elevations.

On middle-elevation mountains up to about 3,600 feet asl, soils are shallow (up to 20 inches deep), well-drained, and formed from colluvium and residuum derived from metamorphic and igneous bedrock mixed with volcanic ash and loess. These are gravelly, stony, and boulder sandy loams occurring on slopes from about 5 to 45 degrees.

On mountains ranging from about 3,500 to 8,300 feet asl, soils are very deep (up to 60 inches), well-drained, and formed in volcanic ash and loess mixed with colluvium and residuum derived from metamorphic and igneous rock. On some mountainsides and in high elevation valley bottoms ranging from about 2,600 to 5,500 feet asl, soils are very deep, well-drained, and formed in volcanic ash and pumice over glacial till. High elevation soils are gravelly, stony, and boulder sandy loams occurring on slopes from about 5 to 45 degrees on mountainsides and 2 to 30 degrees in valley bottoms.

3.2.5.3 Geologic Hazards

Potential geological hazards consist of mass wastage including landslides and rock falls, debris flows, erodible soils on steep slopes, and seismic hazards associated with regional and local faults. A landslide is mapped at Eightmile Lake that formed the lake by blocking Eightmile Creek. Avalanches are common because of deep snow pack and steep slopes.

3.2.6 Icicle Creek Corridor

3.2.6.1 Geology and Physiography

The Icicle Creek sub-region consists of the mainstem Icicle Creek floodplain and valley walls from the mouth of Leland Creek near the Icicle Creek headwaters at RM 26 to the confluence with the Wenatchee River.

The geology of this sub-region is characterized by the same bedrock present in the Alpine Lakes sub-region. Alpine glaciation carved the existing Icicle Valley that extended from the headwaters of Icicle Creek to a terminal moraine in Leavenworth. Alluvium (Qa) is mapped in several places where the valley widens; the most significant alluvial deposits occur in the lower portion south of Leavenworth where the valley widens to over 1 mile. Glacial drift (Qad) is mapped on the east valley wall in the lower portion of the drainage. Mass wastage deposits (Qls) are mapped on the north valley wall near the mouth of Mountaineer Creek.

Topography is controlled by resistant bedrock that forms the walls of the Icicle Valley. Elevations range from 1,000 feet asl near the confluence of Icicle Creek with the Wenatchee River in Leavenworth to greater than 5,000 feet on the valley walls. Slopes on the valley wall exceed 60 degrees in places, and slopes on the valley floor are less than 20 degrees.

3.2.6.2 Soils

Soils in the Icicle Creek sub-region of the Icicle project area are the same as for the Alpine Lakes sub-region for the upper reaches of Icicle Creek (Subsection 3.2.5.2, Soils) and same as the Wenatchee River Corridor sub-region (Subsection 3.2.7.2, Soils) for the lower reach of Icicle Creek.

3.2.6.3 Geologic Hazards

Potential geological hazards consist of mass wastage including landslides and rock falls, debris flows at the mouths of tributaries and on steep slopes, flooding, erodible soils on steep slopes, and seismic hazards associated with regional fault zones and the Leavenworth and Entiat fault zones. Avalanches are common because of deep snow pack and steep slopes.

3.2.7 Wenatchee River Corridor

3.2.7.1 Geology and Physiography

The Wenatchee River Corridor sub-region lies within the Wenatchee River Valley between the cities of Leavenworth and Cashmere.

Geology is primarily characterized by bedrock uplands mapped as continental sedimentary rocks of the Chumstick Formation (Tc) that form the valley walls. Bedrock west of Leavenworth is associated with rocks of the Mount Stuart batholith. Bedrock is overlain by quaternary terrace and alluvial deposits in the Wenatchee River valley bottom that originated primarily from up-valley alpine glacial sources (Qad) but with some

lacustrine deposits of glacial outburst flood origin (Qf). At Leavenworth, the terminus of alpine glaciation, Qad consists of lacustrine sediments overlain by alluvium and coarse moraine deposits. The mapped width of the quaternary deposits on the valley floor from Leavenworth to Cashmere is about 0.5 to 1 mile. Throughout most of the valley, Quaternary deposits form small ridges and terraces above the Wenatchee River where the river has incised the sediments. Alluvium (Qa) is present in the Wenatchee River floodplain and near the mouths of tributaries. Mass wastage deposits (Qls) are mapped on the west side of the valley, south of the junction of Highways 2 and 97.

The Wenatchee River Corridor lies within the Chiwaukum structural low and is bounded to the northeast by the Entiat fault and to the west by the Leavenworth fault. Elevations range from 750 feet asl at the Wenatchee River at Cashmere to over 3,000 feet asl in the mountains surrounding the valley. Topography on the valley margins is controlled by bedrock with slopes less than 30 degrees except areas where streams have incised and have slopes greater than 40 degrees. Terraces on the valley floor generally have slopes less than 20 degrees.

3.2.7.2 Soils

Soils in the Wenatchee River Corridor and lower Icicle Creek are broadly classified by NRCS in valley bottoms as very deep (up to 60 inches), well-drained, and formed in alluvium. These are sandy loams occurring on slopes from about 5 to 15 degrees. Soils on mountainsides are deep (up to 40 inches), well-drained, and formed in volcanic ash and residuum derived from sandstone and metamorphic bedrock. These are silty loams occurring on slopes from about 15 to 25 degrees.

3.2.7.3 Geologic Hazards

Potential geological hazards include landslides, debris flows from intermittent and perennial drainages that empty to the valley, erodible soils, and seismic hazards associated with regional faults and the Leavenworth and Entiat faults.

3.3 Surface Water Resources

This section summarizes the surface water quantity in the project area. It also discusses the overall water budget for the project area. This review does not represent an extent and validity review and is not intended to determine the validity of quantities of water available surface water rights. Surface water resources are addressed for the following sub-regions, including:

- The Alpine Lakes (Square, Klonaqua, Colchuck, Eightmile, Upper and Lower Snow, and Nada Lakes);
- The Icicle Creek drainage from the Alpine Lakes to the confluence with the Wenatchee River; and
- The Wenatchee River Corridor from just upstream of Icicle Creek to the confluence with the Columbia River.

Information about water rights and water resources infrastructure is provided in Section 3.6, Water Use. Information about surface water quality is presented in Section 3.5.2, Surface Water Quality.

3.3.1 Alpine Lakes

The Alpine Lakes sub-region is at the top of the Icicle Creek Subbasin, and includes Square, Upper and Lower Klonaqua, Eightmile, Colchuck, Upper and Lower Snow, and Nada Lakes. There are also numerous other lakes within this sub-region; however; they do not have dams, are not managed for water supply, and are not anticipated to be impacted by the Icicle Strategy.

Square, Upper and Lower Klonaqua, Eightmile, Colchuck, Upper and Lower Snow, and Nada Lakes drain small catchments high up in the watershed. Outflows from these lakes are managed by either IPID or the USFWS. Cumulatively, these catchments drain 10,596 acres and contribute an estimated minimum of 23,871 acre-feet of water to the Icicle Creek system. Table 3-1 provides a summary of the Annual Water Supply from these lakes.

Table 3-1
Alpine Lakes Annual Water Supply Statistics

Lake	Lake Water Surface Elev. (feet)	Drainage Area (acres)	10% Exceedance Annual Inflow (acre-feet)	50% Exceedance Annual Inflow (acre-feet)	90% Exceedance Annual Inflow (acre-feet)	Estimated Annual Inflow – Minimum (acre-feet)
Square	4,989	1,010	8,158	6,148	4,722	3,701
Lower Klonaqua	5,090	800	5,093	3,808	2,895	2,249
Eightmile	4,671	3,804	18,713	14,141	10,896	8,575
Colchuck	5,570	941	4,883	3,665	2,800	2,182
Upper and Lower Snow	5,420 & 5,415	3,060	12,610	9,478	7,254	5,663
Nada	4,989	981	3,310	2,497	1,920	1,507

Note: Elev. = elevation

Square, Upper and Lower Klonaqua, Eightmile, Colchuck, Upper and Lower Snow, and Nada Lakes all have man-made dams at their outlets and have been managed as reservoirs and used to augment the flow in Icicle Creek since the 1920s. The storage in these lakes is actively managed for irrigation and fish propagation use by IPID and USFWS under storage water rights, as described in Section 3.61.1, Alpine Lakes Storage Rights. Measurement of active storage volumes has been performed through collection of LiDAR and bathymetric survey data. Bathymetry was performed on both Eightmile Lake and Upper Klonaqua Lake (only). LiDAR was collected in October 2016, which included Square Lake, Lower Klonaqua Lake, Colchuck Lake, Eightmile Lake, and Upper and

Lower Snow Lakes. Estimated useable storage volumes associated with the Alpine Lakes is provided in Table 3-2 below.

Table 3-2
Alpine Lakes Storage Volume Estimates

Lake	Maximum Normal Stage (feet)	Minimum Normal Stage (feet)	Operational Range (feet)	Active Storage Volume (acre-feet)
Square	4,985	4,954	31	2,130
Lower Klonaqua	5,094	5,066	28	1,690
Eightmile	4,667	4,644	23	1,370
Colchuck	5,563	5,546	17	1,480
Upper Snow	5,433	5,273	160	12,590
Lower Snow	5,429	5,427	2	140

Source: *Appraisal Study, Alpine Lakes Optimization and Automation* (Aspect, 2014)

Each of these lakes has a small dam structure at the outlet that allows for capture and controlled release of water to increase water supply available for diversion from Icicle Creek by IPID or the USFWS. Generally, the lakes begin filling around the beginning of the water year (October) and fill through the late fall, early winter, and spring, even in dry years. Once each lake is full to the constructed spillway or overflow elevation on the dam at the lake outlet, water flows over the dam or constructed spillway to a natural stream channel or tributary to Icicle Creek. Controlled releases from the lakes commence typically in late July or early August in response to seasonal flow triggers in lower Icicle Creek to offset diversions by IPID and the USFWS. Water is released through a low-level outlet system, typically consisting of a gated or valved tunnel or pipeline that extends under or around the dam at the outlet. IPID or the USFWS opens a gate on the low-level outlet to release water and draw down the lake. The USFWS operates a valve each July or August at the outlet of a tunnel and pipeline to control releases from Upper and Lower Snow Lakes to Nada Lake. IPID typically opens gates at one or two of the lakes they operate (Square, Klonaqua, Eightmile, and Colchuck) in late July or early August. During dry years, they may open gates at all of the lakes.

3.3.2 Icicle Creek Corridor

3.3.2.1 Icicle Creek Tributaries

Major Icicle Creek tributaries downstream of the Alpine Lakes include Leland, French, Eightmile, and Snow Creeks.

Leland Creek conveys surface water runoff from the Square Lake drainage. Prospect Creek drains Square Lake and enters Leland Creek several miles downstream. There are several other tributaries to Leland Creek, which drains a tributary basin of approximately 15 square-miles and confluences with Icicle Creek at RM 28.0. Historical streamflows are not available for Leland Creek, but 2016 flow monitoring work found that Leland Creek had a discharge of approximately 19 cfs in late September. Table 3-3 provides all flow data obtained as part of the 2016 flow monitoring study conducted by WDFW for Leland Creek and its tributaries (Personal Communication with Robert Granger, WDFW, 2016).

Table 3-3
Leland Creek Drainage Flows

Date	Location	Discharge (cfs)	Water Temp (°C)
9/20/16	Leland Creek (upstream of confluence with Prospect Creek)	10.30	7.60
9/20/16	Prospect Creek (upstream of confluence with Leland Creek)	8.92	8.60
9/21/16	Leland Creek (upstream of confluence with Icicle Creek)	19.24	5.90

(Source: Personal Communication, Robert Granger, WDFW, 2016)

French Creek confluences with Icicle Creek approximately 6.0 miles downstream of Leland Creek at RM 22.0. Klonaqua Creek drains Klonaqua Lake and joins French Creek high in the system. French Creek drains a tributary basin area of approximately 25 square miles. Flows in French and Klonaqua Creeks are provided in Table 3-4.

Table 3-4
French Creek Drainage Flows

Date	Location	Discharge (cfs)	Water Temp (°C)
9/19/16	French Creek (upstream of Icicle Creek Trail Foot Bridge)	12.56	8.70
9/19/16	French Creek (midway between Icicle Creek and Klonaqua Creek)	13.53	8.50
9/19/16	French Creek (upstream of confluence with Klonaqua Creek)	6.50	8.10
9/19/16	Klonaqua Creek (upstream of confluence with French Creek)	2.98	8.60

(Source: Personal Communication, Robert Granger, WDFW, 2016)

Eightmile Creek drains a tributary area of 30 square miles and conveys surface water runoff from both Eightmile Lake and Colchuck Lake via Colchuck and Mountaineer Creek. Eightmile confluences with Icicle Creek at approximately RM 9.0. Flow data are not available for Eightmile Creek, but Eightmile Creek is believed to provide a significant discharge to the Icicle Creek system.

Snow Creek conveys surface water flow from Upper Snow, Lower Snow, and Nada Lakes to Icicle Creek. Snow Creek confluences with Icicle Creek at RM 5.2, draining a tributary basin of approximately 10 square miles. Flow data is not available for Snow Creek.

3.3.2.2 Icicle Creek Mainstem

The Icicle Creek Subbasin is the largest subbasin in the Wenatchee River Watershed. Mainstream Icicle Creek is approximately 32 miles long, beginning high in the Alpine Lakes Wilderness at Josephine Lake and discharging into the Wenatchee River at the City of Leavenworth near RM 25.6. Figure 1-1 provides an overview of Icicle Creek's location, gaging stations, and major diversions, which includes IPID's, City of Leavenworth's, and LNFH/COIC's point of diversion.

The shape of the Icicle Creek hydrograph is typical for the area. Flows peak in June, with a steady decline throughout the rest of the summer. Low flows typically occur in September and remain low through early October. Stream flow then begins to increase in response to autumn precipitation and remains steady through winter. When snow begins melting in spring, streamflow increases until its summer peak.

Figure 3-2 shows 10 percent, 50 percent, and 90 percent exceedance flows in Icicle Creek at RM 5.8, just upstream of major diversions. Percent exceedance is a way to describe the percentage of time for which an observed stream flow is greater than or equal to a defined stream flow. Low flows have a high exceedance percentage because higher flows are expected most of the time. Conversely, high flows tend to have a lower exceedance percentage. The peak 50 percent exceedance flow at RM 5.8, which represents the peak annual flow during an average year, is approximately 2,000 cfs. The peak flow typically occurs in June. The 50 percent exceedance low flow, which represent the low flow during an average year, occurs in late September and is approximately 120 cfs.

The Icicle Creek mainstem has been divided into five distinct reaches based on characteristics and major infrastructure. These reaches were introduced in Section 1.2.1.1, Adequate Streamflow, and shown on Figure 1-3. A brief description of each reach is provided below.

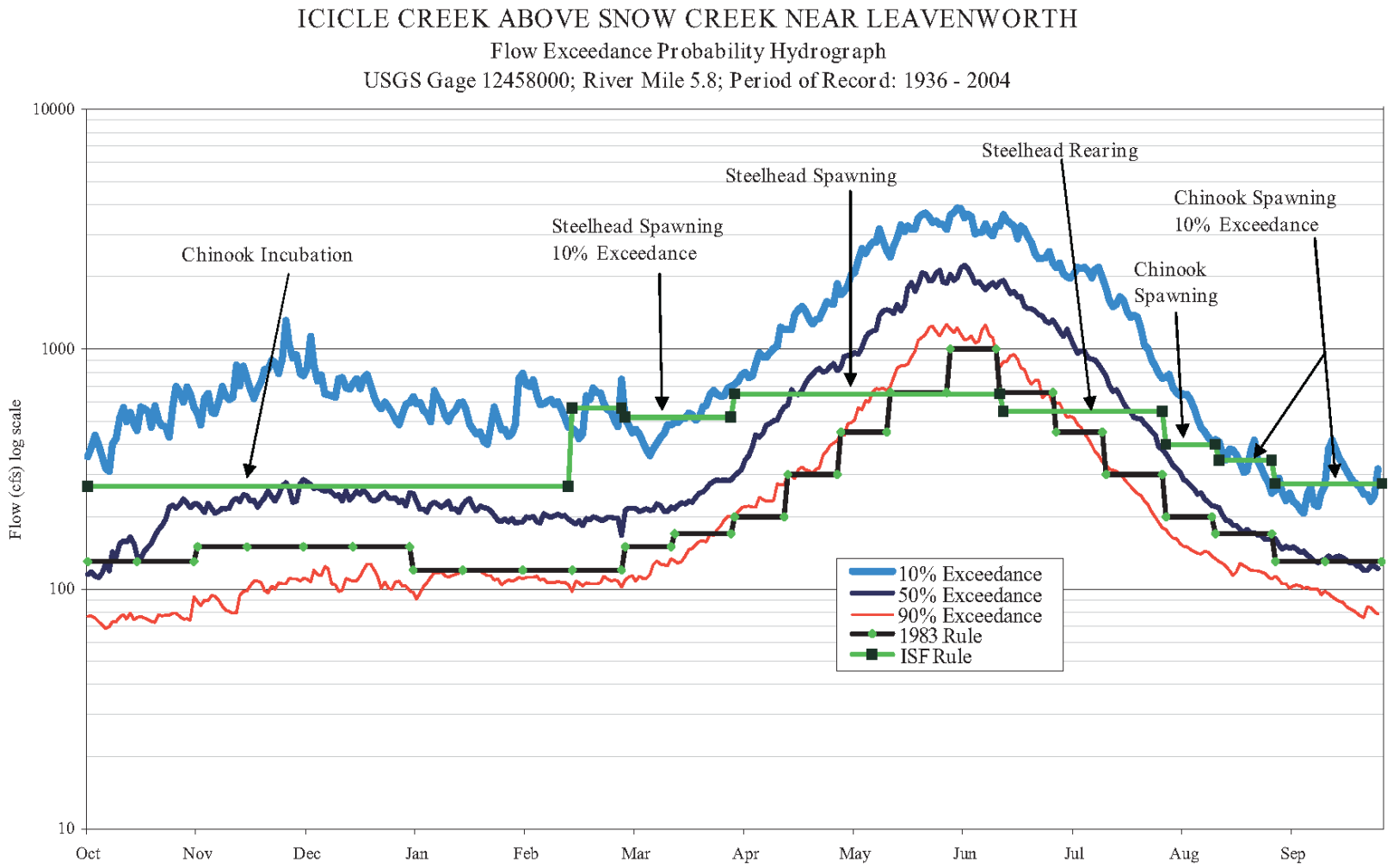
3.3.2.3 Reach 1

Reach 1 of Icicle Creek is located above RM 5.7 and includes Icicle Creek's headwaters. Figures 1-1 and 1-3 provides River Miles and reaches. Reach 1 intercepts major tributaries, including Eightmile Creek, French Creek, and Leland Creek. The Icicle Creek U.S. Geological Survey (USGS) gaging station is also located within this reach at RM 5.8, which is upstream of all the major diversions. Reach 1 ends at the IPID Diversion at RM 5.7. Because Reach 1 benefits from many inputs (tributaries), but few outputs (diversion), this reach tends to have higher flows than those farther downstream.

3.3.2.4 Reach 2

Reach 2 of Icicle Creek begins at RM 5.7 and ends at RM 4.5. Snow Creek flows into Icicle Creek at RM 5.2. Diversions within this reach include IPID's and City of Leavenworth's diversion at RM 5.7. Additionally, diversions occur at the bottom of this reach to LNFH and COIC, who share diversion infrastructure at RM 4.5. The boulder field, which is a major fish passage barrier is also within Reach 2. Flows in Reach 2 are diminished by the IPID diversion during the irrigation season (April through September) and the City of Leavenworth Diversion year-round. IPID has a peak diversion rate of 117 cfs, and City of Leavenworth has the right to divert up to 6.2 cfs. Both of these diversions export water out of the Icicle Creek Subbasin, although IPID has some operational spills in the Icicle Creek Subbasin which return a portion of the diverted water to the system. Table 3-5 provides an estimate of flow in Reach 2 at the boulder field. This is upstream of the City of Leavenworth Diversion.

Figure 3-2. Icicle Creek Stream Flows at RM 5.8



(Source: Wenatchee Watershed Plan, 2006)

Table 3-5
Estimated 2016 Flow at the Boulder Field

Month	Flow at USGS Gauge (cfs)	IPID Diversion (cfs)	Estimated Flow at Boulder Field (cfs)
August	203	100	92
September*	130	95	20
October (1 – 8)**	97	0	97

*IPID stopped diverting on September 30
**Heavy precipitation increased flows beginning October 8th

3.3.2.5 Reach 3

Reach 3 spans the stretch of Icicle Creek from RM 4.5 to 3.9. This reach begins at the LNFH/COIC point of diversion and ends at LNFH's Structure 2. In addition to the above described IPID and City of Leavenworth diversions, flow in Reach 3 is diminished by COIC and LNFH's diversion. LNFH diverts up to 42 cfs year-round, while COIC has the right to divert 11.9 cfs during the irrigation season (late April through September). There are no major tributaries that contribute flow to Icicle Creek in this Reach.

3.3.2.6 Reach 4

Reach 4 of Icicle Creek begins at RM 3.9 and ends at RM 2.7. This reach is defined as the area between LNFH's Structure 2 and the Hatchery Channel spillway. This area is also known as the historical channel and is the location of target flows under the Guiding Principles. Flows in this section of Icicle Creek are diminished by the diversions described for Reaches 1 through 3. Additionally, the operation of Structure 2 decreases flows in this reach. Structure 2 spans the Historical Channel near the entrance to the Hatchery Channel and includes two radial gates that can be lowered to limit flow to the Historical Channel and divert flow to the Hatchery Channel. Based on the size and configuration of the openings in Structure 2, if the gates are fully open, water will still begin to back up into the Hatchery Channel when the flow upstream of Structure 2 reaches approximately 300 cfs. If the gates at Structure 2 are lowered, water can be diverted to the Hatchery Channel at lower flow rates. The Hatchery Channel has an inverse grade, meaning that the invert of the channel slopes up to its Spillway. Water fills the Hatchery Channel until the water surface reaches the spillway crest at the end of the channel. If the gates at Structure 2 are fully open, the water surface in the Hatchery Channel will reach the spillway crest when the flow in Icicle Creek upstream of Structure 2 reaches approximately 990 cfs.

Historically, the gates at Structure 2 were lowered for longer periods to keep the Hatchery Channel hydrated to maintain shallow groundwater supply to the hatchery. Due to restrictions imposed by regulators in an effort to improve fish passage through the Historical Channel, the use of Structure 2 to hydrate the Hatchery Channel has decreased in recent years. However, Structure 2 is still used, when allowed, to fill the Hatchery Channel for shallow aquifer recharge and to maintain turbulent conditions at the plunge pool downstream of the spillway during tribal fishing to attract fish to the pool. In addition, Structure 2 limits the flow that can be passed on the Historical Channel to

approximately 2,600 cfs. Flows in excess of 2,600 cfs could potentially damage habitat in the Historical Channel. There are no major inputs to the system in Reach 4.

3.3.2.7 Reach 5

Reach 5 of Icicle Creek is from RM 2.7 to RM 0.0, which spans from the Historical Channel spillway to its confluence with the Wenatchee River. Flows in Reach 5 are impacted by the diversions described for Reaches 1 through 4. Additionally, local private irrigators have individual surface water diversions along this reach; however, these diversions are orders of magnitude smaller than the diversions described in Reaches 1 through 4. There are no tributaries in this reach, but the LNFH outfall puts a significant amount of water, approximately the amount of water LNFH diverts, back into the system at the top of this reach.

3.3.3 Wenatchee River Corridor

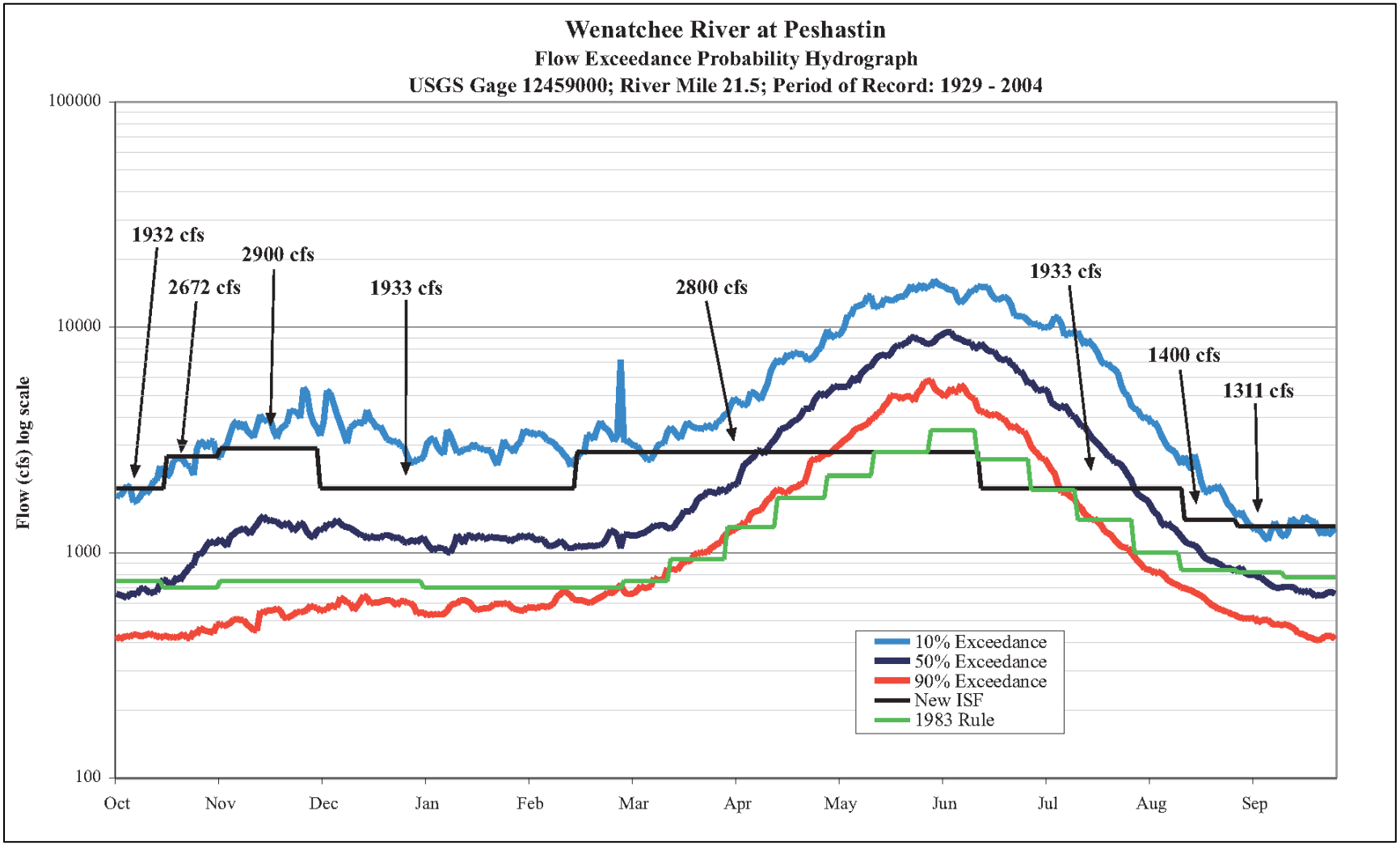
The Wenatchee River flows from the western edge of Chelan County, past Leavenworth, where it is joined by Icicle Creek, to its confluence with the Columbia River in Wenatchee. The Wenatchee River drains the 1,370-square-mile Wenatchee River Watershed, which contains 230 miles of major streams and rivers. Major tributaries to the Wenatchee River include Nason Creek, the Chiwawa River, Chiwaukum Creek, Icicle Creek, Chumstick Creek, Peshastin Creek, and Mission Creek. Icicle Creek contributes 20 percent to the Wenatchee River's flow (Watershed Planning Unit, 2006).

Figure 3-3 provides flows on the Wenatchee River at USGS gaging station 12459000, located near Dryden, just downstream of the confluence with Peshastin Creek at RM 21.5. This point is downstream of where the Wenatchee River intercepts Icicle Creek. Figure 3-3 shows 10 percent, 50 percent, and 90 percent exceedance flows on the Wenatchee River. In the Wenatchee River, flows peak in June and decline throughout summer. The lowest flows occur in September and October, after which streamflow begins to rise in response to autumn precipitation. Streamflow remains stable through much of the winter, with a steady increase beginning in March and April in response to snowmelt, until stream flow peaks again in June. The 50 percent peak exceedance flow that occurs in June is nearly 10,000 cfs. The 50 percent low flow exceedance, which occurs at the end of September and beginning of October, is approximately 600 cfs.

3.3.3.1 Overall Water Budget

The overall water budget of Icicle Creek surface water resources involves various basin inputs and basin outputs. Basin inputs include direct precipitation that falls as either rain or snow, whereas outputs include surface water diversions (less return flow), surface and subsurface water outflow, evaporation, evapotranspiration, and groundwater recharge.

Figure 3-3. Wenatchee Stream Flow near Peshastin Creek



(Source: Wenatchee Watershed Plan, 2006)

Basin Input

Basin inputs primarily consist of precipitation (both as rain and snow). Typically, snow begins accumulating in the highest elevations of the basin in early fall (September/October) and continues through early spring (March/April). The other type of basin input typically considered in water balance calculations include inter-basin transfers of water (e.g., transfer of water in from an external basin); however, this condition does not exist in the Icicle Creek Subbasin.

The Icicle Creek hydrograph in Figure 3-2 shows the basin inputs as they directly relate to stream flow. The mean annual streamflow at the USGS gage at RM 5.8 is 669 cfs (Wenatchee Assessment, 2003). The mean annual volume is 483,484 acre-feet (Wenatchee Assessment, 2003).

The Wenatchee hydrograph in Figure 3-3 shows the basin inputs as they directly relate to stream flow. The mean annual stream flow at the Wenatchee River gage near Peshastin is 3,099 cfs (Wenatchee Assessment, 2003). The mean annual volume is 2,239,941 acre-feet (Wenatchee Assessment, 2003).

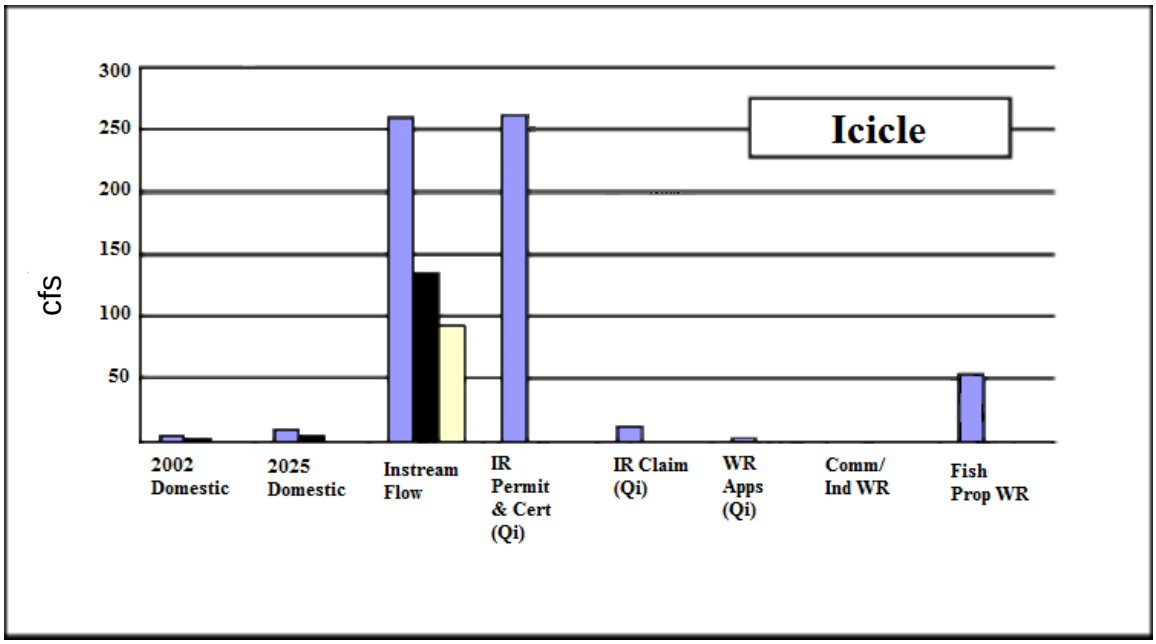
Basin Outputs

Basin outputs consist of evaporation (i.e., from surface water features such as lakes/reservoirs, rivers, and canals), evapotranspiration (e.g., vegetative cover whether naturally occurring or otherwise), surface and shallow subsurface outflow (e.g., Icicle Creek flow), deep recharge (aquifer recharge), out-of-basin transfers (e.g., IPID and COIC diversion), and other consumptive uses such as domestic and municipal supplies from groundwater in continuity with surface water. Basin outputs include:

- IPID Diversion (less return flow) – 117 cfs; 30,000 acre-feet
- COIC Diversion (less return flow) – up to 11.9 cfs; 3,500 acre-feet
- City of Leavenworth Diversion – 6.2 cfs; up to 4,480 acre-feet
- LNFH Diversion (less return flow) – 42 cfs; 30,353 acre-feet
- Evapotranspiration – Unknown
- Rural domestic wells – 1 cfs; 724 acre-feet (Aspect, 2013)
- Other permitted water uses – 9.35 cfs; 1,150 acre-feet

Figure 3-4 provides a summary of the Icicle Water Budget, as prepared by the Watershed Planning Unit in 2006. In Figure 3-4, for Municipal and Domestic demand, the purple bar represents municipal demand and the black bar represents non-municipal domestic demand. For stream flows, the purple bar represents high flows (10 percent exceedance), the black bar represents average flow (50 percent exceedance), and the yellow bar represents low flows (90 percent exceedance). Figure 3-4 indicates that the quantity of water allocated for Icicle Creek exceeds the total water available at 10 percent exceedance flow (high streamflow years). Most of this use is attributed to irrigation water rights. However, this analysis is of all water rights in Ecology's water rights database, which may include water rights that have not been beneficially used in the past and are

Figure 3-4. Icicle Water Budget

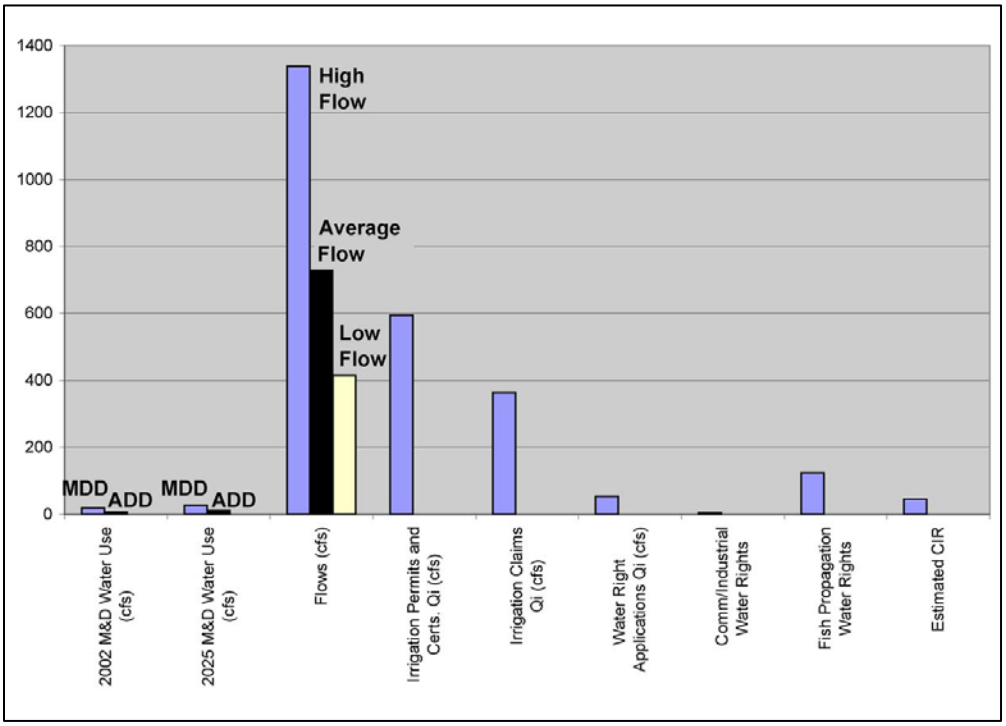


(Source: Wenatchee Watershed Plan, 2006)
Notes: Mun. = municipal; Dom. = domestic; IR. = irrigation; Certs = certificates; Qi = instantaneous quantity; Apps = applications; Comm/Ind = commercial and industrial; W.R. = water right; Prop = propagation

subject to relinquishment. Water rights in Washington State are based on beneficial use, and water rights that are not used are not considered valid and are known as “paper” water rights. Because this analysis did not examine the validity of water rights, actual use in the watershed may be lower.

Figure 3-5 provides a summary of the Wenatchee River Watershed Water Budget, as prepared by the Watershed Planning Unit in 2006. In Figure 3-5, for Municipal and Domestic demand, the purple bar represents municipal demand and the black bar represents non-municipal domestic demand. For Flows, the purple bar represents high flows (10 percent exceedance), the black bar represents average flow (50 percent exceedance), and the yellow bar represents low flows (90 percent exceedance). Figure 3-5 indicates that the quantity of water allocated for the Wenatchee River Watershed is within the high range of available flows but exceeds the 50 percent and 90 percent exceedance flows. As is the case in Icicle Creek, most of this use is attributed to irrigation water rights and claims. However, as discussed above, this analysis did on examine the validity of water rights, and actual use may be lower.

Figure 3-5. Wenatchee River Watershed Water Budget



(Source: Wenatchee Watershed Plan, 2006)

3.4 Groundwater Resources

This section describes the occurrence and movement of groundwater in the Icicle project area. Groundwater quality is discussed in Section 3.5.3, Groundwater Quality. Groundwater resources organized by sub-region:

- The Alpine Lakes (Square, Upper and Lower Klonaqua, Eightmile, Upper and Lower Snow, and Nada Lakes);
- The Icicle Creek drainage from the Alpine Lakes to the confluence with the Wenatchee River; and
- The Wenatchee River Corridor from just upstream of Icicle Creek to the confluence with the Columbia River.

These areas were defined based both on similarity of hydrogeologic conditions within each area, and on where the effect of specific actions (e.g., lake storage restoration, improved irrigation efficiencies, etc.) would be expected to occur. Information and previous studies used to develop this section include:

- Advance Project Plan, Well Rehabilitation, Leavenworth National Fish Hatchery (Robinson & Noble, 1989)

- Initial Watershed Assessment Water Resources Inventory Area (WRIA) 45 Wenatchee River Watershed (Ecology, 1995)
- WRIA 45 Summary of Groundwater/Surface Water Interaction and Groundwater Resource References (Golder, 2005)
- Groundwater Data Summary for the Wenatchee River Watershed Total Maximum Daily Load Study (Ecology, 2007)
- Groundwater Conditions at the Leavenworth National Fish Hatchery, Leavenworth, Washington (USBR, 2010)
- Leavenworth National Fish Hatchery Groundwater Model Update Technical Memorandum (USBR, 2014)
- Leavenworth national Fish Hatchery Water Source Assessment (Aspect, 2014).
- Alternatives Evaluation Study – Public release Version Cascade Orchards Irrigation Company (Anchor QEA, 2015)
- Leavenworth National Fish Hatchery Geophysical Survey Results and Recommendations (Aspect 2015)
- Leavenworth National Fish Hatchery Groundwater Supply Investigation (Aspect 2015)
- Leavenworth National Fish Hatchery Infiltration Gallery Conceptual Alignment (Aspect 2015)

The remainder of this Section provides an overview of hydrogeologic conditions in the project area, groundwater occurrence and flow within the locations described above, and groundwater uses.

3.4.1 Hydrogeologic Setting

This description of the hydrogeologic setting in the Icicle project area builds on the geologic conditions described in Section 3.2, Earth. As discussed previously, bedrock geology in the project area is dominated by crystalline metamorphic and igneous intrusive rock, with the surficial occurrence of sedimentary sandstone, siltstone, and shale rocks in the project area limited to the slopes east and southeast of the City of Leavenworth. Unconsolidated glacial and alluvial deposits overlie the bedrock adjacent to the Alpine Lakes, along the Icicle Creek drainage and its tributaries, and along the Wenatchee River to the Columbia River. These unconsolidated deposits are laterally discontinuous along the Alpine Lakes and in the Icicle Creek drainage above LNFH, where the bedrock-bound valleys are narrow. Adjacent to and below LNFH the Icicle Creek drainage broadens as it approaches the Wenatchee River. Through this area and downstream to the Columbia River the unconsolidated deposits increase in thickness and become laterally continuous.

Groundwater is ultimately derived from precipitation and snowmelt infiltrating through surficial soils and rock, recharging the groundwater system. Groundwater flow is expected to generally follow topography, flowing from higher elevations to lower

elevations, sub-parallel to the flows of Icicle Creek and the Wenatchee River. There is expected to be a high degree of hydraulic continuity between the unconsolidated deposits and surface waters where the two are in contact, with groundwater discharging to or being recharged by surface water depending on location and time of year.

Movement and occurrence of groundwater is controlled primarily by the physical characteristics of the geologic units. In general, wells completed in the bedrock have low reported production capacity, with yields on the order of 1 gallon per minute (gpm), although some wells completed in weathered bedrock reportedly produce yields on the order of 15 gpm (Ecology, 1995). The coarse-grained unconsolidated deposits (e.g., sands and gravels), especially at and below LNFH, are the main source of groundwater in the area. Wells completed in coarse-grained deposits reportedly yield from 5 gpm to more than 100 gpm. Finer-grained unconsolidated deposits (silt, clay, and glacial till) generally do not yield significant quantities of water and may act as barriers to flow, where present.

3.4.2 Groundwater Occurrence and Movement

The following subsections provide a more detailed description of the occurrence and movement of groundwater in the four different areas, with the Icicle Creek sub-region being divided at LNFH.

3.4.2.1 Alpine Lakes

Surficial geology within the Alpine Lakes sub-region of the project area is dominated by igneous intrusive and metamorphic bedrock, with limited unconsolidated deposits mapped only around the shoreline of Eightmile Lake. Detailed water budget data for the lakes are not available but given the prevalence of low-permeability bedrock and the steep terrain, lake hydrology is expected to be dominated by precipitation and snowmelt runoff, with groundwater recharge and discharge a relatively minor component of the water budget.

The limited amount of precipitation and runoff that recharges the bedrock and alluvial groundwater systems is expected to flow toward and discharge to the lakes or migrate down-valley before discharging to the Icicle Creek drainage. This flow pattern is affected by lake stage. When the lakes are at high stage (e.g., during spring runoff or as the result of storage operations) these flows may reverse, with surface water recharging groundwater. Although a minor part of the overall water budget, groundwater likely supports late season water levels in the lakes and downstream flows by discharging to surface water when the lakes at lower stages (e.g., during the summer or fall or as the result of releases from storage operations).

3.4.2.2 Icicle Creek Corridor

Tributaries and Icicle Creek Reach 1 and 2

Surficial geology along the Icicle Creek drainage from the Alpine Lakes to LNFH is dominated by igneous intrusive and metamorphic bedrock, with discontinuous unconsolidated alluvial and glacial deposits mapped along the creek and its tributaries. The creek valley in this section is relatively narrow with steep walls. Similar to the Alpine Lakes, given the prevalence of low-permeability bedrock and the steep terrain,

hydrology in the Icicle Creek drainage is expected to be dominated by precipitation and snowmelt runoff, with only limited groundwater recharge or discharge.

Groundwater occurring in the bedrock and discontinuous alluvial systems is expected to discharge to Icicle Creek and its tributaries. This relationship may be temporarily reversed during periods of high surface water stage and flow, with surface water recharging groundwater. Although groundwater is a minor part of the annual water budget for Icicle Creek and its tributaries above LNFH, groundwater discharge to surface water likely helps support late season flows in the creek.

Icicle Creek Reach 3, 4, and 5

Icicle Creek transitions from a narrow, bedrock-dominated valley to a broader valley with more extensive unconsolidated glacial and alluvial deposits immediately upstream of LNFH at approximately RM 4. This change in geologic conditions has a significant effect on the occurrence and movement of groundwater, with groundwater contained in unconsolidated deposits playing a significant role in the overall water budget.

The upstream edge of this area also coincides with the location of a surface water diversion on Icicle Creek shared by LNFH and COIC. LNFH conveys surface water in a pipeline from the diversion to the hatchery facilities. COIC conveys water in an unlined canal located along the west edge of the alluvial valley, serving lands between the canal and Icicle Creek downstream to the Wenatchee River. Another diversion, operated by IPID, is located further upstream. The IPID canal is largely lined and extends along the east side of the valley and down the Wenatchee River valley, serving lands near the mouth of Icicle Creek and along the Wenatchee River. LNFH also operates the Hatchery Channel, a human-made channel constructed between the LNFH facility and Icicle Creek. The Hatchery Channel is periodically hydrated with water diverted from Icicle Creek to improve recharge to the unconsolidated deposits and support water levels and yields from LNFH's nearby water supply wells.

Surficial geology along the valley floor is mapped as alluvial deposits. Intrusive and metamorphic bedrock is mapped along the steep slopes of the west edge of the valley, and glacial deposits mantle the slopes on the east side of the valley. Depth to bedrock underlying the valley floor is on the order of 150 to 250 feet, depending on location. The alluvial deposits include coarse-grained sand, gravel, and cobbles that readily transmit water, and finer-grained silts and clays that restrict groundwater flow. The coarser-grained deposits form a shallow, unconfined aquifer and a deeper, semi-confined aquifer separated by a discontinuous layer of finer-grained deposits. LNFH operates water supply wells completed in both the shallow and deeper unconsolidated aquifers, with recent combined well yields on the order of 4,000 gpm (USBR, 2010).

Sources of groundwater in this area include direct infiltration of precipitation and snowmelt, recharge from surface water of Icicle Creek and the Hatchery Channel when hydrated, and seasonal leakage from the COIC and IPID irrigation canals. Previous studies (USBR, 2010; USBR, 2014) indicate a high degree of hydraulic continuity between the unconsolidated aquifers and surface waters of Icicle Creek and the Hatchery Channel. Active management of Icicle Creek, Hatchery Channel, and pumping of LNFH's groundwater supply wells all affect groundwater flow and occurrence in this

area. Absent these factors, groundwater flow is expected to be generally down valley, with a component of flow toward Icicle Creek. During periods of high stage in Icicle Creek (e.g., spring runoff) or when the Hatchery Channel is hydrated, groundwater is expected to be recharged from surface water. During periods of lower stage, or when LNFH is operating their supply wells, Icicle Creek generally loses water, recharging the aquifers.

Some seasonal groundwater recharge also likely occurs as a result of leakage from the irrigation canals. A seepage loss study of the unlined COIC canal identified relatively minor losses from the canal of about 5 percent of total flows, or about 0.3 cfs during the period evaluated. Although a seepage loss study has not recently been completed for the IPID canal, the IPID canal is mostly lined through this area, so losses are expected to be less than those for the unlined COIC canal.

3.4.2.3 Wenatchee River Corridor

Surficial geology in the project area downstream from Icicle Creek is predominantly unconsolidated alluvium along the Wenatchee River Valley floor, with sedimentary bedrock forming the valley walls. Depth to bedrock underlying the valley floor is on the order of 100 to 200 feet, depending on location. The alluvial deposits include coarse-grained sand, gravel, and cobbles that readily transmit water, and finer-grained silts and clays that restrict groundwater flow.

Groundwater occurs primarily in the unconsolidated alluvial deposits, with bedrock representing a minor component of the water budget. Wells completed in the bedrock have low reported production capacities, with yields on the order of 1 gpm, although some wells completed in weathered bedrock reportedly produce yields on the order of 15 gpm (Ecology, 1995). Wells completed in the alluvium report yields ranging from about 5 gpm to more than 100 gpm, depending in part on the characteristics of the unconsolidated materials (e.g., grain size, saturated thickness).

Sources of groundwater in this area include direct infiltration of precipitation and snowmelt, recharge from surface water of the Wenatchee River, and infiltration of irrigation and domestic (septic) return flows. Based on the generally coarse-grained nature and relatively thick sequence of unconsolidated deposits adjacent to the Wenatchee River, a high degree of hydraulic continuity is expected between the river and groundwater. This assumption is supported by an Ecology-led study of groundwater-surface water interaction and nutrient loading in the Wenatchee River Watershed (Ecology, 2007) that identified gaining and losing reaches along the entire length of the river, with some areas showing a seasonal transition from gaining to losing conditions.

3.4.3 Groundwater Uses

Groundwater uses in the project area include municipal supply for the Cities of Leavenworth and Cashmere, municipal and multiple domestic supply to smaller water systems, supply to the LNFH for fish propagation, and water right permit-exempt domestic uses. No groundwater uses were identified in the Alpine Lakes area. Groundwater uses within the Icicle Creek drainage above LNFH are limited to about 50

to 60 apparent permit-exempt wells located mostly along Icicle Creek Road, identified based on review of Ecology's well log database. Most of these wells appear to be completed in bedrock rather than unconsolidated deposits.

Groundwater uses in the area from the LNFH to the Wenatchee River include LNFH's permitted withdrawals and apparent permit-exempt domestic uses. LNFH holds water rights that authorize groundwater withdrawals of 6,700 gpm on an instantaneous basis, up to 7,677 acre-feet/year. The number of permit-exempt uses in this area is uncertain, but approximately 300 water well logs from this area were identified in Ecology's well log database.

Groundwater uses downstream from Icicle Creek to the Columbia River include municipal supply for the Cities of Leavenworth and Cashmere, municipal and multiple domestic supply to smaller water systems, and water right permit-exempt domestic uses. Based on information in their 2011 Water System Plan, the City of Leavenworth holds two groundwater rights that authorize withdrawal of 3,000 gpm (6.68 cfs), up to 2,000 acre-feet/year. The Water System Plan states annual quantities authorized for withdrawal under these groundwater rights are non-additive to the City of Leavenworth's surface water rights to Icicle Creek; further, 2,000 gpm (4.46 cfs) of the instantaneous withdrawals authorized under these rights is interruptible and subject to curtailment when flows in Icicle Creek or the Wenatchee River fall below minimum rates. As discussed in Section 1.8 of this document, the City of Leavenworth's water rights are currently under appeal and attributes may change based on the outcome of this litigation.

A water right summary provided by the City of Cashmere indicates they hold four groundwater rights that authorize withdrawal of 1,400 gpm (3.12 cfs), up to 1,227 acre-feet/year. Like the City of Leavenworth, these rights include a combination of additive and non-additive quantities to other water rights. These groundwater rights are not subject to interruption based on instream flows, but several of the City of Cashmere's surface water rights are subject to instream flows. Note that this summary of groundwater rights held by the Cities of Leavenworth and Cashmere was based on review of information provided by the two cities and gathered from Ecology water right files; this review does not represent an extent and validity review and is not intended to determine the validity of quantities of water available under these groundwater rights.

3.5 Water Quality

This section describes water quality of surface and groundwater in the Icicle project area that could be affected by the Program Alternatives. Section 3.3, Surface Water Resources, and Section 3.4, Groundwater Resources, describe these resources in greater detail. The project area includes the Alpine Lakes area within the Icicle Creek Basin, Icicle Creek down to its confluence with the Wenatchee River, the mainstem Wenatchee River from just upstream of Icicle Creek down to its confluence with the Columbia River, and underlying shallow and deep aquifers.

3.5.1 Regulatory Setting

The federal CWA, passed in 1972, aims to restore and maintain the chemical, physical, and biological integrity of the nation's waters. As part of this goal, the CWA sets forth the basic structure for regulating pollutant discharges to surface waterways (e.g., lakes, rivers, ponds, streams, and wetlands) and groundwater (e.g., shallow and deeper aquifers) from both point and non-point sources. The CWA includes provisions for the development of water quality standards, institutes a water quality assessment process to identify impaired waters that do not meet the water quality standards, and establishes the NPDES permitting program to regulate point sources that discharge pollutants to waters of the United States.

The CWA is administered by the U.S. Environmental Protection Agency (EPA) in coordination with state governments. Water quality standards are developed by individual states with oversight from the EPA. Water quality standards identify the potential designated or beneficial uses of surface water bodies within the state (e.g., aquatic life, recreation, and water supply), set water quality criteria (numeric pollutant concentrations and narrative requirements) to provide protection of those designated uses, and include antidegradation policies to protect high quality waters and specify how water quality criteria are to be implemented. The water quality standards for aquatic life and public use of Washington's surface waters are developed and administered by Ecology (Chapter 173-201A WAC; Ecology, 2012a). Where appropriate, these standards are supplemented by the EPA's *Quality Criteria for Water 1986* (EPA, 1986) and its associated amendments. Human health-based water quality criteria used by Ecology are contained in the National Toxics Rule (40 CFR Part 131).

Sections 303(d) and 305(b) of the CWA require states to identify surface waters that do not meet water quality standards and to report the water quality condition of these waters to EPA biennially in the form of a Water Quality Assessment and Integrated Report. This report is used to identify impaired waters that may require the preparation of a water cleanup plan, such as a TMDL allocation or other water quality improvement project. A TMDL describes the type, amount, and sources of water pollution in a particular waterbody, provides an analysis of how much the pollution needs to be reduced or eliminated to meet water quality standards, and establishes targets and strategies to control the pollution in that waterbody (Ecology, 2016a).

Ecology's current Water Quality Assessment and Integrated 305(b) report and 303(d) list were approved by EPA on July 22, 2016. The Water Quality Assessment classifies assessed surface waters into the following water quality categories:

- Category 1 – Meets tested standards for clean waters
- Category 2 – Waters of concern
- Category 3 – Insufficient data
- Category 4 – Polluted waters that do not require a TMDL and have pollution problems that are being solved in one of the three following ways:
  - Category 4a – Has an approved TMDL in place

  - Category 4b – Has a pollution control program in place
  - Category 4c – Is impaired by a non-pollutant, such as low water flow or dams
- Category 5 – Polluted waters that require a TMDL or other water quality improvement project

Category 5 waters are placed on the Section 303(d) list of waters whose beneficial uses have been impaired by pollution. Once a water is placed on the Section 303(d) list, Ecology must then work to develop a TMDL or other water quality improvement project to address the identified impairments.

If there is also a discharge that impacts groundwater, then the requirements of a state waste discharge permit must also be incorporated into the NPDES permit per Chapter 173-200 WAC. Where appropriate, these standards are supplemented by the EPA's *Groundwater Rule* (EPA, 2006)[1], which provides for the protection of public groundwater systems.

3.5.2 Surface Water Quality

As described in Section 3.3, Surface Water Resources, surface waters within the Icicle project area include select Alpine Lakes and their receiving streams that flow to Icicle Creek, Icicle Creek from its headwaters to its confluence with the Wenatchee River, and the Wenatchee River from just upstream of Icicle Creek to the Columbia River. The Wenatchee River and Icicle Creek have been listed on multiple versions of Washington's CWA 303(d) list for temperature, dissolved oxygen, pH, and fecal coliform bacteria (Table 3-6). Other water quality issues include surface water contamination with polychlorinated biphenyls (PCBs), dichloro-diphenyl-trichloroethane (DDT) and its breakdown products (e.g., dichloro-diphenyl-dichloroethane [4,4'-DDD] and dichloro-diphenyl-ethane [4,4'-DDE]), and various other organic pesticides.

[1] Ground Water Rule (GWR) 71 FR 65574, November 8, 2006, Vol. 71, No. 216 Correction 71 FR 67427, November 21, 2006, Vol. 71, No. 224

Table 3-6
Clean Water Act Section 303(d) (Category 5) Listings for Project Waterbodies in the Primary and Secondary Project Development Areas

Waterbody	Water Quality Parameters					
	1996	1998	2004	2008	2012	Current[2]
Icicle Creek	Temperature, Dissolved Oxygen, pH, Instream Flow	Temperature, Dissolved Oxygen, pH, Instream Flow	Temperature, Dissolved Oxygen, pH	Dissolved Oxygen, pH	None	4,4'-DDE, PCB
Wenatchee River	Temperature, Dissolved Oxygen, pH, Instream Flow	Temperature, Dissolved Oxygen, pH, Instream Flow	Temperature, Dissolved Oxygen, pH, 4,4'-DDT, 4,4'-DDD, 4,4'-DDE, Alpha BHC, PCB	Dissolved Oxygen, pH, 4,4'-DDE, PCB	4,4'-DDE, PCB	4,4'-DDE, PCB, Endosulfan

Source: Ecology 2016b

Impaired water quality can adversely affect the designated or beneficial uses of a waterbody, including decreased aesthetic or recreational opportunities, lowered habitat function, and adverse impacts on wildlife and humans. Most of these water quality impairments in the Wenatchee River Watershed occur in the lower portions of the watershed and are largely a result of the much higher degree of urban and agricultural development in the Wenatchee River Corridor.

Within the Wenatchee River Watershed, temperature impairment of water quality has been historically recorded in the lower portion of the watershed within both Icicle Creek and the Wenatchee River (Table 3-6). Water quality degradation related to temperature is caused by a variety of both natural and human-induced processes that contribute to increases in water temperature in streams and other waterbodies. Because warmer water holds less dissolved oxygen than cooler water, increased water temperatures can affect the types of organisms able to live in a waterbody, as well as impairing other designated uses such as recreation and water supply. Increased stream temperatures can result from increases in suspended sediments, removal of riparian vegetation, and decreased instream flows from surface water diversions and groundwater withdrawals.

In addition to increased water temperature, high levels of nutrients, primarily nitrogen and phosphorus, can also result in lowered dissolved oxygen levels. If large amounts of nutrients are available, aquatic plant growth can become excessive and the eventual decomposition of these plants can deplete the water of dissolved oxygen. In the Wenatchee River Watershed, phosphorus is the primary nutrient of concern and enters the river system from a variety of both point and non-point sources. Point sources include wastewater treatment plants and fish hatcheries, and non-point sources include septic

[2] The Washington Department of Ecology's current Water Quality Assessment was submitted to the U.S. Environmental Protection Agency (EPA) in September 2015; it was approved by EPA on July 22, 2016.

systems, agricultural runoff, and abandoned or closed landfills (Ecology, 2009). Such sources are most commonly found in the downstream portion of the project area.

Excessive plant growth from heavy nutrient loading can also cause large, relatively sudden, swings in the pH of the water (Ecology, 2009), which can affect the availability of nutrients and metals and adversely affect aquatic species. High pH (i.e., alkaline) levels are typically encountered in parts of the lower Wenatchee River Watershed and affect aquatic organisms, including all life stages of anadromous fish, by impairing their salt and water balancing process and increasing the toxicity of some contaminants (Ecology, 2009).

Fecal coliform refers to potential disease-causing pathogens (e.g., bacteria and viruses) associated with human and animal waste, which can enter the water body through multiple sources. Water quality degradation from fecal coliform primarily affects water use designations, such as water supply, stock watering, aquatic life support, wildlife habitat, and recreation.

PCBs are organic chlorine compounds that were manufactured in the United States between 1929 and 1979 (Hobbs and Friese, 2016). Common sources of PCB contamination include older electrical equipment (e.g., transformers and capacitors), paints, inks, and sealants. Historically, PCBs have been released into the environment mainly through volatilization into the atmosphere and spills into waterways and onto land. PCBs are known to be carcinogenic and to have adverse effects on the immune, endocrine, nervous, and reproductive systems of humans. In the Wenatchee River Watershed, PCB levels have exceeded water quality standards in portions of the Wenatchee River since 2004 and more recently in the lower-most portion of Icicle Creek in 2015 (Table 3-6).

DDT is a water-resistant chlorinated insecticide that was heavily used to control orchard pests in the Wenatchee River Watershed between the mid-1940s and 1972, when its use was banned by the EPA (Ecology, 2007b). Within the Wenatchee River Watershed, the concentration of DDT and its derivatives have exceeded water quality standards in the lower portion of Icicle Creek and portions of the Wenatchee River more recently (Table 3-6).

To date, Ecology has developed several water quality improvement projects to address impairments that affect project surface waters (Table 3-7). These include TMDLs for temperature (Ecology, 2007b), and dissolved oxygen and pH (Ecology, 2009).

Table 3-7
Water Quality Improvement Projects Affecting Project Surface Waters and Associated Tributaries

Water Quality Improvement Project Name	Pollutant(s)	Applicable Surface Waters	Status
Wenatchee River Watershed Temperature Total Maximum Daily Load	Temperature	• Chiwaukum Creek • Icicle Creek • Little Wenatchee River • Mission Creek • Nason Creek • Peshastin Creek • Brender Creek • Chumstick Creek • Wenatchee River	EPA approved August 2007
Wenatchee River Watershed Dissolved Oxygen and pH Total Maximum Daily Load	Dissolved Oxygen, pH	Wenatchee River Watershed	EPA approved August 2009

Source: Ecology 2016c.

Current water quality is discussed for each of the major project waters in the following sections.

3.5.2.1 Alpine Lakes

As noted in Section 3.3, Surface Water Resources, surface waters within the Icicle Creek Basin originate from high lakes located in the Central Cascades of Washington. This portion of the Icicle project area includes eight lakes: Square Lake, Upper Klonaqua Lake, Lower Klonaqua Lake, Eightmile Lake, Colchuck Lake, Nada Lake, Upper Snow Lake, and Lower Snow Lake, and their receiving streams. These lakes support a variety of designated uses as listed in WAC 173-201A-600, including aquatic life uses, the highest quality recreational use type, and all water supply and miscellaneous uses defined under WAC 173-201A-200 (Table 3-8).

Information on the historic and current water quality of the project lakes is limited, and no water quality studies are listed on the interactive Washington State Lakes Environmental Data website (Ecology, 2016d). Historic lake reconnaissance studies conducted for the USGS in the mid- to late-1970s (Dion et al., 1976; Denthier et al., 1979) provide some basic water quality information for a limited number of lakes. A 1976 study conducted by Dion and others included six of the eight lakes being considered in this EIS (Upper Klonaqua Lake, Lower Klonaqua Lake, Eightmile Lake, Colchuck Lake, Upper Snow Lake, and Lower Snow Lake). That study found the water quality of those lakes to be quite high, with all six lakes having high levels of dissolved oxygen throughout the entire water column and very low nutrient (nitrogen and phosphorus) and bacteria (fecal coliform) levels. Denthier et al. (1979) classified the water quality of these lakes as being excellent, as indicated by high water clarity and low concentrations of dissolved solids. All of the lakes in the Icicle project area were being managed for water storage at the time these studies were conducted.

Table 3-8
Designated Use Listings for Project Waters in the Primary and Secondary Project Development Areas

Waterbody	Aquatic Life Uses						Recreation Uses			Water Supply Uses				Miscellaneous Uses				
	Char Spawning/Rearing	Core Summer Habitat	Spawning/Rearing	Rearing/Migration Only	Redband Trout	Warm Water Species	Extraordinary Primary Contact	Primary Contact	Secondary Contact	Domestic Water	Industrial Water	Agricultural Water	Stock Water	Wildlife Habitat	Harvesting	Commerce/Navigation	Boating	Aesthetics
Alpine Lakes and Receiving Streams (Square Lake, Klonaqua Lake, Eightmile Lake, Colchuck Lake, Nada Lake, Upper Snow Lake, and Lower Snow Lake)		X	X	X			X			X	X	X	X	X	X	X	X	X
Icicle Creek (including tributaries) from mouth to National Forest boundary		X						X		X	X	X	X	X	X	X	X	X
Icicle Creek (including tributaries) from National Forest boundary to confluence with Jack Creek		X					X			X	X	X	X	X	X	X	X	X
Icicle Creek above and including Jack Creek (including all tributaries)	X						X			X	X	X	X	X	X	X	X	X
Wenatchee River mainstem between mouth and Peshastin Creek			X	X				X		X	X	X	X	X	X	X	X	X
Wenatchee River mainstem between Peshastin Creek and the Wenatchee National Forest boundary		X						X		X	X	X	X	X	X	X	X	X

The high water quality of the lakes has been primarily attributed to two factors: 1) limited use by humans due their remoteness, relative inaccessibility, and regulatory protections; and 2) the abundant annual precipitation that allows large volumes of water to flow through them every year, diluting and flushing out any accumulated pollutants (Gilliom et al., 1980). In their 1980 study for USGS, Gilliom et al. analyzed the susceptibility of 60 lakes (including all eight of the project lakes) to water quality degradation by recreational use and determined that all of the project lakes had a low susceptibility to long-term, whole-lake degradation from recreation activities. Although the effect of water management activities on water quality was not specifically addressed in that study, such activities were occurring at the time of the study and would have influenced the water quality observations that were made.

Potential sources of water quality degradation that could affect the lakes are largely limited to recreational uses (e.g., camping and hiking) and ongoing water retention and storage activities by the IPID and USFWS. The major types of pollutants that could enter these lakes from recreational activities include nutrients (nitrogen and phosphorus), pathogens (bacterial, protozoa, and viruses), and sediment. For water retention and storage activities, potential pollutants would primarily be limited to sediment.

None of the lakes or their immediate receiving waters are listed as impaired under Section 303(d) of the CWA. Snow Creek, which receives flow from Nada Lake and Lower Snow Lake, is listed as a water of concern (Category 2) for temperature, pH, and dissolved oxygen in Ecology's current Water Quality Assessment (Ecology, 2016b). Waters listed under Category 2 may have pollution levels that are not quite high enough to violate the water quality standards or there may not have been enough violations to categorize it as impaired according to Ecology's listing policy (Ecology, 2016e). The location of these listings occurs in the vicinity of Snow Creek's confluence with Icicle Creek, which is located downstream of the diversion shared by IPID and the City of Leavenworth and upstream of the diversion shared by the LNFH and COIC. There are no permitted NPDES outfalls on any of the lakes or their immediate receiving waters.

3.5.2.2 Icicle Creek Corridor

Designated uses for Icicle Creek are specified in WAC 173-201A-602 and summarized in Table 3-8. Designated uses include aquatic life support, medium to high quality recreational uses, and all water supply and miscellaneous uses defined under WAC 173-201A-200. Potential sources of water quality degradation that affect Icicle Creek include flow diversion, stormwater runoff from adjacent roads and developed areas, point-source discharges from water treatment plants and other facilities, non-point pollutants from septic systems, and recreational uses. Water quality parameters affected by pollutants from these sources include temperature, dissolved oxygen, pH, turbidity, nutrients, fecal coliform bacteria, and concentrations of various pollutants including heavy metals and organic compounds.

The Leavenworth Water Treatment Plan is an NPDES-permitted facility on Icicle Creek (Ecology, 2016f). That facility is permitted to discharge both process wastewater and non-routine and unanticipated wastewater to Icicle Creek through an outfall located approximately 0.4 mile downstream from the Snow Creek confluence under an NPDES

General Permit for Water Treatment Plants (Ecology NPDES Permit No. WAG645001). The LNFH also has an NPDES permit to discharge wastewater from the hatchery into Icicle Creek (NPDES Permit No. WA0001902). The hatcheries outfall is located at RM 2.7.

Annual temperature monitoring in Icicle Creek has been conducted by the USFWS since 2005 in locations upstream, adjacent to, and downstream of the LNFH (Hall and Kelly-Ringel, 2011; Hall and Henry, 2012; Hall, 2013a, 2013b; Fraser, 2015a, 2015b). Throughout this period, monitoring has indicated that the cumulative effect of two LNFH operations—supplementation with Snow Creek water and the mixing of hatchery return water with well water—reduces in-water temperatures in Icicle Creek during the summer months.

Ecology's current Water Quality Assessment (Ecology, 2016b) records three Category 5 water quality impairment listings for Icicle Creek under Section 303(d) of the CWA (Table 3-6). Two of these are for PCBs and occur in sections of stream channel both upstream and downstream of the East Leavenworth Road Bridge. The other Category 5 listing is for 4,4'-DDE and occurs in a section of the stream upstream from the East Leavenworth Road Bridge. All of these detections were found in the tissue of fish collected from these stream reaches.

During a recent Ecology source assessment study for PCBs and DDT in the Wenatchee River Watershed (Hobbs and Friese, 2016), researchers found that the greater bioaccumulation of PCBs in the Wenatchee River Watershed food web is occurring downstream from Cashmere, approximately 10 RM downstream from the Icicle Creek listing locations. These data appear to suggest that the fish collected from the Icicle Creek reaches were migrating fish that had been feeding in downstream areas. As such, the researchers suggest that the Icicle Creek 303(d) listings for PCBs may be inappropriate.

In addition to its Category 5 listings, Icicle Creek also has several Category 4a listings (approved TMDL in place) for temperature, dissolved oxygen, and pH on Ecology's current Water Quality Assessment (Ecology, 2016b). One Category 4c listing (impairment by a non-pollutant) is also included for instream flow.

The Category 4a temperature listings in Icicle Creek occur between Boggy Creek and Jack Creek, between Doctor Creek and Ida Creek, downstream of Fourth of July Creek, upstream of Bridge Creek, downstream of Eightmile Creek, both upstream and downstream of Snow Creek, downstream of the East Leavenworth Road Bridge, and upstream of the Icicle Creek confluence with the Wenatchee River. The lower portion of Jack Creek is also listed as a Category 4a water for temperature. These listings are being addressed by the Wenatchee River Watershed Temperature TMDL, which was approved by the EPA in August 2007 (Ecology, 2007b).

Category 4a listings for dissolved oxygen and pH occur downstream of the East Leavenworth Road Bridge and upstream of Icicle Creek's confluence with the Wenatchee River (Ecology, 2016b). The Icicle Creek LNFH diversion channel is also listed as a Category 4A water for dissolved oxygen. These impairments are addressed under the

Wenatchee River Watershed Dissolved Oxygen and pH TMDL, which was approved by the EPA in August 2009 (Ecology, 2009) and its associated addendum (Ecology, 2012b).

A portion of Icicle Creek is also Category 4c listed for instream flow impairment. Multiple flow studies performed during the 1990s determined that measured flows in this section of the channel did not meet the instream flows set by the Instream Resources Protection Program – Wenatchee River Watershed, WRIA 45 (Chapter 173-545 WAC) nearly 45 percent of the time or for 66 days on average from August to October (Ecology, 2016g). These conditions are attributed to upstream consumptive uses of water, including streamflow diversions for irrigation, municipal water supply for the City of Leavenworth, and process water supply for the LNFH.

Ecology's current Water Quality Assessment also lists multiple Category 2 (waters of concern) listings for Icicle Creek. Two Category 2 listing for temperature occur in locations both immediately upstream of and within the LNFH diversion channel. Seven Category 2 listings for dissolved oxygen occur in locations between Boggy Creek and Jack Creek, between Bob Creek and Doctor Creek, upstream from its confluence with Bridge Creek, both upstream and within the LNFH diversion channel, and upstream of the East Leavenworth Road Bridge. Jack Creek is also listed as a Category 2 water for temperature. As with the Category 4a listings, areas of low dissolved oxygen are being addressed under the August 2009 Wenatchee River Watershed Dissolved Oxygen and pH TMDL (Ecology, 2009) and its associated addendum (Ecology, 2012b).

3.5.2.3 Wenatchee River Corridor

Designated uses for the Wenatchee River are specified in WAC 173-201A-600 and WAC 173-201A-602 and summarized in Table 3-8. Designated uses include aquatic life support, medium to high quality recreational uses, and all water supply and miscellaneous uses defined under WAC 173-201A-200. Lands within the Wenatchee River Corridor are much more heavily developed than lands located in the higher elevations of the Icicle project area and include several urban areas (Cities of Leavenworth, Peshastin, Dryden, Cashmere, Monitor, Sunnyslope, and Wenatchee) and considerable agricultural lands. As such, potential sources of water quality degradation are more numerous and include flow diversion; point-source discharges from publicly owned treatment works (POTW), municipal stormwater systems, industrial facilities, fish hatchery effluent discharges, and irrigation returns; and non-point pollutants from septic systems, urban runoff, and agricultural runoff. Water quality parameters that are affected by pollutants from these sources include temperature, dissolved oxygen, pH, turbidity, nutrients, fecal coliform bacteria, and concentrations of various pollutants including heavy metals and organic compounds.

Multiple NPDES-permitted facilities discharge to the Wenatchee River. Permitted outfalls include those for the Leavenworth, Peshastin, Dryden, and Cashmere POTWs; multiple fruit packing plants; a Chelan County Public Utility District fish acclimation facility in Dryden; multiple industrial and construction stormwater outfalls; a sand and gravel operation; and multiple irrigation districts for irrigation system weed control.

Ecology's current Water Quality Assessment (Ecology, 2016b) records multiple Category 5 water quality impairment listings for the Wenatchee River, including five for PCBs, five for 4,4'-DDE, and one for endosulfan, an organochlorine pesticide (Table 3-6).

Category 5 listings for PCBs and 4,4'-DDE occur downstream from the Icicle Creek confluence, upstream and downstream of the U.S. Route 2 Bridge in the City of Leavenworth, between the City of Leavenworth and the City of Peshastin, and downstream of the City of Cashmere (Ecology, 2016b). All listings are based on the presence of these pollutants in fish tissue at concentrations that exceed water quality criteria. During a recent source assessment study for PCBs and DDT in the Wenatchee River Watershed (Hobbs and Friese, 2016), Ecology identified multiple potential sources of these pollutants and investigated these potential sources by studying the concentrations in water, biofilms (algae and microbial biomass), and invertebrates in the mainstem of the Wenatchee River. The initial survey showed that the sources of both contaminants are confined to the lower portion of the river (below the City of Leavenworth). The study further identified two distinct PCB source locations—one near the City of Cashmere and the second near the City of Wenatchee. Ecology concluded that both of these sources are likely unknown contaminated sites. For DDT, the study determined that the greatest inputs of DDT into the Wenatchee River are occurring during high-flow and predominantly from the Chumstick Creek and Mission Creek Basins. Irrigation returns were not found to be a large source of DDT to the Wenatchee River. The study also identified an unknown source of DDT between the USGS Peshastin gaging station and Old Monitor Road Bridge just downstream of the City of Cashmere.

The Category 5 listing for endosulfan occurs in Brender Creek, a tributary that enters the Wenatchee River at City of Cashmere, which is also listed as a Category 5 water for chlorpyrifos, a crystalline organophosphate pesticide (Ecology, 2016b). Another Category 5 listing for endosulfan occurs downstream of the City of Cashmere.

In addition to the Category 5 listings, the Wenatchee River and some of its tributaries also have several Category 4a listings for temperature, dissolved oxygen, pH, and bacteria on Ecology's current Water Quality Assessment (Ecology, 2016b). These listings occur at multiple locations throughout the length of the river. These water quality issues are being addressed through the Wenatchee River Watershed TMDLs for temperature (Ecology, 2007b), dissolved oxygen and pH (Ecology, 2009), and fecal coliform bacteria (Ecology, 2007a).

Two Category 4c listings are included for the Wenatchee River in Ecology's current Water Quality Assessment (Ecology, 2016b). River sections identified in these listings occur in the upper portion of the river (between Lake Wenatchee and the City of Leavenworth) and one between the Cities of Leavenworth and Peshastin. These flow deficiencies are attributed to consumptive water uses, particularly irrigation withdrawals.

The current Water Quality Assessment includes multiple Category 2 listings for the Wenatchee River for pH, temperature, dissolved oxygen, and 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD) (Ecology, 2016b). Most of the Category 2 listings for pH, temperature, and dissolved oxygen occur upstream from the City of Leavenworth. The

Category 2 TCDD listings occur in the segment of the river adjacent to the City of Leavenworth, between the Cities of Leavenworth and Peshastin, and downstream of the City of Cashmere.

3.5.3 Groundwater Quality

Groundwater resources in the Icicle project area consist of bedrock and discontinuous alluvial systems and are ultimately derived from rain or snowmelt (Ecology, 1995)[3]. There are two major aquifers in the Wenatchee River watershed: a lower bedrock aquifer and an overlying unconsolidated alluvial and outwash aquifer. The shallower alluvial and outwash aquifer is the main source of groundwater in the area, and in many places has a direct connection with surface waters. Although a minor part of the overall water budget in the Alpine Lakes and upper Icicle Creek portion of the Icicle project area, groundwater likely supports late season water levels in the lakes and downstream tributaries, including Icicle Creek, by discharging to surface waters when levels are lower (e.g., during the summer or fall, or as a result of lake releases from storage operations).

The quality and quantity of the alluvial and outwash aquifer is highly variable depending upon the local geology, the quality of the surface water, and the anthropogenic impacts, such as agriculture. Groundwater quality within the Upper Wenatchee River Watershed is considered to be excellent but deteriorates slightly in the Icicle Creek and Leavenworth areas, and more so moving further downstream (Ecology, 2007)[4]. Elevated nutrient content in the Peshastin and Cashmere areas may be contributing to low dissolved oxygen values in the Wenatchee River.

3.6 Water Use

Water use within the Icicle project area includes a variety of uses, including municipal, rural domestic, fish propagation, instream flows, and irrigation. This section discusses water use and is based primarily on existing state records and operational records of water users, as well as previous reports and studies on water management in the Icicle Creek Subbasin. This review does not represent an extent and validity review and is not intended to determine the validity of quantities of water available under these water rights.

3.6.1 Water Rights

3.6.1.1 Alpine Lakes Water Rights

This section provides a summary of storage water rights for the Alpine Lakes held by IPID and USFWS. This summary is based on information gathered from Ecology's water rights and Dam Safety Office files; WDNR; the USFS and the United States Bureau of

[3] https://fortress.wa.gov/ecy/publications/documents/95160.pdf
[4] https://fortress.wa.gov/ecy/publications/documents/0503018.pdf

Land Management; water right adjudication files from Chelan County Superior Court; and the Chelan County Auditor. Information about land ownership and easements authorizing water impoundment is available in Section 3.17, Wilderness Area.

Attributes of the storage water rights in the project area are provided in Table 3-9. These attributes include storage rights for Colchuck, Eightmile, Klonaqua, Square, Nada, Upper Snow, and Lower Snow Lakes. The rights on Colchuck, Eightmile, and Upper and Lower Klonaqua Lake were subject to the 1927 Icicle Creek water rights adjudication filed in Chelan County Superior Court. The storage rights for Square Lake, Nada Lake, and Upper and Lower Snow Lakes were established after the adjudication began and were not subject to the adjudication. In total, 10,500 acre-feet of storage rights were certificated by IPID, with an additional 16,000 acre-feet of storage certificated by USBR, which are now utilized by the USFWS.

Table 3-9
Attributes of Alpine Lake Storage Rights

Rights Summary Water Source	Certificate Number	Owner Listed on Certificate	Priority Date		Certificated Qi (cfs)	Certificated Qa (afy)	Adjudicated Qi (cfs)	Adjudicated Qa (afy)
Upper and Lower Klonaqua Lake	1227	IID	1926 (Class 5)		25	---	25	2,500
Eightmile Lake	1228	IID	1926 (Class 5)		25	---	25	2,500
Colchuck Lake	1229	IID	1926 (Class 5)		50	---	50	2,500
Square Lake	5527	IID	1926		10	2,000	NA	NA
Snow Lake	1591	IID	1929		25	---	NA	NA
Snow Lake	1592	IID	1929		---	1,000	NA	NA
Snow Lake	1825	USBR	1942		---	16,000	NA	NA

[1] Right confirmed for 83.33 cfs through adjudication. The right was subsequently split and a change to place of use was completed for 1.7525 cfs.
[2] Documented total storage constructed at Snow Lake is 12,000 acre-feet, shared by USFWS and IPID. Under a separate agreement, IPID is entitled to 750 acre-feet of the Snow Lake storage.

Notes: Qi = instantaneous quantity; Qa = annual quantity; cfs = cubic feet per second; afy = acre-feet per year; IID = Icicle Irrigation District; PID = Peshastin Irrigation District; USBR = United States Bureau of Reclamation; --- = not listed; NA = not applicable, these rights were not subject to the adjudication. Qi for the storage rights are a limit on the rate of diversion for storage purposes. Release rates are limited by RCW 90.03.030, which states, "Any person may convey any water which he or she may have a right to use along any of the natural streams or lakes of this state, but not so as to raise the water thereof above ordinary high water mark, without making just compensation to persons injured thereby". IID and PID have entered into a joint operating agreement that specifies PID has 40-percent interested in IID storage rights and Icicle Creek/Snow Creek diversionary rights.

Klonaqua, Eightmile, and Colchuck Lakes Storage Rights

In 1926, IID filed applications with the State of Washington Office of Supervisor of Hydraulics (an Ecology predecessor agency) requesting to divert water from Klonaqua, Eightmile, and Colchuck Lakes for seasonal irrigation. Petitions were also filed with the Washington State Department of Public Lands (a DNR predecessor) to procure the shore and overflow rights to the three lakes. The Office of Supervisor of Hydraulics issued permits to develop the lake sources and the Department of Public Lands issued an order granting "the right to overflow and perpetually inundate said lands."

In 1927, water rights to Icicle Creek and its tributaries were adjudicated in Chelan County Superior Court. The 1929 Final Court Decree affirmed IID's water right permits for the lakes in the amounts of 25 cfs, 2,500 acre-feet per year at Eightmile Lake and Klonaqua Lake, and 50 cfs, 2,500 acre-feet per year at Colchuck Lake. The decree noted that the water rights represented by the permits are "inchoate but may be perfected by compliance with provisions under which the permits were issued; that these rights for storage of water under said permits do not affect the water rights of any other claimant herein reported."

These rights were subsequently certificated by the Office of Supervisor of Hydraulics for 25 cfs (50 cfs at Colchuck Lake) for the purpose of irrigation of 7,000 acres; no annual quantities were specified on the certificates. The Proof of Appropriation (PA) filed to support certificating the storage right to Colchuck Lake indicates that, because of conditions at the site, the reservoir was not raised to the full height planned, that 1,200 acre-feet per year of water was used, and that "utilization of full storage rights necessitate a pumping unit during extreme low flow on Icicle water sheds."

Square Lake Storage Right

An application requesting to divert water from Square Lake for the purpose of irrigation was filed with the State of Washington Office of Supervisor of Hydraulics in 1926. A second application, under the same application number, was filed in 1939 to construct a reservoir and store water at Square Lake. A PA was filed in 1953, asserting completion of construction of the reservoir and distribution system in 1952 and use of up to 40 cfs for "supplementing water supply for total area embraced in Icicle and Peshastin Irrigation Districts… as adjudicated in the Icicle Water right adjudication proceedings." A single certificate was issued for 10 cfs, 2,000 acre-feet per year for irrigation of lands lying within the IPID.

Snow and Nada Lakes Storage Rights

In 1929, IID filed separate applications to appropriate water from Snow Creek and to store water in Snow Lakes. Construction of the storage project was completed in 1940 when USBR drove a tunnel between Nada Lake and Upper and Lower Snow Lakes to provide water for what is now the LNFH. In 1941, IID received two certificates authorizing 25 cfs, 1,000 acre-feet per year for irrigation of 7,000 acres lying within the lands of the IPID. In 1942, Reclamation received a water right certificate for Upper and Lower Snow Lakes in the amount of 16,000 acre-feet per year to supplement the water supply for the hatchery and holding ponds.

Information filed in support of IID's water right included a private agreement between IPID and USBR. This agreement established that USBR would build the control works and provide storage at Upper and Lower Snow Lakes and in return IPID would reduce its rights to Upper and Lower Snow Lakes from 1,000 to 750 acre-feet per year and would not call on storage from Upper and Lower Snow Lakes until water stored in IPID's other reservoirs have begun to be used. File information also indicates that only approximately 12,000 rather than 16,000 acre-feet of storage was constructed by USBR. Based on this, it appears that the current combined storage rights for Upper and Lower Snow and Nada

Lakes are approximately 12,000 acre-feet, of which IPID is entitled to 750 acre-feet per year.

In addition to the storage rights discussed above, there may be reserved rights held by the USFS for waters in the Alpine Lakes Wilderness Area that have not been quantified but could be implied under the federal reserved water right doctrine. However, these water rights would have a priority date of July 12, 1976 (the date the Alpine Area Management Act was passed) or later for lands incorporated into the wilderness area after the management act. Also, the purpose of use of these water rights would be limited to the purpose of wilderness establishment, as described in the Alpine Lakes Area Management Act.

3.6.1.2 Icicle Creek Diversion Rights

Department of Ecology records indicate there are 19 diversionary water rights on Icicle Creek and its tributaries. Cumulatively, these water rights authorize the diversion of 187.36 cfs (Table 3-10.).

Of the 19 water rights listed in Table 3-10, four are major diversions on Icicle Creek that account for 95 percent of the water diverted. These major diverters are IPID, LNFH, COIC, and City of Leavenworth, and these entities are involved in many of the projects proposed under the Icicle Strategy. The following subsections provide more detail on the diversionary water rights held by these four entities.

IPID Diversionary Water Rights

IPID holds diversionary rights to Snow and Icicle Creeks totaling 117.71 cfs (two issued to IID one issued to PID). These water rights were subject to the 1927 Icicle Creek water rights adjudication and have 1910 and 1919 priority dates. The IPID diversion is located at RM 5.7 on Icicle Creek and consists of gravity flow headworks. The water is then conveyed through canals out of basin and into the Wenatchee Valley where it is applied to commercial and residential lands. IPID manages the storage rights discussed above to ensure adequate flow at their point of diversion to satisfy their diversionary rights. An annual quantity is listed on only one of IPID's three water rights. The one water right with an annual quantity authorizes the use of 25,000 acre-feet per year. IPID irrigates 7,000 acres with these water rights. Based on flow measurements at their diversion point, IPID generally diverts the entire quantity authorized under their Icicle Creek water rights.

Table 3-10
Icicle Creek Surface Water Rights

Water Right No.	Person or Organization	Priority Date	Purpose of Use	Qi (cfs)	Qa (afy)	Source Name
S4-*35007JWRIS	Simons, R E	01/01/1901	IR	0.17	50.00	Icicle Creek
S4-*35008JWRIS	Brisky, O	01/01/1901	IR	1.00	300.00	Icicle Creek
S4-*35009JWRIS	Fromm, S J	01/01/1901	IR	0.08	25.00	Icicle Creek

S4-*35010JWRIS	Fromm, S J	01/01/1901	IR	1.00	300.00	Icicle Creek
S4-*35001JWRIS	Cascade Orchards Inc	01/01/1905	IR	11.90	2,065.00	Icicle Creek
S4-CV1P170	Cascade Orchards Inc	01/01/1905	IR	0.20	--	Icicle Creek
S4-*35002ABBJWRIS	Icicle Irrigation District	04/01/1910	IR	81.58	25,000.00	Icicle Creek
S4-CV1P224	Icicle Irrigation District	04/01/1910	IR	1.75	--	Icicle Creek
S4-*35003ABBJWRIS	Snow Creek Water Users Inc	10/14/1910	IR	4.00	450.00	Snow Creek
S4-*35004JWRIS	City of Leavenworth	01/01/1912	MU	1.52	--	Icicle Creek
S4-*00329CWRIS	Peshastin Irrigation District	10/27/1919	IR	34.38	--	Icicle Creek
S4-CV1P18	Snow Creek Water Company	01/03/1922	IR	--	--	Snow Creek
S4-*05300CWRIS	USFS Wenatchee	11/06/1940	DM	0.05	--	Chatter Creek
CS4-01824C@2	USFWS Leavenworth Fisheries Complex	03/26/1942	FS	42.00	27,482.00	Icicle Creek
S4-*16124CWRIS	City of Leavenworth	06/20/1960	MU	1.50	--	Icicle Creek
S4-24376CWRIS	Falzon, D	08/03/1976	IR	0.05	10.00	Icicle Creek
S4-26394	Schmidt, W E	09/27/1979	DS, PW	3.00	1.00	Bridge Creek
S4-28122	City of Leavenworth	01/28/1983	MU	3.18	636.00	Icicle Creek

Source: Ecology, Water Resources Explorer, https://fortress.wa.gov/ecy/waterresources/map/WaterResourcesExplorer.aspx
Notes: Qi = Instantaneous Quantity; cfs = cubic feet per second; Qa = Annual Quantity; afy = acre-feet per year; FS = Fish Propagation; IR = Irrigation; MU = Municipal; DS = Single Domestic; PW = Power Generation; DM = Multiple Domestic

USFWS Diversionary Water Rights

USFWS holds diversionary rights to Icicle Creek that authorize the diversion of 42.00 cfs at RM 4.5. The water right authorizes the use of 27,482 acre-feet per year for fish propagation at LNFH. LNFH has an intermediate force-release performance goal of 1.2 million fish under U.S. v. Oregon, with that goal ultimately increasing to 1.625 million fish. This water right was changed in 2011 via a Chelan County Water Conservancy Board Decision to add a point of diversion at RM 2.8 in the hatchery spillway pool. This additional point of diversion is to be used on a contingency basis should the original point of diversion at RM 4.5 fail to provide sufficient water. The water use is considered non-consumptive and returns to Icicle Creek just below LNFH at approximately RM 2.6. This water right was not subject to the Icicle Creek adjudication, having a 1942 priority date. While diversionary records are not currently available, the change Report of Examination (ROE) and operations indicate the water right is likely in good standing.

COIC Diversionary Water Rights

COIC shares a point of diversion on Icicle Creek with LNFH at RM 4.5. Their water rights provide for the diversion of 11.9 cfs for irrigation of 600 acres. COIC has a 1905 priority date, as confirmed in the Icicle Creek water rights adjudication, and serves lands just south of the City of Leavenworth. In 1940, COIC applied to change a portion of their water right to provide water to LNFH, which was granted by Ecology in the form of Certificate of Change S4-CV1P170. According to the COIC Alternatives Analysis published in 2015, COIC uses approximately 2,000 acre-feet per year, with a peak diversion rate of about 8.0 cfs. LFNH uses the remaining 3.9 cfs authorized under the COIC water right in exchange for maintenance of the diversion infrastructure (WWT, 2015).

City of Leavenworth Diversionary Water Rights

City of Leavenworth has rights to divert 6.2 cfs from Icicle Creek. Their point of diversion is located at RM 5.7, across Icicle Creek from IPID's diversion. The priority dates of City of Leavenworth's water rights ranges from 1912 to 1983, with one of their water rights being adjudicated. The purpose of use for the water rights is municipal, which encompasses uses such as domestic, commercial, and irrigation. The City of Leavenworth has an estimated water service area population of 2,419 people.

The City of Leavenworth also has one pending water right application and several rejected water right applications for water from Icicle Creek for municipal use. As discussed in Section 1.7, Litigation Related to Water Management in the Icicle Creek Watershed, City of Leavenworth appealed Ecology permitting decisions regarding the quantity of their water rights. That litigation is currently on hold pending the outcome of comprehensive water resource planning.

In addition to the Icicle Creek diversion, the City of Leavenworth has groundwater rights, with points of diversion near RM 27.2 of the Wenatchee River. This location is approximately 0.6 mile upstream of the confluence of Icicle Creek and the Wenatchee River. These wells are drilled to approximately 94 and 106 feet deep and have state water rights authorizing the withdrawal of 1,190 acre-feet per year. The City maintains both sources for redundancy purposes, with the Icicle diversion being operational without power. Based on conversations with the City Manager, the City of Leavenworth may be amenable to exercising water made available through the Icicle Strategy from their Wenatchee River well field rather than their Icicle Creek diversion.

Much of the water diverted from Icicle Creek under the above described water rights is used for water service. The three water purveyors, City of Leavenworth, IPID, and COIC, provide water to approximately 3,250 parcels, although some parcels might be counted twice because of dual service (i.e., indoor water provided by City of Leavenworth and outdoor water provided by an irrigation district). Table 3-11 illustrates how many parcels are served by IPID, COIC, and City of Leavenworth. Additionally, this table shows parcels served by size class. As would be expected, the bulk of parcels served by the City of Leavenworth are smaller, less than half an acre in size, while the irrigation districts tend to serve larger parcels that are at least half an acre in size or more. It should be noted

that some of the larger parcels served by the City may also have IPID or COIC service for outdoor irrigation.

Table 3-11
Number of Parcels Served by Entity per Parcel Size Class

Parcel Size	Parcels Served per Entity		
	City	COIC	IPID
0.00-0.10	108	0	0
0.11-0.25	552	0	128
0.26-0.50	270	12	234
0.51-1.00	150	65	361
1.01-2.00	122	118	353
2.01-3.50	36	19	135
>3.50	41	41	508
Total	1,279	255	1,719

3.6.1.3 Wenatchee River Watershed Instream Resources Protection Program

Ecology is required by state law to retain adequate amounts of water in streams to protect and preserve instream resources and uses, such as fish, wildlife, recreation, aesthetics, water quality, and navigation. Ecology does this through the implementation of instream flow rules. Per Chapter 90.22 RCW, Ecology can establish minimum flows or levels on streams and lakes by regulation. This statute sets forth the process for adopting instream flow rules. Instream flow rules are water rights, and consequently, have a priority date consistent with the date they are enacted.

Instream flow rules for The Wenatchee River Watershed are set forth under Chapter 173-545 WAC. The rule was originally adopted in 1983. All water rights in the Wenatchee River Watershed with a later priority date are junior to the instream flow rule and are subject to interruption when instream flows are below the targets prescribed in the rule. The rule was amended December 11, 2007, based on local watershed planning. The control point in Icicle Creek for measuring minimum instream flows is the Ecology gage 45B070 located downstream of LNFH. Figure 3-6 provides a graph of Icicle Creek minimum instream flows as set in WAC 137-545-060(1) compared to the 2015-year flows measured for Icicle Creek at Ecology gage 45070, and Figure 3-6 compares 2016 flows with the flows prescribed in WAC 137-545-060(1). Note, 2015 was a state-declared drought year, while 2016 was not. Minimum instream flows were not met either of these years and are generally not met in throughout the year in "average" years.

The Wenatchee Instream Flow Rule also established a reserve to the Icicle Creek Subbasin (WAC 173-545-090). This reservation was created with an OCPI determination and was affirmed through 2016 legislation after the Swinomish v. Ecology Washington Supreme Court Decision, which limited the use of OCPI determinations for creating reserves to instream flow rules. The reserve allows for the use of 0.1 cfs of water, with an additional 0.4 cfs to be considered after completion of flow restoration efforts targeting habitat on Icicle Creek between RM 5.7 and RM 2.7. Water uses established under the Icicle Creek reserve are not subject to the instream flows established in WAC 173-545-060.

The Wenatchee Instream Flow Rule also prescribes flows in the Wenatchee River at several control points. However, these flows are often not met in drought years, and are regularly not met in average water years. Figure 3-7 shows the Wenatchee Instream Flow Rule at the monitor gaging station with dry, average, and wet year flows.

Figure 3-6. Instream Flow Rule for Icicle Creek and 2015 Flows

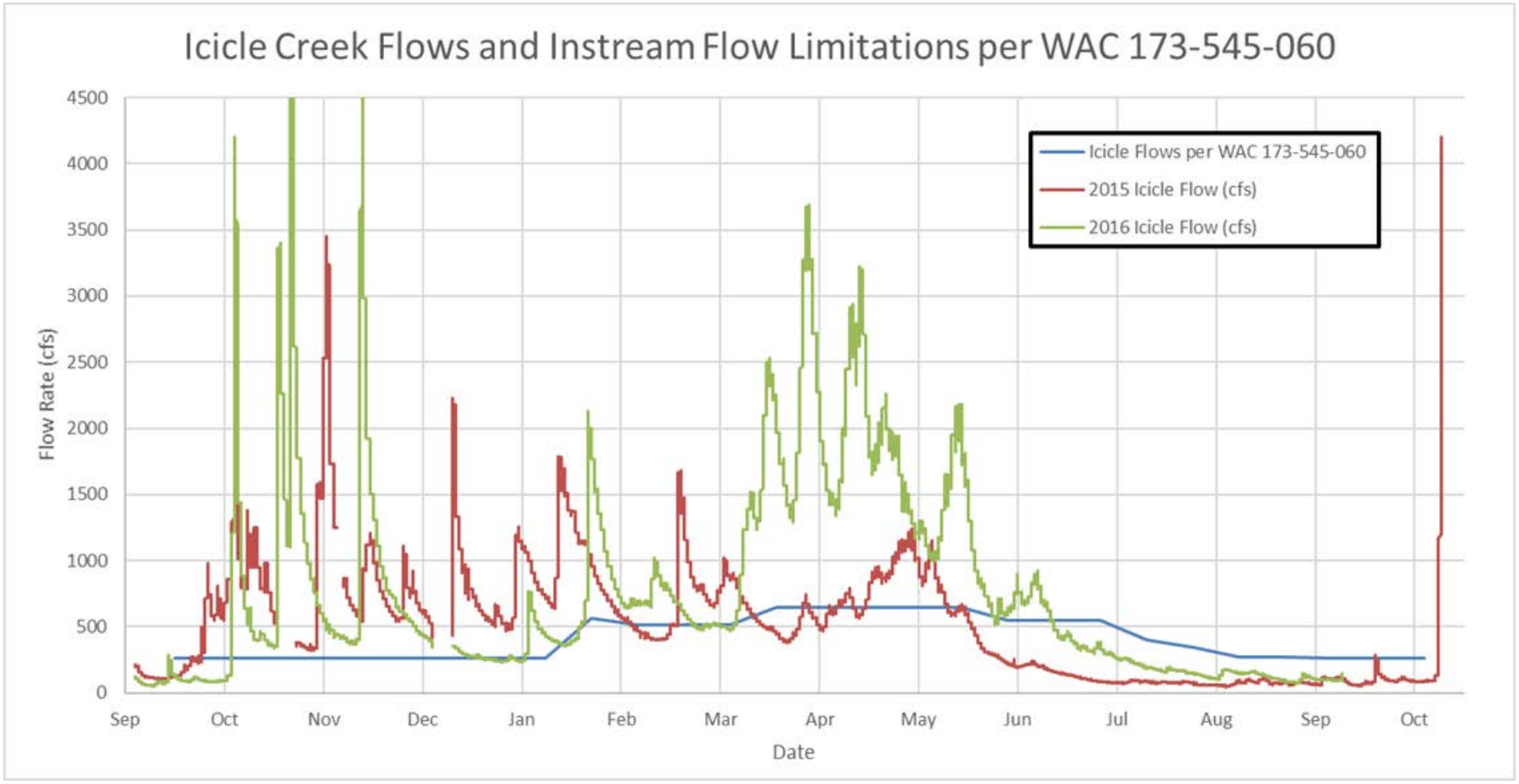
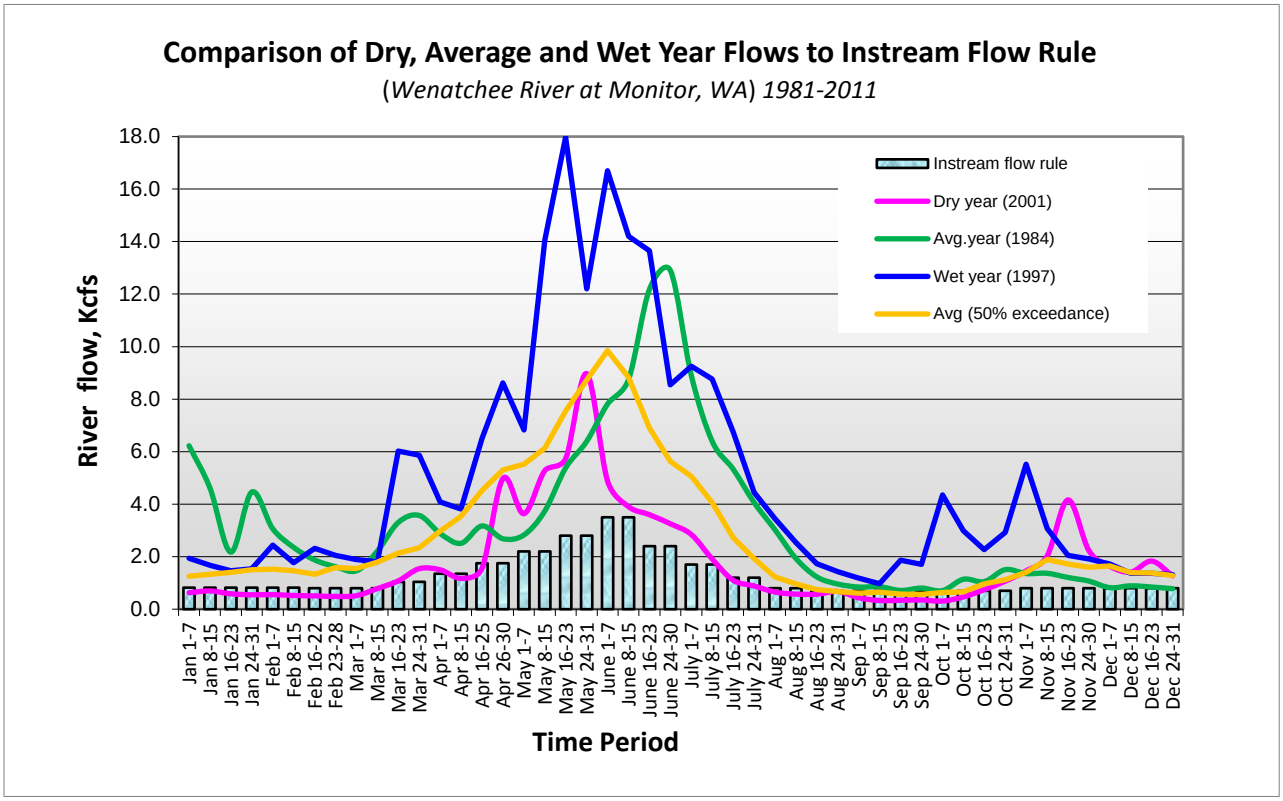


Figure 3-7. Wenatchee Instream Flow Rule at Monitor

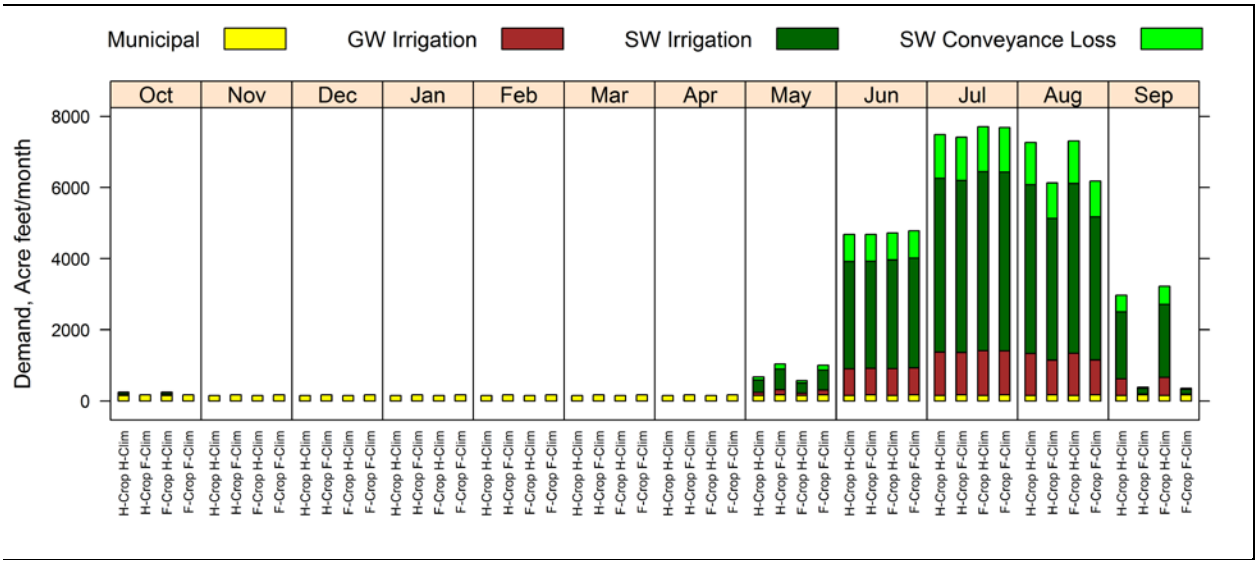


3.6.1.4 Wenatchee Valley Water Rights

The Wenatchee Valley supports a myriad of water uses from municipal to agricultural. Based on Ecology's records, there are approximately 130 active water right records with the Wenatchee River listed as the primary source. Of these, there are 47 interruptible water rights in the Wenatchee Valley, with 34 being irrigation rights. These interruptible water rights account for 5.6 cfs and 1,150 acre-feet per year. The remaining Wenatchee Valley Water Rights account for 10,345 cfs, 32 percent of which is for fish propagation purposes, which is non-consumptive in nature.

The 2016 Columbia River Basin Long-Term Water Supply and Demand Forecast looked at historical and projected future water use demands in the Wenatchee River Watershed by use category. Figure 3-8 illustrates how much water per month has been used historically and is forecasted to be used through 2035. This does not account for instream flow water rights, which the report concluded is the highest demand use in the Wenatchee River Watershed. Figure 3-9 shows the total demand, including instream flow, compared with various flow scenarios.

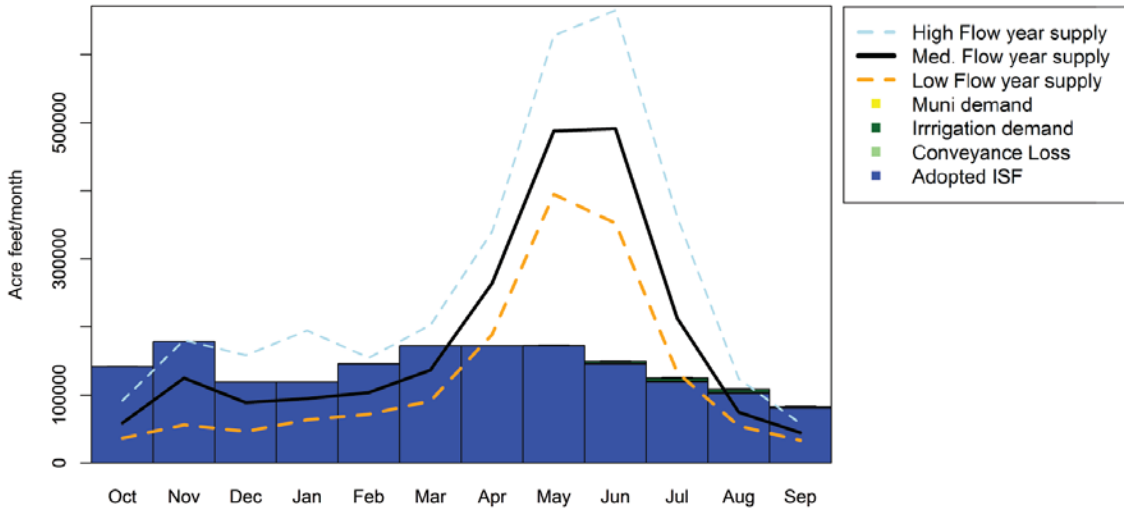
Figure 3-8. Historical and Projected Demand in the Wenatchee River Watershed



Source: Ecology, 2016, *2016 Columbia River Basin Long-Term Water Supply and Demand Forecast*

Note: H-Corp H- Clim = Historical Crops, Historical Climate; H- Crop F- Clim = Historical Crops, Future Climate; F- Crop H- Clim = Future Crop, Historical Climate; F-Crop F- Clim = Future Crops, Future Climate, where H-Crop represents historical crop mix (1981 to 2011); F-Crop as future crop mix (2035) under medium economic scenario; h-Clim as historical climate (1981 to 2011) and F-Slim values represent demand forecast under IPCC 4.5 centering 2035.

Figure 3-9. Comparison of Surface Water Supply and Demand (1981 to 2011)



Source: Ecology, 2016, *2016 Columbia River Basin Long-Term Water Supply and Demand Forecast*

3.6.2 Water Resource Infrastructure

Water Resources Infrastructure includes constructed impoundments (e.g., reservoirs), diversion infrastructure (e.g., diversion boxes and groundwater wells), and conveyance infrastructure (e.g., pipes and canals). A summary of the key water resource infrastructure and water uses are described in the following sections.

3.6.2.1 Storage Reservoirs

There are seven man-made reservoirs in the Icicle project area that coincide with the existence of former natural lakes. Those reservoirs are known as Square, Klonaqua, Eightmile, Colchuck, Upper Snow, Lower Snow, and Nada Lakes.

Square Lake

INFRASTRUCTURE DESCRIPTION

Square Lake is the most hydrologically distant reservoir in the system. Man-made improvements were constructed at Square Lake between the 1920s and 1950s with the goal of impounding approximately 2,400 acre-feet with an operational range of 31 feet. The purpose of storage is to make water seasonally available for irrigation within the IPID service area. Infrastructure at the lake consists of a rock-masonry dam structure that has artificially raised the maximum water surface elevation of the lake from 4,954 feet to approximately 4,985 feet. Mechanical outlet controlling works were also installed and consist of a 30-inch diameter cast iron slide gate with an above-grade mechanized handwheel actuator. The gate itself is installed near the exit of the outlet tunnel, which was blasted through bedrock (approximately 300 linear feet of 5-foot wide by 7-foot tall tunnel). Together, the improvements allow for an active storage volume of approximately 2,130 acre-feet and a release quantity of up to 35 cfs[5]. Other man-made improvements include approximately 230 feet of constructed channel that confluences with the natural channel approximately 260 feet downstream of the lake (spillway). A man-made weir structure was historically used for flow measurement; however, it is in disrepair and is no longer used.

Improvements to Square Lake were reviewed and approved by Washington State Department of Hydraulics in 1939.

OPERATION

Square Lake is one of four storage sites in the Alpine Lakes Wilderness actively managed by IPID. During typical years, only one or two of the lakes is actively managed to increase late summer releases to the Icicle Creek. During drought years, water is withdrawn from most of the lakes. Because Square Lake is more remote and difficult to access, it is operated less frequently than other lakes such as Colchuck and Eightmile Lakes.

During the years when Square Lake is actively managed, IPID personnel hike approximately 13 miles (one way) to the lake to open the gate to start releasing water in July. IPID personnel return in Late September or October to close the gate after the lake has been drawn down and the irrigation season is over. Water flows from the tunnel and

[5] Flows have been measured as high as 35-cfs as recently as 2016; however, significantly higher flows are likely achievable during lake-full conditions.

discharge channel to Prospect Creek, which flows to Leland Creek, which is a tributary to Icicle Creek. The lake refills during the spring when the gate is closed. When the lake is full, water flows over the dam spillway to Prospect Creek. Water continues to flow through the lake and over the dam spillway uncontrolled until the gate is opened again. Although Square Lake is only utilized on a rotational basis, the lake has the potential to refill annually (Aspect and Anchor QEA, 2015).

Upper and Lower Klonaqua Lake

INFRASTRUCTURE DESCRIPTION

Upper and Lower Klonaqua Lake are the second most hydrologically distant lakes and include both an upper and lower lake (two lakes total); however, only one lake (Lower Klonaqua) has been improved to allow for active storage / release of water without pumping. Permanent man-made improvements were constructed at Lower Klonaqua in the 1920s and 1930s with the goal of impounding approximately 2,500 acre-feet of water by IID. The purpose of stored water is for seasonal release into French Creek / Icicle Creek (conveyance purposes) and recapture similar to release from Square Lake. Infrastructure at the lake consists of an earthen and rock-masonry dam structure and spillway that has artificially raised the maximum water surface elevation of the lake to approximately 5,094 feet with an operational range of 28 feet. The dam itself is approximately 10 to 12 feet wide at the dam crest. Mechanical outlet controlling works were also installed as part of the original construction and consist of a 30-inch diameter cast iron slide gate with above-grade mechanized handwheel actuator positioned in a vertical gate shaft accessible from the surface. As-built drawings indicate the outlet works tunnel was constructed as a combination of blasting and cut / cover piping.

Based on LiDAR survey and field observations, the improvements allow for an active storage volume of approximately 1,690 acre-feet. Other man-made improvements include approximately 60 feet of constructed channel that confluences with the natural channel approximately 200 feet downstream of the lake (spillway). The existing outlet tunnel has partially collapsed and is due for maintenance; however, storage release flows of up to 25 cfs[6] have been measured as recently as July 2016 despite apparent flow obstructions.

OPERATION

Klonaqua Lake is one of the four storage sites in the Alpine Lakes Area managed by IPID. During an average water year, only one or two of the IPID-managed lakes is actively managed to increase late summer releases to Icicle Creek. Because Klonaqua Lake (Lower) is more remote and difficult to access, it is operated less frequently than Colchuck and Eightmile Lakes.

During the years when Klonaqua Lake is actively managed, IPID personnel hike more than 10 miles (one way) to the Lower Klonaqua Lake to open the gate in July. IPID personnel return to close the gate in late September or October when the lake is drawn down and the irrigation season is over.

[6] Flows have been measured as high as 25 cfs; however, significantly higher flows are likely achievable during lake-full conditions.

When the gate is open, water discharges through the tunnel and discharge channel to an unnamed creek, which flows to French Creek, which is a tributary to Icicle Creek. Based on recent experience and observations from IPID personnel, Lower Klonaqua Lake typically refills by the summer following the irrigation season when the lake is drawn down. When the lake is full, water flows over the dam spillway. Water continues to flow through the lake and over the dam spillway uncontrolled until the gate is opened again.

Eightmile Lake

INFRASTRUCTURE DESCRIPTION

Eightmile Lake is a tributary reservoir of Eightmile Creek, which has a confluence with Icicle Creek at approximately RM 9.0. Man-made improvements were constructed at Eightmile Lake in the 1920s, resulting in an approximate reservoir elevation of 4,671 feet and a 27-foot operational range originally. This lake functions similar to the other IPID-managed lakes in that water is seasonally released and conveyed through natural channels to the IPID diversion at RM 5.7 of Icicle Creek.

Infrastructure at Eightmile Lake is a combination of earthen embankment and rock-masonry dam and spillway structure with a slide gate controlling the outlet works in the lake during lake-full conditions. The controlling works at Eightmile Lake included a rock-masonry tower positioned above the outlet pipe that supported a handwheel actuator for the outlet gate that controls flow from the lake to low-level outlet pipeline. The rock-masonry tower was destroyed, and the gate actuator was damaged by ice or debris flows (leaving only the gate and partial stem intact). The gate at Eightmile Lake is functional; however, IPID attaches a log to the gate stem to use as a come-along to open and close the gate. In addition, rocks and debris that settle against the gate make it difficult to open and close.

A portion of the existing earthen embankment portion of the dam at Eightmile Lake was eroded during flooding, which has reduced the maximum water surface elevation by at least 4 feet and has limited the storage available for release without the use of pumps or a siphon. The condition of the existing facilities at Eightmile Lake has limited the active storage volume to 1,370 acre-feet with an operational range of 23 feet.

In addition, portions of the low-level outlet pipeline have collapsed. IPID has noticed a significant, recent reduction in the capacity of the low-level outlet as a result of the constriction in the pipe caused by these collapses. IPID has noted that if the low-level outlet capacity is not restored by the time another drought occurs, they will be very limited in their ability to sustain irrigation supplies diverted from Icicle Creek because of diminished flows.

The Jack Creek fire burned much of the upland watershed, including up to the shore of Eightmile Lake, in the summer of 2017. The fire burned trees and brush over a large catchment of Eightmile Lake. The hydrologic characteristics of runoff from the watershed are likely to change due to the burn, resulting in much higher peak runoff rates in the short term during large storm events. These changes increase the risk of potential overtopping and erosion of the embankment, or even complete failure of the existing dam at Eightmile Lake. To address this risk, IPID declared an emergency on March 13, 2018

and is working with Chelan County, Ecology's Dam Safety Office, USFS, National Weather Service, and others to develop and implement emergency action procedures.

OPERATION

Eightmile Lake is one of the four storage sites in the Alpine Lakes Wilderness Area that are managed by IPID. During a typical year, only one of the IPID-managed lakes is actively managed to increase late summer releases to the Icicle Creek. Because of its proximity to Icicle Creek and relative ease of access, the controls at Eightmile Lake are operated more frequently than the controls at the more remote lakes.

The gate on the low-level outlet pipe of Eightmile Lake controls releases from the lake. To actively manage the storage in Eightmile Lake, IPID personnel hike approximately 4 miles (one-way) to the lake to open the gate on the discharge pipeline in July. IPID personnel return to close the gate in late September or October when the lake is drawn down and the irrigation season is over. Release flows as high as 22 cfs[7] were measured from Eightmile Lake during summer 2016.

When the gate is open, water discharges through the low-level outlet to Eightmile Creek, which is a tributary to Icicle Creek. Based on recent experience and observations from IPID personnel, the lake typically refills by the summer following the irrigation season when the lake is drawn down. The active storage capacity available for release and the equivalent volume that has to be refilled is limited by the condition of the dam at the outlet. When the lake is full, water flows over a deteriorated dam spillway outlet to Eightmile Creek. Water continues to flow through the lake uncontrolled until the gate is opened again.

Colchuck Lake

INFRASTRUCTURE DESCRIPTION

Like Eightmile, Colchuck Lake is a tributary reservoir of Eightmile Creek, which has a confluence with Icicle Creek at approximately RM 9.0. Man-made improvements were constructed at Colchuck Lake in the 1920s and 1930s, raising the elevation level to 5,563 feet with an operational range of 17 feet. This lake functions similar to the other IPID-managed lakes in that water is seasonally released and conveyed through natural channels to the IPID diversion at RM 5.7 of Icicle Creek.

Infrastructure at this lake includes a concrete / rock-masonry dam and spillway with a slide gate controlling the outlet works in the lake during lake-full conditions. The controlling works at Colchuck Lake include a rock-masonry tower positioned above the outlet pipe that supports a handwheel actuator for the outlet gate. The control tower is accessible by footbridge. IPID has made recent improvements to the lake, including installation of a buried liner near the dam to limit unwanted seepage. A controlled outlet from the lake generally follows natural channel alignment.

The existing facilities at Colchuck Lake allow for an active storage volume of 1,480 acre-feet with an operational range of 17 feet.

[7] Flows have been measured as high as 22 cfs; however, higher flows may be achievable during lake-full conditions.

OPERATION

Colchuck Lake is one of the four storage sites in the Alpine Lakes Wilderness Area that are managed by IPID. During an average water year, only one of the IPID-managed lakes is actively managed to increase late summer releases to the Icicle Creek. Because of its proximity to Icicle Creek and relative ease of access, the controls at Colchuck Lake are operated more frequently than the controls at the more remote lakes.

The configuration of the dam and infrastructure at Colchuck Lake is similar to Eightmile Lake. The gate, which is located at the inlet to a corrugated metal low-level outlet pipe, controls releases from the lake. To actively manage the storage in Colchuck Lake, IPID personnel hike approximately 4 miles (one way) to the lake to open the gate on the discharge pipeline in July. IPID personnel return to close the gate in late September or October when the lake is drawn down and the irrigation season is over. Release flows as high as 25 cfs[8] were measured from Colchuck Lake during summer 2016.

In the fall of 2012, IPID lowered the lake level at Colchuck Lake sufficiently to perform maintenance on the dam and the control gate. Concrete was added to repair the dam and plug holes in the foundation, which had been leaking. Debris and logs that had built-up on the upstream side of the dam were removed. Maintenance was performed on the control gate and a plank was installed to improve access to the gate. Additional maintenance was performed in fall of 2016 to reduce seepage losses through the dam infrastructure.

Water discharge from Colchuck Lake flows through the low-level outlet pipe to an unnamed creek, which flows to Mountaineer Creek and subsequently Eightmile Creek, which is a tributary to Icicle Creek. Based on recent experience and observations from IPID personnel, the lake typically refills by the summer following the irrigation season when the lake is drawn down. When the lake is full, water flows over the dam spillway outlet to the unnamed creek. Water continues to flow through the lake uncontrolled until the gate is opened again.

Upper and Lower Snow Lakes and Nada Lake

INFRASTRUCTURE DESCRIPTION

Upper Snow Lake, Lower Snow Lake, and Nada Lake drain to Snow Creek, which is another tributary to Icicle Creek. Reservoir improvements at the lakes consist of three man-made dams and one constructed tunnel. The dams operate to provide maximum normal water surface elevations of 5,433 feet at Upper Snow Lake and 5,429 feet at Lower Snow Lake, and control outflow on Nada Lake. The Lower Snow Lake Dam is a rock-masonry structure constructed across the natural outlet to Snow Creek. There is not currently any control of the flow of water through Lower Snow Lake Dam. Water flows freely over the dam to Snow Creek when the lake is full.

The Upper Snow Lake Dam is also a rock-masonry structure that controls flow from Upper Snow Lake to Lower Snow Lake. When Upper Snow Lake is full, water flows over the dam to Lower Snow Lake and on to Snow Creek. When the Upper Snow Lake is

[8] Flows have been measured as high as 25 cfs; however, significantly higher flows may be achievable during lake-full conditions.

drawn down sufficiently, water flows from Lower Snow Lake back to Upper Snow Lake through an opening at the base of the Upper Snow Lake dam controlled by a flap gate. The flap gate is designed to allow for one-way flow from Lower Snow Lake back to Upper Snow Lake, but the USFWS has indicated that the gate leaks. Upper Snow Lake has an operational range of approximately 160 feet that is controlled through an outlet works tunnel between Upper Snow and Nada Lakes. The tunnel was constructed in the 1930s and involves three controlling valves that are operated in sequence to control releases. Once the system is operating, only one valve is required to modulate flow from Upper Snow Lake to Nada Lake.

A dam reconstruction project was completed at Nada Dam, downstream of Upper and Lower Snow Lakes, in 2009. The new dam at the outlet from Nada lake is not currently being used to control the water level in the lake. The dam is a concrete structure with two bays for stop-logs or future slide gates. A Parshall flume was installed below the dam for flow measurement and monitoring. Flow depth is recorded by battery powered monitoring equipment in a stilling well adjacent to the flume. A solar panel is used for recharging the batteries of the monitoring equipment (Aspect/Anchor, 2015).

Based on a 2016 LiDAR survey, the active storage of the Snow Lakes is estimated at 12,590 and 140 acre-feet, respectively.

OPERATION

Upper and Lower Snow Lakes and Nada Lake are operated by the USFWS as part of their management of the LNFH. The operation of these facilities was reviewed in the following recent studies:

- *Management Recommendations for Reservoir Releases from Upper Snow Lake: Leavenworth National Fish Hatchery* (Wurster, 2006)
- *Water Storage Report, Wenatchee River Basin* (Anchor QEA, 2011)

The lakes are operated jointly to increase late summer flows in Snow Creek, which is a tributary to Icicle Creek. The increased flows to Icicle Creek help supply the LNFH's operational requirements (approximately 40 cfs between June and October) and supplement flow in Icicle Creek.

Upper Snow Lake

Upper Snow Lake is actively managed by the USFWS. Water is released from Upper Snow Lake to Nada Lake through the outlet works tunnel and penstock. LNFH personnel hike to a valve shed above Nada Lake (more than 6 miles one way) to open the valve on the penstock in July each year. The valve remains open during the late summer months, typically between mid-July and mid-October. LNFH personnel may return to the lake to adjust the valve during that time to increase the rate of release. Historically, the valve was open an average of 77 days each year between 1998 and 2005, with an average annual release of 3,700 acre-feet (Wurster, 2006).

The USFWS currently operates Upper Snow Lake in accordance with the *Management Recommendations for Reservoir Releases from Upper Snow Lake: Leavenworth National Fish Hatchery* (Wurster, 2006). The USFWS currently releases approximately 7,000

acre-feet from Upper Snow Lake to Nada Lake from July to October. Releases start around 30 cfs in late July and may increase to 60 cfs as natural flows in Icicle Creek drop. After the valve on the outlet is closed in the fall, Upper Snow Lake refills. For 6 of the 7 years (1998 to 2005, excluding 2000) that were evaluated in the *Management Recommendations for Reservoir Releases from Upper Snow Lake: Leavenworth National Fish Hatchery*, Upper Snow Lake was full by the time the valve was opened the following summer. The only year when Upper Snow Lake did not fully refill was 2001, which was a drought year.

At the end of the summer when Upper Snow Lake has been drawn down, the water level in Upper Snow Lake is typically lower than the water level in Lower Snow Lake. Water flows from Lower Snow Lake to Upper Snow Lake through a small (approximately 9-square-foot) hole and flap gate at the base of Upper Snow Lake Dam. In 2005, it was estimated that approximately 200 acre-feet of water passed through the opening.

More information regarding the current condition and operations of the infrastructure is available in the Draft Environmental Assessment issued in 2017 (USBORUSBR, 2017). This assessment was completed to analyze the impacts of installing a new valve at the Upper Snow Lake outlet.

Lower Snow Lake

Lower Snow Lake is not actively managed by USFWS. When Lower Snow Lake is full, water spills over the dam or discharges to Snow Creek through a breach that was identified on the east side of the dam during the 2008 *Safety Evaluation of Existing Dams (SEED) Inspection* (WW Wheeler and Associates, 2009a). Water was observed in the channel downstream of the dam during a site visit on September 25, 2009. During that site visit, the water level behind the dam was 2 to 3 feet lower than the crest of the dam, which indicates that water still flows from the lake through a breach or through leaks in the dam, even when the water level is below the crest of the dam.

Hydrologic Monitoring

The USFWS monitors flows at four sites within the Snow Creek Subbasin. Flows are monitored on Snow Creek at the inflow to Upper Snow Lake, at the penstock that discharges from Upper Snow Lake to Nada Lake, at the flume at the outlet of Nada Lake, and at the confluence with Icicle Creek. The USFWS has actively monitored these sites since 2004 using data loggers to collect data over extended periods of time. This data helps the USFWS manage releases from the lakes.

3.6.2.2 Diversion Infrastructure

Use associated with surface water diversion infrastructure is described in Section 3.19 (Utilities); however, additional description is provided below. There are three significant diversion facilities along Icicle Creek, including surface water diversion for IPID, COIC, City of Leavenworth, - LNFH, and USBR. There are also many individual irrigation diversions that are not specifically identified herein. Furthermore, LNFH also utilizes groundwater well sources for supply.

IPID Diversion

The IPID diversion includes both an in-channel reinforced concrete dam / spillway and a controllable concrete intake structure on the right bank of Icicle Creek at RM 5.7 (controllable with flashboards). The intake structure was recently rehabilitated by IPID in 2015 to improve efficiency. Water is diverted to a reinforced concrete channel. Headgates and an overflow in the diversion channel downstream of the intake structure provide additional control of flow in IPID diversion channel. A rotating drum fish screen at the downstream end of the diversion channel delivers flow to the IPID Division 1 Canal. A bypass delivers excess flow and fish back to Icicle Creek at the fish screen. Flow is measured in a rated section of the channel downstream of the headgates. Diverted quantities at this location are approximately 117 cfs.

City of Leavenworth

The City of Leavenworth utilizes a surface water diversion from Icicle Creek at RM 5.7, on the left bank of Icicle Creek across the creek from IPID's diversion facilities. Both facilities draw from the pool created by the IPID Diversion Dam. City of Leavenworth facilities include a vertical flat panel fish screen in a reinforced concrete enclosure that protects the screen and diversion facilities from ice and debris. A gate on the upstream side of the enclosure is opened to provide sweeping velocity across the screen. Diverted quantities by the City of Leavenworth are approximately 6.2 cfs at this location.

COIC / LNFH Diversion

COIC and LNFH share a diversion at RM 4.5. The diversion includes an in-channel reinforced concrete dam / spillway with a fish ladder, a fish screen, and a gate house that controls flow from the creek to buried pipeline. Water flows through approximately 1,400 feet of buried pipeline to a bifurcation facility that splits flow to the COIC and LNFH systems. The bifurcation includes a large valve on the pipeline that can be opened to release flow from the pipeline to a reinforced concrete box operated by COIC. The concrete box includes a rotating drum fish screen, an overflow bypass, and a weir that measures flow delivered to COIC. Flows not delivered to COIC at the bifurcation are conveyed to LNFH. Diverted quantities at this location are approximately 8 cfs delivered to COIC, with the remaining 3.9 cfs authorized under their right going to LNFH, and up to 46 cfs, delivered to LNFH.

3.7 Fish

This section describes the fish species and life stages present, their distributions, species status, and habitat conditions within the project area. Aquatic invertebrate community structure and influence of habitat conditions are also described. Information on special-status species is provided in Section 3.10, Threatened and Endangered Species. Information on tribal fishing harvest is provided in Section 3.23, Indian Trust Assets and Tribal Fish Harvest.

3.7.1 Alpine Lakes

The Alpine Lakes are included in a group of mountain lakes managed in Washington as "high lakes," which in Eastern Washington are generally considered to be those occurring at an elevation greater than 3,500 feet. Historically, most of the high lakes of Washington lack suitable spawning habitat or productive conditions for rearing juveniles, and probably contained no fish prior to introductions of sport fish by humans (Wydoski and Whitney, 2003). Currently, Washington's high lakes are managed to "protect, restore, and enhance fish populations and their habitats in high lakes while maximizing recreational opportunities consistent with natural resource protection guidelines" (Uehara, 2009). The high lakes fishery is now managed by WDFW to support recreation goals in balance with environmental considerations (Pfeifer, Swayne, and Curtis, 2001). Fish abundance and stocking are tracked by WDFW with the help of volunteer high lakes fishing organizations.

Human introduction of trout and char into the high lakes began as early as the late nineteenth century by settlers, loggers, and miners, and perhaps even earlier by Native American tribes. Some lakes were still periodically stocked by WDFW and volunteers into the 2000s to support a high lakes recreational fishery; however, the majority remain fishless (WDFW, 2016a). Although some lakes have self-sustaining populations, the stocked lakes are managed to sustain low densities and more recently are stocked with fish that would not reproduce successfully, limiting the likelihood of unmanaged population growth in the lakes (Pfeifer, Swayne, and Curtis, 2001).

All of the lakes included in the Icicle Strategy were stocked in the past, but stocking has been discontinued because of lack of funding or sufficient natural reproduction (Maitland, 2016). All lakes were stocked with westslope cutthroat trout (*Oncorhynchus clarki lewisi*) at one time, some with rainbow trout (*O. mykiss*), and some with non-native eastern brook trout and lake trout (*Salvelinus fontinalis* and *Salvelinus namaycush*) (Table 3-12).

Table 3-12
Summary of Alpine Lakes Trout Stocking Status

Lake	Trout Species	Last Year Stocked
Colchuck Lake	Cutthroat	2000
Eightmile Lake	Cutthroat, Rainbow, Lake	2005
Lower Klonaqua Lake	Cutthroat, Rainbow	1970
Upper Klonaqua Lake	Cutthroat	1970
Nada Lake*	Eastern Brook	Unknown
Lower Snow Lake*	Cutthroat, Eastern Brook	Unknown
Upper Snow Lake*	Cutthroat, Eastern Brook	Unknown
Square Lake*	Cutthroat, Rainbow	1979

*Sufficient natural reproduction

3.7.1.1 Habitat Conditions

The Alpine Lakes are relatively pristine compared to downstream habitats, having changed little from conditions prior to European settlement. The Alpine Lakes are characterized by naturally low productivity and provide relatively limited habitat potential for fish primarily because of cold water supplied by melting snow or glaciers, a short growing season, location at the head of the watershed, and lack of inputs of organic material. The primary changes to Alpine Lakes habitat include structures constructed to manage surface water and the introduction of sport fish, including non-native trout.

3.7.2 Icicle Creek Corridor

The Alpine Lakes discharge water to a series of small creeks that are tributaries to Icicle Creek, which is a major tributary to the Wenatchee River. Within the watershed, Icicle Creek provides important high quality and relatively undisturbed headwater habitat for a variety of anadromous[9] and resident[10] fish. Icicle Creek provides approximately 29 river miles of spawning and rearing habitat to native salmon and trout species, including ESA-listed Upper Columbia spring-run Chinook salmon (*O. tshawytscha*), Upper Columbia summer steelhead (*O. mykiss irideus*), and bull trout (*Salvelinus confluentus*) depending on flows and passage through several natural and artificial barriers (Dominguez et al., 2013). However, as noted in Table 3-13, fish habitat in Lower Icicle Creek is reduced in late summer and early fall because of low instream flows during this time of year.

Table 3-13
Current Habitat Limitations on Lower Icicle Creek

Reach	River Miles	Affected Species/Life Stage	Average Year	Low Flow Year
			Months When Target WUA Not Achieved	Months When Target WUA Not Achieved
5	0.2 to 2.4	Steelhead rearing	Late July to late October	Mid-June through October
		Bull trout spawning	None	September through October
4 (Historical Channel)	2.7 to 3.9	Steelhead rearing	Early August to late October	Mid-June through October
		Bull trout rearing	Early August to late October	Mid-June through October
3	3.9 to 4.5	Steelhead rearing	Early August to late October	Early to mid-April and mid-June through October
		Bull trout rearing	Early August to late October	Early to mid-April and mid-June through October
1, 2	6.0 to 9.1	Steelhead rearing	September	ND
		Cutthroat trout rearing	September	ND

Note: conclusions from Granger, 2017
ND = No Data. Analyses have not been performed.
WUA = weighted usable area

[9] Life history pattern of spawning and rearing in tributary streams and migrating to the ocean.
[10] Life history pattern of residing in tributary streams for the fish's entire life without migrating.

Fish passage above LNFH is generally considered to be limited, particularly above the Boulder Field at RM 5.6, which serves as a natural barrier under typical flow conditions. Low numbers of anadromous steelhead and Chinook salmon can pass through the Boulder Field; biologists recently observed two redds[11], and one juvenile anadromous Chinook salmon was observed upstream of the Boulder Field (WDFW, 2016). It is unlikely that coho salmon (*O. kisutch*) can ascend the Boulder Field.

Currently, operation of Structure 5 just downstream of the Boulder Field also limits fish passage during spring and early summer when broodstock collection for LNFH is occurring (mid-May through June). Structure 5 is closed in order to capture and prevent passage of hatchery fish to areas farther upstream. This also prohibits non-hatchery fish from moving upstream of LNFH during this time. Operation of Structure 2 can also limit passage by decreasing flows in this reach when the gates are closed to divert water into the Hatchery Channel. As the operators of LNFH, USFWS coordinates with WDFW, National Oceanic and Atmospheric Administration (NOAA) Fisheries, the Confederated Tribes and Bands of the Yakama Nation, and the Confederated Tribes of the Colville Reservation on the timing of the adjustments for broodstock collection and closing of the gates at Structure 2 to minimize potential impacts on anadromous fish and tribal fishing that occurs at the plunge pool in front of the LNFH.

3.7.2.1 Anadromous Fish

Anadromous fish returning to Icicle Creek are dominated by spring-run Chinook salmon produced at LNFH that pass through Lower Icicle Creek to return to the LNFH facility in spring and early summer. Natural spawning of native anadromous fish is reduced from historical conditions as a result of habitat degradation, including flow diversions, and overfishing. Historical barriers to upstream passage at LNFH also have limited natural anadromous fish spawning to the lower 2 RM of Icicle Creek until improvements to fish passage in recent years.

Icicle Creek also provides spawning habitat for native anadromous fish, including the Upper Columbia spring-run Chinook salmon and Upper Columbia summer steelhead. Both species are listed as endangered under the ESA and are discussed in greater detail in Section 3.10, Threatened and Endangered Species.

LNFH Spring-run Chinook Salmon

Spring-run Chinook salmon are raised at the LNFH as mitigation for the Grand Coulee Dam (USFWS, 2016a). Between 2000 and 2015, the number of adult LNFH spring-run Chinook salmon returning to Icicle Creek each year ranged from 2,403 (in 2013) to 15,082 (in 2001) (O'Brien, 2016). Creel surveys indicate that between 3 percent and 21 percent were caught in the sport fishery in Icicle Creek each year during the same period. A small number were observed in snorkel surveys upstream of LNFH (USFWS, 2016b).

[11] Spawning nests located in stream gravel or lakeshores.

3.7.2.2 Resident Fish

Icicle Creek also supports several key species of resident fish, including bull trout, protected under the ESA: rainbow trout, westslope cutthroat trout, and other species of minnows, sculpins, and suckers.

Bull Trout

Bull trout are distributed throughout the Wenatchee River Watershed, including in Icicle Creek. The Columbia River bull trout distinct population segment (DPS) are listed as threatened under the ESA (USFWS, 1998). A distinct native bull trout population exists in Icicle Creek (USFWS, 2015).

Icicle Creek and other headwater areas of the basin offer some of the best habitat in the Mid-Columbia region. Bull trout spawn in cold, clear headwaters near the crest of the Cascade Mountains that are too cold for other anadromous species. Populations are isolated to headwater areas by downstream conditions that are too warm for incubation and early rearing.

Multiple life-history types of bull trout exist in the Wenatchee River Watershed (USFWS, 2015; Cappellini, 2001). Most bull trout in Icicle Creek are of a fluvial life-history type, meaning they migrate downstream to rear in tributary rivers, the mainstem Wenatchee River, or the Columbia River. Some resident forms that remain close to spawning areas throughout their life cycle are likely to exist given suitable headwater conditions. A small percentage of the population (15 to 20 percent) may migrate long distances to other subbasins of the Columbia River for foraging or overwintering and may return to spawning areas annually every few years. It is unlikely that many bull trout from the Wenatchee River Watershed are fully anadromous. Bull trout may return to spawning areas weeks to months prior to spawning. Most populations in the Wenatchee River Watershed spawn from mid-September to mid-October (USFWS, 2015).

Juveniles eat invertebrates, and subadults and adults eat mainly fish. Bull trout are a highly effective predator on smaller fishes and can limit juvenile salmon populations in some locations (Wydoski and Whitney, 2003). Bull trout are extremely sensitive to habitat degradation by humans because they require cold, clear water for spawning. Bull trout are also threatened by hybridization with eastern brook trout and overharvest by anglers.

Prior to improvements to fish passage management at LNFH in 2001, low numbers of widely dispersed bull trout were observed in the Icicle Creek drainage, mainly in upper Icicle Creek and lower Jack Creek, and with the majority observed below passage barriers at LNFH (Ringel, 1997; Cappellini, 2001). Since 2003, bull trout snorkel surveys have been conducted in Icicle Creek from the Boulder Field area near the confluence with Snow Creek to the confluence with the Wenatchee River. Fish counts have ranged from 10 fish in 2011 to 157 fish in 2009 (USFWS, 2009, 2016b).

Rainbow Trout

Rainbow trout are the most commonly observed fish species in Icicle Creek and tributaries draining the Alpine Lakes (Ringel, 1997; USFWS, 2016b). Genetically

identical to steelhead trout, rainbow trout exhibit a non-migratory resident life history. In some cases, steelhead progeny may take on resident life-histories in subsequent generations and vice-versa. As juveniles, rainbow trout cannot be distinguished from steelhead. Hybridization between rainbow trout and westslope cutthroat trout is common, and hybrids may occur in the Icicle Creek drainage (Ringel, 1997).

Rainbow trout prefer cool, well oxygenated water but can tolerate broader temperature ranges than other salmon and trout. Growth and age at maturity varies greatly and occurs between age 1 and 5 years, depending on water conditions. Rainbow trout spawn in the spring between February and June, and unlike salmon, may spawn many times over a lifetime. Rainbow trout feed mainly on drifting aquatic and terrestrial invertebrates, and only occasionally on other fish.

Westslope Cutthroat Trout

Westslope cutthroat trout are widespread throughout Icicle Creek (Wydoski and Whitney, 2003). The historical distribution was limited to two adjacent river basins, the Lake Chelan and Methow Basins, in the mid-Columbia river and in the Pend Oreille River in northeastern Washington; however, widespread stocking of hatchery-reared fish and subsequent establishment of self-reproducing populations has expanded the distribution of the subspecies to nearly all tributary rivers and streams of the mid- and upper-Columbia River. Extensive stream surveys during the 1990s documented naturally reproducing populations of westslope cutthroat trout in nearly every tributary above 3,000 feet elevation across the Cascade Mountains.

Westslope cutthroat trout in Icicle Creek and the Wenatchee River may have a resident or fluvial life-history (Wydoski and Whitney, 2003). Fluvial forms may return to small tributaries for refuge during high flows. Adult westslope cutthroat trout spawn from March to July in in relatively low densities compared to other salmon in small, cold headwater streams with gravel and cobble substrates and well-oxygenated water. Fry emerge in late spring or summer. Both forms remain mostly stationary as juveniles, establishing feeding stations in low-velocity, moving water. Juveniles tend to move into pools in the fall, seeking suitable winter habitat, and fluvial forms will overwinter in deeper pools and beaver ponds. Westslope cutthroat trout feed on drifting insects, zooplankton, and other larval aquatic invertebrates, and their growth is determined by the length of the growing season, productivity, and water temperatures in headwater areas. Fluvial forms that move into more productive and warmer rivers tend to grow faster and larger, up to 10 to 12 inches over 10 years.

Westslope cutthroat trout populations are likely impacted in Icicle Creek by hybridization with rainbow trout introduced for sport fisheries and by displacement by rainbow trout and non-native eastern brook trout. Introduced eastern brook trout have displaced westslope cutthroat trout in many low gradient reaches of tributary streams, including Eightmile Creek, a tributary to Icicle Creek (Griffith and Leary, 1988). Because of their small size and slow growth, westslope cutthroat trout are vulnerable to predation by native bull trout. All cutthroat trout are vulnerable to overfishing by recreational anglers.

Other Resident Fishes

The community of native resident species in Icicle Creek also includes mountain whitefish (*Prosopium williamson*), longnose sucker (*Catostomus catostomus*), bridgelip sucker (*Catostomus columbianus*), longnose dace (*Rhinichthys cataractae*), redside shiner (*Richardsonius balteatus*), northern pikeminnow (*Ptychocheilus oregonensis*), and sculpin (NPCC, 2004; USFWS, 2009, 2016b). Fewer species have been observed upstream of the LNFH diversion, suggesting that this known fish passage barrier may have reduced species diversity above the barrier over time (Ringel, 1997).

Many of these resident fishes eat plant matter or invertebrates, with the exception of sculpins, which eat large numbers of salmon and trout fry in headwater streams (Hillman, 1989), and northern pikeminnow, which can be effective predators on other fishes in larger rivers (LCFRB, 2004).

Non-native eastern brook trout also occur in Icicle Creek and its tributaries (Ringel, 1997; USFWS, 2009, 2016b).

3.7.2.3 Habitat Conditions

Habitat conditions in the lower portions of Icicle Creek are relatively less favorable for fish as one moves farther downstream towards the City of Leavenworth. In the more developed portions of the Icicle project area, habitat has been adversely affected by bank stabilization and flood control projects, loss of riparian vegetation, increased urbanization and related alterations in sediment transport and flows. In Icicle Creek, the primary limiting factors to fish include reduced habitat diversity, low stream flows, elevated stream temperatures, blocked fish passage, and increased competition among fish species compared to historical conditions (NPCC, 2004).

Recent human uses that have contributed to habitat degradation include water withdrawal for irrigation and domestic uses, agriculture and grazing in riparian zones, timber harvest, road building, fire suppression, urban development, and recreation. Potential impacts on water quality as a result of these activities are described in Section 3.5.2, Surface Water Quality. In Icicle Creek and its tributaries, non-native eastern brook trout may limit native salmon and trout from thriving because of competition and displacement. Hybridization between eastern brook trout and bull trout limits bull trout productivity by producing sterile offspring. In some streams, including Icicle Creek, eastern brook trout have greatly reduced numbers of bull trout (USFWS, 2015).

3.7.2.4 Fish Passage Barriers

Potential salmon and trout spawning habitat occurs up to RM 29 in Icicle Creek; however, there are several natural and artificial barriers that can limit migration through the watershed. These include the following.

- The LNFH diversion (RM 4.5) was constructed in 1930 to 1940 to supply surface water to the hatchery. LNFH shares diversion facilities with COIC and operates the facilities under an agreement with COIC. Since 2001, LNFH has been adaptively managing the intake structure to improve passage (Hall, 2012); however, passage continues to be impaired at very low and very high flows (Anglin et al., 2013).

Between 2012 and 2015, it is estimated that between 287 and 1,003 spring-run Chinook salmon were able to pass above the LNFH diversion annually (Hall, 2012; USFWS, 2016c).

- A natural boulder field (RM 5.6) near the confluence with Snow Creek currently blocks fish passage under most flow conditions. However, it is estimated that passage can occur under high-flow (10-year flood) conditions (Ringel, 1997), or as a series of pools form during a window of flows between 100 to 200 cfs (Dominguez et al., 2013). Large bull trout have been observed above the Boulder Field, indicating that opportunistic adult salmon and trout species may find passage during some flows (Dominguez et al., 2013); however, the Boulder Field presented an obstruction to Chinook salmon and steelhead in at least one study (Cappellini, 2001).
- The IPID diversion (RM 5.7) also hinders upstream passage at moderately low flows less than 150 cfs (reviewed in NPCC, 2004; Dominguez et al., 2013).

Other factors limiting fish passage include the potential for fish to become entrained at surface water diversion facilities on Icicle Creek. Fish screens at the LNFH/COIC diversion (RM 4.5), IPID diversion (RM 5.7), and the City of Leavenworth diversion (RM 5.7) do not currently meet National Marine Fisheries Service criteria and require updating (NPCC, 2004).

3.7.2.5 Tribal Fishing

Within the project area there are Usual & Accustomed Fishing Areas where the YN and CTCR tribes have historically fished. These areas are discussed in greater detail in Section 3.23, Indian Trust Assets and Fishing Harvest. Both the Yakama Nation (YN) and Confederal Tribes of the Colville Reservation (CTCR) maintain fishing rights in Icicle Creek and the Wenatchee River. These tribes target non-listed spring-run Chinook salmon (*Oncorhynchus tshawytscha*) returning to the LNFH (YN, 2009; CTCR, 2011). Known fishing areas include the plunge pool immediately downstream of the LNFH Hatchery Channel spillway and in the mainstem Wenatchee River. The YN maintains fishing rights within a mile of Dryden Dam (not within 25 feet of any fishway), in mid-summer targeting summer-run Chinook salmon and summer-run steelhead (*O. mykiss*) (YN, 2009). The CTCR maintains a summer Chinook fishery in Tumwater Canyon and mainstem Wenatchee River (CTCR, 2011).

Since the reintroduction of coho salmon (*O. kisutch*) to the upper Wenatchee River and Icicle Creek drainages, tribal subsistence fisheries for coho salmon have been opened when runs are large and surplus fish are available (CRITFC, 2011). Upriver sockeye salmon (*O. nerka*) and upriver summer-run Chinook salmon (including the Wenatchee stocks) are harvested by treaty tribes (including the YN) in the mainstem Columbia River prior to ascending their natal rivers.

It is the policy of the YN and CTCR fishery codes to sustainably manage fishery resources and enhance fish and habitat off the Yakama and Colville Reservations to support tribal harvest for subsistence, recreational, and economic needs of tribal members (YN, 2009; CTCR, 2011). Refer to Section 3.23, Indian Trust Assets and Tribal Fish Harvest, for more

information about fishing limits. From 1999 to 2003, the YN harvest in Icicle Creek averaged 2,905 spring-run Chinook per year and an average of over 3,000 surplus adults returning to LNFH were provided directly to Columbia River tribes (YN, CTCR, Spokane Tribe, and the Kalispell Tribe) and food banks. In 2015, CTCR anglers caught 113 hatchery-origin spring-run Chinook salmon from mid-May to early June (Rayton, 2016).

The harvest of whitefish, sucker, pikeminnow, and other native resident fish and non-native species are open year-round to tribal members unless restricted by specific regulation (YN, 2009). Efforts are also underway to restore harvestable lamprey populations in the Wenatchee River Watershed (YN, 2016).

3.7.3 Wenatchee River Corridor

As noted in Section 3.3, Surface Water Resources, Icicle Creek is a major tributary to the Wenatchee River, which links Icicle Creek to the Columbia River. The Wenatchee River is a major migratory pathway for several fish species, including ESA-listed species. Wenatchee River salmon and steelhead stocks are reduced from historical levels largely as a result of habitat degradation, including flow diversion, lowered water quality, and overfishing. In comparison to other rivers of similar size in Washington, the Wenatchee River continues to provide good quality and diverse habitat for a variety of anadromous and resident fish downstream of Icicle Creek.

3.7.3.1 Anadromous Fish

The Wenatchee River provides habitat to several native populations of anadromous fish, including Upper Columbia spring-run Chinook salmon, Upper Columbia summer-run steelhead, and bull trout that are all protected under the ESA.

Upper Columbia Spring-run Chinook Salmon

Spring-run Chinook salmon within the Icicle project area include the Wenatchee stock[12] of the Upper Columbia Spring Chinook Evolutionarily Significant Unit (ESU), which is listed as endangered under the ESA (NOAA Fisheries, 2016; 64 FR 14308; 70 FR 37160). Wenatchee stock includes fish that spawn in the Wenatchee River and its tributaries, but not those spring-run Chinook that return to LNFH.

Prior to spawning, adults hold in deeper pools and under cover in the mainstem Wenatchee River or natal tributaries. Juveniles (parr) may redistribute downstream from tributaries to the middle and lower Wenatchee River during their first spring or fall, then typically overwinter in fresh water before migrating to sea the following spring (Peven, 2003; Hillman and Chapman 1989 in Chapman, 1989).

The number of adults estimated to return to the Wenatchee River can vary considerably from year to year; however, average abundance declined steadily from greater than 3,000 fish in the 1960s to less than 500 fish in the mid-1990s (10-year average) (WDFW, 2016b). Numbers have increased in recent years to a 10-year average exceeding 1,500 fish since 2010. Hatchery-reared fish have supplemented the number of spawning adults since

[12] This population is considered a distinct stock based on its spawning distribution, early run timing beginning in May, early spawn timing in very late July through September, and genetic composition.

the early 1990s; however, natural production has not recovered to a level that would sustain a recreational fishery (WDFW, 2010).

From 1989 to 2015, an estimated average of 148 Wenatchee River adult spring-run Chinook salmon per year migrated into Icicle Creek to spawn. Evidence of spring-run Chinook spawning has been observed from the mouth of Icicle Creek to the confluence with Snow Creek; however, the majority of redds are observed from the LNFH to Sleeping Lady (RM 2.8 to 3.3) (Hillman et al., 2016). The spring-run Chinook salmon spawners in Icicle Creek are strays that originate from the Chiwawa Hatchery supplementation program and White River in the upper Wenatchee River Watershed.

Summer-run Chinook Salmon

Wenatchee summer-run Chinook salmon[13] are also found in the Wenatchee River. Prior to spawning, adults hold in deeper pools and under cover in the mainstem, and spawning occurs throughout the mainstem with redds observed specifically within 8 miles of the City of Leavenworth near the confluence with Icicle Creek (WDFW, 2016b). Small numbers of summer-run Chinook salmon enter Icicle Creek to spawn. Since the late 1980s, the spawning population has been supplemented by hatchery-reared spawners.

Over the past several decades, the number of Wenatchee summer-run Chinook salmon returning to their native spawning areas has been relatively stable between 6,000 and 8,300 fish (10-year average). The abundance of adults returning to the spawning grounds has exceeded WDFW's goals for achieving sustainability of the population of 7,500 fish in 17 out of 29 years (WDFW, 2016b).

From 2006 to 2015, 2 to 75 summer-run Chinook salmon redds have been observed in Icicle Creek downstream of LNFH (Hillman et al., 2016). Summer-run Chinook salmon spawning in Icicle Creek are a mixture of hatchery-origin strays and wild-origin fish.

Summer-run Steelhead

Summer-run steelhead in the Icicle project area include the Wenatchee stock[14] of the Upper Columbia Summer Steelhead ESU, which is listed as threatened under the ESA (NOAA Fisheries, 2016; 64 FR 14308; 70 FR 37160).

Most spawning takes place in the Wenatchee River and tributaries upstream of the confluence with Icicle Creek, including the Little Wenatchee, Chiwawa, and White Rivers, and Nason Creek. Spawning also takes place in Icicle Creek and other tributaries downstream of Icicle Creek, including Mission and Peshastin Creeks (NPCC, 2004; WDFW, 2016b).

Adult steelhead enter the Wenatchee River from August through the following April and spawn in very late March through May. Steelhead parr may redistribute downstream away from natal streams during their first year to rear in mainstem reaches of the Wenatchee

[13] This population is considered a distinct stock based on its spawning distribution, river entry time in June, spawn timing in late September through mid-November, and genetic composition.
[14] This population is identified as a distinct stock based on their spawning distribution and run timing.

River. Steelhead tend to remain in fresh water until migrating to sea as yearlings the following spring (reviewed in NPCC, 2004).

During the 54 years from 1962 to 2015, the annual goal of 3,000 spawning adults was estimated to have been met in only 9 years, and a minimum abundance of 1,000 spawning adults required for population recovery has been met in 35 years.

From 1962 to 2015, the estimated number of adult spawners has varied considerably. A major decline in the late 1970s and early 1980s occurred when the number of spawners dropped to near or below 100 fish in 6 consecutive years. Since 1987, the Wenatchee summer-run steelhead population has been supplemented by fish raised in hatcheries. Numbers have increased since the early 1990s with an average number of spawners between 1,000 and 2,500 fish (10-year average) (WDFW, 2016b).

In 2014 and 2015, it is estimated that 121 and 135, respectively, Wenatchee summer-run steelhead spawners reached Icicle Creek, representing a mixture of hatchery-origin strays and wild-origin fish (Hillman et al., 2016). The number of summer-run steelhead redds observed in the lower reaches of Icicle Creek has ranged from a low of 6 to a high of 180 from 2001 to 2013.

Coho Salmon

Coho salmon (*O. kisutch)* were once extinct in the Wenatchee River Watershed but were reintroduced in 1999 through an effort led by the CTCR and YN. Currently, coho salmon spawn and rear in the mainstem Wenatchee River between the City of Cashmere to Lake Wenatchee and in Icicle Creek (NPCC, 2004).

Coho salmon enter the Wenatchee River in early September through late November, spawning between mid-October to late December. Coho fry emerge in April or May, then distribute themselves downstream to tributaries or off-channel habitat where they overwinter and rear for 1 year until migrating to sea the following March through May (NPCC, 2004).

Over the past several decades, the number of coho within the Icicle project area has been increasing. Between 1999 and 2011, the number of fish returning to the Wenatchee River ranged from 350 adults to 23,000 adults with the population reaching sufficient numbers in 2009, 2011, 2014, and 2015 for tribal and sport fisheries to be opened (Galbreath et al., 2013; Kraig and Scalici, 2016).

Sockeye Salmon

Sockeye salmon (*O. nerka*) that migrate through the Wenatchee River include the Wenatchee stock of the Upper Columbia River sockeye salmon stocks, which are considered healthy and are not ESA-listed. However, monitoring has been recommended because of the potential for the species to become threatened (64 FR 14528). Wenatchee sockeye salmon originate in tributary sub-watersheds to Lake Wenatchee, upstream of the confluence with Icicle Creek.

Yearling juvenile sockeye salmon migrate to sea in the spring. Adults return to the Wenatchee River Watershed in June and July after 2 to 3 years at sea, with the peak of the run entering the Wenatchee River in mid-July.

Recreational fishing of Wenatchee sockeye salmon occurs in Lake Wenatchee when the numbers of returning fish meet state goals of 23,000 fish (WDFW, 2016c). No sockeye salmon fishery is allowed in the mainstem Wenatchee River.

Pacific Lamprey

Pacific lamprey (*Entosphenus tridentatus*) occur throughout the Wenatchee River downstream of Icicle Creek but have not been observed in Icicle Creek (Beals and Lampman, 2016a). Pacific lamprey are a federal species of concern and state priority species (USFWS, 2010; WDFW, 2008).

Larval lamprey are filter feeders that inhabit silt and mud substrate in slow-moving water for 4 to 7 years in temperatures up to 77 °C (Wydoski and Whitney, 2003). In the Columbia River, juveniles metamorphose in October or November and immediately migrate downstream to sea in the fall or the following spring where they feed parasitically by attaching to larger fish and sucking body fluids using their sucker-like mouths, sharp teeth, and rasping tongues. Adult Pacific lamprey migrate back to fresh water in spring and summer, overwinter in deep pools, then spawn the following spring from April through July. Adults cease feeding after entering fresh water and subsist on energy stores through spawning, after which most will die; however, some may survive and return to sea. Adults spawn by excavating nests in fine gravel and sandy substrate in relatively cool (45 to 50 °C), oxygen-rich water at the tails of pools and riffles.

Pacific lamprey abundance in the Wenatchee River Watershed is estimated to be greatly reduced from historical conditions. Adult lamprey counts at mainstem Columbia River dams since 2000 indicate that the number of lamprey observed in the mid-Columbia River near the confluence with the Wenatchee River has ranged from approximately 31 to 3,036 fish annually (DART, 2016); however, it is unknown how many of this subset of adults enter the Wenatchee River each year to spawn (Johnsen and Nelson, 2012).

3.7.3.2 Resident Fish

Bull trout, rainbow trout, westslope cutthroat trout, and other resident species (listed below) are prevalent throughout the Wenatchee River and tributaries.

Bull Trout

Bull trout reside in headwater areas to tributaries of the Wenatchee River, and fluvial life-history types may use the Wenatchee River as foraging habitat or as a migratory corridor. The Wenatchee River Watershed has high diversity among bull trout populations[15].

Fluvial bull trout that originate in headwaters of the Chiwawa River have been monitored by WDFW since 1989; the total number of redds[16] observed has averaged 233 redds, ranging from 71 redds in 1990 to 377 redds in 1999 (WDFW, 2016a).

[15] Seven distinct spawning populations of bull trout are identified in the Wenatchee River Watershed based on their geographic distribution and isolation from other spawning populations and unique genetics.
[16] Typically, each redd is fertilized by one male bull trout.

Rainbow and Westslope Cutthroat Trout

Rainbow trout and westslope cutthroat trout are common throughout rivers and lakes of Washington, including the Wenatchee River and tributaries (Wydoski and Whitney, 2003). See Section 3.7.2.2, [Icicle Creek] Resident Fish for life-history information.

Other Resident Fishes

Other native resident fish that inhabit the Wenatchee River include mountain whitefish; three-spined stickleback (*Gasterosteus aculeatus*); minnows, including chiselmouth (*Acrocheilus alutaceus*), peamouth (*Mylocheilus caurinus*), longnose dace, speckled dace (*Rhinichthys osculus*), redside shiner, northern pikeminnow, and possibly leopard dace (*Rhinichthys falcatus*) and Umatilla dace (*Rhinichthys umatilla*), which have spotty distributions in the region; suckers, including longnose sucker, bridgelip sucker, largescale sucker (*Catostomus macrocheilus*), and mountain sucker (*Catostomus platyrhynchus*); and sculpins, including mottled sculpin (*Cottus bairdii*), shorthead sculpin (*Cottus confuses*), torrent sculpin (*Cottus rhotheus*), and possibly Paiute sculpin (*Cottus beldingii*) based on one historical account (Chapman, 1989; Wydoski and Whitney, 2003; NPCC, 2004).

As in Icicle Creek, many of these resident fishes eat plant matter or invertebrates, with the exception of sculpins (Hillman, 1989) and northern pikeminnow that become effective predators on other fishes when they grow to larger sizes in larger rivers (e.g., greater than 300 millimeters [mm]) (LCFRB, 2004).

Non-native crappie also occur in the Wenatchee River (NPCC, 2004).

3.7.3.3 Habitat Conditions

In general, fish habitat in the Wenatchee River has been degraded over time through a variety of causes, including agriculture, road and railroad development, and increased urbanization and development. Habitat impacts have resulted from floodplain development for agriculture and urban uses, irrigation diversions, bank armoring, and reduced habitat-forming woody debris, and riparian vegetation removal.

3.7.3.4 Barriers to Passage

Passage through the Wenatchee River up to Icicle Creek is relatively unobstructed compared to rivers of similar size in the Pacific Northwest.

In the Lower Wenatchee River, Dryden Dam, an 8-foot-high irrigation diversion dam, has a fish ladder to facilitate passage, but may cause migration delay for some salmon (Reviewed in NPCC, 2004) and may limit lamprey passage (Johnsen and Nelson, 2012).

Irrigation diversions are typically designed to exclude juvenile salmon and other fish but may impair downstream redistribution and passage of larval and juvenile lamprey in the lower Wenatchee River Watershed (reviewed in Johnsen and Nelson, 2012). Larval lamprey are small enough to easily pass through bypass traps and screens and become entrained in irrigation canals during water diversion in summer and become stranded when canals are dewatered in the fall. Recent salvage efforts at the Dryden Diversion, located just downstream of Peshastin Creek at RM 28.3, have rescued and released approximately 6,500 juveniles in 1 year (Mosey, 2009), and it was estimated that tens of thousands of

larval and juvenile lamprey may be entrained in just the Dryden Diversion each year (Beals and Lampman, 2016b).

3.7.4 Aquatic Invertebrates

Invertebrates are a major source of food for fish, and changes in invertebrate communities may result in changes in the condition of fish communities (Waters, 1982; Wilzbach et al., 1986). Salmon and trout commonly feed on larval or recently emerged invertebrates such as mayflies, stoneflies, and caddisflies that are fully aquatic at the larval stage, and zooplankton such as water fleas and tiny crustaceans.

In the Alpine Lakes, trout feed primarily on zooplankton and benthic invertebrates. In outlet streams from the Alpine Lakes, Icicle Creek, and the Wenatchee River, the aquatic invertebrate community appears to increase in diversity with increasing stream order (Adams, 2012), owing to changes in food sources from courser to more fine organic particulate matter (Vannote et al., 1980).

Aquatic invertebrates, like other aquatic organisms, respond to changes in water quality, food abundance, and other habitat parameters. Macroinvertebrate community composition can reflect historical water quality or habitat degradation (Rosenberg and Resh, 1993). In Washington State, benthic macroinvertebrate (invertebrates large enough to be seen without magnification) communities are analyzed to monitor the health of streams (Plotnikoff and Ehinger, 1997). Key conditions that influence the aquatic invertebrate communities in Icicle Creek and the Wenatchee River include elevated water temperature and associated low dissolved oxygen, phosphorus enrichment, and associated elevation of pH (Adams, 2012). A biological assessment of the macroinvertebrate community of Icicle Creek and the Wenatchee River reflects a signal of poor water quality in the lower Wenatchee River downstream of the Town of Monitor, fair water quality between Dryden and Monitor, and good water quality near the Town of Peshastin and in Icicle Creek, with the exception of points immediately downstream of the City of Leavenworth (Adams, 2012). The macroinvertebrate community appeared to be most disturbed in two locations on the Wenatchee River, near and downstream of City of Leavenworth, and downstream of the City of Cashmere to the mouth of the Wenatchee River, with sites of concern in the upper Icicle Creek near two recreational camping areas. Pollution tolerant species were present; however, a clear pattern was not discernable and may reflect localized factors in the stream.

3.8 Vegetation

Vegetation within the Icicle project area supports a variety of different landscapes, ranging from forested areas, riparian corridors, wetlands, and more urbanized development. Within the project area, these vegetation types provide wildlife habitat, ecosystem services, and recreational and aesthetic value.

This section is based primarily on existing information and aerial photograph analysis. Although existing mapping, WDFW Priority Habitat and Species data (WDFW, 2016), and USFWS National Wetlands Inventory data provide an indication of the potential presence or absence of sensitive areas, such as wetlands, this information would be field verified as appropriate during project-level review. Field visits were completed for some parts of the project area as indicated below.

3.8.1 Alpine Lakes

The Alpine Lakes are located on the eastern side of the Cascade Mountain range in an area that includes alpine and subalpine biotic zones. The Alpine Lakes within the Icicle project area include Colchuck, Eightmile, Upper and Lower Klonaqua, Square, Nada, and Upper and Lower Snow Lakes.

These lakes are located east of the Cascade crest. The Icicle project area in and adjacent to these lakes exhibits a range of vegetation communities from west to east as a result of differences in elevation and precipitation. The crest of the Cascades annually receives about 180 inches of precipitation, mostly in the form of snow, while lower elevations in the eastern portion of project area, near the City of Leavenworth, average 25 inches of precipitation a year.

The Alpine Lakes are dominated by forested habitat with species such as silver fir (*Abies amabilis*), subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and mountain hemlock (*Tsuga mertensiana*) in the upper elevation areas. Avalanche chutes are brushy with deciduous species such as Sitka alder (*Alnus sinuata*), vine maple (*Acer circinatum*), and Rocky Mountain maple (*Acer glabrum*). Lower elevations include Douglas fir (*Pseudotsuga menziesii*), western white pine (*Pinus monticola*), ponderosa pine (*Pinus ponderosa*), shore pine (*Pinus contorta*), western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*) (USFS, 2016; Franklin and Dyrness, 1973).

All of these species were observed during a reconnaissance site visit to Colchuck, Eightmile, Upper and Lower Klonaqua, and Square Lakes in July 2016. Similar forest and shrub vegetation communities are likely present at Nada and Upper and Lower Snow Lakes, based on aerial photograph analysis and the similar elevation and location of these lakes.

Dominant shrub and understory species observed during the July 2016 site visits include Scouler willow (*Salix scouleriana*), Cascade azalea (*Rhododendron albiflorum*), twinberry (*Lonicera involucrata*), white spirea (*Spiraea betulifolia*), red huckleberry (*Vaccinium parvifolium*), kinnikinnick (*Arctosaphylos uva-ursi*), and western thimbleberry (*Rubus parviflorus*). Common and scientific names of plant species observed during the July 2016 site visits are provided in Table 3-14.

Existing mapping does not identify any wetland habitats within the vicinity of Colchuck, Eightmile, Upper and Lower Klonaqua, Square, and Upper Snow Lakes; however, palustrine scrub-shrub (PSS) and palustrine forest (PFO) wetland systems have been mapped in a few locations along the shoreline of Lower Snow and Nada Lakes (WDFW, 2016; USFWS, 2016). Reconnaissance surveys confirmed wetland conditions are present at several of the lakes and along the trail to Eightmile Lake. Wetland conditions were also observed along the

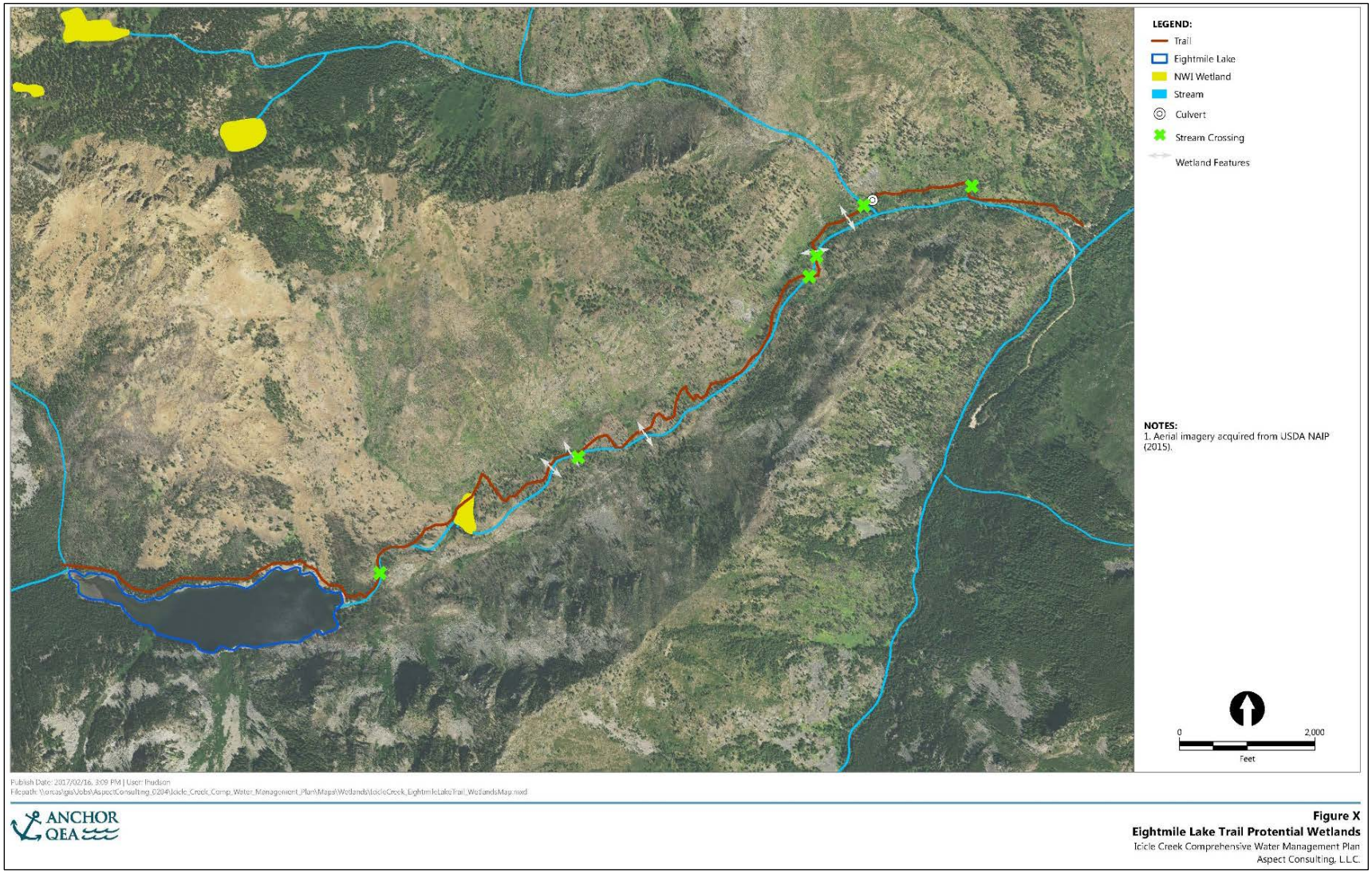
Eightmile Lake trail in several locations. These wetlands included palustrine emergent (PEM), PSS, and PFO wetland systems associated with creeks and streams along the trail (See Figure 3-10).

Table 3-14
Plant Species Observed at the Alpine Lakes during the July 2016 Site Visit

Scientific Name	Common Name	Indicator Status
Abies grandis	Grand fir	FACU-
Abies amabilis	Silver fir	FACU
Abies lasiocarpa	Subalpine fir	FACU
Acer circinatum	Vine maple	FAC-
Acer glabrum	Rocky mountain maple	FACU
Achillea millefolium	Yarrow	FACU
Alnus sinuata	Sitka alder	FACW
Arctostaphylos uva-ursi	Kinnikinnick	FACU
Holodiscus discolor	Oceanspray	UPL
Lonicera involucrata	Twinberry	FAC+
Lupine polyphyllus	Large-leaved lupine	FAC+
Mahonia aquifolium	Tall Oregon grape	UPL
Picea engelmannii	Engelmann spruce	FAC
Pinus monticola	Western white pine	FACU
Pinus ponderosa	Ponderosa pine	FACU-
Plantago major	Common plantain	FACU+
Populus tremuloides	Quaking aspen	FAC+
Populus trichocarpa	Black cottonwood	FAC
Pseudotsuga menziesii	Douglas fir	FACU
Pteridium aquilinum	Bracken fern	FACU
Rhododendron albiflorum	Cascade azalea	FACU
Rosa nutkana	Nootka rose	FAC
Rubus parviflorus	Western thimbleberry	FAC-
Salix lasiandra	Pacific willow	FACW
Salix scouleriana	Scouler willow	FAC
Sambucus cerulea	Blue elderberry	FACU
Smilacina racemosa	False-Soloman's-seal	FAC-
Spiraea betulifolia	White spirea	FACU
Thuja plicata	Western redcedar	FAC
Tsuga mertensiana	Mountain hemlock	FACU
Vaccinium ovatum	Evergreen huckleberry	UPL
Vaccinium parvifolium	Red huckleberry	UPL

Notes: FAC = Facultative, FACU = Facultative Upland, FACW = Facultative Wetland, UPL = Obligate Upland

Figure 3-10. Wetland Near Eightmile Lake



At Eightmile Lake, wetland conditions were not observed at the outlet location, but several potential PEM, PSS, and PFO wetland features were observed along the lake shoreline. PEM and PSS wetland conditions were present near the outlet location at Square Lake and in several areas along the shoreline of Square Lake. Overall, potential wetland habitat was more common at Square Lake than any of the other three lakes investigated during the site visits. At Klonaqua Lake, PEM and PSS wetland conditions were present in the vicinity of the outlet location and appeared to be present in some locations along the lake shoreline, but the majority of the lake shoreline was composed of upland habitat. Wetland features were not present at the outlet location at Colchuck Lake and the majority of the lake shoreline resembled upland conditions.

3.8.2 Icicle Creek

3.8.2.1 Vegetation

Vegetation along the Icicle Creek corridor is dominated by forested communities similar to the species identified in Section 3.8.1, Alpine Lakes. The species composition changes with elevation and corresponding changes in precipitation. At the higher elevations near the upper end of Icicle Creek, vegetation is similar to that found at the Alpine Lakes. At the lower elevations in the valley near the City of Leavenworth, the Icicle Creek riparian corridor includes more roads, agricultural, and rural residential development. Vegetative communities include those associated with more developed areas such as roads, agricultural fields, residential properties, golf courses, and other urban developments. The majority of the riparian corridor along Icicle Creek includes upland habitat; however, existing mapping identifies PEM, PSS, and PFO wetland features along the shoreline of Icicle Creek in several locations (WDFW, 2016; USFWS, 2016).

The following subsections address in greater detail the vegetative communities present in areas with the greatest potential to be affected by the Program Alternatives.

3.8.2.2 Icicle Creek Boulder Field

The Icicle Creek Boulder field is an approximately 2,600-foot-long high-gradient reach of Icicle Creek located upstream of RM 5.6. This is one of the locations where fish passage could be addressed as part of the Strategy Alternatives (Dominguez et al., 2013). Riparian habitat south of this reach along Icicle Creek includes steep sloped upland forest and shrub vegetation communities with rock features as a dominant substrate. To the north, trees and shrubs occur in isolated and sparse patches with rock substrate as the dominant ground cover. A gravel parking lot and a gravel access road are located north of the creek, ranging from 50 to 200 feet from the creek shoreline. Icicle Road is just north of the access road and vegetation is similar to the steep sloped hillside to the south. No wetland habitat is mapped along this reach of Icicle Creek (USFWS, 2016b).

3.8.2.3 Leavenworth National Fish Hatchery

LNFH is located adjacent to Icicle Creek at RM 3.0, about 2 miles south of the City of Leavenworth. LNFH diverts surface water from Icicle Creek at RM 4.5 for fish production at the hatchery. LNFH discharges effluent back to Icicle Creek at RM 2.8.

Proposed activities associated with the alternatives at the LNFH include water quality and fish passage improvements between RM 2.8 and 4.5.

The LNFH property is developed with buildings, raceways, ponds, other structures, and paved and unpaved impervious surfaces. Riparian habitat adjacent to the Hatchery Channel includes upland tree, shrub, grass, and herbaceous habitat typical for the region. Paved and unpaved roads are located near the channel. Rural residential development and pasture are located west and north of LNFH. The Icicle Creek historical channel is located east of the hatchery channel. Upland forest and shrub vegetation communities are located in higher elevations east and south of the Icicle Creek historical channel. No wetland habitat is mapped within the LNFH; however, the Icicle Creek historical channel east of the hatchery channel has been mapped as palustrine scrub-shrub wetland habitat (USFWS, 2016b).

3.8.2.4 Confluence of Icicle Creek and the Wenatchee River

The confluence of Icicle Creek and the Wenatchee River is located at the south end of the Leavenworth city limits. Riparian habitat in this portion of the Icicle project area includes upland tree, shrub, grass, and herbaceous vegetation communities typical for the region. Land use also includes residential development and pasture with associated paved and unpaved roads. The Leavenworth Golf Club and residential development is located on the left bank of the Wenatchee River, across from the Icicle Creek and Wenatchee River confluence. Palustrine emergent wetland habitat is mapped adjacent to Icicle Creek (USFWS, 2016b).

3.8.3 Wenatchee River Corridor

The Icicle project area extends along the Wenatchee River from near Icicle Creek downstream to the confluence with the Columbia River at the City of Wenatchee and includes riparian and upland areas. The majority of land use in this part of the project area consists of agricultural activities, and the main vegetative communities consist largely of orchards. The IPID irrigation canals extend down the valley on the hillsides on both sides of the Wenatchee River and provide water for irrigation of agricultural properties from the City of Leavenworth down to the Town of Monitor. Agricultural lands are intermixed with scattered residential development, intensifying near City of Wenatchee and the confluence with the Columbia River. Riparian trees in this area are limited to narrow bands of deciduous trees such as black cottonwood (*Populus trichocarpa*), along the banks of the Wenatchee River and its tributaries. Along the banks of the Wenatchee River there is scattered riparian habitat, similar to that described in Section 3.8.2, Icicle Creek.

While the majority of the Wenatchee River Corridor is upland, existing mapping identifies palustrine emergent (PEM), palustrine shrub (PSS), and palustrine forested (PFO) wetland features in the Wenatchee River Corridor in numerous locations (WDFW, 2016; USFWS 2016). [17] This includes the area currently being considered for the IPID

[17] The palustrine system includes all nontidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity is below 0.5 ppt

Pump Station on the right bank of the Wenatchee River near the Highway 2 Bridge, adjacent to the Town of Dryden (Figure 2-43). Land use in this area is dominated by orchards and rural residential development with associated paved and unpaved roads. No wetland habitat is mapped in this area of the Wenatchee River (USFWS, 2016b).

3.9 Wildlife

Wildlife diversity is generally related to the structure and composition of plant species within vegetative communities. Wetlands and forested areas with well-developed shrub layers are likely to support the greatest number of species and populations of wildlife (Brown, 1985). Coniferous and deciduous forest and wetland environments provide habitat for a variety of wildlife species because of the vegetative diversity and availability of forage and nest sites.

This section is based on existing information and aerial photograph analysis. Field visits were completed for some parts of the Icicle project area as indicated below.

Overall, wildlife habitat in the Alpine Lakes and Icicle Creek portions of the Icicle project area are relatively high quality and provide diverse habitat to support a variety of wildlife species. Habitat within the Wenatchee River Corridor is more impacted by urban development and provides lower quality wildlife habitat for wildlife species to occupy. More developed portions of the project area tend to support wildlife species adapted to human activities and disturbance.

3.9.1 Alpine Lakes

3.9.1.1 Amphibians and Reptiles

Wetlands and riparian areas associated with the Alpine Lakes and receiving streams in this portion of the Icicle project area provide habitat for a variety of amphibians, such as Pacific tree frog *(Pseudacris regilla),* western toad (*Anaxyrus boreas*), tailed frog (*Ascaphus truei*), Cascades frog *(Rana cascadae)*, Columbia spotted frog (*Rana luteiventris*), and long-toed salamander *(Ambystoma macrodactylum).* Several frogs, were observed during a reconnaissance field visit to five of the Alpine Lakes (Colchuck, Eightmile, Upper and Lower Klonaqua, and Square Lakes) in July 2016. Frogs observed during the site visit were observed within the lakes, not on land. The frog species were assumed to be the Cascades frog, based on the limited visibility of observing the frogs within the lake water.

The USFS performed large-scale amphibian presence/absence surveys in the Icicle Creek Basin in July and August 2016. Within the Icicle Creek Basin, the surveys included Nada and Upper and Lower Snow Lakes and the five lakes observed during the July site visits, including Colchuck, Eightmile, Upper and Lower Klonaqua, and Square Lakes. Amphibian species observed at these eight lakes during the USFS surveys included Cascades frog (Square Lake), Columbia spotted frog (Upper and Lower Snow Lakes),

Pacific tree frog (Upper and Lower Klonaqua, and Square Lakes), and long-toed salamander (Upper and Lower Snow Lakes) (Claeson, 2016).

Reptiles, such as the western garter snake (*Thamnophis elegans*), are likely to occur in the upland habitats surrounding the lakes. Upland habitats with rocks and wood debris support species such as northern alligator lizard (*Elgaria coerulea*) and western fence lizard (*Sceloporus occidentalis*). Common garter snakes *(Thamnophis sirtalis)* and northern alligator lizards were observed during the July 2016 site visits.

3.9.1.2 Mammals

Mammal species associated with forested habitats at the Alpine Lakes include mountain beaver (*Aplodontia rufa*), bobcat (*Lynx rufus*), hoary marmot (*Marmota caligata*), fisher (*Martes pennanti*), Douglas squirrel (*Tamiasciurus douglasii*), voles (*Microtus spp.*), pika (*Ochotona princeps*), and striped skunk (*Mephitis mephitis*). Larger mammals, such as elk (*Cervus elaphus*), black-tailed deer *(Odocoileus hemionus),* black bear (*Ursus americanus*), cougar (*Felis concolor*), and coyote *(Canis latrans),* are also found in the forested habitat. Mountain goats (*Oreamnos americanus*) are found in the high-altitude areas (USFWS, 2016a). Deer tracks and scat were frequently observed during the July 2016 site visit.

Wetlands and riparian areas associated with streams originating from the lakes provide habitat for bats (*Myotis spp.*), shrews *(Sorex spp.),* common opossum *(Didelphis marsupialis),* and raccoon *(Procyon lotor).* These and similar species depend on water for foraging and breeding habitat.

3.9.1.3 Birds

Forested habitats in this portion of the Icicle project area provide foraging and nesting habitat for a wide variety of bird species with more than 150 species of birds recorded (USFWS, 2016a). Songbird species that occupy habitats found within the Alpine Lakes area of the Icicle project area include song sparrow *(Melospiza melodia),* bushtit *(Psaltriparus minimus),* Bewick's wren *(Thryomanes bewickii),* Stellar's jay *(Cyanocitta stelleri),* spotted towhee *(Pipilo erythrophthalmus*), Swainson's thrush (*Catharus ustulatus*), winter wren (*Troglodytes troglodytes*), varied thrush (*Ixoreus naevius*), black-capped chickadee (*Parus atricapillus*), chestnut-backed chickadee (*Parus rufescens*), dark-eyed junco (*Junco hyemalis*), golden-crowned kinglet (*Regulus satrapa*), and red-breasted nuthatch (*Sitta canadensis*).

Migratory bird species, such as black swift (*Cypseloides niger*), Cassin's finch (*Carpodacus cassinii*), fox sparrow (*Passerella iliaca*), loggerhead shrike (*Lanius ludovicianus*), olive-sided flycatcher (*Contopus borealis*), rufous hummingbird (*Selasphorus rufus*), and willow flycatcher (*Empidonax traillii*), likely use forested habitats for foraging during spring and fall migrations (USFWS, 2016a).

Predatory birds, such as bald eagle (*Haliaeetus leucocephalus*), red-tailed hawk *(Buteo jamaicensis),* and osprey *(Pandion haliaetus),* commonly hunt in these habitat types and occur in forested areas near bodies of water. Snags and downed trees along the lake edges also provide perch sites for these and other raptor species. Snags in forested habitats also

provide potential nest sites for cavity-nesting birds, such as great horned owl (*Bubo virginianus*) and species of woodpeckers, including Lewis's woodpecker (*Melanerpes lewis*), downy woodpecker (*Picoides pubescens*), northern flicker (*Colaptes auratus*), and pileated woodpecker (*Dryocopus pileatus*).

Lake and wetland habitats containing riverine, emergent, scrub/shrub, and forested wetland types provide wildlife habitat for a variety of bird species. Lakes can be expected to provide habitat for belted kingfisher *(Ceryle alcyon*) and wintering and migratory waterfowl, including gadwall *(Anas strepera),* American widgeon *(Mareca americana),* mallard *(Anas platyrhynchos),* common loon (*Gavia immer*), and western grebe (*Aechmophorus occidentalis*). Emergent and scrub/shrub wetland areas provide habitat for red-winged blackbird *(Agelaius phoeniceus),* song sparrow *(Melospiza melodia),* and marsh wren *(Cistothorus palustris),* among others. Great blue heron *(Ardea herodias)* may forage in lake and wetland habitats where they could prey on amphibians and other species.

3.9.2 Icicle Creek

The Icicle Creek corridor provides similar forested, riparian, and wetland habitat conditions that would support the same types of wildlife species as the Alpine Lakes area with more variation in plant species and vegetation communities likely to the result of the lower elevation and precipitation in the Lower Icicle Creek area. Species more vulnerable to human activities and development, such as larger mammal species like black bear and cougar, would be less likely to be found near roads and parcels with residential development in the lower elevation areas of Icicle Creek. This part of the Icicle project area includes more native and non-native wildlife species adapted to human activity because of the presence of roads, agricultural fields, residential properties, golf courses, and other developments. Roads also function as a potential barrier to migration of larger mammal species such as deer and elk.

3.9.2.1 Icicle Creek Boulder Field

The Icicle Creek Boulder Field, as described in Section 3.8.2.2, is an approximately 2,600-foot-long high-gradient reach of Icicle Creek located near RM 5.6. Wildlife species likely to occur within this area include birds, mammals, reptiles, and amphibian species similar to those described for the Alpine Lakes in Section 3.9.1. Species adapted to human activity and disturbances would occur associated with roads and residential development in the vicinity.

3.9.2.2 Leavenworth National Fish Hatchery

LNFH, as described in section 3.8.2.3, is located adjacent to Icicle Creek at RM 3.0, about 2 miles south of the City of Leavenworth. Upland wildlife species within this area would also include those better adapted to human activity and disturbance, such as crows, squirrels, etc. Fish and aquatic invertebrates are described in Section 3.7, Fish.

3.9.2.3 Confluence of Icicle Creek and the Wenatchee River

The area near the confluence of Icicle Creek and the Wenatchee River, as described in Section 3.8.2.4, is located at the south end of the Leavenworth city limits. Just upstream, the COIC shares a point of diversion with LNFH located on Icicle Creek at RM

4.5. Riparian habitat in this part of the Icicle project area includes upland tree, shrub, grass, and herbaceous habitats typical for the region as described in Section 3.8, Vegetation. Land use also includes residential development and pasture with associated paved and unpaved roads. The Leavenworth Golf Club and residential development is located on the left bank of the Wenatchee River, across from the Icicle Creek and Wenatchee River confluence. Palustrine emergent wetland habitat is mapped adjacent to Icicle Creek (USFWS, 2016b). Upland wildlife species within this area would also include those better adapted to human activity and disturbance, such as crows, squirrels, etc.

3.9.3 Wenatchee River Corridor

The Icicle project area extends along the Wenatchee River from Icicle Creek downstream to the confluence with the Columbia River at the City of Wenatchee and includes riparian and upland habitat areas and associated wildlife.

The majority of the potential wildlife habitat in the Wenatchee River Corridor area of the Icicle project area is relatively lower quality because of the dominant presence of residential and commercial development, roads, and agricultural land use. Developed areas provide habitat for disturbance-tolerant species such as American crow (*Corvus brachyrhynchos*), American robin (*Turdus migratorius*), European starling (*Sturnus vulgaris*), and house sparrow (*Passer domesticus*).

Developed areas reduce available wildlife habitat for mammals and limit habitat value for larger mammals that require greater areas of unbroken habitat to forage and reproduce. These areas are populated by common, urban-adapted mammal species, including raccoon, opossum, and eastern gray squirrel, and a variety of small mammals, including deer mice and old world rodents (such as the Norway rat).

The IPID irrigation canals extend down the valley on the hillsides on both sides of the Wenatchee River and provide water for irrigation of agricultural properties from City of Leavenworth down to the Town of Monitor. Species in these areas include native and non-native wildlife species adapted to human activity because of the presence of roads, agricultural fields, residential properties, and commercial and other developments.

3.10 Threatened and Endangered Species

This section describes plant, wildlife, and fish species that are listed as threatened or endangered under the ESA that have the potential to occur within the project area. This section also provides information on state priority habitats and species established by WDFW.

Section 9 of the ESA prevents the take of endangered species and, for threatened species, authorizes the agencies (NOAA Fisheries and USFWS) to adopt regulations necessary and advisable for species conservation, which may include prohibiting take (16 U.S. Code §

1538). The ESA defines "take" to mean harass, harm, pursue, hunt, shoot, wound, trap, capture, or collect, or attempt to engage in any such conduct.

The ESA requires NOAA Fisheries and USFWS to designate critical habitat for listed species, defined as follows: 1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and 2) specific areas outside the geographical area occupied by the species at the time of listing if the agency determines that the area itself is essential for conservation.

The Washington State Hydraulic Code serves to protect fish and their habitats. Implementing elements of the Program Alternatives that use, divert, obstruct, or change the natural flow or bed of fresh state waters would require a Hydraulic Project Approval from WDFW. Implementing certain projects related to the Program Alternatives would also likely include compliance with local critical areas codes, zoning ordinances, and other land use requirements.

ESA-listed species were identified based on information from the USFWS endangered species web sites (USFWS, 2016a, 2016b). The statewide *Priority Habitat and Species* (PHS) *List* includes priority terrestrial and aquatic habitats, as well as priority habitat features (WDFW, 2008). The *WDFW PHS List* also identifies specific counties in Washington where priority species have been documented. Field visits were completed for some parts of the Icicle project area as indicated below.

3.10.1 Federal Threatened and Endangered Plant Species

There are three ESA-listed plant species identified by the USFWS (USFWS, 2016a) as potentially occurring within Chelan County: showy stickseed (*Hackelia venusta*), Ute ladies' tresses (*Spiranthes diluvialis*), and Wenatchee Mountains checkermallow (*Sidalcea oregana var. calva*). Of these, two species, showy stickseed and Wenatchee Mountains checkermallow have the potential to occur within the Alpine Lakes, Icicle Creek Corridor, and Wenatchee River Corridor as shown in Table 3-15 (USFWS, 2016b). Ute ladies tresses could potentially be found in the vicinity but is not likely to occur within the Icicle project area. Wenatchee Mountains checkermallow also has critical habitat within Chelan County, although none is located within the project area. The status and preferred habitats of federally listed and proposed plant species protected under the ESA as identified by USFWS, are presented in Table 3-15.

Table 3-15
Federally Listed and Proposed Plant Species

Common Name (Scientific Name)	Agency	Status[1,2]	Preferred Habitat[3]	Chelan County[1]	Alpine Lakes Area[2]	Icicle Creek Corridor Area[2]	Wenatchee River Corridor Area[2]
Flowering Plants							
Showy stickseed (*Hackelia venusta*)	USFWS	Endangered	Grows in openings of ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*) forests on loose, well-drained, granitic rocky or sandy soils. It is found on unstable talus slopes, and ledges or cracks on cliff faces at lower elevations.	X	X	X	X
Ute ladies' tresses (*Spiranthes diluvialis*)	USFWS	Threatened	Adapted to early- to mid-seral, moist to wet conditions, where competition for light, space, water, and other resources is normally kept low by periodic or recent disturbance events. Major occupied habitat types include: 1) alluvial banks, point bars, floodplains, or ox-bows associated with perennial streams, with a high water table and short, perennial graminoid- and forb-dominated vegetation maintained by grazing, periodic flooding, or mowing; 2) river floodplain habitats that experience regular spring flooding and/or frequent large scale floods, but maintain relatively stable, moist to wet soil in summer, within moist meadow, riparian woodland, or riparian shrubland communities; 3) shores of lakes and reservoirs, in mesic meadow-type vegetation maintained by lake level fluctuations or seasonal flooding of gravel bars.	X			
Wenatchee Mountains checkermallow (*Sidalcea oregana var. calva*)	USFWS	Endangered	Moist meadows with surface water or saturated upper soils into early summer. Sites generally dominated by perennial herbs and rhizomatous, perennial grasses; deciduous and coniferous trees and shrubs including ponderosa pine, Douglas fir, and quaking aspen (*Populus tremuloides*) may also be present. May occur along permanent or intermittent streams, near seeps, springs, or small drainages.	X	X	X	X

Notes: 1) USFWS 2016b; 2) USFWS, 2016a; 3) NatureServe, 2015

3.10.2 Federal Threatened and Endangered Wildlife Species

There are six ESA-listed wildlife species with the potential to be found within Chelan County: marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), yellow-billed cuckoo (*Coccyzus americanus*), Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), and grizzly bear (*Ursus arctos horribilis*). Wolverine (*Gulo gulo*) is proposed for listing as threatened (USFWS, 2016b). These seven species are identified by the USFWS as having the potential to occur within the Icicle project area as shown in Table 3-16. Each of these species is identified as potentially occurring in each portion of the Icicle project area with the exception of northern spotted owl, which USFWS does not identify as potentially occurring within the Wenatchee River portion of the project area (USFWS, 2016b). Given the existing habitat conditions within the Wenatchee River portion of the project area, the listed marbled murrelet, Canada lynx, gray wolf, grizzly bear, and wolverine species are very unlikely to occupy the available habitat but could potentially occur in the vicinity of this portion of the project area, per USFWS data. The status and preferred habitats of federally listed and proposed species protected under the ESA within Chelan County and the project area, as identified by USFWS, are presented in Table 3-16.

There are three ESA-listed species with designated critical habitat in Chelan County: marbled murrelet, northern spotted owl, and Canada lynx, and one proposal to list critical habitat for yellow-billed cuckoo (USFWS, 2016a). However, of those species with designated critical habitat in Chelan County, northern spotted owl is the only one that has critical habitat located within the Icicle project area. Northern spotted owl critical habitat covers most of the Alpine Lakes and Icicle Creek portions of the project area. Designated critical habitat for marbled murrelet, Canada lynx, and the proposed critical habitat for yellow-billed cuckoo are not located within the project area (USFWS, 2016b). This information is summarized in Table 3-17.

3.10.3 Federal Threatened and Endangered Fish Species

Wenatchee spring-run Chinook salmon (*Oncorhynchus tshawytscha*) are included in the upper Columbia ESU that is listed as endangered under the ESA (NOAA Fisheries, 2016; 64 FR 14308; 70 FR 37160; 76 FR 50448). Wenatchee summer-run steelhead (*Oncorhynchus mykiss*) are included in the upper Columbia ESU that is listed as threatened under the ESA (NOAA Fisheries, 2016; 71 FR 834; 76 FR 50448). Various federal, state, county, and tribal regulatory mechanisms are in place to minimize or avoid habitat degradation by human uses, and a 5-year review by NOAA Fisheries has recommended specific future actions to improve habitat and sustainability of these species (NOAA Fisheries, 2016).

Bull trout (*Salvelinus confluentus*) are listed as threatened under the ESA (76 FR 50448; 63 FR 42757). The Wenatchee River Watershed (including Icicle Creek and other tributaries) has been designated as one of 24 bull trout core areas within the Mid-Columbia Recovery Unit (USFWS, 2015). The Wenatchee River Watershed is one of four core areas that contain the healthiest and most stable bull trout populations and should be managed to maintain the populations and prevent introduction of new threats.

Table 3-16
Federally Listed and Proposed Species, ESA Status, and Preferred Habitats that Occur in Chelan County and the Alpine Lakes, Icicle Creek, and Wenatchee River Corridor Project Areas

Common Name (Scientific Name)	Agency	Status[1,2]	Preferred Habitat[3]	Chelan County[1]	Alpine Lakes Area[2]	Icicle Creek Corridor Area[2]	Wenatchee River Corridor Area[2]
Birds							
Marbled murrelet (*Brachyramphus marmoratus*)	USFWS	Threatened	Mature, old-growth forests (nesting, roosting)	X	X	X	X
Northern spotted owl (*Strix occidentalis caurina*)	USFWS	Threatened	Mature, old-growth forests (nesting, roosting, foraging); second-growth used for dispersal	X	X	X	
Yellow-billed cuckoo (*Coccyzus americanus*)	USFWS	Threatened (Western U.S. DPS)	Breed in open woodlands, parks, deciduous, riparian woodlands; nest in tall cottonwood and willow riparian woodlands, moist thickets, orchards, or overgrown pasture	X	X	X	X
Terrestrial Mammals							
Canada lynx (*Lynx canadensis*)	USFWS	Threatened	Occurs in boreal and montane regions dominated by coniferous or mixed forest with thick undergrowth, but also sometimes enters open forest, rocky areas, and tundra to forage for abundant prey	X	X	X	X
Gray wolf (*Canis lupus*)	USFWS	Endangered	Security habitat is greater than 300 meters from roads; ungulate prey base	X	X	X	X
Grizzly bear (*Ursus arctos horribilis*)	USFWS	Threatened	Now found mostly in arctic tundra, alpine tundra, and subalpine mountain forests; most populations require huge areas of suitable habitat	X	X	X	X
Wolverine (*Gulo gulo*)	USFWS	Proposed Threatened	Large expanse of minimally disturbed forest	X	X	X	X

Notes: 1) USFWS, 2016b; 2) USFWS, 2016a; 3) NatureServe, 2015

Table 3-17
Federally Listed and Proposed Species Critical Habitat Status that Occur in Chelan County and the Alpine Lakes, Icicle Creek, and Wenatchee River Corridor Project Areas

Common Name (Scientific Name)	Agency	Critical Habitat Status[3]	Chelan County[1]	Alpine Lakes Area[2]	Icicle Creek Corridor Area[2]	Wenatchee River Corridor Area[2]
Birds						
Marbled murrelet (*Brachyramphus marmoratus*)	USFWS	Designated	X			
Northern spotted owl (*Strix occidentalis caurina*)	USFWS	Designated	X	X	X	
Yellow-billed cuckoo (*Coccyzus americanus*)	USFWS	Proposed	X			
Terrestrial Mammals						
Canada lynx (*Lynx canadensis*)	USFWS	Designated	X			

Notes: 1) USFWS, 2016; 2) USFWS, 2016; 3) NatureServe, 2015

Pacific lamprey (*Entosphenus tridentatus*) and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) are designated as "species of special concern" by USFWS (2016b). While a petition to list Pacific lamprey under the ESA was determined not to be warranted, USFWS acknowledges that Pacific lamprey have declined in the Columbia River Basin and has published "Best Management Practices to Minimize Adverse Impacts to Pacific Lamprey (*Entosphenus tridentatus)"* (USFWS, 2010).

Several of the species described in Section 3.7, Fish, occur in the Icicle project area and are Washington State Priority Species, including the described salmon and trout species, Pacific lamprey, mountain sucker (*Catostomus platyrhynchus*), leopard dace (*Rhinichthys falcatus*), and Umatilla dace (*Rhinichthys umatilla*) (WDFW, 2008). State priority species are the focus of specific management recommendations intended to protect and enhance populations and relevant habitats.

For upper Columbia spring-run Chinook salmon and upper Columbia steelhead, areas of critical habitat affected by the Icicle Strategy include the mainstem of the Wenatchee River downstream of Icicle Creek and Icicle Creek upstream to the confluence with Frosty Creek (70 FR 52630), although the specific endpoints are not determined. These waters are shown in Figure 1-8. All of the areas of Wenatchee River, Icicle Creek, and tributaries to Icicle Creek that are accessible to bull trout are designated as bull trout critical habitat (75 FR 63897).

Locally adapted stocks of the listed spring-run Chinook salmon and summer-run steelhead are propagated in hatchery programs for conservation and reintroduction to the upper Wenatchee River Watershed, specifically the Chiwawa and Wenatchee Rivers and Nason Creek. Juveniles are overwintered at Chiwawa Hatchery and released directly to upper Wenatchee River tributaries, subsequently migrating downstream through the mainstem Wenatchee River. Additional information about fish within the Icicle project area is presented in Section 3.7, Fish.

3.10.4 WDFW Priority Habitats and Species

Of the 20 priority habitats recognized in Washington by WDFW, 11 occur in Chelan County (Table 3-18). Within the Alpine Lakes and Icicle Creek portions of the Icicle project area, six of these habitats are likely to be found. These include Biodiversity Areas, Riparian, Freshwater Wetlands, Instream, Old-Growth/Mature Forest, and Snags and Logs. The Wenatchee River Corridor includes these same priority habitat types with the exception of Old-Growth/Mature Forest and Snags and Logs. Given the mountain habitat of the Alpine Lakes, additional priority habitats that are likely to occur include Caves, Cliffs, and Talus (WDFW, 2008, 2009, and 2016).

Two of the eleven priority habitats that occur in Chelan County, Aspen Stands and Shrub-steppe, are not documented within the Icicle project area. Shrub-steppe habitat is located in the upland areas of the Wenatchee River Corridor in the vicinity of the project area. Aspen stands could occur in the vicinity of the project area in forested habitats.

The WDFW priority habitat types likely to occur within the Icicle project area are described below and the potential for occurrence within the project area is presented in Table 3-18.

Table 3-18
WDFW Priority Habitats that Occur in Chelan County and Potentially Occur within the Project Area

PHS Type	Chelan County[1]	Alpine Lakes Area[3]	Icicle Creek Corridor Area[2]	Wenatchee River Corridor Area[2]
Priority Habitats – Terrestrial Habitats[1]				
Aspen Stands	X			
Biodiversity Areas	X	X	X	X
Shrub-steppe	X			
Old-growth/Mature Forest	X	X	X	
Riparian	X	X	X	X
Priority Habitats – Aquatic Habitats[1]				
Freshwater Wetlands and Fresh Deepwater	X	X	X	X
Instream	X	X	X	X
Priority Habitat Features				
Caves	X	X		
Cliffs	X	X		
Snags and logs	X	X	X	
Talus	X	X		

Notes: 1) WDFW, 2008; 2) NatureServe, 2016; 3) WDFW, 2016

3.10.4.1 Biodiversity Areas

Biodiversity areas are defined as follows:

a) The area has been identified as biologically diverse through a scientifically based assessment conducted over a landscape scale (e.g., ecoregion, county- or city-wide, watershed, etc.). Examples include, but are not limited to, WDFW Local Habitat Assessments, Pierce County Biodiversity Network, and Spokane County's Wildlife Corridors and Landscape Linkages; or

b) The area is within a city or an urban growth area (UGA) and contains habitat that is valuable to fish or wildlife and is mostly composed of native vegetation. Relative to other vegetated areas in the same city or UGA, the mapped area is vertically diverse (e.g., multiple canopy layers, snags, or downed wood), horizontally diverse (e.g., contains a mosaic of native habitats), or supports a diverse community of species as identified by a qualified professional who has a degree in biology or closely related field and professional experience related to the habitats or species occurring in the biodiversity area. These areas may have more limited wildlife functions than other priority habitat areas due to the general nature and constraints of these sites in that they are often isolated or surrounded by highly urbanized lands.

3.10.4.2 Corridors

Corridors are areas of relatively undisturbed and unbroken tracts of vegetation that connect fish and wildlife habitat conservation areas, priority habitats, areas identified as biologically diverse (see attribute a above), or valuable habitats within a city or UGA (see attribute b above).

3.10.4.3 Riparian

The riparian habitat type is defined as the area adjacent to flowing or standing freshwater aquatic systems. Riparian habitat encompasses the area beginning at the ordinary high water mark and extends to that portion of the terrestrial landscape that is influenced by, or that directly influences, the aquatic ecosystem. In riparian systems, the vegetation, water tables, soils, microclimate, and wildlife inhabitants of terrestrial ecosystems are often influenced by perennial or intermittent water. Simultaneously, adjacent vegetation, nutrient and sediment loading, terrestrial wildlife, as well as organic and inorganic debris influence the biological and physical properties of the aquatic ecosystem. Riparian habitat includes the entire extent of the floodplain and riparian areas of wetlands that are directly connected to stream courses or other fresh water.

3.10.4.4 Freshwater Wetlands

The freshwater wetlands habitat type includes lands that are transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following attributes: the land supports, at least periodically, predominantly hydrophytic plants; substrate is predominantly undrained hydric soils; and/or the substrate is non-soil and is

saturated with water or covered by shallow water at some time during the growing season of each year.

3.10.4.5 Instream

Instream habitat type includes the combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.

3.10.4.6 Old Growth/Mature Forest

Old-growth East of Cascade Crest

This habitat type includes stands that are highly variable in tree species composition and structural characteristics as a result of the influence of fire, climate, and soils. In general, stands will be greater than 150 years of age, with 25 trees per hectare (trees/ha; 10 trees/acre) that are greater than 53 centimeters (cm; 21 inches) diameter breast height (dbh), and 2.5 to 7.5 snags/ha (1 to 3 snags/acre) that are greater than 30 to 35 cm (12 to 14 inches) diameter. Downed logs may vary from abundant to absent. Canopies may be single or multi-layered. Evidence of human-caused alterations to the stand will be absent or so slight as to not affect the ecosystem's essential structures and functions.

Mature Forests

Mature Forest habitat types are defined as stands with average diameters exceeding 53 cm (21 inches) dbh; crown cover may be less than 100 percent; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; and are 80 to 200 years old west and 80 to 160 years old east of the Cascade Crest.

3.10.4.7 Snags and Logs

This habitat type occurs within a variety of habitat types that support trees. Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a dbh of greater than 51 cm (20 inches) in western Washington and greater than 30 cm (12 inches) in eastern Washington and are greater than 2 meters (m; 6.5 feet) in height. Priority logs are greater than 30 cm (12 inches) in diameter at the largest end, and greater than 6 m (20 feet) long. Abundant snags and logs can be found in old-growth and mature forests or unmanaged forests of any age; in damaged, burned, or diseased forests; and in riparian areas. Priority snag and log habitat includes individual snags and/or logs, or groups of snags and/or logs, of exceptional value to wildlife because of their scarcity or location in a particular landscape. Areas with abundant, well-distributed snags and logs are also considered priority snag and log habitat. Examples include large, sturdy snags adjacent to open water, remnant snags in developed or urbanized settings, and areas with a relatively high density of snags.

3.10.4.8 Caves

This habitat type includes caves, which are defined as a naturally occurring cavity, recess, void, or system of interconnected passages (including associated dendritic tubes, cracks, and fissures) that occur under the earth in soils, rock, ice, or other geological

formations, and are large enough to contain a human. Mine shafts (a human-made excavation in the earth usually used to extract minerals) may mimic caves and abandoned mine shafts with actual or suspected occurrences of priority species should be treated in a manner similar to caves.

3.10.4.9 Cliffs

Cliffs are defined as being greater than 7.6 m (25 feet) high and occurring below 1,524 m (5,000 feet) high.

3.10.4.10 Talus

This habitat type consists of homogenous areas of rock rubble ranging in average size of 0.15 to 2.0 m (0.5 to 6.5 feet), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. Talus may be associated with cliffs.

Overall, more than 45 priority species of birds, mammals, amphibians, and reptiles have been documented as occurring within Chelan County (WDFW, 2008, 2009). A variety of WDFW priority species have also been specifically documented within the Icicle project area (WDFW, 2016). A complete list of WDFW priority species documented within Chelan County and the project area is presented in Appendix D.

3.11 Aesthetics

There are a number of visual resource programs used by various agencies to catalog and help prioritize the management of visual resources on public lands. These include the Scenery Management System (USFS, 1996), Visual Impact Assessment Guidelines (U.S. Department of Transportation, 2015), and the Visual Resource Management System (Department of the Interior, 1984). Application of the methods, concepts, and terms contained in these guidance documents provide a more standardized way to objectively evaluate aesthetic resources and potential changes affecting these resources.

In managing aesthetic values within public lands, these programs provide guidance on assessing the overall scenic quality of a particular landscape. This generally includes determining the visual character of an area, identifying any unique aesthetic features or views, and considering what sensitive viewer groups may be present.

To describe the visual character of an area, it is necessary to first define important viewpoints. Viewpoints are specific locations from which representative views of the overall area can be seen by sensitive viewer groups. Representative views are typically broken down into foreground (generally 0 to 0.25 miles from the viewer), middleground (0.25 miles to 2 miles), and background (greater than 2 miles). Within the foreground, viewers can detect surface textures and details. Middleground views emphasize the geometric landscape form over details, but development may still be noticeable if it contrasts in line, form, texture, or color with the surroundings. The background view loses all textural detail, and development tends to only be noticeable if change is of a larger scale and there is a stark contrast in form or line between the development and surrounding landscape.

Sensitive viewer groups can include residents, workers, recreationalists, and motorists. Their overall sensitivity to visual changes depends on the extent to which they are exposed to a particular view and how important the visual character is to their activity. In general, viewers are considered to be more sensitive to visual changes if they are repeatedly exposed to the same view and if that view contributes to the underlying activities.

Unique aesthetic resources or views include things like unique or different landscape features or formations. This can include built environments, such as city skylines, or natural features, such as mountains or lakes. Specific corridors can also be designated by the National Scenic Byway Program as having unique visual qualities.

In general, visual character refers to the overall feel or nature of a viewpoint. The character can be more natural with few man-made elements or more urban with many man-made structures. The character is based on the landscape elements found (e.g., landform, vegetation, rocks, water features).

Visual quality refers to how intact the visual character is. If there are conflicting visual elements, such as some man-made structures in an otherwise pristine natural landscape, the visual quality of that landscape would not be as high as areas where the landscape is more uniform.

3.11.1 Alpine Lakes

The Alpine Lakes are located in the northern Cascades in an area that features striking views provided through dramatic terrain, lakes, and creeks, and a wide-variety of ecotypes as a result of elevation and precipitation variability throughout the 400,000 acres.

Land uses and related activities within the Alpine Lakes Wilderness Area (ALWA) are governed in part by the Wilderness Act of 1964 (16 United States Code [USC] 1131). In addition to allowing for certain land uses, including water resources management facilities, the act also designates scenic use as one of the six public purposes of wilderness. The Act requires wilderness character to be preserved consistent with other allowed uses (36 Code of Federal Regulations 293).

Sensitive viewer groups within this part of the Icicle project area consist of recreationalists and some IPID and USFWS staff who conduct periodic operations and maintenance activities at the lakes. Recreational use in this area is described in greater detail in Section 3.15, Recreation. In general, 150,000 visitors (USFS, 2017) hike into the lakes annually, mostly in the summer months, to camp and enjoy the wilderness.

Important viewpoints at each of the potentially affected lakes were selected based in part on recreational use data. In general, trailheads at each lake were selected because those are the areas where the most people arrive at the lakes and experience sweeping views of the lakes and surrounding mountains. Representative views of this area are shown in the figures below.

As shown in Figures 3-11 to 3-13, which include a selection of photographs from the lakes, the Alpine Lakes visual character is defined by the lakes in the foreground, sloped conifer forests punctuated by snags in the middleground, and seasonally snow-capped mountain peaks in the background. In general, these views are relatively intact. The existing dams and outlet infrastructure are visible in certain views; however, most of the facilities are small in scale or compatible with the surrounding landscape (i.e., blend in) or are blocked by vegetation or landform from areas heavily accessed by recreationalists.

Figure 3-11. Eightmile Lake Vista

Figure 3-12. Klonaqua Lake Vista

Figure 3-13. Square Lake Vista

The anthropogenic features present in this part of the Icicle project area vary between the lakes but consist primarily of primitive campgrounds and trails (Figures 3-14 and 3-15), and water resources infrastructure such as valve or gate structures (Figure 3-16), exposed gate operators (Figure 3-17), and dam structures (Figure 3-18). The materials used in both the recreation and irrigation facilities tend to camouflage these features into the surrounding landscape, making the overall character appear more natural and visually intact.

Figure 3-14. Eightmile Lake Trail

Figure 3-15. Campsite near Klonaqua Lake

Figure 3-16. Valve House and Outlet near Nada Lake

Figure 3-17. Gate Actuator and Gate Chamber near Klonaqua Lake

Figure 3-18. Dam Structure at Square Lake

3.11.2 Icicle Creek Corridor

Lower in the watershed, the upper portion of the Icicle Creek Corridor, particularly the portion located within the Wenatchee National Forest, has similar vegetative character as the Alpine Lakes; however, closer to the City of Leavenworth the visual character becomes more developed with urban and agricultural uses that include more man-made features, such as paved roads, parking areas, trails and trailheads, and rural residential development.

Outside of the national forest in the lower portion of the watershed near the City of Leavenworth, recreational vehicle (RV) campgrounds, extensive agriculture, and rural and residential development are present. Infrastructure development is extensive within the LNFH. Throughout the majority of the Icicle Creek Corridor, there are limited creek crossing bridges with the exception of trails, a few residential access bridges, hatchery structures, and the East Leavenworth Road. The creek bank includes a fairly continuous but relatively thin band of riparian vegetation, though gaps in this buffer occur in a few areas of the hatchery and along a few rural or agricultural properties south and east of the City of Leavenworth.

Important viewpoints along the Icicle Creek Corridor were selected based in part on recreational use data. In general, trailheads leading to the Alpine Lakes wilderness and public access routes within the LNFH were selected because these are the areas where the most people experience extended views of Icicle Creek. Representative views are shown in Figures 3-19 and 3-20.

Figure 3-19. Icicle Creek Boulder Field from Snow Lakes Trailhead

Figure 3-20. Icicle Creek from Leavenworth National Fish Hatchery, Structure 5

3.11.3 Wenatchee River Corridor

Further downstream, the Wenatchee River Corridor contains even more intensive residential and agricultural uses. This Wenatchee River Corridor also includes more intensive development, including residential, commercial, and recreational uses within the City of Leavenworth and other towns and cities. Icicle Road and Highway 2 both cross the Wenatchee River at bridges in the City of Leavenworth. Riparian vegetation within the City of Leavenworth is fairly intact, though gaps are present at the golf course and along some residential and agricultural properties. Downstream of the City of Leavenworth, the upland areas are dominated by agricultural activities, providing pastoral landscape views mostly characterized by orchard activities. In this segment of the Wenatchee River Corridor, several roads and bridges cross the river. A railroad and Highway 2 run along the Wenatchee River. Both the railroad and the highway cross the river on bridges at multiple locations. Local roads also cross the river on bridges near Peshastin, Dryden, Cashmere, and Monitor. Riparian vegetation on the riverbank persist, though the vegetation has gaps where there is development near the Town of Peshastin, the Peshastin Mill, and residential development within the Town of Dryden.

The Stevens Pass Greenway was designated a National Scenic Byway in 2005. This corridor includes Highway 2 beginning in the City of Monroe and extending to the orchards around the Town of Peshastin. The National Scenic Byway Program designates

specific corridors that contain unique visual qualities. These areas are regulated under the Intermodal Surface Transportation Efficiency Act of 1991 (23 USC 101). This program designates scenic transportation routes and encourages strategies for "protecting and enhancing the landscape and view corridors surrounding such a highway" (USFS, 2003).

Important viewpoints along the Wenatchee River Corridor were selected based on public water access locations and proximity to the scenic byway as these are the areas where the most people experience extended views of the Wenatchee River. Representative views are shown in Figures 3-21 and 3-22.

Figure 3-21. Wenatchee River at Icicle Road Bridge near Public River Access

Figure 3-22. Wenatchee River from Highway 2 Bridge at Town of Dryden

3.12 Air Quality

3.12.1 Regulatory Setting

The Federal Clean Air Act (CAA, U. S. Code Title 42, Chapter 85) is administered by the EPA. The EPA is mandated to set standards on air emissions considered harmful to public health (primary standards) and public welfare (secondary standards). These National Ambient Air Quality Standards (NAAQS) are set for six criteria pollutants, which include carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter[3-18], and sulfur dioxide.

While the EPA is the primary regulatory authority, the CAA is largely implemented by the states and local and tribal authorities. The Ecology Central Regional Office is responsible for air quality control within Chelan County. The CAA requires states to classify air basins as either being in attainment or nonattainment with respect to the

[18] Particulate matter is broken out into two categories: fine particulate matter 2.5 micrometers or smaller (PM 2.5), and large particulate matter less than 10 micrometers (PM 10).

criteria pollutants. In areas designated as nonattainment areas, the local or regional air quality authority must prepare a State Implementation Plan (SIP) that demonstrates how the area will achieve attainment by federally mandated deadlines.

In addition, the CAA includes provisions to maintain scenic vistas within federally designated Class 1 areas (40 Code of Federal Regulations [CFR] 81), which includes the Alpine Lakes (WAC 173-400-118). Ecology has developed a Regional Haze SIP to comply with requirements to minimize impacts on visibility within these designated areas. The SIP focuses on controlling emissions from fixed large facilities, such as smelters and other industrial facilities (Ecology, 2010).

Ecology has also identified Washington State Ambient Air Quality Standards (SAAQS) for the protection of human health (primary standards), which supplement the NAAQS and include limits for emissions of total suspended particulates, lead, particulate matter, sulfur dioxide, carbon monoxide, ozone, and nitrogen dioxide (Chapter 70.94 RCW). Several state regulations also apply to regulating air emissions from operations (e.g., stationary facilities) and construction activities consistent with these standards (Chapter 173-400 WAC).

3.12.2 Current Air Quality Environment

There are two current air quality monitoring stations within the Icicle project area. The first is in the City of Leavenworth and is operated by the USFS to monitor air quality in order to make decisions on initiating controlled burns. The second air quality monitoring station is in the City of Wenatchee and is operated by Ecology. The purpose of this station is to collect wind speed, wind direction, and temperature in support of PM 2.5 monitoring at the City of Wenatchee (Ecology, 2016a). Historically, Chelan County has not exceeded the NAAQS and is currently in attainment for criteria pollutants (Ecology, 2016b).

Within the Alpine Lakes portion of the Icicle project area, haze is a major concern and can affect the views that visitors to the lakes experience. An air quality monitor was established at the Snoqualmie Ski Area in 1993 to assess visibility impairment within the surrounding area. Based on the monitoring data, sulfates were the largest contributor to visibility impairment in the Snoqualmie Ski Area, followed by organic carbon, ammonium nitrate, and elemental carbon. With the implementation of the State Regional Haze SIP in this area, visibility improved 20 percent between 2000 and 2009. Visibility is anticipated to reach background levels (approximately 84 miles) by 2064 based on the current rate of improvement (USFS, 2013).

Major air pollution sources within the Icicle project area occur as the result of outdoor burning (year round, except during summer fire safety burn bans), wildfires, agricultural burning (spring and fall burn seasons), orchard heaters, smudge pots, silvicultural burning, and woodstove use. In rare instances, smoke from some burns may become entrained in evening downslope flow and settle in sheltered valleys (Ecology, 2015). Table 3-19 defines sources of pollutants that contribute to increased haze within the Icicle project area.

Table 3-19
Sources of Regional Haze Pollutants

Pollutant	Anthropogenic Sources	Natural Sources
Sulfates	Coal-fired Power Plants, Diesel Engines, Industrial Boilers	Volcanoes
Organic Carbon	Incineration, Household Heating	Fire, Vegetation
Nitrates	Cars and Trucks, Off-Road Vehicles, Industrial Boilers, Agriculture	Soils, Lightning, Fire
Fine Soil	Off-Road Vehicles, Agriculture	Wind-blown Dust
Elemental Carbon	Soot, Diesel Engines	Fire
Fine Particulate Matter	Combustion Processes, Roads	Fire
Coarse Particulate Matter	Construction, Roads, Woodstoves, Fireplaces	Wind-blown Dust, Fire

Source: USFS, 2013.

Potentially sensitive receptors include any groups or individuals who are particularly vulnerable to air pollution. This typically includes children, the elderly, or any other persons with health complications. Potentially sensitive receptors within the Icicle project area are largely limited to the more urbanized areas, closer to the Cities of Leavenworth and Wenatchee.

3.13 Climate Change

Climate change poses a challenge for water resource planning, protection, and use. This is because of increased uncertainty in timing, form, and distribution of precipitation and water demand. Climate change will impact water supplies within the region, affecting uses such as instream flows, municipal, and agricultural. This section discusses the current and projected climatic conditions regionally and within the Icicle project area. Additionally, predicted impacts of climate change on streamflow is provided for the Alpine Lakes Area and Icicle Creek sub-regions.

3.13.1 Current Climatic Conditions

Climate in the Pacific Northwest is influenced by the interactions and seasonal variation of atmospheric circulation patterns, especially the seasonal migrations of the Aleutian Low pressure system and the North Pacific (Hawaii) High pressure system (CIG, 2004). These patterns generally lead to cold, wet winters and warm, dry summers, with local variation based on marine influences and elevation.

Climate in the valleys west of the Cascades follows the pattern of cool, wet winters and warm-dry summers. However, with the marine influence of this area, mild temperature regimes are dominant. Average annual precipitation in most places west of the Cascades is more than 30 inches. As a result of orographic lift, precipitation on the westerns slopes of the Cascades is extremely high, with most places receiving in excess of 100 inches per year (CIG, 2004).

Climate east of the Cascade crest is more continental, with warmer, drier conditions. This is in stark contrast to the maritime climate of the western portion of the region. The Cascade Mountains create this regional dichotomy in climate, with the rain-shadow effect driving the dry conditions in eastern Washington and creating a barrier between the maritime low pressure and the continental high pressure. In the eastern lowlands, average annual precipitation is generally less than 20 inches, with some places receiving as little as 7 inches (CIG, 2004).

The Wenatchee River Watershed is located on the eastern slopes of the Cascade Mountains. The headwaters, located at high elevations in the Cascades, receive considerable precipitation, which mostly falls as snow. Lower elevations of the Wenatchee River Watershed receive more modest amounts of precipitation. Table 3-20 lists average annual precipitation for weather stations located in and near the Wenatchee River Watershed.

Table 3-20
Available NWS Climate Records in/near Wenatchee River Watershed
(adapted from Wenatchee Watershed Assessment, 2003)

Agency	Station No.	Name/Location	Period of Record	Average Annual Precipitation (inches)
NWS	458089	Stevens Pass	1950-1994	84.5
NWS	454446	Lake Wenatchee	1948-1985	39.3
NWS	456534	Plain	1948-Present	37.0
NWS	454572	Leavenworth 3 S	1948-1973; 1979-Present	25.3
NWS	450929	Wenatchee EXP STN	1950-1951; 1971-1997	10.3
NWS	459074	Wenatchee	1931-Present	8.9
NWS	459082	Wenatchee FFA AP	1959-Present	8.4

This pattern holds true for the Icicle Creek Subbasin. Although, because of its elevation and location, it lowest elevations in the Icicle Creek Subbasin receive more precipitation than the lowest elevations in the Wenatchee River Watershed. The nearest weather station to the upper Icicle Creek Watershed is located at Stevens Pass, which is a little over 2 miles from the most northwestern reaches of the Icicle Creek Subbasin. As illustrated in Table 3-20, the average annual precipitation for Stevens Pass is 84.5 inches.

The City of Leavenworth 3 S is the lowest and eastern-most weather station in the Icicle Creek Subbasin and receives approximately 25.3 inches of precipitation annually.

3.13.2 Projected Future Climatic Conditions

During the past 100 years, the Pacific Northwest has become warmer and wetter (Mote et al., 2005). Models predict a continuation of this trend. Temperatures will continue to increase within the Pacific Northwest region, along with small increases in precipitation, shifts in the seasonality of precipitation, and increased high precipitation events; however, to what degree depends on greenhouse gas emission scenarios (CIG, 2009). These climatic changes are likely going to decrease snow pack in the Cascades, with early snowmelt. The CIG predicted in their 2009 *Washington Climate Change Impacts Assessment*, that probable impacts are decreased April 1 snowpack (by as much as 40 percent in the 2040s), reduced reservoir storage, and increased stream temperatures. This will have profound effects on the Wenatchee River Watershed, which is characterized as a snow dominant basin (Tohver, 2016). By the 2040s, the Wenatchee River Watershed will likely be a rain/snowmelt transient watershed. This will mean lower snowpack, earlier run off, and more precipitation will fall as rain (Tohver, 2016). These future climate conditions are anticipated in the Icicle Creek Subbasin as well.

3.13.3 Implications for Stream Flow in Icicle Creek

Modeling indicates the changes in climate discussed above will have substantial impacts on Icicle Creek streamflow (CIG, 2017). In Icicle Creek, the model predicts an average minimum flow would decrease by as much as 75-percent in 2050 for a 2-year return period (CIG, 2017). Conversely, the results indicate an increase percent change in peak flows in 2050 based on the 2-year return period: 22 percent, 20 percent, and 58 percent, respectively (CIG, 2017). This indicates that systems will become flashier, with lower low flows and higher peak flows. With warmer winters, run off will increase considerable in the early part of the water year, leaving less water instream during critical low flow months. Table 3-21 provides the average change in percentages by month for 2050.

Figure 3-23 through 3-28 details the impacts of these projected changes on the streamflow averages in Icicle Creek. As illustrated in the figures, by 2030 under low and high greenhouse gas scenarios, the model predicts higher flows from December through April, with lower flows from May through November. The model predicts that low flows will also be lower than what has been observed historically. The results indicate a reduced peak flow, which is predicted to occur in mid-April as opposed to June, when the average peak flow has historically occurred. As time progresses, the model predicts that these trends will become more extreme. In 2050, under low greenhouse gas emissions, the results indicate that peak flow will be reduced compared to the historical peak flow, with a greater volume of flow between the month of October and May. By 2080, the model predicts that this trend will be further exaggerated, with a much flatter hydrograph. The results indicate that average flows will increase dramatically in the winter months (October to April) and will be much lower from May to September. Under the high greenhouse gas scenarios, these trends are similar, but accelerated and exaggerated.

Table 3-21
Streamflow Percentage Change Based on Climate Change Modeling 2050 (CIG, 2017)

Month	Percentage Change Based on GHG Scenario		
	Low	Mid	High
October	5	8	9
November	27	32	55
December	16	63	106
January	14	63	201
February	32	57	206
March	41	67	244
April	9	102	143
May	-7	4	35
June	-50	-28	9
July	-71	-41	-28
August	-75	-62	-31
September	-41	-39	-20

Figure 3-23. Icicle Creek Modeled 2030 Flows (Low Greenhouse Gas Emissions)

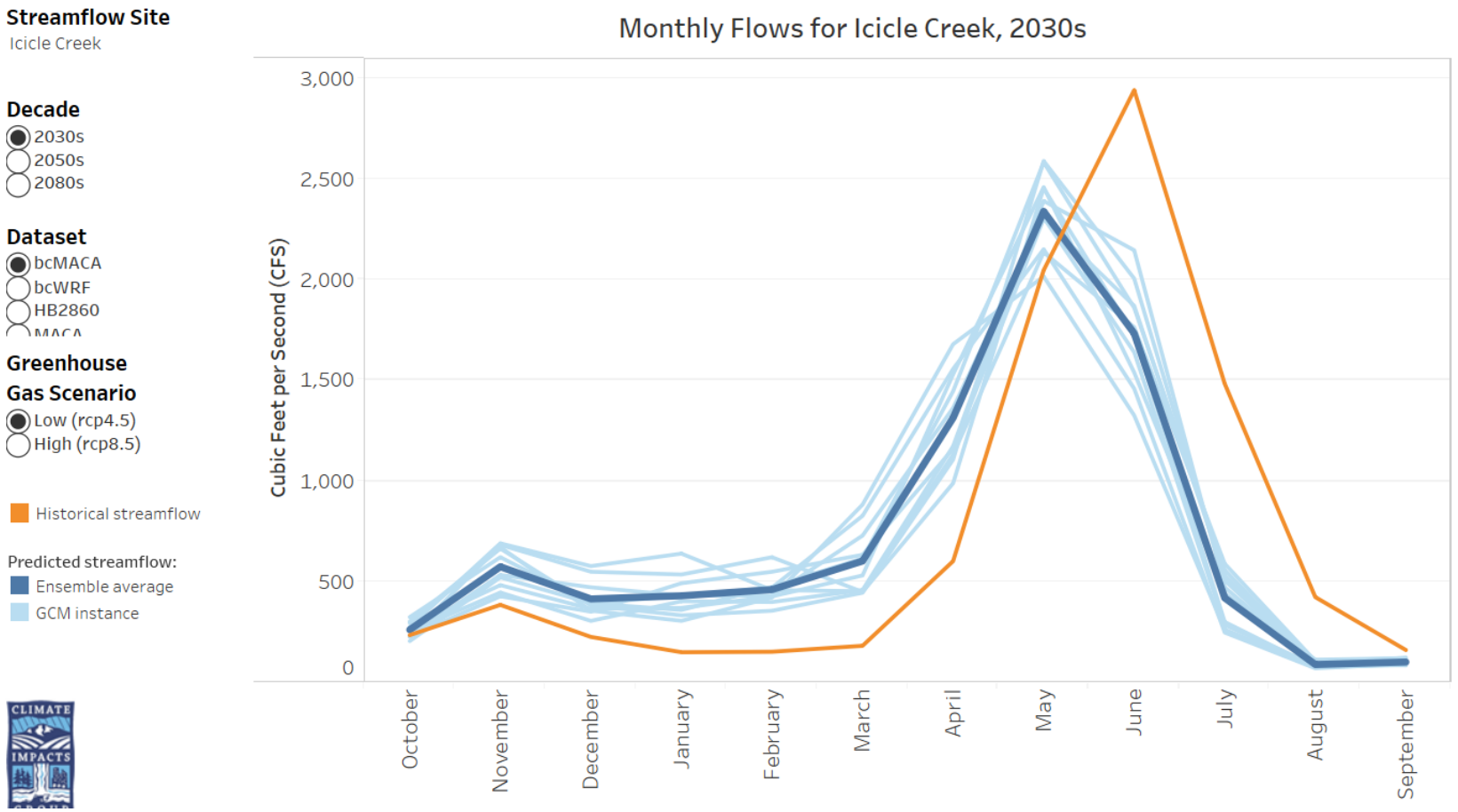


Figure 3-24. Icicle Creek Modeled 2030 (High Greenhouse Gas Emissions)

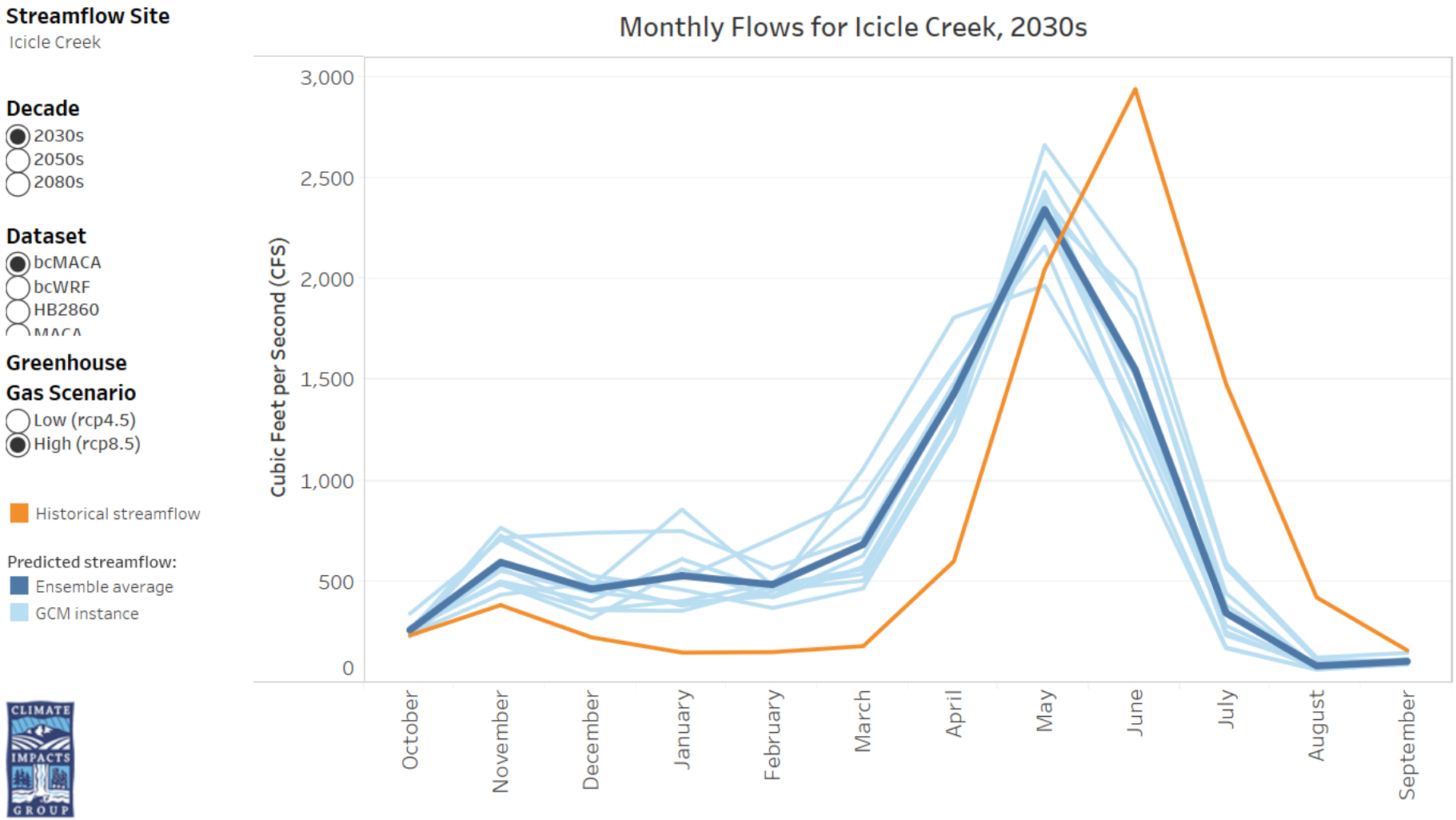


Figure 3-25. Icicle Creek Modeled 2050 Flows (Low Greenhouse Gas Emissions)

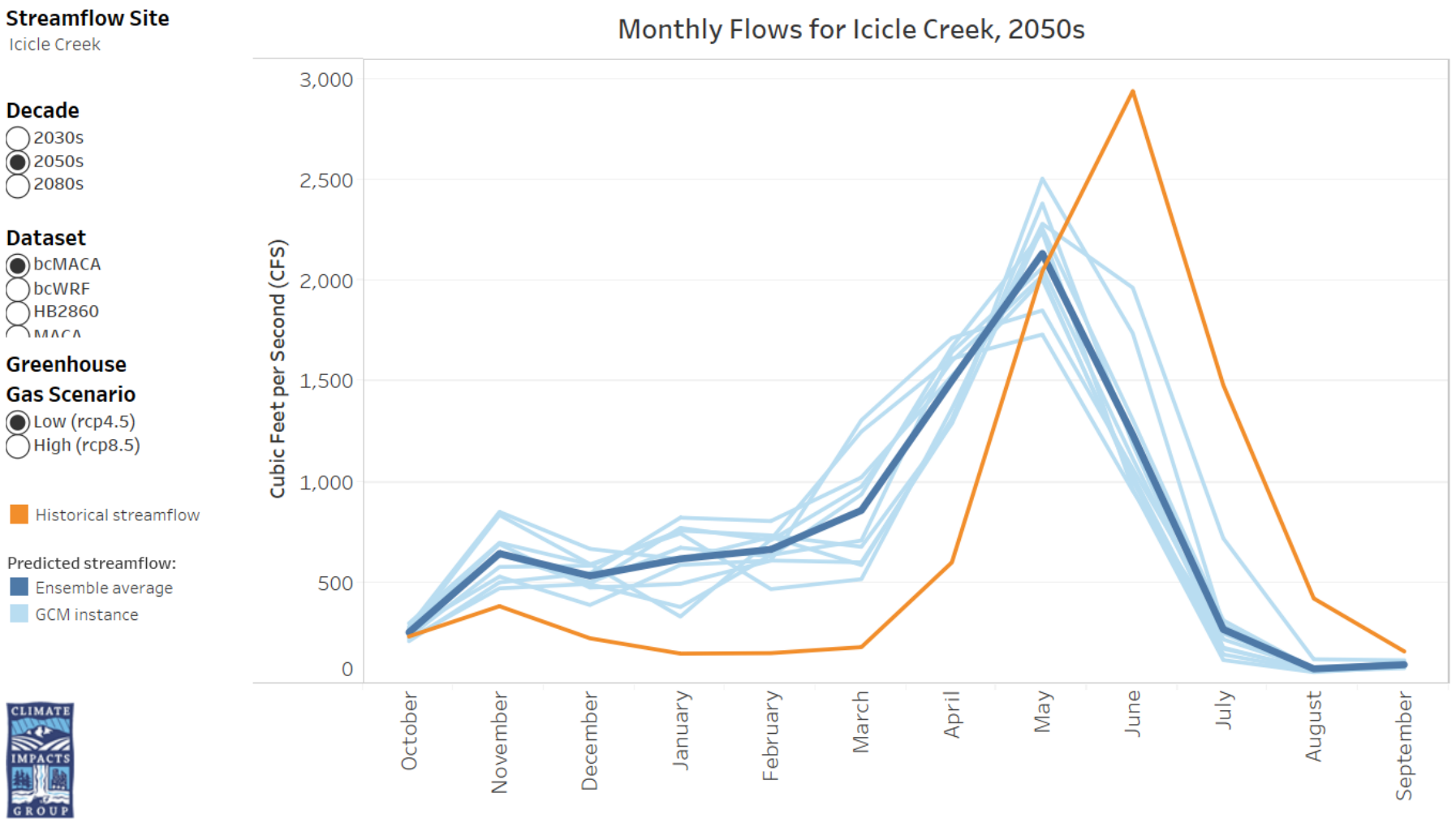


Figure 3-26. Icicle Creek Modeled 2050 Flows (High Greenhouse Gas Emissions)

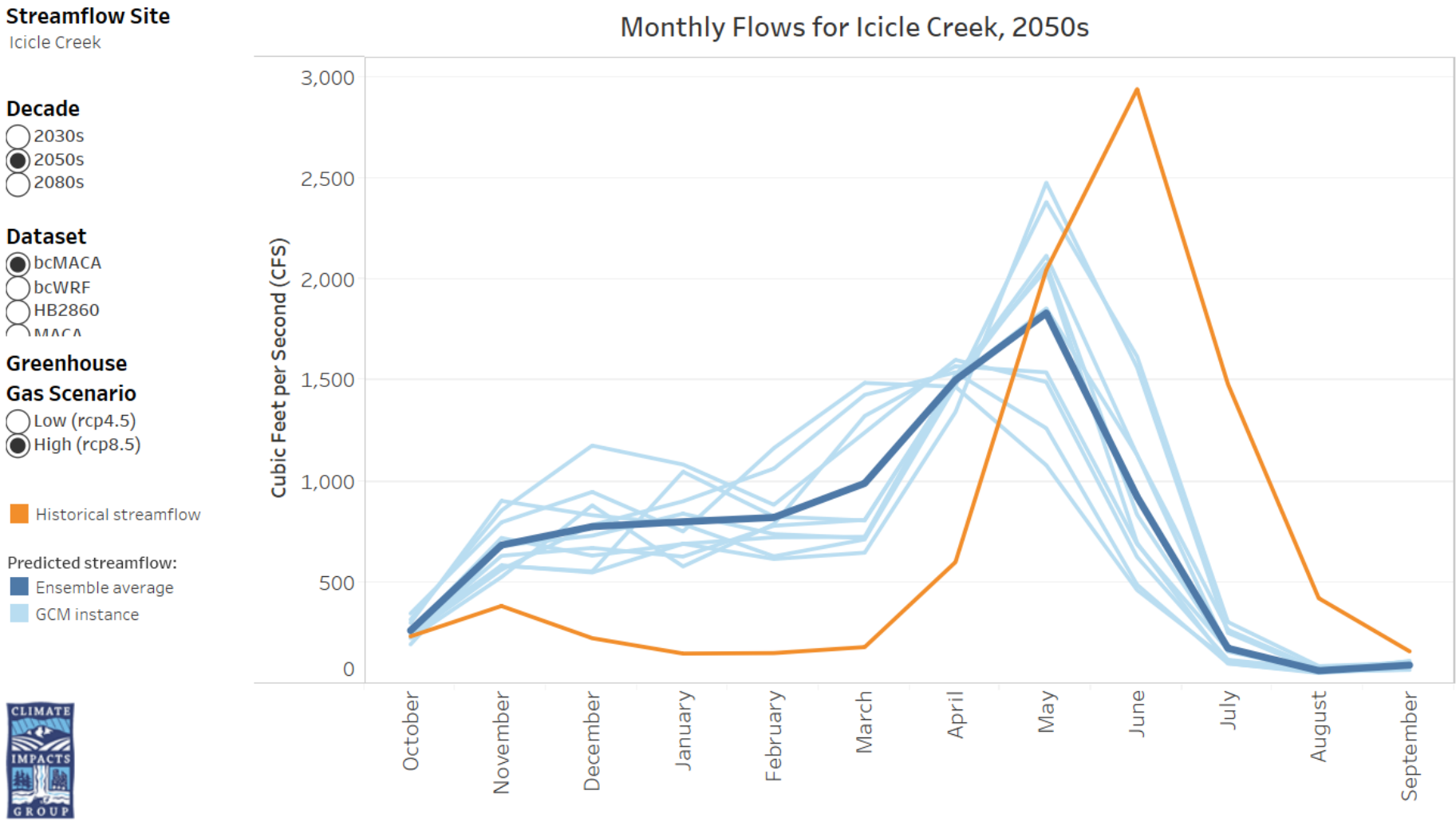


Figure 3-27. Icicle Creek Modeled 2080 Flows (Low Greenhouse Gas Emissions)

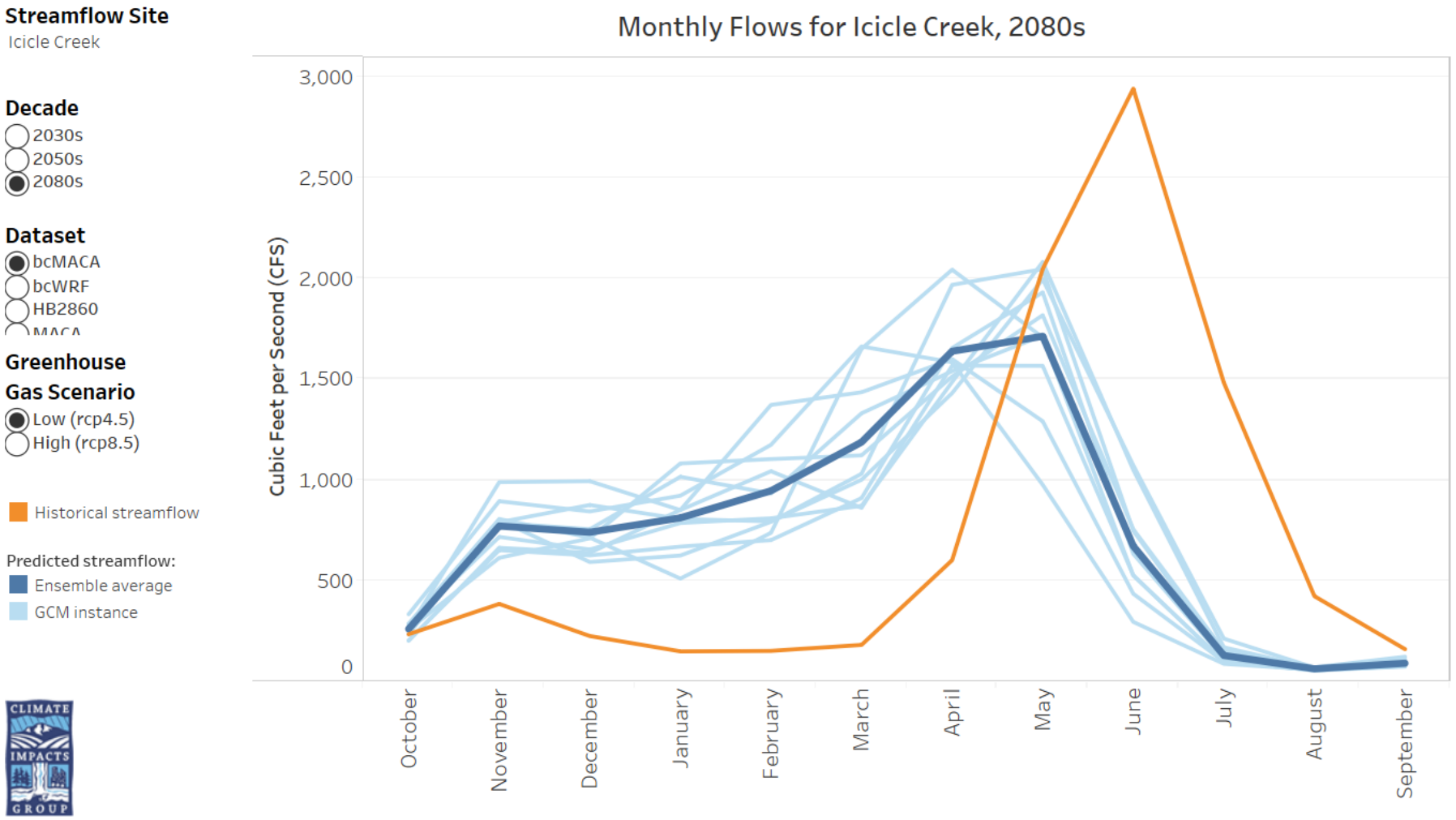
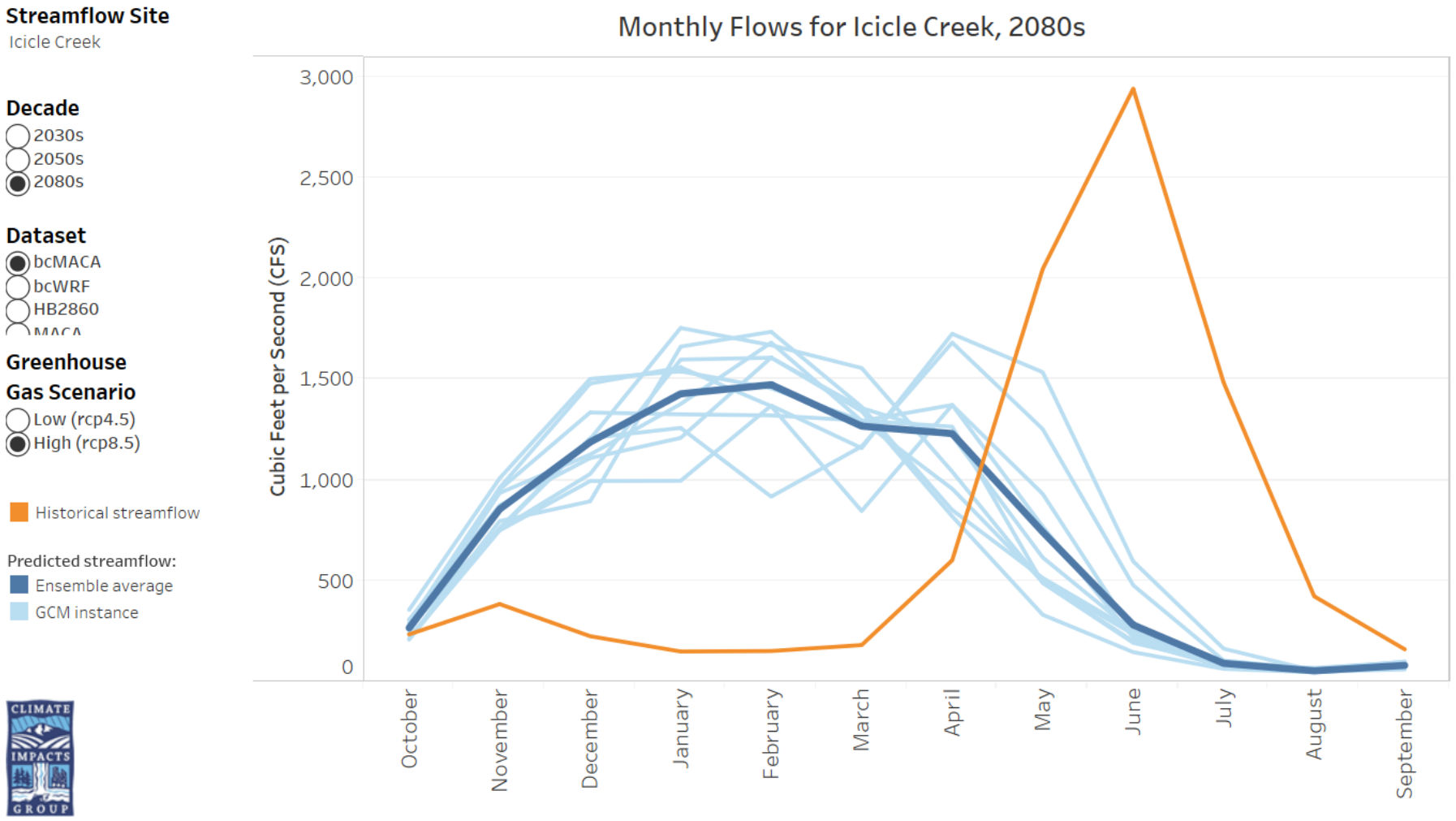


Figure 3-28. Icicle Creek Modeled 2080 Flows (High Greenhouse Gas Emissions)



For the Alpine Lake catchments evaluated as part of the Icicle Strategy, the results predict a similar shift in peak flows from June to May, with a drop in peak flows and low flows. The biggest changes are predicted in the northwestern-most lakes, Klonaqua and Square. These catchments have the largest predicted drop in peak and low flows. However, all catchments appear to have an increase in flows during the winter months. This is likely tied to predicted changes in precipitation type and the timing of snow melt. As time progresses or under high greenhouse gas scenarios, these changes become more extreme. The 2030 modeling under low greenhouse gas scenarios predicts slightly higher winter flow, with peak flows occurring about a month earlier (May rather than June), a rapid decrease in flow from May through July, and low flows in August. Under the 2080 high greenhouse gas scenario, the results indicate much more wintertime flow (October through April), significantly reduced peak flow occurring in April, and severely reduced flows throughout the summer. Figures 3-29 through 3-35 show the predicted flow in these catchments in 2050 based on low greenhouse gas emissions.

Figure 3-29. Colchuck Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

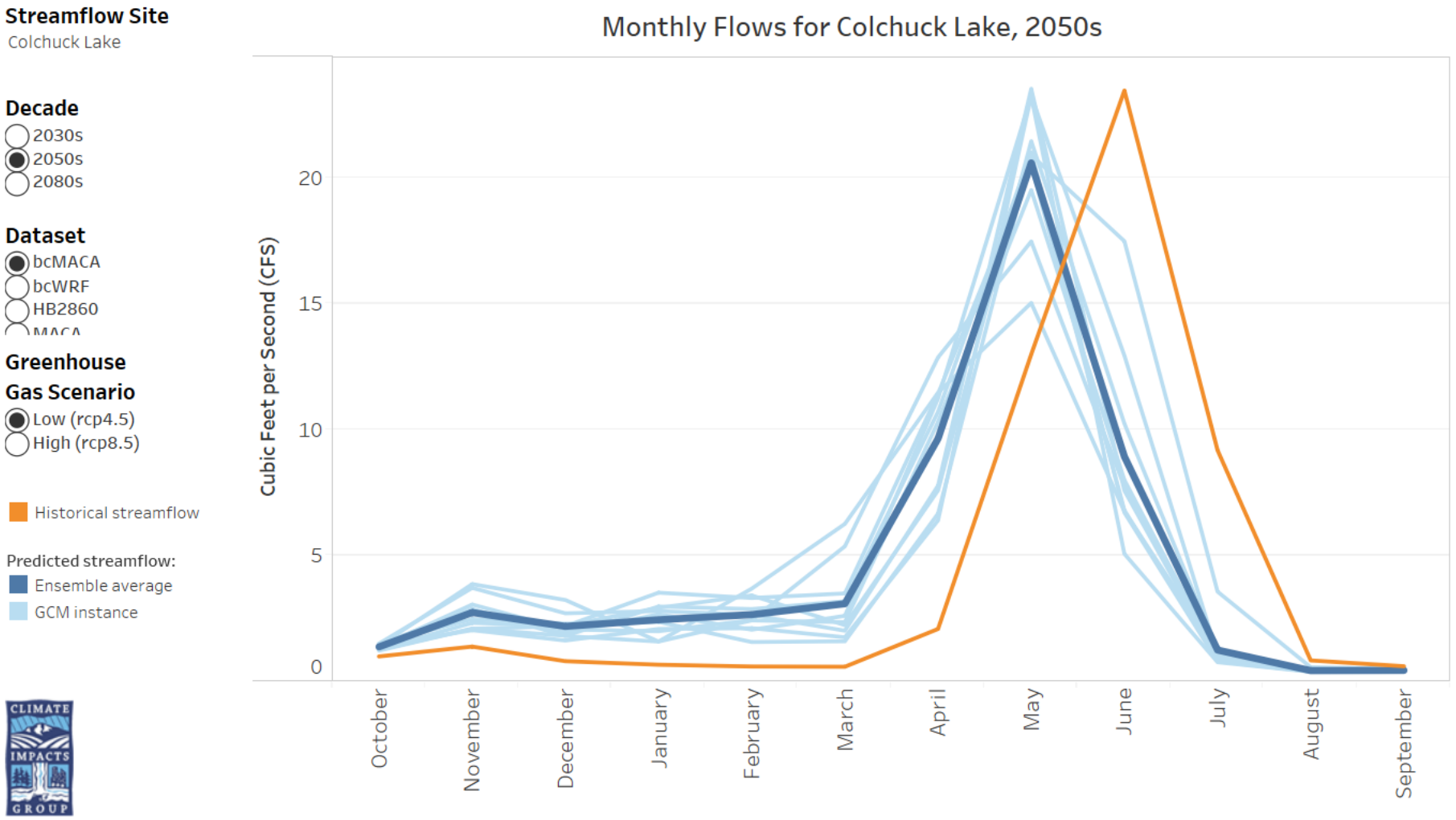


Figure 3-30. Eightmile Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

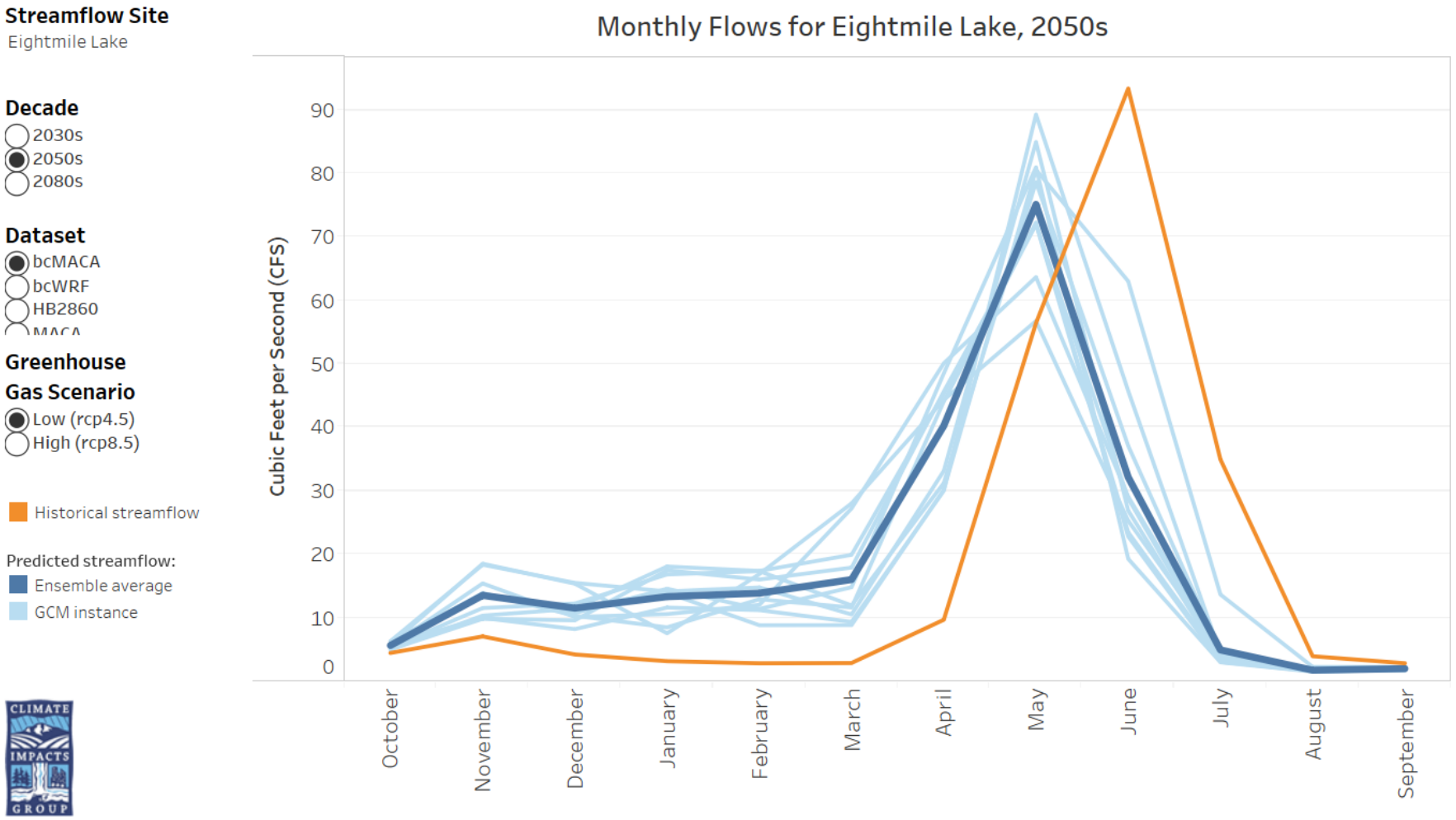


Figure 3-31. Klonaqua Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

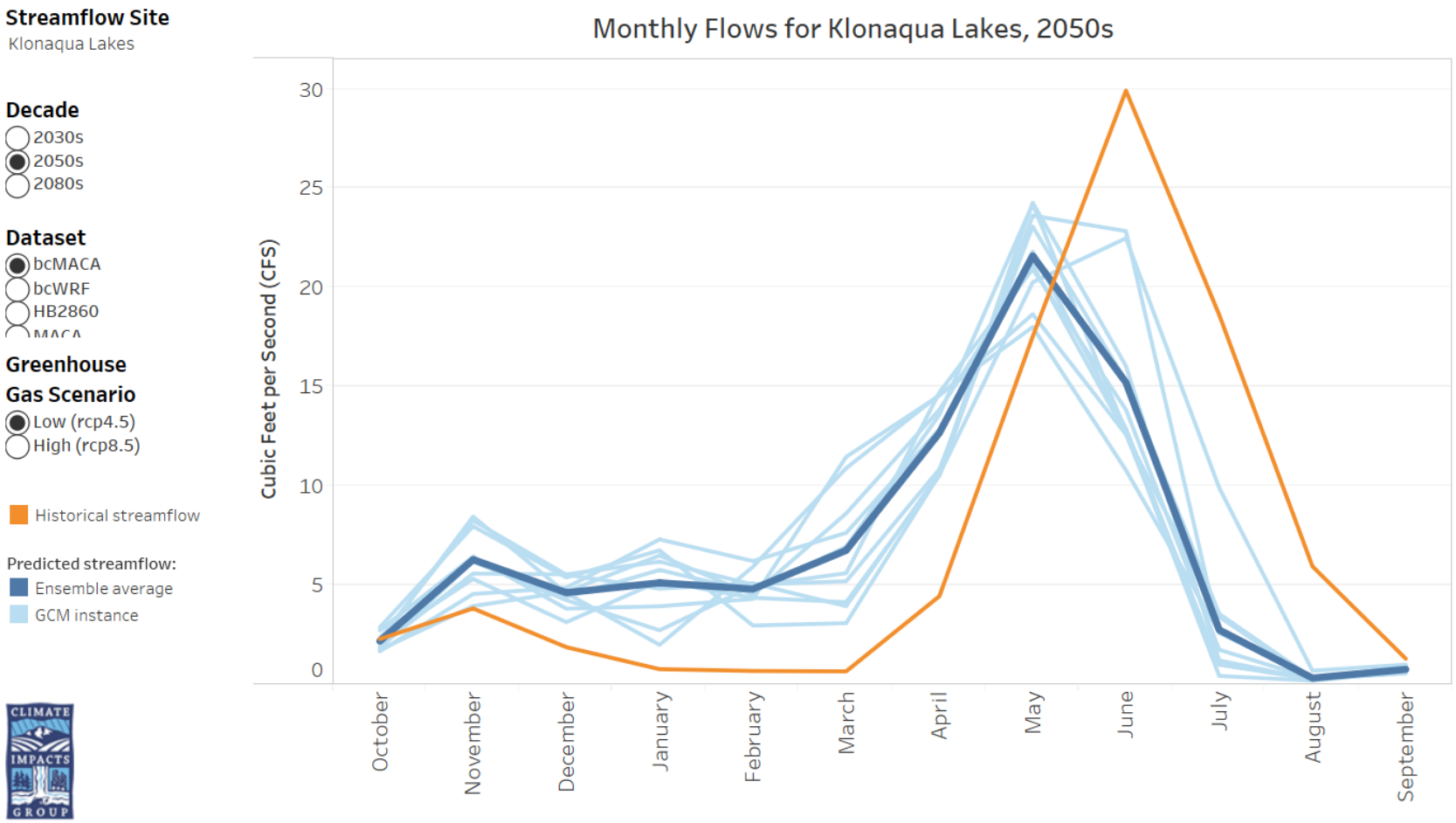


Figure 3-32. Square Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

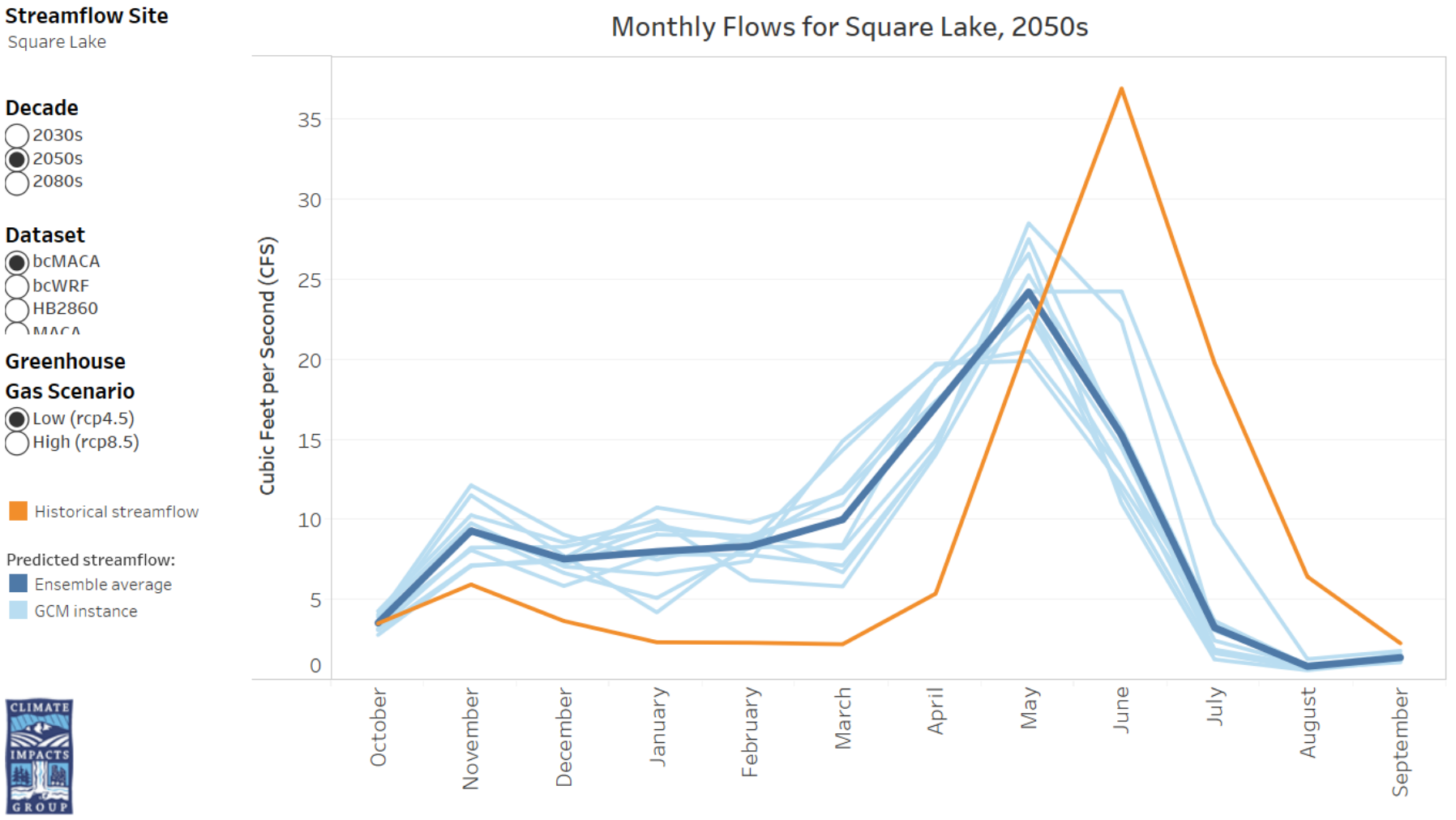


Figure 3-33. Nada Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

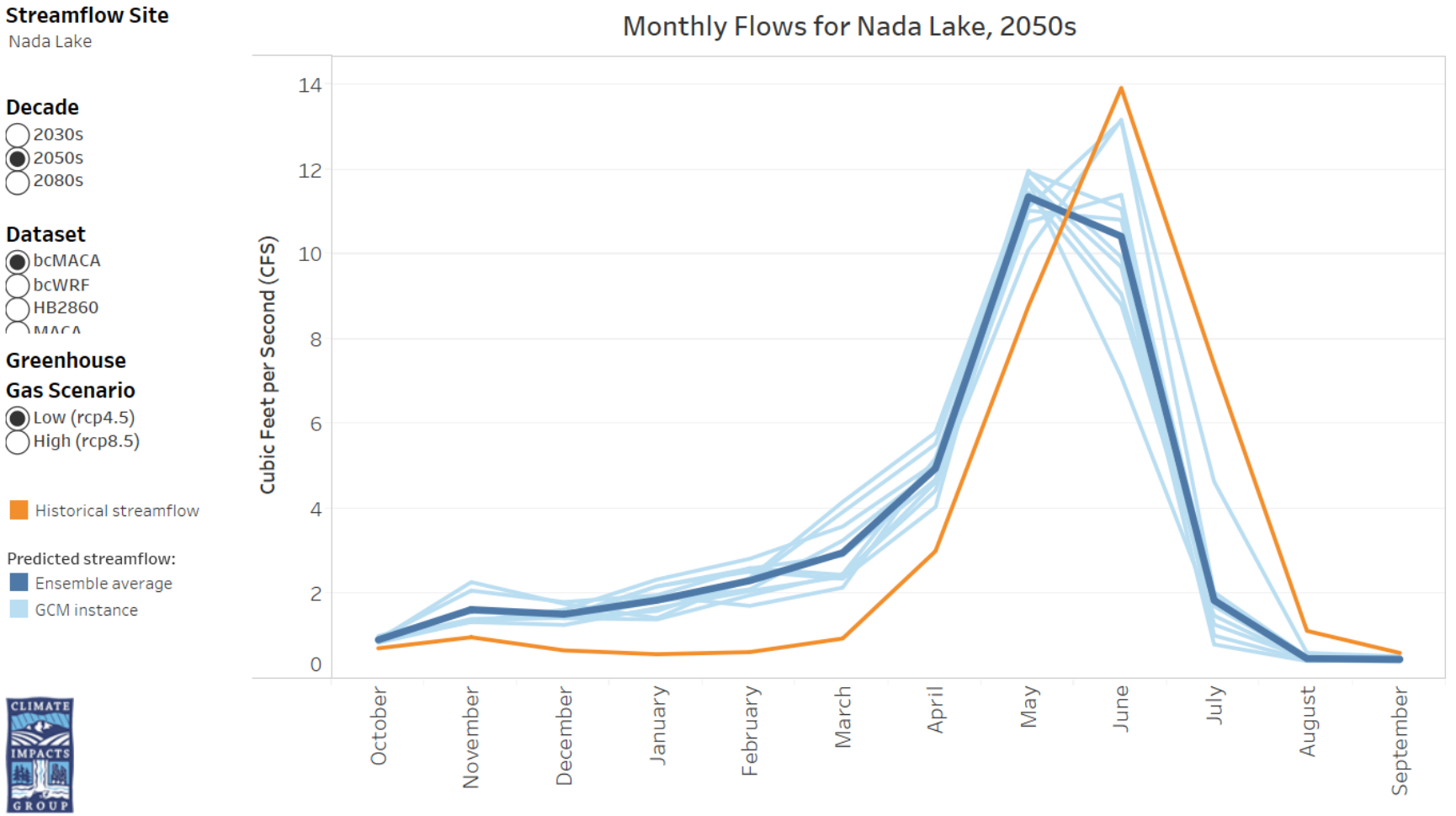


Figure 3-34. Lower Snow Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)

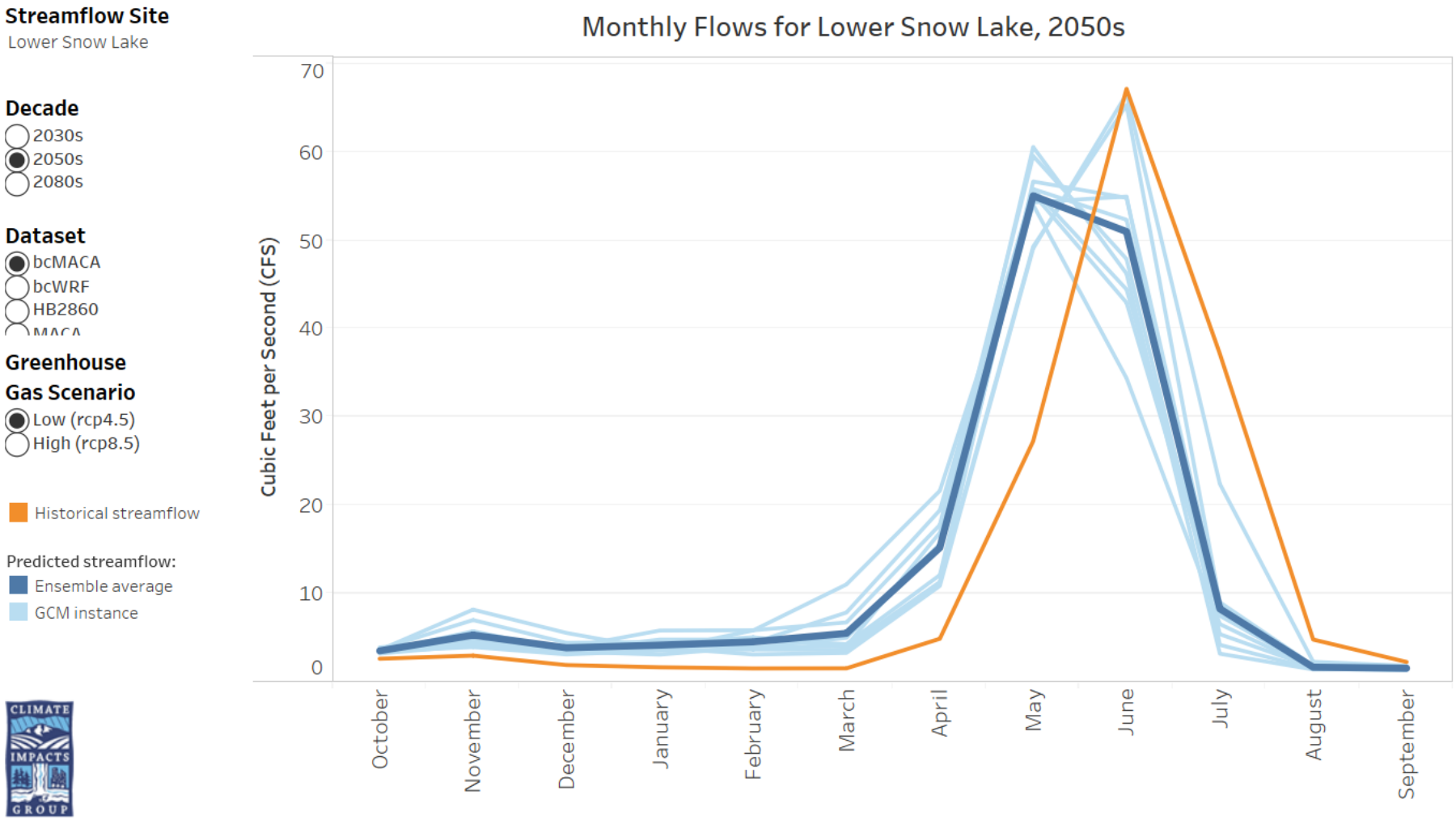
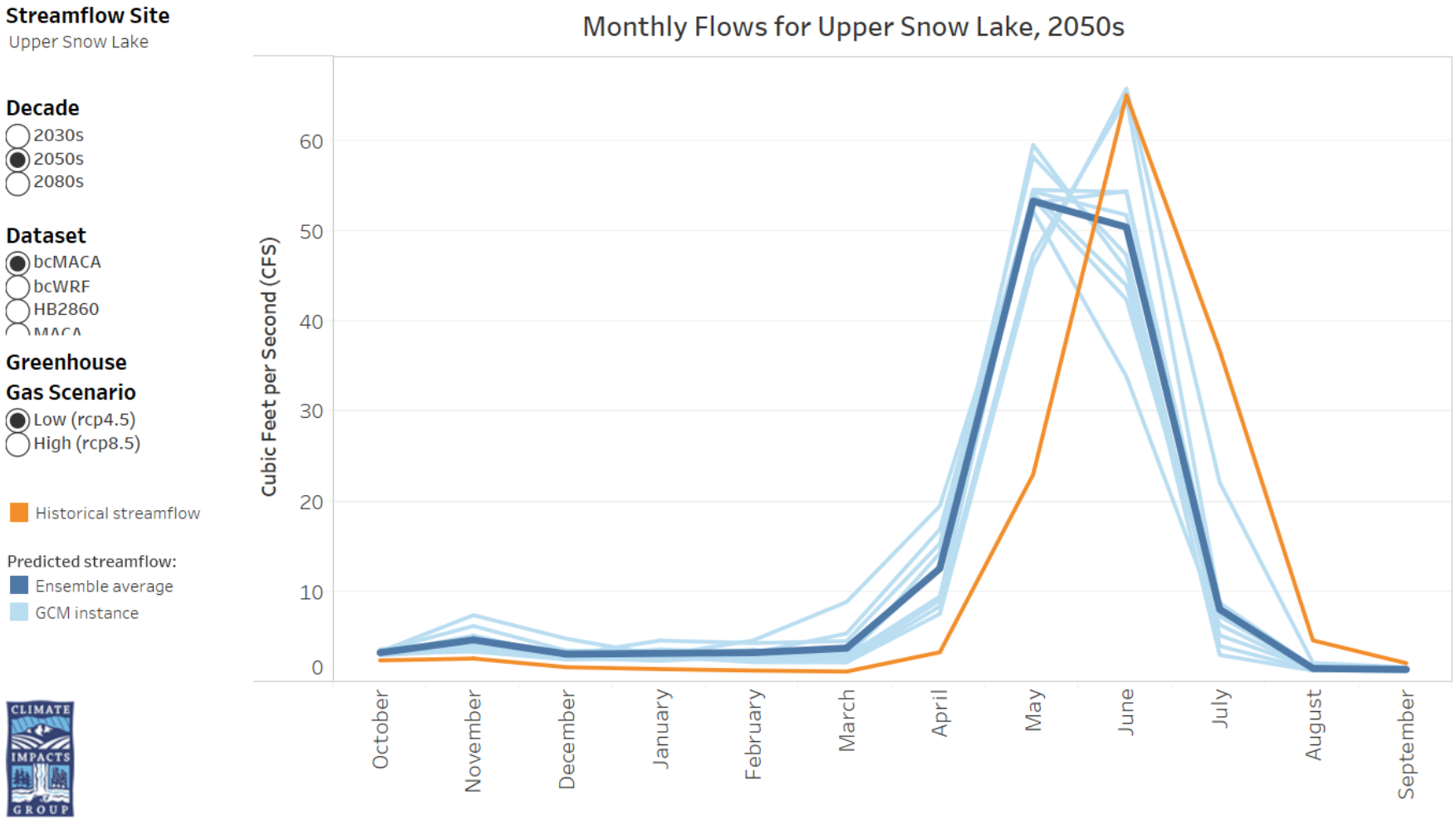


Figure 3-35. Upper Snow Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions)



3.14 Noise

Noise is generally defined as unwanted sound. Sound is measured in terms of both pressure and frequency, based on the ear's sensitivity. The human ear is less sensitive to higher and lower frequencies than to mid-range frequencies. Therefore, sound level meters used to measure environmental sound generally incorporate a filtering system that discriminates against higher and lower frequencies in a manner similar to the human ear to produce noise measurements that approximate the normal human perception of noise. Measurements made using this filtering system are termed "A-weighted decibels," abbreviated as dBA. Sound levels referred to in this PEIS are stated as hourly equivalent sound pressure levels (Leq) in terms of dBA.

Sound levels decrease with distance from a sound source. The Leq sound level from a linear source, such as a road, will decrease by 3 to 4.5 dBA for every doubling of distance between the source and the receiver. The Leq sound level from a point source, such as a generator, will decrease by approximately 6 dBA for every doubling of distance between the source and the receiver. A 10-dBA change in noise level is perceived by most people to be approximately a doubling in loudness (e.g., an increase from 50 dBA to 60 dBA causes the perceived loudness to double). Generally, 3 dBA is the minimum change in outdoor sound levels that can be perceived by a person with normal hearing.

Ambient environmental sound is often described in using a day-night average sound level (Ldn). This metric measures sounds using an A-weight equivalent over a 24-hour period. It also uses an additional 10-dBA weighting for nighttime hours (10:00 p.m. to 7:00 a.m.) to account for greater nighttime sensitivity to noise (EPA, 1978). The Program Alternatives are not anticipated to generate long-term sources of noise; however, short-term construction noise could be generated. Table 3-22 shows common types of sound generated by construction activities.

Table 3-22
Typical Construction Noise Levels

Noise Source	Maximum Noise Level (dBA)[1]	Notes
Threshold of hearing	10	Barely audible
Rustling leaves, broadcast and recording studio	20	Extremely quiet
Quiet rural area	30	Very Quiet
Whisper; lowest limit of urban ambient sound	40	One-eighth as loud as 70 dBA.
Quiet suburb	50	One-fourth as loud as 70 dBA.
Conversation (3 feet)	60	Half as loud as 70 dBA. Fairly quiet

Noise Source	Maximum Noise Level (dBA)[1]	Notes
Vacuum cleaner, gas lawn mower at 100 feet	70	Upper 70s are annoyingly loud to some people.
Garbage disposal; freight train (at 100 feet)	80	2 times as loud as 70 dBA. Possible damage in 8 hours of exposure.
Motorcycle at 25 feet; diesel truck at 50 feet	90	4 times as loud as 70 dBA. Likely damage in 8 hours of exposure
Construction site; jackhammer	100	8 times as loud as 70 dBA. Serious damage possible in 8 hours of exposure
Jet flyover (1,000 feet)	110	16 times as loud as 70 dBA.
Thunderclap; chain saw	120	32 times as loud as 70 dBA. Commonly accepted pain threshold.
Jet taking off (200 feet)	130	Painful

Modified from several sources including: https://www.chem.purdue.edu/chemsafety/Training/PPETrain/dblevels.htm; http://www.roads.maryland.gov/Index.aspx?PageId=827; OSHA, 2013
Notes: 1) Noise is measured as A-weighted decibels (dBA) at 50 feet from the source.

3.14.1 Regulatory Setting

3.14.1.1 Federal Noise Control Standards

The Federal Noise Control Act of 1972 (42 U.S.C. §4901 et seq.) established a national policy to protect people from noise that may be harmful to their welfare. This policy generally delegates responsibility for regulating noise to state and local governments (EPA, 2016).

3.14.1.2 State and Local Noise Control Standards

Ecology administers the State Noise Control Standards through Chapter 173-60 WAC, which adopted the Federal Noise Control Act of 1972 in order to establish maximum permissible noise standards based on zones. WAC 173-60-030 defines environmental designation for noise abatement (EDNA) zones into three classifications (A, B, C). Class A EDNA is typically where people reside and sleep, and include residential areas and recreational areas, such as camps, parks, camping facilities, and resorts. Class B areas include those requiring protection against noise interference with speech, such as commercial, retail, and recreational facilities, including theaters or amusement parks. Class C areas include those where economic activities are of such a nature that higher noise levels than experienced in other areas is normally to be anticipated, such as industrial areas or warehouses.

Maximum permissible noise levels are established in WAC 173-60-040. Table 3-23 below shows maximum dBAs from a source and the maximum dBAs that can be received within the three classifications. Exemptions are listed in WAC 173-60-050 and include construction noise generated between 7:00 a.m. and 10:00 p.m.

Table 3-23
Maximum Permissible Noise Levels for Non-Exempt Activities

EDNA of Noise Source (dBA)	EDNA of Receiving Property		
	Class A	Class B	Class C
Class A	55	57	60
Class B	57	60	65
Class C	60	65	70

Source: WAC 176-60-040
Note: All numbers are in A-weight decibels (dBA)

Along with the maximum permissible noise levels described in Table 3-23, there are additional limitations to Class A lands, where a reduction of 10 dBA is required between the hours of 10:00 p.m. and 7:00 a.m.

Chelan County regulates noise standards through Title 7 of the Chelan County Code. Below are applicable excerpts from Title 7 of the Chelan County Code relating to noise:

> **7.35.030 Public disturbance noises.**
>
> It is unlawful for any person to unreasonably cause or make, or for any person in possession of property to allow to originate from the property, sound which is a public disturbance noise. Public disturbance noises include the creation of loud, raucous, frequent, repetitive or continuous sounds that exceed a reasonable person standard so as to disturb or interfere with the peace, comfort and repose of another. (Res. 2012-36 (part), 4/30/12).
>
> **7.35.040 Exceptions.**
>
> (a) The provisions of this chapter shall not apply to:
>
> (1) Regularly scheduled community events conducted on property owned by a governmental agency or public school district and conducted with the express permission of an authorized representative of the property owner; and
>
> (2) Preparation for and action of regularly scheduled events held in the County of Chelan and authorized by an appointed representative of the county.
>
> (b) The ordinary and usual ringing of trolley bells by a mass transit carrier, e.g., Link trolley bus.
>
> (c) Sounds from construction activity during the hours of seven a.m. to ten p.m. and any activity necessary for the preservation of the public health, safety and welfare.
>
> (d) Sounds that are the result of agricultural activities.

3.14.2 Current Noise Environment

The Icicle project area for noise includes the Alpine Lakes and the Icicle Creek and Wenatchee River Corridors. The Alpine Lakes portion of the Icicle project area is remote and exposed to little man-made noise. Noise sources in this area are predominantly associated with natural conditions, periodic recreational activity, and periodic noise for operation and maintenance of the IPID facilities. The primary sensitive noise receptors in this area include recreationalists who are hiking to and camping around the lakes. Moving away from the lakes down the watershed, development becomes increasingly more urbanized with higher density agricultural, residential, and commercial land uses (Chelan County, 2016). The predominant noise sources include intermittent sounds related to rural residential and agricultural noise with increasing noise related to urbanization moving closer to the Cities of Leavenworth and Wenatchee. Within the more urbanized areas, typical sound includes traffic noise and noise from commercial activity. Sensitive receptors to noise changes within the more urbanized areas include residents, workers, and recreationalists. Their sensitivity to changes in the noise environment would depend on the relative change in noise conditions and how close to and for how long they are exposed to the change.

3.15 Recreation

Outdoor recreationists are attracted to the project area by the quality of the scenery and by the variety of recreation opportunities, including fishing, hiking and backpacking, horseback riding, rock climbing, white-water kayaking and rafting, river tubing, skiing, snowshoeing and other related activities such as camping, picnicking, and wildlife viewing. Public demand for access to rivers, streams, lakes, and trails continues to increase each year.

A review of existing recreation opportunities and conditions is presented below and broken into the three sub-regions of the project area: the Alpine Lakes Area, Icicle Creek, and the Wenatchee River Corridor.

3.15.1 Alpine Lakes Area

The upper reaches of the Icicle project area include popular recreational destinations. All of the Alpine Lakes sub-region is located within the ALWA. The ALWA encompasses approximately 394,000 acres in the Central Cascades Region (USFS, 2017)[3-19]. The ALWA is accessed by 47 trailheads and 615 miles of trails.

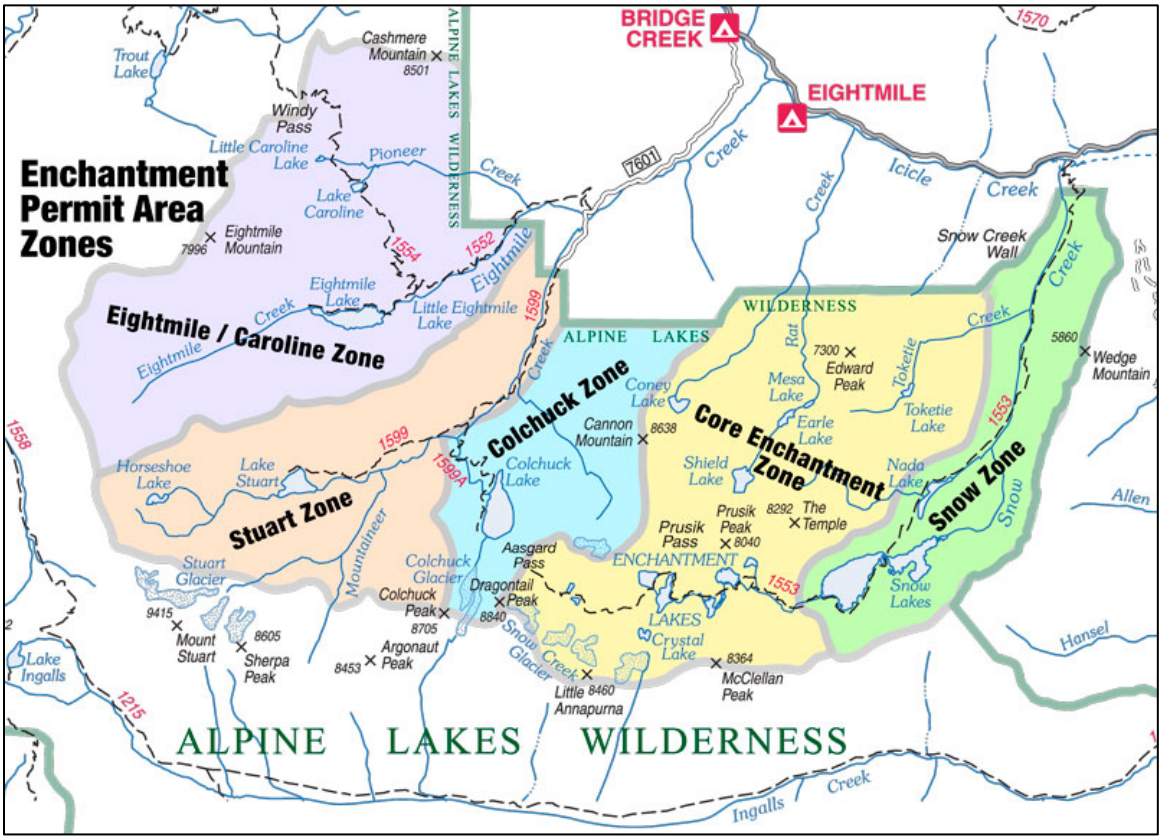
The ALWA is visited by nearly 150,000 people each year (USFS, 2017a)[3-20]. Permits are required for all visitors between May 15 and October 31. The maximum group size is 12 (combined people and stock), except for the Enchantment Permit Area, which is located

[19] https://www.fs.usda.gov/recarea/okawen/recarea/?recid=79432
[20] ALW Regulations Booklet:
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5407053.pdf

in the project area, where the maximum group size is 8. Additional restrictions apply to camping, campfires, and stock use. A valid Recreation Pass is required for vehicles parked at trailheads.

Within the ALWA, the Enchantment Permit Area (Figure 3-36) is a particularly popular backpacking destination. The Enchantment's Permit Area is within the Icicle project area and includes Eightmile, Colchuck, Nada, and the Upper and Lower Snow Lakes.

Figure 3-36. Enchantment Permit Area Zones (USFS, 2017b)[3-21]



3.15.1.1 Hiking

Trails were the original transportation system in the Alpine Lakes Area (Alpine Lakes Management Plan, 1981). Most of the trails on the east side of the Cascades were established near the turn of the century by herdsmen moving sheep through the high mountain country. In the early 1900s, following establishment of the National Forests, the trail system became the transportation network between fire lookouts and guard stations. Today, trail use is predominantly for recreation and supports hiking, climbing, backpacking, stock, and other backcountry uses.

[21] Interactive map on recreation.gov: accessed January 2017 (https://www.fs.fed.us/ivm/index.html?minx=-13711415&miny=5848140&maxx=-13124379&maxy=6175290)

The USFS maintains a network of trails that provide access into the ALWA for hiking, climbing, and backpacking. Within the Enchantment Permit Area (Figure 3-35), the Stuart Lake Trail (#1599) provides access to the Stuart Zone, and to the Colchuck and Core Enchantment zones via the Colchuck Lake Trail (#1559.1/1559A). The Snow Lakes Trail (#1553) provides access to the Snow Zone, and the Eightmile Lake Trail (#1552) provides access to the Eightmile/Caroline Zone and to areas outside the Permit Area via the Eightmile-Trout Creek Trail (#1554).

According to the USFS, day-use hiking in the Enchantment Permit Zone continues to increase in popularity each year (Table 3-24). The USFS reports that compliance with day-use permit applications ranges from 50 to 75 percent, depending upon the time of year (USFS, 2016[3-22]). Table 3-24 provides use numbers for self-registered day users at two popular trailheads, Snow Lake Trailhead and Stuart/Colchuck Trailhead. Specific information about final user destination was not readily available, so it is unclear from this dataset how many visitors went to Colchuck Lake vs. Stuart Lake. Although information from local users indicate Colchuck Lake is the more popular destination of the two. Additional permit information was not available for Eightmile Lake, which is one of the most popular destinations in the ALWA.

Table 3-24
Approximate Number of Day-Use Permits in Enchantment Permit Area Zone[1]

Year	Snow Lakes Trailhead	Stuart/Colchuck Trailhead	Total
2012[2]	850	1,350	2,200
2013	900	2,900	3,800
2014	1,000	3,400	4,400
2015	1,100	4,600	5,700

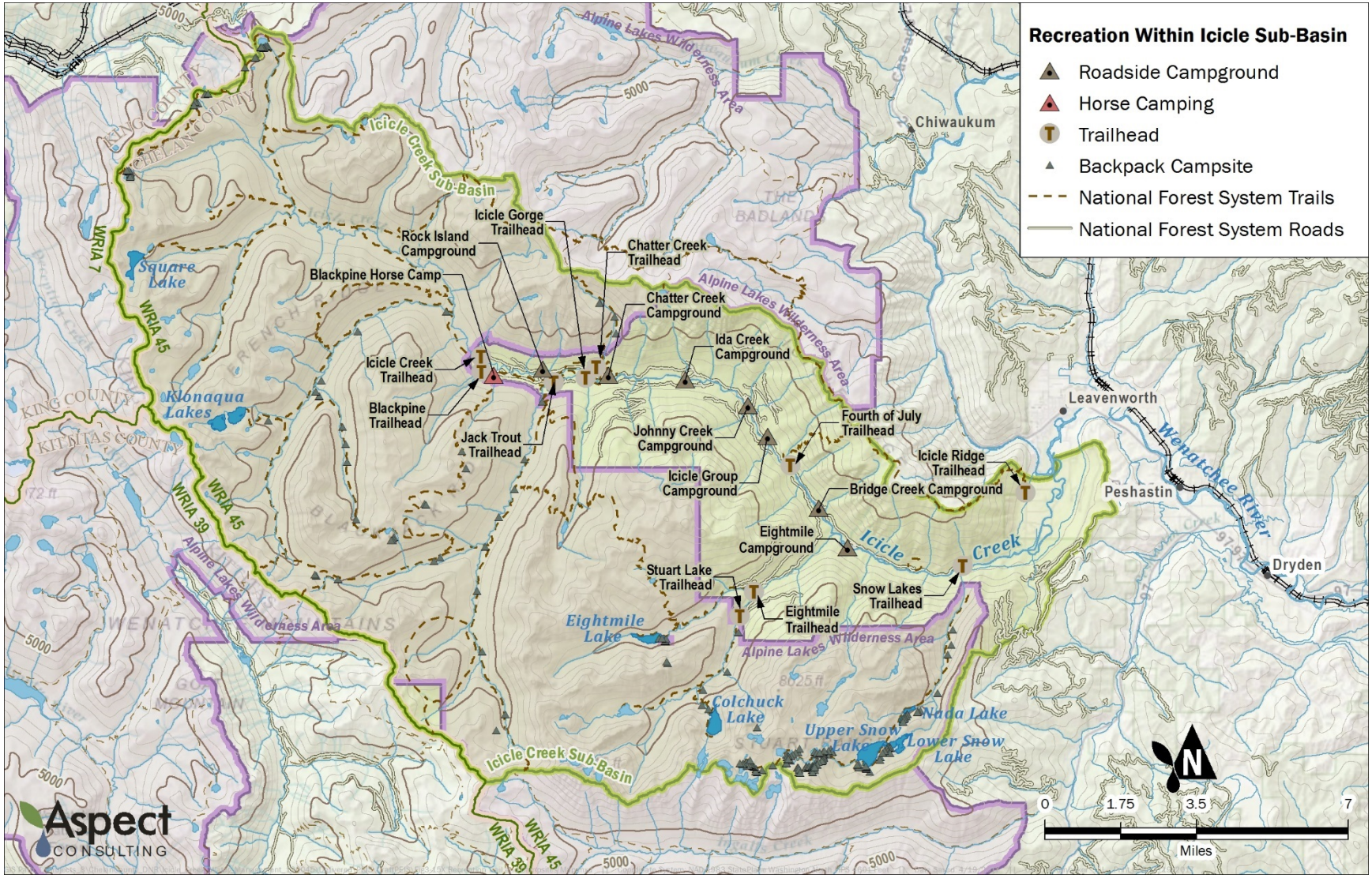
[1] Permits are for groups, which may contain up to 8 persons
[2] Severe fires in 2012 resulted in closure of Enchantments for over a month

Within the project area, hiking to Klonaqua and Square Lakes also occurs. Day-use permits are required and are self-issued at the trailhead. These areas are outside of the Enchantment Permit Area Zone, and details on the number of day-use permits for these areas was not readily available. However, because these lakes are more remote and not included in the Enchantment Permit Area Zone, it is likely these areas have a much lower number of visitors. The Klonaqua Lake Trail (Trail #1563) is located 7.2 miles up the French Creek Trail, with the total one-way distance to Lower Klonaqua Lake of 10.8 miles. The Square Lake Trail (Trail #1567) is accessed via Icicle Creek and Leland Creek Trails, with a total one-way distance to the lake of approximately 13 miles. Trail reports indicate that Square Lake Trail is difficult to hike on due to downed trees and lack of maintenance, which may also discourage use.

Figure 3-37 provides an inventory of recreational facilities and use areas and existing conditions at these sites within the Alpine Lakes Area. These data were collected and provided by USFS.

[22] Numbers provided to Aspect via 20161220 USFS PEIS Data Gap Action Plan.doc

Figure 3-37. Recreation Sites and Existing Conditions within the Alpine Lakes Area



(Source: USFS geospatial files)

3.15.1.2 Horseback Riding and Stock Use

Horseback riding and use of stock animals (e.g., llamas and mule) is permitted in the ALWA but not on the Snow Lakes Trail or the Stuart Lake Trail (except from the Saturday following Labor Day to January 1). Additionally, access to the Klonaqua Lakes is prohibited to stock. Stock are allowed on the Eightmile Lake Trail and Square Lake Trail; however, overnight stock use is prohibited. Additionally, Square Lake Trail has had limited maintenance since the 2003 Square Lake Fire, and trail conditions are rough and not recommended for stock. Restrictions for stock use in the ALWA include containment at least 200 feet from lakes, use of processed feed, and use of designated camps near certain lakes and meadows.

3.15.1.3 Backpacking/Camping

Overnight camping in the ALWA requires a permit from the USFS. Maximum length of stay is 14 consecutive days. For areas outside the Enchantments Permit Area, permits are self-issued at the trailhead. For camping within the Enchantments Permit Area between May 15 and October 31, applicants must submit a request to an online, pre-season lottery. Any permits not allocated by the lottery are available on a first come, first served basis through the recreation.gov advance reservation system. Additionally, 25 percent of permits are held by the Leavenworth Ranger District for day-of trips (i.e., walk up lottery).

Demand for overnight permits in the Enchantment Permit Area far exceeds the number available. In 2016, the USFS received 19,646 lottery applications for overnight stays. Even when the available quota of permits was reduced in 2014 and 2015 because of an increasing amount of observable impacts (e.g., widening trails, loss of fragile vegetation, development of new social trails and campsites, proliferation of switchback cuts), the total number of people camping increased as a result of increasing party size. In 2015, an estimated 10,200 people camped in the Enchantment Permit Area. No site-specific numbers are available for Colchuck, Eightmile, or Snow Lakes, however Table 3-25 and Table 3-26 provide details on permit applications by year.

Table 3-25
Lottery Applications by Year

Year	Number of Applications
2009	1,770
2010	
2011	+3,000
2012	
2013	+4,000
2014	+8,000
2015	12,034
2016	19,646

Table 3-26
2015 Enchantment Zone Permit Area Data

Awarded Permits	1,946
Total Applications	12,034
Success Rate	16%

3.15.1.4 Recreational Fishing

There is a non-tribal sport fishery for resident trout in the ALWA. Prior to human settlement, most of the high lakes were barren of fish (Alpine Lakes Area Management Plan). The WDFW has stocked the lakes in the ALWA and Enchantments Permit Area in the past. No stocking currently occurs in Colchuck, Eightmile, Klonaqua, Square, Nada, or Upper and Lower Snow Lakes (Table 3-27).

Table 3-27
WDFW Trout Stocking in the Alpine Lakes Wilderness Area

Lake	Species	Last Year Stocked	Next Year to Stock	Comments
Colchuck	CT	2000	Discontinued	May have been discontinued due to loss of funding for aircraft
Eightmile	RB,CT,LT	2005	Discontinued	May have been discontinued due to loss of funding for aircraft and presence of lake trout
Klonaqua (lower)	RB,CT	1970	Discontinued	May have been discontinued due to loss of funding for aircraft
Klonaqua (upper)	CT	1970	Discontinued	May have been discontinued due to loss of funding for aircraft
Nada	EB	?	Discontinued	Stocking discontinued due to sufficient natural reproduction of eastern brook trout
Snow (lower)	EB,CT	?	Discontinued	Stocking has been discontinued due to sufficient natural reproduction, or lack of funding to plant with aircraft
Snow (upper)	EB,CT	?	Discontinued	Stocking has been discontinued due to sufficient natural reproduction, or lack of funding to plant with aircraft
Square	CT,RB	1979	Discontinued	Stocking has been discontinued due to sufficient natural reproduction

Notes: CT = Cutthroat Trout; RB = Rainbow Trout; EB = Eastern Brook Trout; LT = Lake Trout
Table data provided by T. Maitland, email communication between Dan Haller and Travis Maitland (WDFW).

Fishing for trout in the many of the Alpine Lakes is managed by WDFW. In addition to possessing a freshwater fishing license, anglers age 15 and over must comply with specific size limits, gear restrictions, and bag limits (WDFW, 2017). Eightmile, Square, Klonaqua, and Colchuck Lakes are open to fishing year-round, while access to Nada and Upper and Lower Snow Lakes is limited by seasonal access into the Core Enchantment Zone. For additional information on fish within this part of the project area, see Section 3.7, Fish.

3.15.1.5 Water-Based Recreation

Swimming within the Alpine Lakes likely occurs in conjunction with hiking and backcountry camping activities during the summer. However, this use is likely limited by water temperatures, which are relatively cold even during the summer months.

3.15.1.6 Winter Recreation

Information about wintertime recreation in this portion of the project area is somewhat limited. However, Eightmile Creek Trail is used for snowshoeing. Additionally, Colchuck and Eightmile Trails are known as winter climbing and backcountry skiing destinations, with regular but low density use. Motorized recreation use is prohibited year-round, and skiing and snowshoeing routes are not groomed.

3.15.2 Icicle Creek Corridor

3.15.2.1 Hiking and Stock Use

Six trailheads provide access from Icicle Road to the network of backcountry trails in the project area and beyond: Fourth of July (#1579), Chatter Creek (#1580), Jack Creek (#1558), Jack Pine (#1597), Black Jack Ridge (#1565), and Icicle Creek (#1551) (USFS, 2017[3-23]). Additionally, three trails provide hiking opportunities near and along Icicle Creek: Icicle Gorge (#1596), Jack Pine (#1597), and Bruce's Boulder (#6723). Trails within this part of the program area that provide access to other trails include the Icicle Creek Trail and Icicle Gorge Trail.

Horseback riding and use of stock animals (e.g., llamas and mules) from trailheads along Icicle Creek is permitted, although not on all trails. Stock use is permitted on Icicle Creek Trail.

3.15.2.2 Camping

The campgrounds in this part of the project area are heavily used by paddlers, rock climbers, mountain bikers, and hikers. The USFS operates eight campgrounds along Icicle Creek (Table 3-28). These areas provide campsites for tents and RVs between April and October. Campgrounds range in size from 56 sites (Johnny Creek) to 6 sites (Bridge Creek). Blackpine Creek horse camp provides pull-through sites for horse trailers and related amenities suitable for horseback riders.

[23] USFS Interactive visitor map*

Table 3-28
USFS Campgrounds along Icicle Creek

Campground Name	Number of Sites	Operational Period
Eightmile	45 sites for tents or RVs, one large site that can accommodate up to 70 people and 25 vehicles	April to October
Bridge Creek	6 single sites, one large site that can accommodate up to 70 people and 35 vehicles	April to October
Icicle Group Campground	one large site that can accommodate up to 30 guests and 6 vehicles	June to October
Johnny Creek	65 sites for tents or RVs	May to October
Ida Creek	10 sites for tents or RVs	May to October
Chatter Creek	12 sites for tents only, one large site that can accommodate up to 45 people and 12 vehicles	May to October
Rock Island	22 sites for tents or RVs	May to October
Blackpine Creek Horse Camp	10 sites for tents or RVs to	May to October

3.15.2.3 Recreational Fishing

There are two non-tribal sport fisheries in Icicle Creek: the spring-run Chinook salmon fishery that runs from mid-May through July 31, and the resident trout fishery that occurs from the Saturday before Memorial Day through October 31 (WDFW, 2016[3-24]). Fishing in Icicle Creek is managed by WDFW (WDFW, 2016[3-25]). Targeted species include hatchery-origin spring-run Chinook salmon returning to LNFH, steelhead/rainbow trout, eastern brook trout, westslope cutthroat trout, and mountain whitefish.

WDFW actively conducts creel surveys for the spring-run Chinook salmon fishery in order to gather data for producing estimates of angler effort, harvest, and incidental catch and release of other species such as steelhead and bull trout. This fishery has been a mainstay for many years and can be very popular for both local and out of area anglers. Between 2001 and 2015, an annual average of 2,918 anglers fished approximately 15,187 hours each year and harvested 907 hatchery-origin spring-run Chinook salmon (Table 3-29).

WDFW does not actively creel survey the resident trout fishery. This fishery is mainly composed of rainbow trout, but there are occasional catches of cutthroat, eastern brook, and bull trout; this information is gained through anecdotal angler reports as well as hook-and-line sampling efforts conducted by WDFW.

[24] Personal communication (email) between Dan Haller and Travis Maitland, WDFW District 7 Fish Biologist
[25] http://wdfw.wa.gov/publications/01818/wdfw01818.pdf

Table 3-29
Sport Fishery Effort for Hatchery-origin Spring-run Chinook Salmon on Icicle Creek (WDFW)

Year	Fishery Season	Anglers	Hours Fished	Fish Harvested
2001	May 7 – July 22	2,932	13,194	2,260
2002	May 16 - July 31	3,811	17,150	1,201
2003	May 16 - July 31	4,016	29,133	935
2004	May 16 - July 31	1,339	9,187	347
2005	May 28 - July 31	1,108	8,130	103
2006	May 26 - June 14[1]	--	--	--
2007	May 22 - July 31	1,058	7,754	115
2008	May 15 - July 31	1,147	7,144	347
2009	May 22 - July 31	1,530	8,235	640
2010	May 13 - July 31	5,231	23,549	996
2011	May 21 - July 31	9,201	45,642	3,622
2012	May 19 - July 31	4,922	21,492	971
2013	May 18 - July 31	1,979	9,644	323
2014	May 23 - July 31	1,587	7,299	406
2015	May 20 - July 18	990	5,064	433
	Average:	**2,918**	**15,187**	**907**

[1] Early closure of fishery related to theft of 200 broodstock from LNFH on June 9, 2006 (http://www.outdoors-411.com/news/fishing/060613-hatchery-fish-theft.html)

-- no information found

In addition to possessing a freshwater fishing license, anglers age 15 and over must comply with specific size limits, gear restrictions, and bag limits when fishing in Icicle Creek. Fishing for salmon and steelhead requires a Columbia River Salmon/Steelhead Endorsement. Seasonal regulations apply to three distinct geographic reaches:

- From between the closure signs located 800 feet upstream of the mouth to 500 feet downstream of LNFH, hatchery-origin spring-run Chinook salmon may be targeted from mid-May through July, and when permitted under special rule changes.
- From the shoreline markers where Cyo Road intersects Icicle Creek at the Sleeping Lady Resort upstream to the IPID footbridge, trout and game fish may be targeted from the Saturday before Memorial Day through October; hatchery-origin spring-run Chinook salmon may be targeted from May through July.
- From the IPID footbridge to Leland Creek, and all tributaries (including Leland Creek), trout and other gamefish may be targeted from the Saturday before Memorial Day through October.

3.15.2.4 Water-Based Recreation

Whitewater kayaking occurs between Rock Island Campground and LNFH, a distance of approximately 20.4 miles (American Whitewater, 2017). Kayaking occurs when flow is between 700 and 2,000 cfs. Difficulty ranges from Class II to V+ under normal flow conditions.

The upper section of Icicle Creek includes a mix of Class II to V+ rapids. This run is accessed at Rock Island Campground and ends at Johnny Creek Campground. This section includes the Class V rapid at Icicle Gorge. The middle section of Icicle Creek is classified as an expert run (Wenatchee Outdoors). Popular access points along this reach include Eightmile Campground, Bridge Campground, and Johnny Creek Campground. There are additional pullouts at Snow Creek Trailhead and Ida Creek that can be used as access. The lower section of the Icicle Creek run starts at the Snow Creek trailhead and ends upstream of the dam at LNFH. At normal flows, this run is considered a class IV+ (advanced whitewater experience).

During the summer, at low-flow conditions, stand-up paddleboards (SUP) and tubes are a popular activity on lower Icicle Creek downstream of LNFH. Many local outfitters rent SUPs and tubes and provide shuttle service between access and take-out points. These activities draw many visitors to Icicle Creek.

Portions of Icicle Creek suitable for recreational swimming are generally located between LNFH and the confluence with the Wenatchee River. Recreational swimming is not a well-monitored activity in Icicle Creek, so its popularity is unknown. However, SEPA scoping comments indicate that recreational swimming does occur. It is likely that swimming is generally associated with river tubing and SUP activities or camping during the summer.

3.15.3 Wenatchee River Corridor

3.15.3.1 Hiking and Stock Use

The majority of land along the Wenatchee River is privately owned. However, there are several parks that provide access to walking and hiking along the Wenatchee River. These parks include the City of Leavenworth's Enchantment Park, Blackbird Island Park, and Waterfront Park, Cashmere's Riverside Park, the Port of Chelan's public use trail in Peshastin, and Confluence State Park in Wenatchee.

3.15.3.2 Camping

The majority of land along the Wenatchee River is privately owned. Limited camping opportunities exist in the adjacent uplands. Chelan County operates the Wenatchee River County Park campground near the Town of Monitor, which includes tent and RV sites, picnic areas, and riverfront access. This park is a popular take-out point for river tubers. Confluence State park also provides camping at the confluence of the Wenatchee and Columbia Rivers.

3.15.3.3 Recreational Fishing

Fishing in the Wenatchee River for salmon and steelhead is managed by the WDFW (WDFW, 2016[26]). Targeted species include summer-run Chinook salmon and steelhead, when permitted.

In addition to possessing a freshwater fishing license, anglers must comply with specific size limits, gear restrictions, and bag limits when fishing in the Wenatchee River. Fishing for salmon and steelhead requires a Columbia River Salmon/Steelhead Endorsement. Seasonal regulations apply to one distinct geographic reach:

- From the mouth to Icicle River Road Bridge, salmon may be targeted during August and September, and when permitted under special rule changes. Within this reach, the Wenatchee River is closed from 400 feet below Dryden Dam upstream to Peshastin Creek.

3.15.3.4 Water-Based Recreation

The Wenatchee River is a popular destination for whitewater kayakers and rafters during high-flow periods, and for tubers during summer low-flow conditions. Up to 15 commercial rafting companies offer guided whitewater rafting trips on the Wenatchee River during the spring and summer. The City of Cashmere has developed Riverside Park with accommodations for whitewater enthusiasts, including a take-out ramp for commercial and private rafters to exit the river, restrooms, picnic areas, and parking.

During the summer, swimming, tubing, kayaking, and stand up paddleboarding are popular activities on the Wenatchee River. Popular access sites include parks in Leavenworth, Cashmere, and Peshastin, and Confluence State Park. Several local outfitters rent tubes and provide shuttle service between access and take-out points. WDFW also maintains eight access sites on the Wenatchee River, that are heavily used for water-based recreation during the summer months.

3.16 Land Use

The broad range of land use activities in the project area can be attributed to the highly variable landscape over which surface waters flow, from wilderness area, to forested hills, through orchards in the Wenatchee River Valley, to the shrub-steppe of the eastern watershed at the confluence of the Wenatchee and Columbia Rivers.

The land uses in the rural areas of the project area, as a whole, are primarily forest management and production, orchard production, scattered residences, agricultural support facilities, and small home-based industries. Nearly all land in the Alpine Lakes Area is congressionally designated wilderness area.

[26] http://wdfw.wa.gov/publications/01818/wdfw01818.pdf

This section addresses the regulatory framework of land use within the project area, this includes the current land uses and ownership.

3.16.1 Regulatory Setting

The following Federal, state, and local regulations and policies apply specifically to land uses within the project area. Additional regulations applicable to other resources within the project area are presented in Chapter 1.

- The Wilderness Act
- The National Forest Management Act
- State Shoreline Management Act
- The Forest Practices Act
- Zoning
- Comprehensive land use planning
- Sensitive areas ordinances.

These policies and regulations are described in more detail below. The following subsections are organized based on jurisdiction.

3.16.1.1 Federal Land Use Regulations

Wilderness Act, 1964

The Wilderness Act of 1964 (Wilderness Act) established the National Wilderness Preservation System. Additionally, wilderness uses and rules are established in the Wilderness Act. As noted in Section 3.15, Recreation, part of the upper reaches of the project area includes the ALWA, which was established under the Wilderness Act and under the Alpine Lakes Management Act of 1976. Much of the lands within the upper portions of the project area are governed by these acts. The regulation of wilderness lands is discussed in greater detail in the Section 3.17, Wilderness Area.

National Forest Management Act, 1976

Every forest managed by the USFS must develop a Forest Plan, as mandated in the National Forest Management Act. The upper portions of the project area are located within the Okanogan-Wenatchee National Forest. Methods for developing and revising the plan are outlined in the Act, including required content. The direction of the planning document provides the basis for any land-use decisions made within the National Forest. The Wenatchee National Forest's plan, adopted in 1990, is currently being revised and updated as the Okanogan-Wenatchee Forest Plan. The Alpine Lakes Management Plan, adopted in 1982, is the plan used to manage the lands within the ALWA.

3.16.1.2 State Land Use Regulations

Washington Shoreline Management Act

Shorelines of the state (defined in RCW 90.58.030(2)) are regulated through the Shoreline Management Act (SMA) of 1971; as amended. The SMA is administered by Ecology, who delegates authority to local jurisdictions to manage their shorelines through the preparation and implementation of a Shoreline Master Program (SMP). Within the project area, Chelan County and the Cities of Leavenworth, Wenatchee, and Cashmere all have accepted SMPs. The intent of each jurisdiction's approved SMP is ensure protection of shoreline ecosystems, public access, and water uses. The permitting matrix located in Section 5-3 (Table 5-1) provides details on which projects being considered under the Icicle Strategy are subject to the SMA.

Washington Forest Practices Act

Forest practices on all non-federal and non-tribal lands in Washington are regulated by means of the Forest Practices Act. The Washington Forest Practices Board governs forestry practices by adopting rules and regulations such as maintenance and restoration of aquatic and riparian lands. These rules are implemented and enforced by WDNR.

Growth Management Act

The Growth Management Act, Chapter 36.70A RCW is a state regulation that requires local governments to designate urban growth boundaries, creating critical area ordinances, and developing comprehensive plans.

3.16.1.3 Local Land Use Regulations

Critical Areas Ordinance

Under the Growth Management Act, Chelan County developed a Critical Areas Ordinance to protect wetlands, areas with critical recharging effects on aquifers, fish and wildlife habitat conservation areas, frequently flooded areas, and geologically hazardous areas. These areas have been incorporated into the County zoning codes, which includes setback requirements.

Comprehensive Plan and Zoning

In Washington State, counties manage land use through comprehensive planning and zoning. In Chelan County, these activities are conducted by the Community Development Department. Under the framework provided in the Growth Management Act, Chelan County adopted its Comprehensive Plan in 2000, which was updated in 2007, and is currently undergoing another update. Included in the comprehensive planning process was the establishment of urban growth areas to promote contiguous and orderly development. Each of the municipalities within the project area have an established urban growth area. Comprehensive planning and zoning designates the geography, frequency, and density of land uses. Table 3-30 describes the types of land uses regulated by Chelan County.

Table 3-30
Zoning designations in Chelan County

Land Use Designation	Area (acres)
Agriculture In Open Space (Chapter 84.34 RCW)	9,300.1
Agriculture Related Activities	87.2
Agriculture-Not In Open Space	6,562.7
Aircraft Transportation	20.5
All Other Residential	1,556.9
Amusements	4.8
Automobile Parking	2.6
Business Services	9.5
Communication	19.9
Contract Construction Services	39.3
Cultural Activities	0.0
Designated Forest Land (Chapter 84.33 RCW)	64,606.6
Educational Services	98.4
Fabricated Metal Products	1.4
Finance, Insurance/Real Estate Services	4.2
Food/Kindred Products	8.8
Furniture and Fixtures	0.6
Governmental Services	344,757.1
Highway/Street Right-Of-Way	15.4
Hotels/Motels	119.7
Household 2-4 Units	13.8
Institutional Lodging	82.5
Lumber/Wood Prod Exc Furniture	148.2
Mining Activities	487.9
Miscellaneous Manufacturing	2.5
Miscellaneous Services	3,284.8
Mobile Home Parks/Courts	76.2
Multi-Units 5 Or More	14.5
Non-Residential Condominiums	0.2
Noncommercial Forest	23,590.9
Open Space (Chapter 84.34 RCW)	544.0
Other Cultural & Recreational	3.0
Other Resource Production	4,812.7
Other Retail Trade	10.1
Other Trans, Comm, & Utilities	2.9
Other Undeveloped Land	259.2
Parks	435.5
Personal Services	6.2
Petroleum Refining/Related Industries	9.6

Land Use Designation	Area (acres)
Primary Metal Industries	7.9
Professional Services	15.9
Public Assembly	356.7
Railroad/Transit Trans	118.9
Recreational Activities	428.2
Repair Services	10.6
Residential Hotels-Condominium	7.3
Resorts and Group Camps	382.0
Retail Trade-Apparel/Access	0.2
Retail Trade-Bld. Mat., Farm Eqpt	18.8
Retail Trade-Eating/Drinking	41.8
Retail Trade-Food	31.1
Retail Trade-Furniture	666.5
Retail Trade-Gen Merchandise	4.6
Retail Trade-Trans/Accessories	3.2
Rubber/Misc Plastic Products	1.1
Single Family Units	16,807.1
Stone, Clay & Glass Products	2.4
Timberland in Open Space (Chapter 84.34 RCW)	2,017.7
Undeveloped Land	38,040.6
Utilities	1,060.6
Vacation and Cabin	7,344.2

In addition to county planning and zoning, each municipality within the project area has zoning ordinances and urban area comprehensive plans that have been developed under the framework provided in the Growth Management Act.

3.16.1.4 Current Land Use

Table 3-31 provides a breakdown of the primary land uses within the project area.

Table 3-31
Land Use in Acres

Land Use Type (Zone Districts)	Area (Acres)
Forest lands	13,1380.2
Rural public lands and facilities	170.7
Rural residential	5,376.0
Rural village	0.3
Rural waterfront	0.4
Water	119.3

In the project area, land use generally falls within two major categories, Federal and private. These uses are described in more detail below.

3.16.1.5 Federal Ownership and Land Use

The USFS manages 87 percent of the land in the Icicle Creek Subbasin, which makes up a large portion of the project area. Much the land located within the Alpine Lakes Area and Reach 1 through 3 of the Icicle Creek Corridor is under federal management, with most land in the Alpine Lakes Area being managed under the Alpine Lakes Management Plan. However, there are private in-holdings within the Alpine Lakes Area, which are not subject to the management requirements in the Alpine Lakes Management Plan.

The other major area of Federal ownership within the project area includes the LNFH, which is located along the Icicle Creek Corridor and is owned and operated by USFWS. The current target species for the hatchery is spring Chinook salmon. The CTCR and the YN are partners in the operation of the LNFH (Chelan County Shoreline Inventory and Analysis, 2009). LNFH operates as mitigation for Grand Coulee Dam with an interim release target of 1.2 million fish, and a long-term target release goal of 1.625 million fish.

To support the operation of LNFH, USFWS owns 157.69 acres in the lower Icicle watershed, near Icicle Creek RM 2.7. This includes the hatchery itself and administrative buildings. Additionally, USFWS owns the majority of lands associated with the Nada/Snow Lakes systems within the ALWA. These lands, shorelines, and lakes are operated to provide water for fish propagation at the hatchery. The ownership and operation of the lands are described in more detail in Section 3.6, Water Use, and 3.17, Wilderness Area.

3.16.1.6 Private Ownership and Land Use

Much of the project area located in the Wenatchee River Corridor and Reach 5 of the Icicle Creek Corridor is privately owned. Private land use is primarily agriculture and residential. In addition to the private land in Reach 5 and the Wenatchee River Corridor, there are approximately 50 private creek-side parcels located in the Icicle Island development in Reach 2. Land Use Planning

3.16.1.7 Comprehensive Planning

As discussed in section 3.16.1.3, Comprehensive Planning, which is required under the state's Growth Management Act, occurs at the county and municipality level. Comprehensive planning provides guidance and direction to the County and City governments on development and land use. Comprehensive Plans within the project area include the Chelan County Comprehensive Plan, the City of Leavenworth Comprehensive Plan, the Peshastin Urban Growth Area Comprehensive Plan, the Town of Dryden Comprehensive Plan, the City of Cashmere Comprehensive Land Use Plan, and Wenatchee Urban Area Comprehensive Plan.

3.16.1.8 Upper Wenatchee Community Lands Plan

The Upper Wenatchee Community Lands Plan is a proposal to look at how community ownership of high-priority parcels can benefit the community while supporting diverse stakeholder needs related to the properties. The initial phase began in December 2014 and concluded in September 2016. The process was led by the Trust for Public Land, along with Chelan County, The Nature Conservancy, and the Chelan-Douglas Land Trust.

Together with local stakeholders, these groups created a vision for future growth within the plan study area, that includes in part the project area.

The plan study area reaches from City of Cashmere to Stevens Pass. Broken into the following three sub-regions, each is characterized by a checkerboard of both private and public land ownership:

- Nason Ridge/Lake Wenatchee
- Peshastin/Blewett Pass
- Chumstick Valley/Leavenworth

The plan identifies the following goals that are also consistent in part with the Icicle Strategy Guiding Principles.

1. Sustainable forests that support biodiversity, are maintained to reduce fire intensity, and increase resilience to climate change.
2. Working lands for a thriving economy.
3. Existing access to public land to be maintained while also increasing year-round recreation opportunities.
4. Lands that support wildlife (habitat, including for fish).
5. High-quality water resources (and sufficient quantity).
6. Private property availability (for development, business, and other uses).

It is likely, any projects developed through the Icicle Strategy targeting habitat enhancement would be achieved through a partnership with the Community Lands Plan program.

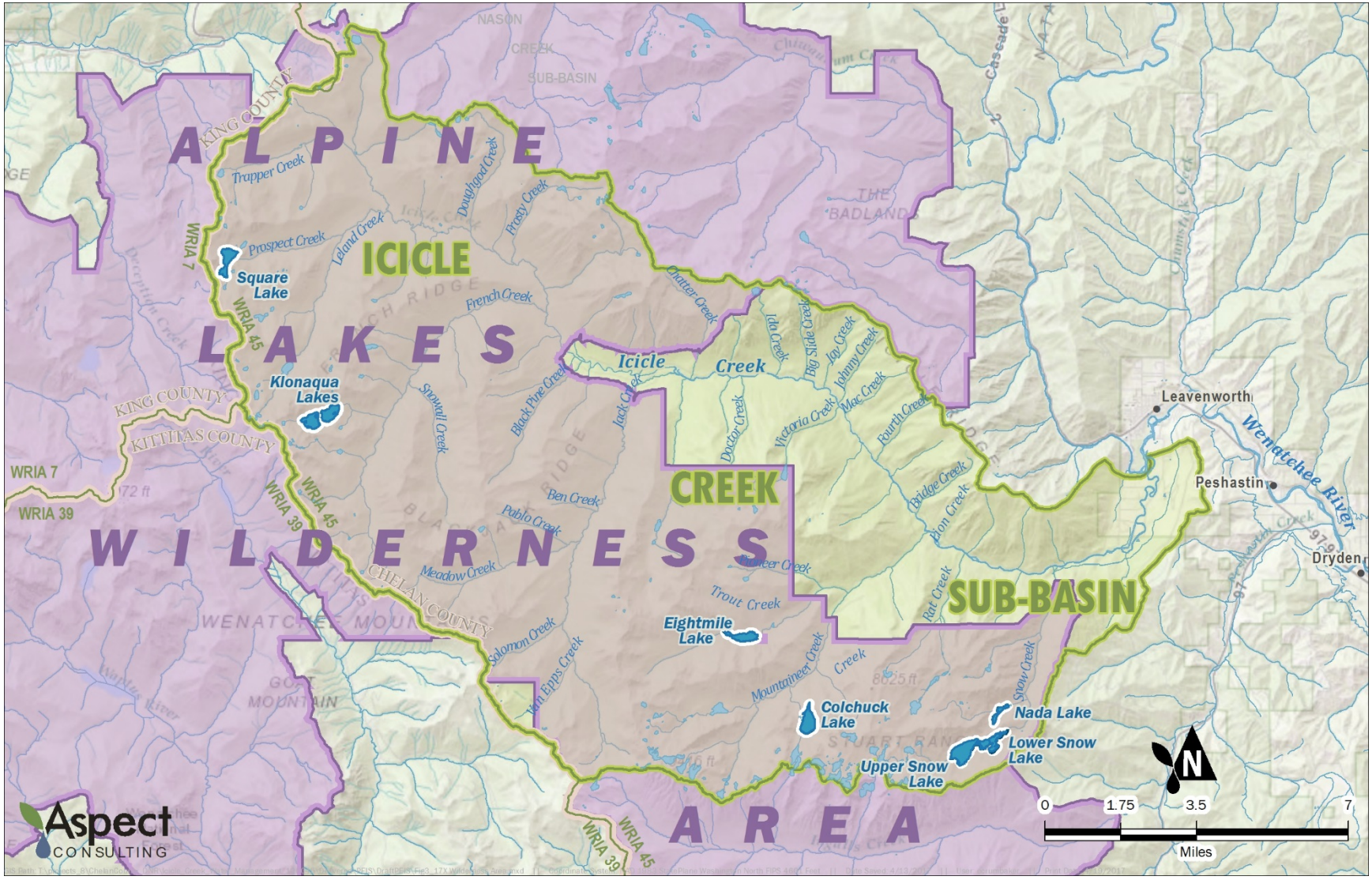
More detail about the Upper Wenatchee Community Plan can be found on Chelan County's website[27].

3.17 Wilderness Area

As noted in Section 3.16, Land Use, a large part of the project area's Alpine Lakes Area sub-region is within the federally designated ALWA (Figure 3-38). Designated wilderness is the highest level of conservation protection for federal lands. Congress has directed four federal land management agencies—USFS, Bureau of Land Management, USFWS, and National Park Service—to manage wilderness areas to preserve and, where possible, to restore their wilderness character.[28] Therefore, this section addresses more specifically, the management and use of wilderness lands within the project area.

[27] http://www.co.chelan.wa.us/natural-resources/uwclp-minutes?parent=planning
[28] https://wilderness.nps.gov/faqnew.cfm

Figure 3-38. Alpine Lakes Wilderness Area



3.17.1 Wilderness Act History

In 1964 Congress passed the National Wilderness Act for purposes of protecting federal lands. In 1976, the Alpine Lakes Wilderness Management Act was passed, setting aside over 300,000 acres as federally designated wilderness.[29] In 2014, the ALWA was expanded to include over 414,000 acres.

3.17.1.1 Pre-Wilderness Act Use

The ALWA was originally designated the Alpine Lakes Limited Area in 1946 when the Regional Forester set aside 256,000 acres of federal lands for protection and study until they could be further classified and management designation could be assigned.[30] This designation did not offer protection from resource extractions and was exclusively regulated by the USFS.[31] The region and adjacent areas were being extensively used for mining and timber extraction.[32] Efforts to further protect the lower valley forests of the Alpine Lakes began in the 1950s through the 1960s.

3.17.1.2 Wilderness Act History and Designation

The Wilderness Act, signed into law in 1964, created the National Wilderness Preservation System and recognized wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." The Act further defined wilderness as "an area of undeveloped federal land retaining its primeval character and influence without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions…."[33]

The Wilderness Act prohibits permanent roads and commercial enterprises, except for commercial services that may provide for recreational or other purposes of the Wilderness Act. Wilderness areas generally do not allow motorized equipment, motor vehicles, mechanical transport, temporary roads, permanent structures, or installations. Wilderness areas are to be primarily affected by the forces of nature, though the Wilderness Act does acknowledge the need to provide for human health and safety, protect private property, control insect infestations, and fight fires within the area.[34] Wilderness areas are managed under the direction of the Wilderness Act, subsequent legislation (such as the Alaska National Interest Lands Conservation Act), and agency policy.

3.17.1.3 Alpine Lakes Management Act

The purpose of the 1976 Alpine Lakes Management Act was to "…provide for public outdoor recreation and use and for economic utilization of commercial forest lands,

[29] https://www.wilderness.net/NWPS/documents/publiclaws/PDF/94-357.pdf
[30] 1979 Wenatchee National Forest (N.F.)/Mt. Baker National Forest (N.F.)/Snoqualmie National Forest (N.F.), Alpine Lakes Area Acquisitions: Environmental Impact Statement (https://books.google.ca/books?id=7zw3AQAAMAAJ&dq=In+1946,+256,000+acres+was+designated+as+the+Alpine+Lakes+Limited+Area+by+the+Forest+Service.&source=gbs_navlinks_s)
[31] http://www.washington.edu/uwpress/search/books/MARDRC.html
[32] http://www.washington.edu/uwpress/search/books/MARDRC.html
[33] https://wilderness.nps.gov/faqnew.cfm
[34] https://wilderness.nps.gov/faqnew.cfm

geological features, lakes, streams and other resources…by present and future generations…" For administrative purposes, the Management Act considers the Alpine Lakes area as three subareas: the Alpine Lakes Wilderness, the Intended Wilderness, and the Management Unit (Figure 3-39). The federal lands in the ALWA are administered in accordance with the 1976 Management Act and the 1964 Wilderness Act. The Intended Wilderness is adjacent non-federal land that becomes federal land upon acquisition. A peripheral Management Unit area surrounds the ALWA and Intended Wilderness and is administered in accordance with laws and regulations applicable to national forests.

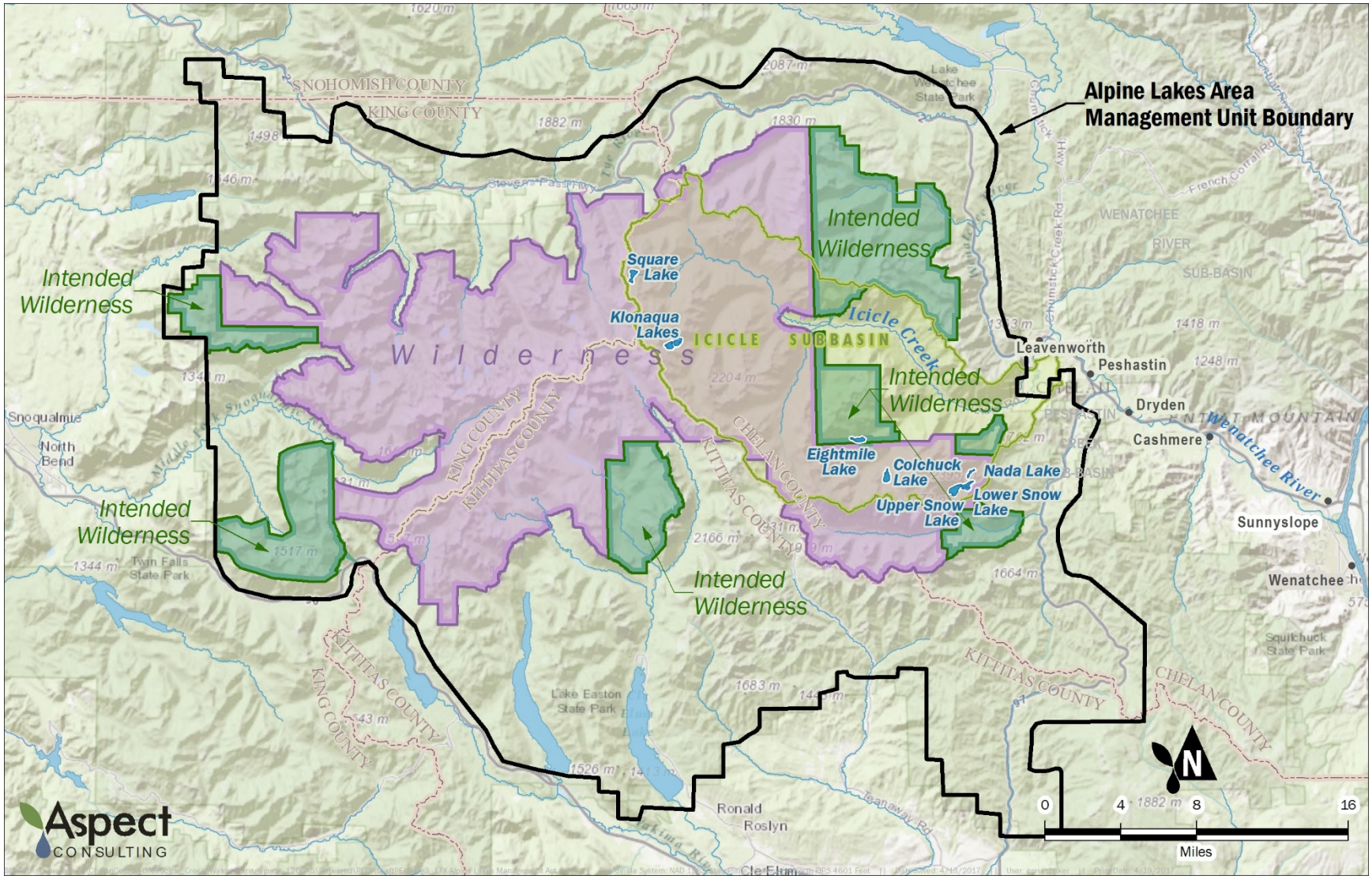
3.17.1.4 Intended Wilderness

In an effort to acquire Intended Wilderness, Congress appropriated Land and Water Conservation Fund funds to purchase three in-holdings: Burlington Northern Santa Fe Railway (BNSF), Pack River Company, and IPID. BNSF and Pack River were purchased. IPID sold and exchanged some lands within the Wilderness Area.

As part of the IPID land sale and exchange agreement, IPID and the USFS entered into a contract in 1986 that stipulated which land would be exchanged by the two entities and what rights IPID would reserve on sold and exchanged lands. In 1990, IPID and USFS executed the land exchange. The result was USFS acquisition of several key parcels of land around Klonaqua, Eightmile, and Colchuck Lakes and the Snow Lakes trailhead with IPID reserving several rights to the properties associated with Klonaqua, Eightmile, and Colchuck Lakes:

> "a nonexclusive, perpetual easement across, through, along, and upon the property described herein for the purposes of maintenance, repair, operation, modification, upgrading and replacement of all facilities presently located in or upon the property described herein, together with a nonexclusive right of ingress to and egress from all such facilities for all such purposes, in accordance with Rules and Regulations of the Secretary of Agriculture, 36 CFR 251.17 and 251.18, attached hereto and made a part hereof, in such manner as not unreasonably to interfere with its use by the United States, its authorized users or assigns, or cause substantial injury thereto.
>
> The Grantor [IPID] may exercise the rights hereunder by any means reasonable for the purposes described, including but not limited to the use of motorized transportation and equipment, or aircraft. These rights include the right to regulate water level of all facilities located upon the property described herein. In performing maintenance, repair, operation, modification, upgrading and replacement of facilities located in or upon the property described herein, the Grantor will not without prior written consent of the Forest Service, which consent shall not unreasonably be withheld, materially increase the size or scope of the facilities."

Figure 3-39. Alpine Lakes Management Act Area



Additionally, the USFS issued agriculture irrigation and livestock watering easements for those portions of Colchuck Lake that were not covered by the easement described above and Square Lake. These easements grant IPID the right to operate and maintain their water facilities with consultation and concurrence from the USFS. Before the issuance of these easements, Square Lake was operated by IPID under a special use permit because USFS determined Square Lake was not under the jurisdiction of Washington State DNR because of navigability criteria.

The land exchange documents and easements are provided in Appendix E.

USFWS owns the shorelines and potentially the lakebed of Upper Snow, Lower Snow, and Nada Lakes. In 1971, USFWS and USFS investigated the possibility of USFS obtaining ownership of these lands. However, this investigation found that USFS acquisition of these lands was prohibited by the Fish and Wildlife Coordination Act of 1934. In 1971, USFS and USFWS drafted a Memorandum of Agreement (MOA) regarding management around these lakes. A copy of the unsigned MOA is provided in Appendix E; however, it is unclear whether or not this MOA was executed and confirmation was not obtained prior to publication of this document.

3.17.2 Use

3.17.2.1 Wilderness Use

The intent of wilderness areas, as designated in the 1964 Wilderness Act, is to preserve wilderness character rather than to establish any particular use. Thus, descriptions of use in the 1964 Wilderness Act and 1976 Management Act generally focus on prohibitions of use. The Wilderness Act prohibits permanent roads or commercial enterprises, except where they provide for recreation or other purposes of the Act, and generally prohibits the use of motorized equipment; however, certain nonconforming uses are permitted as described within the act, including access to non-federal inholdings and for the maintenance and reconstruction of existing water infrastructure, such as dams.

3.17.2.2 Non-Wilderness Use

Non-wilderness uses that are authorized and do occur within the boundaries of the ALWA include reservoir operations and use of motorized equipment for maintenance of these reservoirs and helicopter transport to and from the reservoirs. These non-wilderness uses are permissible under various ownership structure and agreements, easements, and permits, with helicopter transport being approved in a 1981 Environmental Assessment (USFS, 1981). Table 3-32 provides a description of the various use authorities for select lakes where proposed activities may occur: Eightmile, Upper Klonaqua, Lower Klonaqua, Colchuck, Square, Upper Snow, Lower Snow, and Nada Lakes. Additionally, this section discusses those authorities.

Table 3-32
Easement and Permit Summary for Select Alpine Lakes

Lake	Operator	Current Owner	Former Owner	Primary Use Authority	Additional Authority	Key Language in Use Authority
Eightmile	IPID	USFS	IPID	1990 Special Warranty Deed	n/a	Excepting and reserving the right to overflow and inundate the bed and shore; water rights granted; perpetual easement across, through, along, and upon the property for maintenance, repair, operation, modification, upgrading, and replacement of all facilities presently located in and upon the property. IPID may exercise the rights by any means reasonable... including... motorized transport and equipment or aircraft. These rights include... regulating water level. Grantor will not without the prior written consent of the Forest Service, which consent shall not unreasonably be withheld, materially increase the size or scope of the facilities.
Lower Klonaqua	IPID	USFS	IPID	1990 Special Warranty Deed	n/a	
Upper Klonaqua	-	USFS	IPID	1990 Special Warranty Deed	n/a	
Colchuck	IPID	USFS	IPID/ USFS	1990 Special Warranty Deed	2000 Agriculture Irrigation and Livestock Watering System Easement and Special Use Permit	
Square	IPID	USFS	USFS	2000 Agriculture Irrigation and Livestock Watering System Easement	Special Use Permit	Authorizes right-of-way and water conveyance systems; does not authorize extension or enlargements; authorizes operation and maintenance of facilities with consultation and concurrence from USFS.
Upper Snow	USFWS	USFWS	USFWS	Ownership	MOA	USFWS owns these lakes or owns easement from the state for the shorelines, depending on whether the lakes are navigable. Ownership grants USFWS the ability to manage the lakes in compliance with applicable local, state, and federal laws. Documents obtained from the USFS through a FOIA request indicates there may be an MOA between USFWS and USFS regarding the management of trails near the shoreline of these lakes. However, a signed copy of an MOA was not made available through the FOIA request.
Lower Snow	USFWS	USFWS	USFWS	Ownership	MOA	
Nada	USFWS	USFWS	BOR/USFWS	Ownership	MOA	

Ownership

There are parcels within the ALWA that are not owned by the USFS. Such parcels that are related to the Icicle Strategy are those owned by USFWS. Ownership of these lakes provides USFWS continued use of these lakes as reservoirs and provides them the right to maintain and upgrade their facilities in compliance with applicable regulations and permits.

Easements

When conveying land to a new owner, a property owner can reserve rights or easements to that land. As discussed above, this was the case when USFS acquired IPID lands within the Wilderness Area boundary. IPID reserved the right to continue operating the lakes in accordance with their water rights. Additionally, IPID reserved the right to maintain and upgrade the facilities. Based on background documents between IPID and USFS from the 1980s and 1990s, this includes the use of motorized equipment for work on the facilities and access to the sites.

USFS Special Use Permit

The USFS special use authorization is a legal document, such as a permit, lease, or easement, that allows occupancy, use, rights, or privileges on USFS land. Special uses within the project area currently allowed by USFS include the following:

- Square Lake and the northern section of Colchuck Lake were historically operated under special use permits. In 2000, USFS issued an Agriculture Irrigation and Livestock Water System Easement that permits the use of these lakes for irrigation operations. These easements authorize right-of-way and water conveyance systems. Any extension or enlargement of the lakes is not authorized. Additionally, operation and maintenance of the facilities must occur with concurrence from the USFS.
- The Icicle radio repeater station is located outside the ALWA on Icicle Ridge. The station is on USFS land and is operated with a special use permit. Implementation of Alternative 1 and Alternative 4 may require the use of this radio repeater station for the automation project, although locations on private land are also being considered.

3.17.3 Wilderness Character

As established in the 1964 Wilderness Act, wilderness preservation is “for the protection of these areas, the preservation of their wilderness character.” There has been no legal definition of wilderness character since the 1964 Wilderness Act; however, four distinct and necessary “qualities” of wilderness character have been identified by wilderness scholars [35]. These four qualities—naturalness, opportunities for solitude or a primitive and unconfined type of recreation, undeveloped, and untrammeled—were selected to link local conditions and management with the statutory language of the 1964 Wilderness

[35] In Focus: Wilderness Character, Landres, Vagias, Stutzman, 2012, ttps://www.fs.fed.us/rm/pubs_other/rmrs_2012_landres_p001.pdf

Act.[36] A summary of these four attributes are presented below.[37] For the ALWA, no scientific or systematic approach has been developed or referenced to date to specifically depict the condition of this wilderness area's wilderness character.

Natural

The natural quality defines wilderness as containing ecological systems that are substantially free from the effects of modern civilization. This quality is degraded by the intended or unintended effects of modern people on the ecological systems inside the wilderness since it was designated.

Solitude

The solitude, or primitive and unconfined recreation quality, defines wilderness as containing outstanding opportunities to experience solitude, remoteness, and primitive recreation free from the constraints of modern society. This quality is degraded by settings that reduce these opportunities, such as visitor encounters, signs of modern civilization, recreation facilities, and management restriction on visitor behavior.

Undeveloped

The undeveloped quality defines wilderness as an area without permanent improvements or modern human occupation. This quality is degraded by the presence of non-recreational structures and installations, habitations, and by the use of motor vehicles, motorized equipment, or mechanical transport, because these increase people's ability to occupy or modify the environment.

Untrammeled

The untrammeled quality is the degree to which wilderness is unhindered and free from modern human control or manipulation. The untrammeled quality is degraded by actions that intentionally manipulate or control ecological systems, whereas the natural quality is degraded by the intentional and unintentional effects from actions taken inside wilderness, as well as from external forces on these systems.

3.18 Shorelines

Shorelines of the State (defined in RCW 90.58.030[2]) are regulated through the SMA of 1971, as amended. The SMA is administered by Ecology, who delegates authority to local jurisdictions to manage their shorelines through the preparation and implementation of a SMP.

[36] https://www.fs.fed.us/rm/pubs_other/rmrs_2012_landres_p001.pdf
[37] Landres, P., C. Barns, J.G. Dennis, T. Devine, P. Geissler, C.S. McCasland, L. Merigliano, J. Seastrand, and R. Swain. 2008. Keeping it Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System. 81 pages. USDA Forest Service, Rocky Mountain Research Station General Technical Report RMRS-GTR-212, Fort Collins, Colorado.

Within the Icicle project area, Chelan County and the Cities of Leavenworth, Wenatchee, and Cashmere all have approved SMPs. Specific SMP policies applicable to the Icicle project area include, among other things, protections to address flood hazards and regulate frequently flooded areas.

Frequently flooded areas, as designated by these local jurisdictions, are defined in part by mapping, studies, and guidance from the Federal Emergency Management Agency (FEMA). FEMA mapping and studies delineate an area with a 1 percent annual chance of flooding as the 100-year flood zone or floodplain. For development to be approved in the 100-year floodplain, it is typically required that a qualified professional certify that there will be no net loss of flood storage capacity and that the development results in no increase ("zero rise") in water surface elevation during a flood.

Higher potential for flooding can also contribute to increased risk or erosion along these waterways. In general, surface water moves across land or within stream channels at higher velocity during flood or peak flow events, increasing the water potential to pick up sediment and transport it to other areas. To some extent these processes are natural; however, during high flow events, large amounts of sediment can be moved and, depending on the extent of erosion, can cause damage to streambanks, impact aquatic habitat, degrade water quality, and in some cases, damage private property.

3.18.1 Alpine Lakes

As discussed in greater detail in Section 3.3, Surface Water Resources, the primary waterbodies in this part of the Icicle project area include several high-altitude lakes that are fed by rain and snowmelt. Located in the uppermost portion of the Icicle Creek Basin, they drain into adjacent streams that are tributaries to Icicle Creek, which is a tributary to the Wenatchee River.

As noted in Section 3.17, Wilderness Area, the USFS owns and administers the ALWA, which encompasses the lakes within the Icicle project area. IPID has an easement agreement with the USFS that was established when the Wilderness Area was created and the lakes were transferred to the USFS. The easement establishes additional rights for use, management, maintenance, and operation of the lakes by IPID. The USFWS owns the property adjacent to Upper and Lower Snow Lakes and Nada Lake within the ALWA and has landowner rights related to the use, management, maintenance, and operation of those lakes. In addition, Chelan County has jurisdiction over Shorelines of the State in this part of the project area.

The shorelines of these lakes are generally rocky. In some cases, there are steeper slopes leading up to the lake edge, consisting of loose rocks and talus. In other areas, the shoreline is more gradual and consists of larger boulders and vegetation, mainly pine trees, growing up to the shoreline. Important shoreline functions within this part of the Icicle project area include flood retention and habitat and ecosystem functions and values.

Under existing conditions, these lakes are managed to store and release flows for downstream uses. IPID manages Eightmile, Klonaqua, Square, and Colchuck Lakes for

downstream irrigation use. The USFWS manages Nada and Upper and Lower Snow Lakes for downstream use by the LNFH. Small dams and related infrastructure (e.g., gates, pipes) were constructed at the outlets of each lake in the early half of the twentieth century to control the releases into adjacent streams.

Current IPID operating procedures result in the release of water from one to two of the IPID-managed lakes each year beginning in early summer (July) until early fall (October). The length and extent of releases depends on water conditions in Icicle Creek near the IPID diversion facilities. During drought years, water may be released from all of the IPID-managed lakes. The USFWS service releases water from Upper Snow Lake through a tunnel, penstock, and release valve to Nada Lake. Releases from Upper Snow Lake typically occur between July and October. Lake levels at the lakes that are targeted for release are typically drawn down over a period of approximately 2 to 3 months before release valves or gates are closed, rain and snow increases, and lake levels begin to rise again. Lake levels in all of the lakes are typically highest in the spring and early summer and lowest in the late summer and early fall.

In this part of the Icicle project area, managed and natural flows from the lakes result in fluctuating water levels that influence the potential for erosion and flooding along the lakeshores and in downstream tributaries. Under existing conditions, erosion and flooding potential along the lakeshores is relatively small because the shorelines are typically rocky and the watershed is adapted to seasonal fluctuations in lake levels. When a lake is full, excess water in the lake spills over the small dam structure and flows downstream at a flow rate that matches the natural inflow from the watershed above the lake. Most of the lakes are typically full during the spring and early summer and water flows through the lakes without any attenuation from the storage volume in the lake. Lake draw down occurs slowly over a period of 2 to 3 months during the late summer, which results in relatively minor, if any, lakeshore erosion. Flows from the lakes contribute to typical patterns of erosion in downstream tributaries with the potential being highest at all lakes in the spring when the lakes are full and natural runoff rates are at their peak.

Because the lakes are fed by rainwater and snowmelt, during years where precipitation is higher than average, lake levels increase and the lakes fill earlier in the spring. When the lakes are full, there is greater potential for localized flooding and erosion because peak flows are not attenuated by the storage capacity in the lakes. When the lakes are not full and peak flow events occur, the storage volume in the lake is available to capture inflows and attenuate flow rates downstream to reduce potential for downstream flooding and erosion. However, the lakes are not generally managed to reduce downstream flooding or attenuate peak flow rates. They are managed to capture water for release in the late summer to meet downstream water supply needs.

3.18.2 Icicle Creek Corridor

As discussed in greater detail in Section 3.3, Surface Water Resources, Icicle Creek is one of the primary tributaries to the Wenatchee River. It is primarily fed by rain and snowmelt from the ALWA and other forest areas.

Depending on the specific location, shoreline jurisdiction along Icicle Creek is granted to Chelan County or the City of Leavenworth. The shoreline typically consists of large boulders and rocks with some riparian forested vegetation, consisting of vegetation very similar to the Alpine Lakes in the higher altitudes. Further downstream and closer to the City of Leavenworth, the shoreline becomes less rocky and less heavily vegetated with larger trees. Shoreline vegetation in the lower reaches of Icicle Creek includes more shrubs and smaller trees. Important shoreline functions within this part of the Icicle project area include flood retention and habitat and ecosystem functions and values.

Similar to the Alpine Lakes tributaries, the timing and volume of flows along Icicle Creek influence the potential for localized flooding and erosion. In general, this system is adapted to a range of flow rates, with higher flows in the winter and spring, and lower flows in the late summer and early fall. Under typical conditions, minor streambank erosion occurs in a manner typical to stream systems with peak spring flows resulting in increased stream turbidity. Because the lakes in the upper watershed and diversion facilities downstream are typically operated to manage flows and water supply in the late summer, their operation does not have as much impact on peak flow rates in Icicle Creek, which typically occur during the winter or spring.

During years when precipitation is higher than average, increased creek flows may contribute to increased localized flooding, erosion, and stream turbidity. Areas with a higher risk of flooding include areas along the banks and floodplain of Icicle Creek from the Boulder Field at RM 5.6 to the City of Leavenworth. Floodplain mapping within the Icicle Creek corridor has not yet been updated by FEMA. Based on the available floodplain mapping, the 100-year floodplain (area with 1 percent annual chance or greater of flooding) is generally limited to a narrow corridor in the canyon upstream of LNFH that includes the banks of a limited floodplain area along Icicle Creek. The 100-year floodplain expands farther upland where Icicle Creek enters the broader valley near LNFH and expands downstream of the LNFH to the City of Leavenworth (FEMA, 2016).

3.18.3 Wenatchee River Corridor

Shoreline jurisdiction along the Wenatchee River near its confluence with Icicle Creek is granted to Chelan County or the Cities of Leavenworth, Cashmere, or Wenatchee, depending on the specific location. Near the City of Leavenworth, the shoreline is generally similar to Icicle Creek. As the river flows downstream toward its confluence with the Columbia River, the shoreline becomes less densely vegetated and more open with some areas of sandy beach. Important shoreline functions also include flood retention and habitat and ecosystem functions and values.

Similar to the upper watershed, this river system is also adapted to a range of flow rates, with higher flows occurring in the winter and spring and lower flows occurring in the late summer and early fall. Under typical conditions, minor streambank erosion occurs in a manner typical to river systems with peak spring flows resulting in increased stream turbidity. During peak storm events, the potential for flooding and erosion increases. Floodplain mapping within the Wenatchee River Corridor has not yet been updated by

FEMA. Based on available floodplain mapping, the 100-year floodplain (area with 1 percent annual chance or greater of flooding) generally includes the river banks and a narrow floodplain area along the Wenatchee River from Icicle Creek to the Columbia River. The extent of the 100-year floodplain extends farther upland as the valley broadens toward the City of Wenatchee (FEMA, 2016).

3.19 Utilities

This section discusses utilities within the Icicle project area. Most public utilities are provided by Chelan County, cities, special districts such as public utility districts, and private suppliers. These utilities include water service, solid waste, water treatment, and electricity.

Water service utilities are the most likely to be impacted by the Icicle Strategy and the Program Alternatives and are the focus of this section. However, several other utilities are in the project area, especial the lower portion of the Icicle Creek Corridor sub-region and the Wenatchee River Corridor sub-region. These utilities include electricity provided by Chelan County PUD, wastewater services provided by Chelan County PUD, City of Leavenworth, City of Cashmere, and City of Wenatchee. They are mainly concentrated in more developed areas and may need to be addressed during project construction.

3.19.1 Water Purveyors

3.19.1.1 City of Leavenworth

City of Leavenworth is the only major municipal water purveyor that uses Icicle Creek surface water as part of their water supply. Details of the City of Leavenworth water right and diversionary infrastructure is provided in Section 3.6.1, Water Rights. This section details their municipal water production.

Historical Water Use

In 1988, Leavenworth produced 501 million gallons of water from its water treatment plant and wells for 986 service connections (WSP, 2011). The number of service connections increased to 1,380 in 2013 while the production of water decreased to 279 million gallons[38]. Both the service connection increase and the production decrease have been fairly steady over the period of record. This downward trend in water use can be attributed largely to a variety of conservation efforts the City of Leavenworth has implemented. Although this significant reduction could also be related to structural improvements, implementation of metering, and other operational changes.

[38] Data from City of Leavenworth 2013 Water Use Efficiency Annual Performance Report submitted to Washington State Department of Health May 4, 2014

Water Conservation

Since 2008, the City of Leavenworth has invested approximately $3.6 million to improve distribution, storage, and metering of water to decrease water loss and improve accountability. A breakdown of these projects is listed below in Table 3-33.

Increased water conservation by the City of Leavenworth is one of the projects included in the Program Alternatives of the Icicle Strategy, with the exception of the No-action Alternative. These conservation efforts are detailed in Section 2.5.4, Domestic Conservation, and is anticipated to save up to 400 acre-feet per year, which will be made available for additional water service by the City of Leavenworth.

Table 3-33
Capital Improvement Projects Made by the City of Leavenworth to Improve Conservation and Accountability of Water Use (Aspect, 2014)

Year	Project	Cost
2008	Icicle Road Reservoir Reconstruction	$2,212,618
	9th Street Watermain	$295,258
	Commercial Street Watermain	$134,539
	Meter Upgrades	$3,336
2009	Meter Upgrades	$10,648
2010	Meter Upgrades	$12,714
2012	Meter Upgrades	$8,370
	Front/Div - 14th Watermain	$233,708
	Source Water Meters	$5,453
2013	Meter Upgrades	$1,483
	East Leavenworth Road Watermain	$681,009
	Front Street Watermain	$9,900
	Source Water Meters	$1,877
Total		$3,610,913

Current Water Use

In 2017, the City of Leavenworth served approximately 1,404 connections (Varela & Associates, 2018). The City of Leavenworth's water comes from both groundwater wells and surface water diversions from Icicle Creek. The City maintains dual sources for supply redundancy. Surface water withdrawals from Icicle Creek are routed through the City's water treatment plant, which treats approximately 2.0 million gallons per day (gpd) during peak demand in the summer irrigation season. Conservation efforts have decreased usage from 389 gpd per Equivalent Residential Unit (ERU) in 2002 to 304 gpd per ERU in 2012, a decrease of 85 gpd per ERU or approximately 22 percent (Aspect, 2014). The City of Leavenworth recently revised their water system plan (WSP) and found the average gpd per ERU in 2016 to be 266 gpd/ERU (Varela & Associates, 2018). Table 3-11 shows the number or parcels and the size class of those parcels for the City of Leavenworth and other water purveyors who divert from Icicle Creek.

Projected Future Need

The City of Leavenworth WSP projects long-term population and water demand growth (Varela & Associates, 2018). Based on this analysis, projected water demanded in 20-yeas is estimated at 495 million gallons annually (Varela & Associates, 2018). Production in 2017 was 320 million gallons. However, implementation of water use efficiency efforts may impact this demand projection.

3.20 Transportation

This section addresses transportation networks throughout the Icicle project area. Transportation facilities include trails, roadways, railways, water transport, and air transport. Not all of these transportation types are located in the sub-regions discussed in this section (Alpine Lakes, Icicle Creek, Wenatchee River) and will be omitted from the subsections as appropriate.

3.20.1 Alpine Lakes

Trails were the original transportation network throughout the upper Icicle Creek Subbasin in the Alpine Lakes region and remains one of the few ways to access the Alpine Lakes today. This area contains several hundred miles of trails. Some of the trails contained in the subbasin are well maintained and frequently used while others have fallen into disrepair or have been covered by debris as a result of fires in the region. Trail use is closely tied to outdoor recreation and discussed further in Section 3.15, Recreation.

Air transport via helicopters is the only way other than trails to access the Alpine Lakes area. Helicopter use is limited in this area because of wilderness regulations, as discussed in Section 3.17, Wilderness Area. Helicopters are used for emergency purposes and for maintenance and operation transport for IPID. In 1981, the USFS conducted an environmental assessment on IPID's helicopter use and found it permissible.

3.20.2 Icicle Creek Corridor

Icicle Creek Road runs from the City of Leavenworth near the confluence of Icicle Creek and the Wenatchee River for approximately 18 miles up Icicle Canyon. This road is used primarily for recreational purposes as it accesses various trailheads, climbing routes, and swimming areas along Icicle Creek. There are also USFS roads that diverge from Icicle Creek Road and meander through the Wilderness Area. Except for the City of Leavenworth, Icicle Creek Road and the adjoining USFS roads are the only roadways within the Icicle Subbasin. Because Icicle Creek Road comes to a dead end after 18 miles up the Icicle Canyon, it is not a primary transportation route and generally exists for recreational purposes.

3.20.3 Wenatchee River Corridor

The Wenatchee River Corridor contains several major roadways. These include federal Highways 97 and 2, and a small portion of State Route 209. There are also several county

and city roads located in this area. Highway 2, which runs along the Wenatchee River, is designated as a National Scenic Highway, which is discussed in more detail in Section 3.11.3, Wenatchee River Corridor [Aesthetics].

There is also one railroad that runs parallel to the Wenatchee River from the City of Leavenworth to City of Wenatchee. This rail line is owned by BNSF and serves both passengers and freight. This rail line connects the Wenatchee area to City of Seattle and City of Spokane.

3.21 Cultural Resources

Cultural resources can be buildings and other man-made structures or objects, or a site, landscape, or district associated with human use in the past. For the purposes of this evaluation, cultural resources are considered to be those eligible for listing in local, state, or national preservation registers. Tribal resources within the Icicle project area are addressed in Section 3.22, Indian Sacred Sites, and Section 3.23, Indian Trust Assets and Fishing Harvest.

3.21.1 Environmental Context

The Icicle project area is in the Wenatchee River Watershed on the east slopes of the Cascade Range. The project area includes the Alpine Lakes in the Icicle Creek Basin, Icicle Creek to its confluence with the Wenatchee River, and the Wenatchee River from just upstream of Icicle Creek to its confluence with the Columbia River. The area is part of the Northern Cascades physiographic province, characterized by deeply dissected mountains with glacially created features, crossed by east- and west-flowing streams (Franklin and Dyrness, 1973:17-20). Bare rock outcrops are common.

The upper portion of the Icicle project area is characterized by high relief and relatively sparse vegetation. Soils are typically thin and formed in glacially derived sediments, colluvium, and volcanic ash (NRCS, 2016). The lower portion of the project area, extending to the Wenatchee River Corridor, is characterized by landforms and vegetation more common in the valley bottoms. Soils can be much deeper and formed in alluvium and loess as well as glacial till (NRCS, 2016).

Prior to historic-era and modern changes, the alpine terrain in the upper Icicle project area would have been a source of toolstone for local communities and certain faunal species such as bighorn sheep. The valley-bottom terrain in the lower elevations would have hosted a wider variety of large mammals, as well as anadromous and resident fish, birds, and various species of edible and usable plants.

3.21.2 Cultural Context

The Icicle project area is located within the Columbia Plateau. General cultural histories have been developed for the plateau as a whole (Chatters and Pokotylo, 1998), as well as various sub-regions and drainages. Most are focused on river valleys where larger sites

are more plentiful (e.g., Grabert, 1968). Because the prehistory of the mountain regions of Washington is poorly understood compared to the coasts and riverine lowlands, this section is primarily based on the better-understood riverine valley cultures; however, these communities also likely used the surrounding mountains as part of their seasonal movements.

At the end of the Pleistocene, hunters of large mammals fanned out across North America. This culture is known in the Columbia Plateau as Paleoindian (Ames and Maschner, 1999:64 66), and dates to the Early Period, about 12,000 to 8,000 years ago. The earliest Paleoindian sites recorded in the Columbia Plateau are attributed to the Clovis culture, a regional expression of Paleoindian. Clovis sites are rare across the region, and in mountain environments "game density would have been too low, and exploitation costs too high relative to the lowlands to have attracted significant use" (Burtchard, 2007: 17). However, there are a few sites near the Icicle project area, including the Ritchey-Roberts Clovis cache in nearby East Wenatchee, dating to 12,250 before present (BP) (Mehringer and Foit, 1990). An undated Clovis projectile point has also been found near Cle Elum, near Snoqualmie Pass (Burtchard, 2007).

After the brief but widespread Clovis occupation, a "broad-spectrum" hunter-gatherer culture developed in the Columbia Plateau region and persisted until the middle Holocene, around 5,300 years ago. A number of dated sites in the Cascade Range are attributed to this period, primarily lithic quarries and scatters (Mierendorf, 1986).

A shift toward more permanent settlement began around 6,000 years ago. Known as the Late Middle Period in the Columbia Plateau, this period lasted until the beginning of the early Holocene around 3,000 years ago (Chatters and Pokotylo, 1998; Ames et al., 1998). In Cascade Mountain environments, there is an increase in dated sites consistent with the expectation of more intensive resource use (Burtchard, 2007).

Late Holocene cultures in the Columbia Plateau region exhibit a "shift in adaptations…to storage-dependent collector strategies" (Chatters and Pokotylo, 1998:76), which are characterized by intensive salmon fishing and associated storage features, social inequality, large permanent winter villages, and diverse tool assemblages. The Cascade Range continued to be used during this time, despite some expectation that long-range travel might decrease as villages became more important (Schalk, 1984). Some sites contain multiple non-local toolstone types, indicating that they may have functioned as larger camps (Mierendorf, 2004). The late Holocene archaeological cultures correlate with historic ethnographic descriptions.

The Icicle project area is in the traditional territory of the Wenatchee (Wenatchi) Tribe, a Middle Columbia Salishan group speaking Columbian, an Interior Salishan language. The cultural pattern in the Columbia River Basin at the time of historic contact was based on a seasonal round that took advantage of fish runs, abundant game, and root resources, as well as trade, kinship ties, and intermarriage among groups (Walker, 1998). Prior to historic resettlement, permanent winter villages anchored the seasonal round. Villages often contained a large communal structure or "longhouse," as well as smaller auxiliary structures (Miller, 1998). Before the adoption of the horse, these structures were semi-

subterranean, but after about anno domini (AD) 1720, even winter village structures were aboveground mat houses. Villages were the basic political unit (Miller, 1998).

The communities of the southern Columbia Plateau began to see the effects of Euro-American contact decades before the first explorers and traders arrived in the area. These effects, beginning around AD 1600, included introduced diseases, trade goods, and the introduction of the horse (Walker and Sprague, 1998).

The Wenatchee Tribe signed the Yakima Treaty in 1855 at Walla Walla, which was followed by several years of warfare (Wilma, 2006; Yakama Nation, 2016). Many descendants are now part of the YN while others belong to the CTCR (Wilma, 2006). Additional information about tribal resources is provided in Sections 3.22, Indian Sacred Sites, and 3.23, Indian Trust Assets and Tribal Fish Harvest.

Prospectors, traders, and missionaries began to arrive in the Wenatchee River area in the 1860s and 1870s, followed by homesteaders. The railroad arrived in 1892, and the City of Wenatchee incorporated the same year (Wilma, 2006). With construction of the railroad and the growth of irrigation, the Wenatchee River area became primarily agricultural, known as the "Apple Capital of the World" (Wilma, 2006).

The Wenatchee National Forest was created by President Theodore Roosevelt in 1907, headquartered in the City of Leavenworth. Shortly thereafter, forester Albert "Hal" Sylvester began surveying the new forest and assigning place names (Bentley, 2010). Sylvester named Icicle Creek and Icicle Ridge after the Columbian language name *na-sik-elt*, which means "narrow canyon" (Bentley, 2010). A guard station was constructed at Chatter Creek in 1916, and a bridge in 1922 (Beidl, 2010).

Water quickly became the single most important factor restricting the success of the agricultural industry. The earliest cooperative irrigation projects in the Peshastin area began in the 1800s, and IID and PID were formed in the early 1900s (Grubb, 2016). The Reclamation Act of 1902 allowed the federal government to manage water use. Early projects were primarily agricultural, but in the 1930s, large hydroelectric dams were constructed, including those on the Columbia River (Reclamation, 2010). The LNFH was built in 1939 as partial mitigation for impacts to fish resulting from the construction and operation of the Grand Coulee Dam on the Columbia River.

Water storage and release systems were constructed for irrigation, including facilities at Colchuck, Klonaqua, Square, and Eightmile Lakes. The facilities at Colchuck Lake were constructed in the early 1920s and Klonaqua Lake in the early 1930s—though the dam at Colchuck Lake appears to have been replaced in the 1950s (Jantzer, 2016). The water release systems at Square Lake and Eightmile Lake were built later, in the 1930s and 1940s (Jantzer, 2016). IID and PID constructed the facilities jointly and have historically shared the operation and maintenance of the systems. The systems generally consist of a low rock-masonry dam and a combination of pipes or tunnels with gates that control the release of stored water from the upper portions of each lake. The water released augments flow in Icicle Creek for maintenance of withdrawals by IPID. The dams have been altered and maintained throughout the decades, with various components of the infrastructure upgraded and replaced (Jantzer, 2016).

Water is also managed at Upper Snow, Lower Snow, and Nada Lakes by the USFWS. A tunnel runs from the northeast corner of Upper Snow Lake to a gatehouse containing control valves that release water to Nada Lake. There is also a small rock-masonry dam at Upper Snow Lake where it connects to Lower Snow Lake, another at Lower Snow Lake at its outlet to Snow Creek, and a reinforced concrete structure at the outlet of Nada Lake. These were originally constructed in the 1930s and early 1940s by the USBR for the USFWS to maintain the supply of cold surface water to LNFH (USFWS, 2014). The tunnel and valve unit were designed and built by USBR Engineer Louis Ackerman (USFWS, 2014).

The ALWA was designated in 1976. The Okanogan National Forest and the Wenatchee National Forest were administratively joined in 2000 and became the Okanogan-Wenatchee National Forest (USFS, 2016).

3.21.3 Previously Recorded Resources

Within the Icicle project area, there are 19 documented archaeological sites and 4 historic structures according to DAHP's Washington Information System for Architectural and Archaeological Data (WISAARD) lists. Four of these resources have been determined to be eligible for listing on the National Register of Historic Places (NRHP)[39]. These are the LNFH, the Chatter Creek Guard Station, and culturally modified trees (cedars that have been peeled to harvest the bark) locations (sites FS1624 and FFS1573). The peeled cedars and the Chatter Creek Guard Station are not in the vicinity of any of the proposed projects that compose the Program Alternatives and are not discussed further.

Potential changes at the LNFH are included in all the Program Alternatives. The property is NRHP-listed under Criterion A because of its association with the history of fish conservation and restoration, and under Criterion C because it embodies the distinctive characteristics of hatchery conception and design between 1939 and 1941 (Speulda, 1997).

WISAARD indicates that 17 cultural resources surveys have been completed within the upper portions of the Icicle project area, including the Alpine Lakes and Icicle Creek. Of those, most are outside the area that would likely be affected by any of the Program Alternatives. Five of the surveys were conducted at the LNFH, and none revealed any significant historic, archaeological, or cultural resources other than the LNFH complex itself.

In lower portions of the Icicle project area, including the Wenatchee River Corridor, 75 cultural resources surveys have been conducted, resulting in the identification of 21 archaeological sites (5 precontact sites, 10 historic sites, 4 precontact isolates, and 2 sites with both precontact and historic components). There are also four recorded cemeteries and one burial. None of these resources are in the vicinity of any of the Program Alternatives.

[39] To be eligible for listing in the NRHP, a property must retain its integrity and meet one or more of four criteria for significance: association with broad patterns of history, direct association with a historically important person(s), masterful design or engineering, or the potential to yield important data.

3.21.4 Archaeological Survey

To provide additional information about the potential to encounter cultural resources within the Icicle project area, an archaeological survey at four of the Alpine Lakes was completed in July 2016 (Bundy, 2017). This survey included a pedestrian survey and recordation of irrigation structures.

The survey revealed no cultural resources along the existing Eightmile Trail. At four lakes—Colchuck, Square, Klonaqua, and Eightmile—historical water release systems were recorded. The four water release systems were evaluated for their NRHP eligibility, individually and as a historic district. The systems share similar structure and serve the same function of providing water to the City of Leavenworth and surrounding agricultural areas. The water release systems are recommended NRHP-eligible both individually and as a historic district. The structures are recommended eligible under the following:

- Criterion A for their association with historically significant and controversial water management in Chelan County
- Criterion B for the unique style influenced by the extremely difficult terrain and constraints of mid-century construction methods
- Criterion D for the potential to yield data about early twentieth century engineering and construction

Although the systems have been upgraded and modified through the decades, this sort of maintenance is common for industrial and agricultural historic properties. The water release systems retain integrity of location and setting because they are in their original locations and the surrounding landscape has changed little. They retain integrity of design, workmanship, and materials, with the local stone, concrete, and timber components consistent—even between structures built 30 years apart. They retain integrity of feeling and association, which is expressed in the contrast between the rustic construction (native stone, hand-cranked machinery) and the wilderness setting.

In addition to the four water release systems, a construction work camp was observed at Klonaqua Lake. This site is also potentially eligible for listing in the NRHP both individually and as contributing to the historic district under Criterion D. The site has a surface artifact scatter and remnant structure, and potentially buried artifacts and features. It has the potential to yield data important to the study of working conditions and methods in an alpine environment in the early twentieth century.

The dams at Upper and Lower Snow Lakes have not been surveyed and no recommendation for eligibility in the NRHP has been made. Photos show simple rock-masonry structures, similar to those constructed at the IPID water release systems.

3.22 Indian Sacred Sites

Sacred sites may include ceremonial areas and natural landmarks that are religious or symbolic representations. Indian Trust Assets, including Usual and Accustomed Areas, are addressed in Section 3.23, Indian Trust Assets and Fishing Harvest.

Sacred sites are considered cultural resources and require consideration under the State Environmental Policy Act. Sacred sites can also be recorded as Traditional Cultural Properties (TCPs) under Section 106 of the National Historic Preservation Act, which applies to projects involving federal actions (Parker and King, 1998).

The Icicle project area is in the traditional territory of the Wenatchee (Wenatchi) Tribe. The Wenatchee Tribe signed the Yakima Treaty in 1855 at Walla Walla (Wilma, 2006; Yakama Nation, 2016). Many descendants are now part of the Confederated Tribes and Bands of the Yakama Nation, while others belong to the Confederated Tribes of the Colville Reservation or other tribes (Wilma, 2006).

No sacred sites or TCPs have been recorded in the Icicle project area in Washington State DAHP's database; however, Indian tribes may have written or oral records of sacred sites that are not recorded in the DAHP database.

The Confederated Tribes and Bands of the Yakama Nation are members of the Icicle Work Group. Coordination with tribes and tribal organizations will continue throughout the program.

3.23 Indian Trust Assets and Fishing Harvest

This section describes Indian Trust Assets (ITAs), including Usual and Accustomed (U&A) Areas with the potential to be affected by the Program Alternatives. ITAs are legal interests in property held in trust by the United States for federally recognized Indian tribes or individual Indians. ITAs may include land, minerals, federally reserved hunting and fishing rights, federally reserved water rights, and instream flows associated with trust land. U&A Areas are areas where tribes have historically hunted, gathered, and fished.

Information about the specific tribes and other tribal resources within the Icicle project area is presented in Section 3.22, Indian Sacred Sites. Information about fisheries in general is presented in Section 3.7, Fish.

3.23.1 Legal Framework for Protection

Beneficiaries of the Indian trust relationship are federally recognized Indian tribes with trust land, and the United States acting as trustee. By definition, ITAs cannot be sold, leased, or otherwise encumbered without approval of the U.S. government.

The federal government has a trust relationship with Indian tribes, and federal agencies are required to engage and consult federally recognized tribal governments on a government-

to-government level when their actions affect ITAs. This relationship is governed by treaties, statutes, federal judicial decisions, and the historical evolution of the trust doctrine.

The U.S. Department of Interior (DOI) Departmental Manual Part 512.2 delegates the responsibility for ensuring protection of ITAs to the heads of bureaus and offices (DOI, 1995). The DOI is required to "protect and preserve ITAs from loss, damage, unlawful alienation, waste, and depletion" (DOI, 2000). Depending on federal involvement for individual projects, there could be a requirement to formally consult with potentially affected federally recognized tribes. Additionally, state-funded capital construction projects or land acquisition projects for the purpose of capital construction require Governor's Executive Order 05-05 review. This order requires all state agencies to integrate Washington State DAHP, the Governor's Office of Indian Affairs, and concerned tribes into the capital improvement project planning process to protect the public interest in historic and cultural sites.

In 1854 to 1855, representatives of the U.S. government negotiated separate treaties with the tribes and bands of the Columbia River Basin, which included the YN. The treaty between the YN and the U.S. government protects the YN's rights to continue traditional fishing practices and reserves to the tribes the right to take "fish at all usual and accustomed places in common with citizens of the United States" within their respective reservations, at all U&A fishing sites on lands ceded to the U.S. government, and at all U&A fishing sites outside the reservation or ceded areas (YN and U.S. Government, 1855).

Although the CTCR did not sign a treaty during the 1855 council between tribes and the U.S. government, non-treaty agreements made with U.S. government representatives protect similar fishing rights of CTCR tribal members (CTCR, 2016).

3.23.2 Usual and Accustomed Areas

U&A Areas include areas where tribes have historically hunted, gathered, and fished. Within the Wenatchee River Watershed, there are U&A fishing areas for the YN and CTCR. The YN also has U&A fishing places in many locations along the Columbia River and outside of the Columbia River Basin in accordance with treaty fishing rights (YN, 2009). Both the YN and CTCR maintain fishing rights in Icicle Creek, targeting non-listed spring-run Chinook salmon (*Oncorhynchus tshawytscha*), returning to the LNFH in the area adjacent to LNFH downstream to the confluence with the Wenatchee River (YN, 2009; CTCR, 2011), including the plunge pool immediately downstream of the LNFH Hatchery Channel spillway.

In the mainstem Wenatchee River, the YN maintains fishing rights within a mile of Dryden Dam (not within 25 feet of any fishway), in mid-summer targeting summer-run Chinook salmon and summer-run steelhead (*O. mykiss*) (YN, 2009). The CTCR maintains a summer Chinook salmon fishery in Tumwater Canyon and mainstem Wenatchee River (CTCR, 2011). Since the reintroduction of coho salmon (*O. kisutch*) to the upper Wenatchee River and Icicle Creek drainages, tribal subsistence fisheries for coho salmon have been opened when runs are large and surplus fish are available (CRITFC, 2011). Upriver sockeye salmon (*O. nerka*) and upriver summer-run Chinook

salmon (including the Wenatchee stocks) are harvested by treaty tribes (including the YN) in the mainstem Columbia River, prior to ascending their natal rivers.

It is the policy of the YN and CTCR fishery codes to sustainably manage fishery resources and enhance fish and habitat off the Yakama and Colville Reservations to support tribal harvest for subsistence, recreational, and economic needs of tribal members (YN, 2009; CTCR, 2011). The harvest of trout, salmon, and steelhead is allowed only by fishery regulation passed by tribal fish and wildlife committees. Harvest rates and fishery openings are determined annually by tribal and state fishery co-managers based on preseason run-size estimates and in-season observations of numbers of fish entering the Lower Columbia River. From 1999 to 2003, the YN harvest in Icicle Creek averaged 2,905 spring-run Chinook salmon per year and an average of over 3,000 surplus adults returning to LNFH were provided directly to Columbia River tribes (YN, CTCR, Spokane Tribe, and Kalispell Tribes) and food banks. In 2015, CTCR anglers caught 113 hatchery-origin spring-run Chinook salmon from mid-May to early June (Rayton, 2016).

The harvest of whitefish, sucker, pikeminnow, and other native resident fish and non-native species are open year-round to tribal members unless restricted by specific regulation (YN, 2009). Pacific lamprey (*Entosphenus tridentatus*) is a culturally and commercially important species for the tribes and is a tribal trust species. Pacific lamprey are a traditional delicacy harvested by many Northwest Indians for use as food, ceremonial, and medicinal purposes. Efforts are underway to restore harvestable lamprey populations in the Wenatchee River Watershed (YN, 2016).

3.24 Socioeconomics

This section provides information on the social and economic conditions within the Icicle project area to provide context for comparing the costs and benefits of the Program Alternatives to each other and to the No-action Alternative. This section provides an overview of the regional economy, including the labor force, employment by industry, and wages and income. This section also includes a discussion of OCR investment considerations relevant to evaluating the costs and benefits associated with large-scale fish recovery efforts. Information for this section was gathered from the U.S. Census Bureau; the Chelan County Auditor's Office; Chelan and Douglas Counties Profile, prepared by the Washington Employment Security Department (ESD; 2015); and from the Washington State Department of Ecology's Office of Columbia River.

3.24.1 Regional Economic Setting

The Icicle project area is located within the Wenatchee Metropolitan Statistical Area (WMSA), which is composed of Chelan and Douglas Counties. The WMSA relies on agriculture as the main source of employment. In Chelan County, agriculture is the largest industry, making up 24.1 percent of total employment, followed by private health care services (13.5 percent). In addition, other substantial sources of employment include government, retail, and leisure and hospitality. Tourism plays a large part in the local

economy in Chelan County due in part to attractions like Lake Chelan and the City of Leavenworth (ESD, 2015).

As the largest source of employment, agriculture is the primary economic driver for the region. In particular, tree fruit, including apples, cherries, pears, and peaches, provides a significant contribution to the local economy. Grape production and wineries also contribute to both agriculture and tourism. Agricultural employment also directly links to nonfarm employment through support services such as food processing, packaging, and distribution (ESD, 2015).

Flows from Icicle Creek support agricultural uses in the Icicle project area as well as a range of other demands, including providing water for domestic uses and habitat for fish. Taken together, these demands are often greater than the water supply needed to meet them, resulting in the need to collaboratively and collectively identify solutions to balance water resource needs with the County's needs for economic growth and security.

3.24.2 Population, Housing Stock, and Property Values

The total population in Chelan County in 2015 was 75,644. This represents a 10 percent increase over the 2005 population of 68,747. In comparison, the Washington State population increased by 14 percent over the same period, from 6,257,305 to 7,170,351 (Census, 2017a, 2017b).

The increase in housing stock was similar to the increase in population in Chelan County. In 2005, there were 32,738 housing units. In 2015, there were 36,452 housing units, an increase of 11 percent. Housing stock in Washington State also increased by 11 percent over that period of time, from 2,691,015 to 2,991,484 (Census, 2017a, 2017b).

Property values in Chelan County have increased significantly over the past 10 years. In 2016, the total taxable assessed value was $9.7 billion. This represents a 60 percent increase over the 2006 total taxable assessed value of $6.1 billion. However, property tax revenue only increased by 37 percent between 2006 and 2016, from $75 million to $103 million, respectively (Walter, 2016).

Table 3-34 provides a summary of changes in population, housing stock and property values in Chelan County.

Table 3-34
Chelan County Population, Housing Stock, and Property Value Changes

	2005	**2015**	**% Change**
Population	68,747	75,644	10%
Housing Units	32,738	36,452	11%
	2006	**2016**	**% Change**
Total Taxable Assessed Value	6,066,908,249	9,709,253,746	60%
Total Property Tax Revenue	75,220,200	103,275,501	37%

3.24.3 Labor Force

The recent recession had a delayed effect on the WMSA labor market with the worst impacts occurring primarily in 2009 and 2010. Nonfarm employment in the two-county WMSA peaked at an average of 40,200 jobs in 2008, then declined until bottoming out in 2010 with 38,100 jobs (ESD, 2015).

In 2014, the WMSA's nonfarm economy averaged 40,600 jobs, which was a 3.2 percent growth rate from the previous year and back to pre-recession conditions. The statewide job growth rate was 2.7 percent for the same period. Over 75 percent of the jobs added in 2014 were in construction, health services, and leisure and hospitality (ESD, 2015).

3.24.4 Employment by Industry

More than 66 percent of all jobs in 2014 in Chelan County fall into five industries: agriculture, health services, local government, retail trade, and accommodations and food services. Table 3-35 shows jobs by industry and the percent of employment it represents.

Table 3-35
2014 Chelan County Employment

Sector	Number of Jobs	Share of Employment
Agriculture, forestry and fishing	9,962	24.1%
Health services	5,602	13.5%
Local government	4,766	11.5%
Retail trade	4,379	10.6%
Accommodations and food services	4,097	9.9%
All other industries	12,539	30.3%
Total covered employment	41,345	100%*

Source: Washington Employment Security Department, 2015
* Values do not equal 100% due to rounding.

3.24.5 Wages and Income

In 2014, Chelan County's workers received $1.48 billion in wages. Although agriculture was the largest job provider in Chelan County in 2014, agricultural wages represent a proportionally lower percentage of the County's total wage income. Table 3-36 presents the payroll and the percentage of total wages for each industry within Chelan County.

Table 3-36
2014 Chelan County Wages

Industry	Payroll	Share of Payrolls
Health services	$304,232,620	20.5%
Local government	$234,376,378	15.8%
Agriculture, forestry and fishing	$228,904,393	15.4%
Retail trade	$115,390,841	7.8%
Wholesale trade	$103,679,515	7.0%
All other industries	$498,177,888	33.6%
Total covered payrolls	$1,484,761,635	100%

Source: Washington Employment Security Department, 2015
* Values do not equal 100% due to rounding.

3.24.6 Costs and Benefits

In 2006, Washington State passed legislation establishing the Columbia River Management Program, which tasked Ecology to seek out new water supplies within the state of Washington for instream and out-of-stream uses, leading to the development of the OCR. Since that time, OCR has improved water supply in eastern Washington through the development of additional water sources, totaling 410,000 acre-feet with an additional 337,878 acre-feet to be developed in the near term (Ecology 2016).

OCR has funded numerous projects to meet its directive. The costs to develop water supplies, which have to do with making the water physically and legally available for instream flows or out-of-stream allocations, ranges considerably depending on project specifics, but the average is $500/acre-foot. These costs typically include project conceptualization, appraisal, feasibility study, pre-design, design, environmental review, stakeholder outreach, construction, and permitting to authorize the source of water.

Implementation of the Icicle Strategy would require similar costs to develop the additional water supply. This would mainly result in short-term costs in exchange for longer-term benefits.

The costs and benefits specific to each Program Alternative are discussed in Section 4.24, Socioeconomics. Relevant to this discussion, implementation of the Icicle Strategy is anticipated to affect the following components of socioeconomic conditions within the Icicle project area:

- Land value and annual property tax revenue
- Jobs and labor income
- Increased instream values

3.24.6.1 Land Value and Annual Property Tax Revenue

In Washington State, all real and personal property is subject to taxation, unless specifically exempted by law. There are many taxing districts in Chelan County, including fire districts, the regional library, cities, county government, roads, hospitals, ports, and many others. The amount of money that taxing districts raise is determined by the local government and its budget-making authority. As land value changes, so can the revenue generated for each taxing district.

3.24.6.2 Jobs and Labor Income

Investment in public projects creates jobs; however, the actual increase in jobs at the regional level depends on the funding source. If the construction funding is entirely local and from existing sources, the effect can be small because funds may be diverted from other efforts. If the funding is from external sources, the effect can be greater. However, with large-scale construction projects in rural areas, much of the labor and materials can come from outside the local and regional economies, muting the potential benefit. Nonetheless, increases in construction at the local level contributes to greater economic activity as workers spend more of their labor income in the local economy.

3.24.6.3 Increased Instream Values

Although the concept is difficult to quantify or monetize, a clear connection between healthy aquatic ecosystems and the economic livelihood of local communities is identified by the National Research Council in the book *Valuing Ecosystem Services: Toward Better Environmental Decision-Making* (NRC, 2005). As described by EPA in their report *Valuing the Protection of Ecological Systems and Services: A Report of the EPA Science Advisory Board*, the value associated with increased instream flows is a function of how ecological goods and services contribute to human well-being (EPA, 2009). However, there is "non-use value" that must also be considered. The idea of "non-use value" has to do with the preference for a public good or service that is not derived directly from its use, as explored by Mansfield in her report *Klamath River Basin Restoration Nonuse Value Survey* (RTI, 2012). That is, some people will value recovery of a fish run not because they want to consume the fish, but rather because they value the existence of the fish run.

3.25 Environmental Justice

Environmental Justice is the fair treatment of all people regardless of race, color, national origin, or income. Fair treatment means that disadvantaged populations do not bear disproportionate adverse impacts from a particular action compared to the rest of the population. For the purposes of this analysis, this section looks at minority and low-income data for the Icicle project area using data provided by the U.S. Census Bureau and the Washington Office of Financial Management (OFM). Information about tribal resources within the Icicle project area, including the potential for Indian Sacred Sites and Indian Trust Assets and Fish Harvest, are described in Sections 3.22, Indian Sacred Sites, and 3.23, Indian Trust Assets and Fishing Harvest, respectively.

3.25.1 Minority Populations

Table 3-37 provides statistics on the minority population composition for the State of Washington, Chelan County, and within the Icicle project area defined as Census Tracts 9602, 9605, 9606, 9607, 9608.01, and 9608.02[40]. As shown, minority populations within the Icicle project area are generally proportionate to those in the county and state,[41] with the exception of a slightly higher percentage of Hispanic or Latino populations. However, these differences are not assumed to be substantial because of the wide margin of error posed by the data used for this study. Additionally, as discussed in greater detail in Section 3.23, Indian Trust Assets and Fishing Harvest, potentially affected minority populations include members of area Indian groups. While census data are available for recognized Indian reservations, specific data for tribal members are not. Tribal members may be affected regardless of whether or not they reside on their reservations.

Table 3-37
Race and Ethnicity

	State of Washington	Chelan County	Icicle Project Area[a]
Total Population	7,061,410	75,030	31,304
One Race			
White	5,698,518 (81%)	70,669 (94%)	29,600 (95%)
Black or African American	278,360 (4%)	409 (<1%)	127 (<1%)
American Indian and Alaska Native	130,780 (2%)	1,337 (2%)	469 (2%)
Asian	562,903 (8%)	779 (1%)	355 (1%)
Native Hawaiian and Other Pacific Islander	50,698 (<1%)	169 (<1%)	83 (<1%)
Two or more races	340,151 (5%)	1,667 (2%)	671 (2%)
Hispanic or Latino[a]	879,410 (13%)	21,501 (29%)	6,375 (20%)

Source: OFM, 2015; percentages are rounded.
Notes: a) The Icicle project area includes Census Tracts 9602, 9605, 9606, 9607, 9608.01, and 9608.02. b) As defined by the OFM, Hispanic or Latino race included as subset of White category.

[40] Census tracts selected include those located within the Icicle Creek Basin and Wenatchee River Watershed where the proposed projects composing the Program Alternatives are focused. Census tracts that include the Alpine Lakes are not listed because project activities are proposed for areas where no residences are allowed. As noted, tribal resources with the potential to be affected are addressed in Section 3.23, Indian Trust Assets and Fishing Harvest.

[41] For context, the U.S. EPA considers impacts on minority populations to be disproportionate if the minority population exceeds 50 percent of the study area population or if the minority population percentage of the study area is meaningfully greater than the minority population percentage in the general population or the reference area (Council on Environmental Quality, 1997).

3.25.2 Low-income Populations

Table 3-38 provides information about low-income populations for the same geographic areas. Similar to data presented for minority populations, low-income populations within the Icicle project area are proportionate to populations at the state- and county-level.

Table 3-38
Income, Poverty and Unemployment

	State of Washington	Chelan County	Icicle Project Area[a]
Income			
Median household Income	$60,294	$50,876	$58,158
Per capita income	$37,640	$25,619	$29,613
Percent Below Poverty			
Individuals	13.5%	14.8%	14.9%
Percent unemployed	8.8%	9.2%	12.8%

Source: ACS, 2014
Notes: a) The Icicle project area includes Census Tracts 9602, 9605, 9606, 9607, 9608.01, and 9608.02.