BIOLOGICAL ASSESSMENT

For

Operation and Maintenance

Of

Leavenworth National Fish Hatchery

Lead Agency:
U.S. Fish and Wildlife Service
Leavenworth National Fish Hatchery
Leavenworth, WA

Cooperators:
U.S. Fish and Wildlife Service
Mid-Columbia River FRO
Leavenworth, WA

July 10, 2006

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I. INTRODUCTION

In previous consultations with the U.S. Fish and Wildlife Service (USFWS) on Leavenworth National Fish Hatchery (LNFH) operations (USFWS 1999, 2002), the agency concluded that LNFH's operations, including its water intake system, were not likely to adversely affect ESA listed bull trout or other USFWS listed species under the Endangered Species Act (ESA). This Biological Assessment (BA) provides updated information on hatchery operations and maintenance and an updated assessment on potential effects of the hatchery on federally listed, proposed, and candidate species and designated critical habitat. The Fisheries program has determined that the operation and maintenance of the Leavenworth National Fish Hatchery may affect listed bull trout and has initiated formal ESA consultation for all aspects of the operation and maintenance of LNFH and consideration for appropriate incidental take statements is requested to ensure that proposed management activities will not likely jeopardize the continued existence of listed species nor adversely modify critical habitat for the next five years.

LNFH has been actively pursuing development and implementation of long-term solutions to fish passage since 1998. A Final Environmental Impact Study for the Icicle Creek Restoration Project was completed in January 2002. Portions of the Restoration project were completed in 2005. Phase II of the Restoration project which included construction of a collection and sorting facility to pass native fish has been delayed due to citizen concerns that have been raised and because permits from federal, state, and local agencies were not received in time to meet critical construction timelines. Because of ongoing concerns raised about the selected alternative, the USFWS has agreed to reevaluate possible long-term strategies for native fish passage and replacement of the outdated water intake structure to improve conditions for listed species. The Bureau of Reclamation (Bureau) has offered to facilitate a Project Alternative Solution Study

(PASS) process to address this issue with a planning meeting on the PASS process scheduled for July 14, 2007.

By 2011, LNFH expects to re-initiate consultation to incorporate long-term strategies to benefit fish passage and aquatic habitat. Therefore, we are requesting this consultation address hatchery operations and maintenance in the interim for the next five years. Until that time, this operations and maintenance plan for LNFH will improve environmental conditions in the action area compared with the effects of past operations and maintenance. These changes will provide interim benefit for aquatic species including bull trout and should mitigate adverse effects until the facilities are adequately upgraded and operations modified.

The following provides a summary of past consultations between the Leavenworth National Fish Hatchery (LNFH) and the USFWS. Consultations with NOAA for their listed species have been conducted separately and are not included here.

February 1999. Biological Evaluation submitted for the Leavenworth National Fish Hatchery Complex (*Complex = LNFH, ENFH, WNFH*) with a finding that operations and maintenance may affect but are not likely to adversely effect bull trout. March 1999 memorandum received from the Moses Lake Ecological Services Field Office concurring with that determination (FWS Reference # 1-9-99-I-112).

December 17, 2001. Biological Assessment (amended) submitted for the Icicle Creek Restoration Project. The FRO determined implementation of the project was not likely to adversely affect the listed mammals, birds and plants nor critical habitat of the Northern Spotted Owl. The FRO further determined the project was likely to adversely affect bull trout. On April 17, 2002, the FRO received a Biological Opinion (RE: Icicle Creek Restoration Project, FWS Reference: 02-F-E-0081) dated March 12, 2002, from the Eastern Washington Ecological Services Field Office (EWFO) in which the EWFO concurred with the determination regarding mammals, birds and plants, and completed formal consultation.

February 19, 2002. Biological Assessment (supplemental) submitted for Icicle Creek Surface Water Withdrawal by LNFH (*for current water delivery system*). The LNFH determined that ongoing management actions would not likely jeopardize the continued existence of federally listed species nor adversely modify critical habitat. The consultation was never completed as general agreement was reached between ES and LNFH to defer consultation regarding water use issues until the proposed Water Supply System Rehabilitation Project.

December 2002. Hatchery and Genetic Management Plan for the Leavenworth National Fish Hatchery Complex (*Complex = LNFH, ENFH, WNFH*) submitted. The FRO/LNFH determined the continued operations of the three hatcheries "may affect, but are not likely to adversely affect" species including bull trout. On December 10, 2002 Memo received indicating "The Service concurs with the FRO's determination that the project may affect but is not likely to adversely affect the mentioned federally listed species." Amendment to FWS Permit # 1-9-99-I-112/FWS Reference # 03-I-W0062.

April 22, 2003. Biological Assessment submitted requesting informal intra-Service consultation on proposed LNFH Fuels Reduction Project. The LNFH requested concurrence with the determination of "may affect, not likely to adversely affect" for the bald eagle and bull trout, and "no effect" for the grizzly bear, gray wolf, Canada Lynx, northern spotted owl, and three plant sp. Leavenworth NFH received concurrence from the Central Washington Field Office (CWFO) in letter dated May 6, 2003 (FWS Reference: 03-I-W0222, HUC: 17-02-00-11-04).

May 6, 2003. Memo from FRO to CWFO submitted providing notice that the Icicle Creek Restoration Project, FWS Reference: 02-F-E-0081 (formal consultation not re-initiated) would be implemented in two phases.

December 1, 2004. FRO submits Biological Assessment for LNFH's Hatchery Water Supply System Rehabilitation Project. The FRO determined that the project "may affect, but is not likely to adversely affect" gray wolf, grizzly bear, spotted owl, bald eagle, "no effect" on plant species, and "Is likely to Adversely Affect" bull trout and the FRO therefore requested formal consultation.

December 15, 2004. The FRO submits an Addendum to the Biological Assessment (12/17/2001) for the Icicle Creek Restoration Project. The addendum provided additional information and clarification and indicated that the changes would reduce if not eliminate effects outlined in the original BA and therefore formal consultation or re-initiation was not requested.

II. PROJECT LOCATION

A. Legal Description

Township 24N, Range 17E, Section 23 & 26

B. General Location

LNFH is located three miles south of Leavenworth, Washington, near the mouth of Icicle Canyon. LNFH withdraws surface water from Icicle Creek at river mile 4.5 and returns water to the creek at approximately river mile (rm) 2.8. LNFH also operates and manages three lakes / reservoirs (Lower Snow, Upper Snow and Nada Lakes) located approximately 7 miles from the hatchery and about 1 mile above it in elevation in the Alpine Lakes Wilderness.

III. AFFECTED ACTION AREA

The affected action area for the operation and maintenance of LNFH is the Icicle Creek Basin including areas upstream of LNFH. The lower 5.5 miles of Icicle Creek is clearly the area most affected by LNFH and therefore the focus of this assessment. It is recognized however that fish released from Leavenworth NFH also inhabit the Wenatchee River and some of its tributaries, the Columbia River and some of its tributaries, and the Pacific Ocean. However, the impacts in

these areas from operations and maintenance of LNFH are considered minimal and therefore are not discussed.

Icicle Creek is a major fourth order tributary to the Wenatchee River. It is 31.8 miles long, with 85 tributaries, and drains a 136,759 acre (211 mi^2) basin containing 14 glaciers and 102 lakes. The U.S. Forest Service (USFS) manages 87%, with 74% in the Alpine Lakes Wilderness Area, of the Icicle Creek catchment and manages it as a Tier 1 key watershed under the Northwest Forest Plan (USFS 1994). Therefore, public lands in the Icicle Creek drainage are managed for at risk salmonids and other fish species.

The Wenatchee basin encompasses approximately 3,551 square kilometers (1,371 square miles) in central Washington. The watershed heads at the Cascade crest and flows east towards the Columbia Plateau. The Wenatchee River drains into the Columbia River at the town of Wenatchee. Other major tributaries are the White and Little Wenatchee Rivers, which drain into Lake Wenatchee (source of the Wenatchee River), Chiwawa River, and Nason Creek

Icicle Creek is primarily snowmelt fed. About 21% of the flow in a hot, dry summer is estimated to originate from glacier melt (Mullan *et. al.* 1992). The measured flow in Icicle Creek ranges from a minimum of 44 cfs to a maximum of 14,100 cfs according to readings taken from the USGS gauging station (rm 5.8) located above all major water diversions. The discharge of Icicle Creek is altered by water diversions which can reduce the flow in the lower reaches to very low levels during the summer and early fall (WRWSC 1998). The City of Leavenworth and the Icicle-Peshastin Irrigation District (Appendix A) divert water above the Snow Lakes trailhead (rm 5.7) and LNFH and Cascade Irrigation Company divert water below the trailhead (rm 4.5). Irrigation diversions can remove 48% and 79% of the mean August and September flows, respectively (Mullan *et al.* 1992).

The Icicle Creek watershed has a long history of human impacts beginning with sheep herding and mining in the late 1800's. Recent uses include timber harvest, road building, fire suppression, campground development, private residences, commercial development, and recreation. Five percent of Icicle Creek's watershed, outside of the wilderness boundary, has been directly impacted by logging (USFS 1994a). Road building has occurred for development, recreation, and timber harvest. Over 11% of the vegetation along lower Icicle Creek has been removed from private property (WRWSC 1998). The Icicle Creek watershed is a popular recreation area for hikers, rock climbers, fishermen, and many others. Natural disturbances such as fires and landslides are prevalent in the watershed. Recently, the 1994 forest fires burned 12% of the watershed (USFS 1994a). In 1999, a landslide introduced a large quantity of sediment into the Icicle Creek above LNFH.

Upper Icicle Creek is rated Class AA and Lower Icicle Creek is rated Class A surface water by the Washington State Department of Ecology. Water quality concerns in Icicle Creek and the mainstem Wenatchee River include not meeting Washington State 303(d) standards for water temperature, dissolved oxygen, pH, in-stream flow (WRWSC 1998), and total PCB's (WDOE 2004).

Salmonid species present in the watershed include hatchery spring Chinook salmon *Oncorhynchus tshawytscha*, hatchery coho salmon *O. kisutch*, steelhead *O. mykiss*, sockeye salmon *O. nerka*, bull trout, non-native brook trout *S. fontinalis*, westslope cutthroat trout *O. clarki lewisi*, redband trout *O. mykiss gairdneri*, and Mountain whitefish *Prosopium williamsoni*. There are also native and non-native non-salmonids in Icicle Creek including dace *Rhinichthys* spp., lamprey *Lampetra* spp., sculpin *Cottus* spp., suckers *Catostomus* spp., and others.

IV. FORESEEABLE FUTURE ACTIONS IN THE ICICLE CREEK WATERSHED

A. Icicle Creek Restoration Project

The original design of the Leavenworth National Fish Hatchery, built between 1939 and 1941, involved diverting the majority of Icicle Creek's flow through a canal with an energy control dam at the base and construction of holding dams and weirs in the historic creek channel (river mile [rm] 2.8 to rm 3.8). As a result of these structures migrations of endangered steelhead, threatened bull trout and many other fish species were affected. To address this issue the USFWS in cooperation with the USFS and Bureau of Reclamation identified and partially implemented a proposed action, the Icicle Creek Restoration Project (ENSR 2000, USFWS 2001b, 2001c, 2002a, 2002b, & 2004). The Icicle Creek Restoration Project was separated into two phases. Phase I was implemented and completed in 2003. Phase I included removal of Structure 2 except the headgate and removal of all of Structures 3 and 4. The purpose and need of Phase II is to provide long-term, sustainable year-round passage to native fish through LNFH grounds and provide riverine fish habitat within LNFH grounds. Implementation of Phase II has been delayed due to legal action, citizen and agency concerns, and delays in receiving needed permits and approvals. LNFH will continue efforts to implement Phase II.

To address these ongoing concerns, the Bureau has offered to lead a Project Alternative Solution Study process which will develop and evaluate alternatives for providing fish passage, habitat improvement, and the water intake system.

B. LNFH'S Water Supply System Rehabilitation Project

The purpose of the LNFH's Water Supply System Rehabilitation Project is to upgrade fish protection and passage facilities at its point of diversion and replace structural components of the intake facility and water delivery system that are degraded and failing (Sverdrup 2000, USFWS 2003, USFWS 2004b). As part of the project design, the LNFH is considered the inclusion of a pump-back system component to its proposed project. The proposed pump-back system is currently designed to return up to 20 cfs of water to Icicle Creek at LNFH's point of diversion (rm 4.5) and return up to 12 cfs to Cascade Irrigation District upon their request. As noted above, implementation of this project has been delayed and is proposed for reconsideration using the Bureau's PASS process. The LNFH will continue efforts to improve fish upstream and downstream passage conditions at its intake diversion dam. The LNFH will also continue efforts to reduce entrainment of fish at the intake through on-site screening.

C. Other

The Draft Upper Columbia River Salmon Recovery Plan (UCSRB 2005) also mentions other actions which are likely to occur in the foreseeable future and include: Lower Icicle Creek Instream Target Flow Recommendation; Streambank stabilization and riparian habitat restoration in the Lower Icicle Creek; Fish passage protection facilities at the City of Leavenworth's point of diversion; Fish passage protection facilities at the Icicle Peshastin Irrigation District's point of diversion, and campground relocation and road decommissioning on Forest Service Land.

V. PROPOSED ACTION: OPERATION AND MAINTENANCE OF LNFH

A. Background

Leavenworth NFH was authorized by the Grand Coulee Fish Maintenance Project, April 3, 1937 and reauthorized by the Mitchell Act (52 Stat. 345), May 11, 1938. The Mitchell Act authorized the Secretary of Commerce "…to establish one or more salmon cultural stations in the Columbia Basin in each of the states of Oregon, Washington, and Idaho." The hatchery is one of three mid-Columbia stations constructed by the Bureau of Reclamation (BOR) as fish mitigation facilities for the Grand Coulee Dam, Columbia Basin Project. Although reauthorized by the Mitchell Act, funding was provided through a transfer of funds from the BOR to the Service until 1945. From 1945 to 1993, the Service had funding, management, and operation responsibilities for the Leavenworth National Fish Hatchery Complex (Complex; made up of Leavenworth, Entiat and Winthrop NFH's). Beginning on October 1, 1993, the BOR assumed funding responsibility for the Complex while the Service continues to manage and operate the three facilities (Leavenworth, Entiat, and Winthrop NFH's).

In addition to the initial authorizations mentioned above, hatchery operations are authorized, sanctioned and influenced by the following treaties, judicial decisions and specific legislation:

- Treaty with the Walla Walla, Cayuse, Umatilla Tribes, 06/09/1855
- Treaty with the Yakama, 06/09/1855
- Treaty with the Nez Perce, 06/25/1855
- Treaty with the Tribes of Middle Oregon, 06/25/1855
- Executive Order (Treaty with Bands of Colville), 04/08/1872
- U.S. v. Oregon (Sohappy v. Smith, "Belloni Decision", Case 899), 07/08/1969
- Endangered Species Act of 1973, 87 Stat. 884, 12/28/1973
- Salmon and Steelhead Conservation and Enhancement Act, 94 Stat. 3299, 12/22/1980
- Pacific Salmon Treaty Act of 1985 (U.S./Canada Pacific Salmon Treaty), Public Law 99-5, 16 U.S.C. 3631, 03/15/1985

When the Complex was first chartered, spring Chinook salmon and steelhead were identified as the primary mitigation species. The initial operating plan for the Complex called for adult spring Chinook salmon and summer steelhead to be trapped at Rock Island Dam and hauled to LNFH for holding and spawning. Salmon and steelhead trapped at the Rock Island Dam represented a mix of fish destined for the upper Columbia River system. The LNFH was considered to be the

primary adult holding and spawning site with eggs being shipped from there to the Entiat and Winthrop NFHs. However, over the years, fertilized eggs were imported from a variety of sources.

Over the years, the LNFH production program has included a variety of species including spring and summer Chinook, coho, steelhead, kokanee, and various resident salmonids. Since 1974, spring Chinook salmon have been the priority species and the success of the program has allowed a sport and tribal fishery in most years.

Leavenworth NFH is currently a single species facility rearing only the "Carson lineage" stock of spring Chinook salmon. The Carson lineage stock was derived from fish captured at Bonneville Dam and genetic analysis indicate that these fish represent some unknown admixture of fish from the mid and upper Columbia and Snake River populations (Campton 2000). Enough adults return to LNFH annually to meet productions targets and LNFH has not imported eggs or fry for release into Icicle Creek in more than twenty years.

Currently, LNFH targets a release of 1.625 million spring Chinook salmon smolts into Icicle Creek (rm 2.8) during mid-April. Production goals at this facility were set by the Columbia River Fish Management Plan under U.S. vs. Oregon. Initially this plan set a production goal of 2.2 million spring Chinook salmon smolts annually, but this was renegotiated in 1991 to 1.625 million for release year 1993 and beyond. The migration corridor for released smolts and returning adult fish includes approximately 489 river miles (2.8 rm Icicle Creek, 26 rm Wenatchee River, and 460 rm Columbia River) and the Pacific Ocean. Adult salmon returning to the hatchery in excess of broodstock stock needs support a tribal (approx. rm 2.7 to 2.8, spillway pool) and sport fishery (approx. rm 0 to 2.7) In Icicle Creek.

Leavenworth NFH also supports the Yakama Nation's Coho Reintroduction Project by providing rearing space for approximately 750,000 coho presmolts which are acclimated on station approximately two to four months prior to release in mid-April. The Yakama Nation also uses a trap at structure 5 to capture returning adults for broodstock during the fall.

B. Fish Production and Associated Facilities

1) Broodstock collection and holding

Spring Chinook salmon broodstock collection at the hatchery is managed to maintain the genetic integrity of the stock. The Service management goals are to ensure that adult broodstock is randomly collected for spawning across the run in proportion to the rate at which they return. To accomplish this, two adult holding ponds are utilized. The east pond is designated to hold broodstock and the west pond is operated to randomly collect returning adults. For example, as the fish return, a proportion is moved to the east pond to be held as broodstock. This strategy requires constantly monitoring the number of fish going over Rock Island Dam. Using historical data to determine what percentage of the Rock Island Dam will return to LNFH, one can calculate the proportion to keep as the run progresses.

All broodstock used for production voluntarily enter the holding ponds. Adults swim up the ladder and into one of two holding ponds. The holding ponds measure 15 x 150 feet, and are joined in the middle by an adjustable slide gate. The gate is opened, and adults are allowed to enter the second pond during sorting, counting, etc. The holding ponds supply attraction water for the ladder. The broodstock collection target is 1,000 adult salmon at a gender ratio of 1:1. This number is based on density and flow indices, which relate to the amount of available water and space.

Adult spring Chinook salmon return to the hatchery from May into July and the fish ladder is operated at this time to collect broodstock. In years with large adult returns the fish ladder is closed periodically (few days) to prevent overcrowding in the holding pond while collecting broodstock throughout the adult return period. Overcrowding degrades water quality in the pond. Of primary concern is the potential for significantly reduced dissolved oxygen levels which, if unchecked, can lead to fish kills. In addition, excessive numbers of fish in the holding pond exacerbate stress levels of fish (increasing oxygen demand) and increase the potential for lateral disease transmission. The strategy of occasionally closing the ladder also allows additional harvest opportunities by sport and tribal anglers. A gate is lowered at the bottom of the ladder to prevent fish access while flow from the ladder remains the same.

Non-target fish of size (steelhead, bull trout, suckers, whitefish, etc.) encountered in the adult holding pond are netted and immediately returned to the spillway pool in Icicle Creek with the following exceptions: Spawned adult steelhead are returned to the spillway pool (to continue downstream migration) and unspawned adult steelhead are placed upstream of the hatchery as per consultation with NOAA. Bull trout are handled according to protocols established between LNFH and the Central Washington Field Office (see *Handling Bull Trout*, page 19). These larger fish can be observed while sorting or counting which generally takes place weekly during broodstock collection. Smaller sized fish (potentially including juvenile Chinook and coho salmon, steelhead, trout, suckers, whitefish, and adult and juvenile dace etc.) that fit between the crowder bars and avoid netting can remain in the holding pond until it is drained at the conclusion of the spawning season (late-August). They exit to icicle Creek via the fish ladder as the pond is drained.

The adult holding ponds are supplied with Icicle Creek water and tempered with well (ground) water to maintain a temperature between 45° - 50° F. Flow into the holding ponds is managed to meet or exceed one gallon of inflow per fish per minute. Formalin (167 ppm for 1 hour) treatment is administered to holding ponds and antibiotic treatment of female brood is administered one to two times prior to spawning to combat vertical transmission of bacterial kidney disease (BKD).

Surplus / Excess Protocol

If the number of salmon entering the adult holding pond exceeds the number needed for production the excess salmon are “surplused” to Native American tribes. There is a tiered process for distribution of federal surplus property. If Tribes decline the surplus fish then they are given to Trout Unlimited through a formalized agreement. LNFH will contact the USFWS’s Central Washington Field Office prior to conducting excess / surplus procedures to discuss

where to release captured bull trout. LNFH personnel will attempt to remove bull trout and steelhead prior to excessing although in most cases encounter with these fish will occur during the crowding procedure (during excessing). The receiving groups also participate in the excessing process under the close supervision of hatchery personnel. Prior to the excessing activity, LNFH staff informs the individuals performing the work on proper identification and handling techniques of bull trout or steelhead. All steelhead, bull trout or any other species besides spring Chinook salmon encountered will be returned to Icicle Creek live by hatchery personnel.

2) Spawning

The first spawning date is mid-August and spawning is normally completed by Labor Day. Eggs are taken once per week. Ripe females are separated with an equal amount of males the day before spawning to expedite the spawning procedure. The day of spawning a small number of fish are crowded into a lift system and then to an anesthetic vat. Once the fish are anaesthetized they are placed on a table where males and females are separated and sacrificed via a sharp blow to the head. Ripe females are bled prior to spawning.

Fish are randomly selected and mated as close to a 1:1 male/female ratio as possible. Typically the sex ratio for the returning adults is skewed 60/40 in favor of the females. If needed, males may be used twice. Jacks (age-3 males) are randomly included in the spawning population at a rate not to exceed 5% of total males used (per Regional genetics guidelines).

3) Incubation.

From fertilization to the eyed stage, eggs from one female are in individual incubator trays receiving three to four gallons per minute of ground water. Throughout the incubation period (August to October), eggs are treated daily with 1,667 ppm of formalin for fungus control. During the eyed stage, eggs are culled for Bacterial Kidney Disease (BKD), mortalities picked and the remaining eggs enumerated and placed back in the incubator trays. Prior to brood year 2005, deep troughs were used for incubation and early rearing.

4) Rearing.

Rearing facilities include the aforementioned adult holding ponds, forty-five 8 x 80 raceways, fourteen 10 x 100 covered raceways, nine fiberglass troughs, 108 fiberglass tanks (an additional 19 are being considered), plus 40 small and 22 large Foster-Lucas ponds. In 2005, 68 small concrete troughs were removed because PCB's were found in the paint which coated the troughs (WDOE 2004a).

Buttoned up fry are moved from incubation trays to tanks inside the nursery building for their initial feeding in mid-December. Fry are fed starter feed for the first six months.

In late-February / early-March, fry are moved outside to thirty, 8 x 80 raceways and remain there until the previous brood year is released (Mid-April). After release all empty rearing units are cleaned with high pressure water. The fish marking staff from the Columbia River Fisheries Program Office in Vancouver, WA mark, inventory and move all fish in May. All spring Chinook salmon receive an adipose fin clip and approximately half are implanted with a coded

wire-tag (CWT). May is the optimal time to mark fish at this facility for a variety of reasons: 1) the fingerlings are about 100 fish/pound, a good size for marking and handling; 2) fingerlings are near their maximum pond density and need to be moved; and 3) water temperatures are cool enough to facilitate successful handling.

After spawning the two adult ponds are power washed / cleaned in preparation to receive fingerlings. In early October, fish from thirty raceways are moved to the two adult holding ponds and additional fish are added to the remaining fifteen 8 x 80's. This action empties the top two banks of 8 X 80 raceways for the next years fry. Fish will remain in these rearing units until release in April.

Beginning with brood year 1991, rearing space has been managed so that density indices (the ratio of weight of fish to rearing unit volume and fish length) do not exceed 0.2. In order to achieve low indices, total production was reduced from 2.2 million to 1.625 million smolts. Reduced production correlates w/ a decreased incidence of BKD.

Fish are fed daily based on their size and the water temperature. Smaller fish are fed smaller amounts more often (6 to 8 feedings per day) and large fish are fed once per day. Approximately 100,000 pounds of fish food is fed annually at a conversion rate of 1.1 pounds of fish food fed equaling 1 pound of fish flesh gained.

Ponds are cleaned depending on the amount of feed expended, generally a few times per week. Cleaning entails sweeping the rearing unit with a course brush from the head end to the tail end. No cleaning agents are used, and all water and waste is directed to the pollution abatement pond where waste material settles. Discharge from the abatement pond into Icicle Creek is routinely monitored according to the NPDES permit (see Section V.C.4. Water Discharge).

5) Release.

Leavenworth NFH reduced yearling production from 2.2 million to a release goal of 1.625 million in release year 1993. All spring Chinook salmon smolts are force released directly from the rearing unit to Icicle Creek around the third week of April. Although attempt is made to coincide the smolt release with a discharge event this facility is constrained within a spill window negotiated with Chelan PUD for Rock Island Dam. A significant change occurred in this program beginning with brood year 2000 compared to the previous 1994-1999 period. Starting with brood year 2000, coded-wire tagging has increased from 17% to 50%, and the percent of adipose clipped juveniles has increased from 17% to 100%. Additionally, brood years 2000-2002 were part of a lower Columbia River transportation study which increased the portion of Passive Integrated Transponders (PIT) tags from ~5,000 to 260,000 annually. PIT tagging in recent years (2005 @~15K) is being conducted by the Fish Passage Center (Cooper 2006). McNary and Bonneville Dam bypass facilities are capable of detecting PIT tagged fish.

The size at release averages 18.2 fish/pound (1994-2005 range = 16.1 – 22.5 fish/lb). This size was determined to result in a fish which is in good health at the time of release, migrates to the ocean fairly rapidly, and generates adult escapement to sustain the program and provide harvest

opportunities. After release all vacant rearing units are power washed and cleaned so fish from the next brood year can be moved into them.

The average travel time from release to McNary Dam, for release years 1998 – 2003, is 27.2 days with a minimum travel time of 20 days in 1998 to a maximum time of 35 days in 2001. McNary Dam is approximately 204 miles from Leavenworth NFH. The average survival from release to McNary Dam is 57.1% with a minimum survival of 50% in 2001 to a high of 64% in 2003 (SURPH database 2004).

An emergency fish release could occur at any time. An extended low water situation resulting from prolonged drought, fire, water delivery system failure, ice formation along the delivery pipeline, etc. could prompt such a release. A contingency plan was developed to address concerns with low water situations (Appendix E) and noted in the plan is an emergency fish release which is considered the final and most extreme measures to address the low water situation.

6) Fish Health Management.

The primary objective of fish health management production programs at Service hatcheries is to produce healthy smolts that contribute to the program goals of that particular stock. Another equally important objective is to prevent the introduction, amplification or spread of certain fish pathogens which might negatively affect the health of both hatchery and naturally producing stocks.

Fish Health Policy:

The Olympia Fish Health Center (FHC) in Olympia, WA provides for fish health at LNFH under the USFWS Fish Health Policy (http://www.fws.gov/policy/manual.html Part 713). In addition, the 1994 annual report "Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries," by the Integrated Hatchery Operations Team (IHOT 1995) provides fish health guidelines as approved by northwestern state, federal, and tribal entities.

The documents above provide guidance for preventing or minimizing diseases within and outside of the hatchery. In general, movement of live fish into or out of the hatchery are approved in the U.S. v Oregon Production Advisory Committee forum and noted on the State of Washington Brood Document. If a fish transfer or release is not on the Brood Document, permits from the Washington Department of Fish and Wildlife, the Service, and any other states through which the fish travel must be obtained and approved by co-managers. Fish health exams and certifications must be completed prior to any releases or transfers from the hatchery to minimize the risk of disease transmittance to other populations. Finally any vehicle that transfers the fish or eggs is disinfected before being brought onto the station and after use at the hatchery; this also includes fish marking equipment.

Fish Health Examinations:

Routine Examination: A Fish Health Specialist visits approximately once per month to examine juvenile fish at LNFH. Juvenile fish are sampled to ascertain general health on each stock and broodyear. Based on pathological signs, age of fish, and concerns of hatchery personnel, the

examining Fish Health Specialist determines the appropriate tests. Tests typically include microscopic examinations of the skin, gills, and internal organs. Kidneys (and other tissues, if necessary) are checked for the common bacterial pathogens by culture and/or other tests specific for the particular pathogen of interest. Blood may be examined for signs of infection and cellular or biochemical abnormalities. Additional tests for virus or parasites are done if warranted. The Fish Health Specialist may also examine fish which are moribund or freshly dead to ascertain potential disease problems in the stocks.

Diagnostic Examination: The Fish Health Specialist conducts diagnostic exams when needed or when requested by hatchery personnel. Moribund, freshly dead fish or fish with unusual signs or behavior are examined for disease using necropsy and appropriate diagnostic tests.

Pre-release / Transfer Examination: LNFH staff notifies Olympia FHC at least six weeks prior to a release or transfer of fish from the hatchery. Tissue samples are collected on 60 fish of the stock being transferred or released. The pathogens screened for include: infectious hematopoietic necrosis virus (IHNV); infectious pancreatic necrosis virus (IPNV); viral hemorrhagic septicemia virus (VHSV); R. salmoninarum; Aeromonas salmonicida; Yersinia ruckeri; and under certain circumstances other pathogens such as Myxobolus cerebralis and Ceratomyxa shasta.

Adult Certification Examination: During spawning, tissues are collected from adult fish to ascertain viral, bacterial, and parasite infections and to provide a brood health profile for the progeny. All females used as broodstock are assigned a number and tested for R. salmoninarum (causative agent of BKD). This number is also used to track the eggs. All female are ranked according to the level of risk they pose to potentially passing BKD to their progeny. The eggs from high and moderate risk females are culled; however, on occasion progeny from moderate risk fish are kept to meet production targets. Eggs and fish from moderate risk parents are reared at lower densities and in separate rearing units.

Chemotherapeutant Use:
Administration of therapeutic drugs and chemicals to fish and eggs reared at LNFH is performed only when necessary to effectively prevent, control, or treat disease conditions. All treatments are administered according to label directions in compliance with FDA and EPA regulations for the use of aquatic animal drugs and chemicals. EPA and FDA consider the environmental effects acceptable when the therapeutant are used according to the label.

Erythromycin injections for spring Chinook salmon female broodstock stock are critical for management of bacterial kidney disease (BKD). Erythromycin treatment helps control horizontal transmission between adults in the holding pond and vertical transmission from the mother to its progeny. All female spring Chinook salmon held at LNFH are injected with erythromycin once, in mid-July. An extra-label veterinary prescription allows administration of the drug. Injected carcasses are not used for stream nutritional enhancement or human consumption.

Adult spring Chinook salmon held in the holding ponds are administered a Formalin treatment at least three times per week to control external pathogens. Additional treatments may be administered upon recommendation from a Fish Health Specialist.

An iodine compound (approximately 1% iodine) is used to water harden and disinfect eggs after spawning. The eggs are disinfected in 50 ppm iodine in water buffered by sodium bicarbonate (at 0.01%) for 30 minutes during the water-hardening process. Eggs received from other hatcheries are also disinfected in the same manner prior to contact with the station's water, rearing units or equipment.

Analysis of fish feed:
Abernathy Fish Technology Center provides routine quarterly proximate analysis of the fish food to ensure that it meets the feed manufacturer's specifications. If nutritional concerns arise, LNFH or Olympia FHC staff consults with the Abernathy Fish Technology Center's Fish Nutritionist who then performs or coordinates testing for specific levels or quality of ingredients in the feed.

7) Monitoring and Evaluation

The Mid-Columbia River Fishery Resource Office (MCRFRO) provides monitoring, evaluation, and coordination services concerning LNFH production. MCRFRO staff monitors hatchery returns, straying rates, biological characteristics of the hatchery stock, fish marking, tag recovery, and other aspects of the hatchery program, and they maintain the database that stores this information. MCRFRO also cooperates with the hatchery, fish health and technology centers, and co-managers to evaluate fish culture practices, assess impacts to native species, and coordinate hatchery programs both locally and regionally.

As assessed by MCRFRO, the average survival for completed CWT brood years 1979 – 1995 is 0.25% with a standard deviation of 0.17%. The minimum survival was 0.009% for brood year 1990 and maximum survival was 0.65% for brood year 1988. Preliminary information indicates that recent brood year returns (1996-1998) have increased substantially with an average survival of 0.88% (stdev = 0.23%) with a current within basin return of 1.05% for brood year 1998. CWT information provides contribution estimates to various marine and freshwater fisheries in addition to recoveries at hatcheries or spawning grounds throughout the Columbia Basin. Data compiled by MCRFRO indicates, for return years 1999 – 2001, that approximately 40% of Leavenworth NFH spring Chinook were recovered at the hatchery, 28% were harvested in treaty/ceremonial fisheries (primarily Icicle Creek), 20% were captured in freshwater/Columbia River sport fisheries (13% Icicle Creek), 9% were recovered on Wenatchee Basin spawning grounds (Icicle and Peshastin Creeks= 7%), and 3% were harvested in lower Columbia River gillnet fisheries. Less than 1% was estimated to have been harvested in marine fisheries.

The MCRFRO and LNFH will coordinate with Ecological Services and others to develop study proposals that will evaluate fish passage issues associated with operations and structures of LNFH. These study proposals will be submitted for funding consideration through the USFWS' Fisheries Operational Needs System (FONS) on September 1, 2007. Passage issues include

those related to operations of historic channel structures and at the intake dam. Study proposals for addressing Icicle Creek bull trout genetic issues will also be developed and submitted through FONS. The first meeting to discuss these study needs has been scheduled for July 18, 2007.

Water Temperature
From 1999-2001 hourly water temperatures were recorded by the USFWS at four locations in Icicle Creek): (1) below LNFH's final outflow; (2) middle of historic channel (rm 3.4); (3) at the intake; and (4) near Chatter Creek campground (approx. rm 16; MCRFRO 2002).

In the summer of 2005 the USFWS started collecting more extensive water temperature data in Icicle Creek using ONSET Optic Stowaway recorders. The recorders are located at nine stations from the boulder area (rm 5.6) to downstream of LNFH. A recorder is also located in Snow Creek. Daily mean water temperatures for the July – October 2005 period at these ten stations are presented in Appendix D. Other data summaries including daily minimum, maximum, and mean 7-day maximums are available. LNFH also began recording water temperature from the effluent at the adult pond fish ladder and from the pollution abatement pond in the summer of 2005.

8) Other Information
Freshwater Fisheries Management:
Washington, Oregon, and the four treaty tribes (Yakama, Warm Springs, Umatilla and Nez Perce), that are parties to the Columbia River Fish Management Plan (US v Oregon) prepare harvest strategies based on run size predictions made by their respective fishery agencies. They jointly present their findings to the Columbia River Compact through the Technical Advisory Committee (TAC). The Columbia River Compact, created by Congress, has the authority to approve or reject sport and commercial fishery proposals for the mainstem Columbia River. In their deliberations, the Compact considers the findings of the TAC. If findings are in compliance with the management plan, broodstock stock goals and ESA guidelines, and the run size prediction shows a harvestable surplus, the Compact sets a season for non-tribal and/or tribal fisheries in the mainstem Columbia River.

If a harvestable surplus is predicted for Icicle Creek, the State of Washington and Yakama Nation set regulations for terminal area non-tribal sport and/or tribal subsistence fisheries. Fishing regulations are established to also provide adequate escapement for hatchery production and meet ESA guidelines. The sport anglers are allowed to fish the lower three miles of Icicle Creek (500 feet downstream of the adult pond fish ladder entrance to 400 feet upstream of the confluence with the Wenatchee River) while tribal fishers are limited to the spillway pool area. The tribal fishery is one of only three dip net fisheries in the state. The sport and tribal fisheries have similar season structure - typically opening in early to mid-May and concluding in later July. Fishing effort within the two fisheries is also similar with peak effort occurring during the later part of May through mid-June. This is the time of peak upstream movement of spring Chinook through Icicle Creek. Beyond June fewer new fish arrive in Icicle Creek and the physical condition of fish already present begins to deteriorate. Both factors are likely responsible for substantially decreasing angler effort as the season progresses into July.

Yakama Nation's Coho Reintroduction Project:
Leavenworth NFH supports the Yakama Nation's Coho Reintroduction Project by providing rearing space for approximately 750,000 Coho presmolts which are acclimated on station approximately two to four months prior to a mid-April release in Icicle Creek. The Yakama Nation uses a fish trap at structure 5 during the fall (generally October through November) to capture returning adult Coho salmon for broodstock stock. The Yakama Nation, in conjunction with the Bonneville Power Administration, the primary funding source for the project, consulted with NOAA Fisheries and USFWS on this project (FWS Reference Number 01-I-EO231). A complete description of the Coho Reintroduction Project can be reviewed in those consultation documents.

Handling Bull Trout

During routine operation and maintenance at LNFH bull trout may be encountered and need to be handled to return them to Icicle Creek. To minimize harm associated with handling bull trout several precautions will occur. Prior to handling bull trout hands will be free of sunscreen, lotion, or insect repellent. When practical all bull trout handling procedures will be implemented at times that avoid temperature stress of affected fish. It may be necessary to conduct the activity in the morning or evening on hot summer days to avoid temperature stress to captured fish. If bull trout are held in a tank, a healthy environment for the stressed fish shall be provided and the holding time shall be minimized. Water to water transfers, the use of shaded, dark containers, and supplemental oxygen will all be considered in implementing fish handling operations. If a bull trout is showing signs of stress or injury, it will only be released when able to maintain itself. It may be necessary to nurture the fish in a holding tank until it has recovered. All dip net or seine mesh netting will be composed of fine mesh (no knot) material.

The release location for a captured bull trout depends on where it was captured and what river conditions prevail at that time. The general procedure is described in the table below:

Capture Location	Release Location
Adult holding pond*	Call CWFO Monday of each week during broodstock collection to determine release location
Trap at structure 5	Call CWFO Monday of each week during broodstock collection to determine release location
Inside trash rack at intake diversion	Below and near intake diversion dam (RM 4.5)
Screen chamber/sand settling pond	In pool below spillway dam (RM 2.8)
Other	closest, safe release location in Icicle Creek

*If structure 5 is not impeding fish passage release fish in the spillway pool.

C. Water Supply System

LNFH shares a point of diversion with Cascade Orchard Irrigation District (Cascade) in Icicle Creek at rm 4.5. LNFH maintains and operates the intake diversion dam and its associated intake structures as part of a 1939 contract between the United States and Cascade. Cascade has a 1905 water right for 12.4 cfs during the irrigation season (May 1st through October 1st) and LNFH holds a 1942 water right to divert 42 cfs all year long.

The hatchery's water delivery system consists of four major components and conveyance systems: (1) Point of diversion and gravity flow delivery system; (2) the Snow / Nada Lake Basin supplementation water supply reservoirs; (3) the well system on hatchery property; and 4) water discharge facilities. LNFH's water rights for each component are shown in Table 1. Each of these four major components and conveyance systems are described individually below.

1. Point of diversion and gravity flow delivery system

LNFH's intake facilities contain several components. The intake system relies on gravity flow to convey water from the intake to the hatchery. Gravity flow is the preferred method of conveyance as it is far more reliable than any other system of water conveyance such as systems that rely on electric pumps and the associated power system back up's. Primary to the LNFH water intake system is a low rubble masonry diversion dam with concrete spillway crest across Icicle Creek. Comprised of a concrete base with flash boards on top, the dam raises water elevations several feet allowing a portion of the flow to be diverted through a grizzly rack (bars spaced at about 6 inches) and into a concrete water conveyance channel. In the late 1980's, the diversion dam was rehabilitated and a fishway constructed at the entrance to the conveyance channel. Because of high bed and suspended sediment loads present in the creek during portions of the year, the pool and weir design of the fishway proved to be unsuccessful for passing fish. Today the fishway is not used to pass fish and is operated periodically during high turbid flows as a sluiceway to flush accumulated sediment away from in front of the conveyance channel's entrance.

Water which enters the conveyance channel is transported a short distance from the coarse grizzly rack to a small building which houses a fine rack (1 ½ inch bar spacing), an overflow spill section, and a sediment sluicing section. The course and fine racks serve to limit the size of the debris which enters the pipeline.

Hatchery personnel inspect the intake structure twice daily (once at the start and once at the end of the working day, typically 7:30AM to 4:00 PM) to remove accumulated debris from trash racks and to ensure adequate flow is entering the diversion canal. Inspections occur more often during higher flows and accompanying heavier debris loads; and during colder water temperature periods when ice forms on the trash racks.

A discharge channel guides the spilled water and sluiced material back to the creek downstream of the building. Water retained in the system is transported from the fine rack into a 33 inch diameter buried pipeline. A slide gate is located at the pipe entrance to regulate flow into the

pipe. Normally this gate is left fully open. Approximately 1,260 feet down gradient from the beginning of the pipe system is a gate valve that controls flow into Cascade's delivery system. Cascade's pipe leads to a small drum screen that provides a means of bypassing fish from Cascade's diversion flow back to the river (rm 4.2). The drum screen has been updated; however the fish bypass system as a whole is presently not up-to-date and does not work effectively during low flow.

A maximum of 42 cfs of river water that does not enter Cascade's water delivery system is transported through a 31 inch diameter buried pipeline approximately 5,200 feet to the hatchery. Before water enters the hatchery it is either routed into a sand settling basin (normal operation) or directly to the rearing units. The sand settling basin, on occasion, needs to be cleaned of sediment. The water is drawn down and any fish entrained are netted and transferred back to Icicle Creek. The sand settling basin has a fish bypass system which empties into the pollution abatement pond. Fish depart the pollution abatement pond volitionally through an overflow weir and pipe which discharges into Icicle Creek at the northern edge of the main hatchery complex (rm 2.7).

From the sand settling basin water is transported through the main pipeline to one of two separate screen chambers, the "outside" and "inside" screen chambers. These screens, which are composed of vertical static screen panels, are used to filter fish and debris from the hatchery water supply. Both screen chambers meet the National Marine Fisheries Service (NMFS, NOAA Fisheries) 1994 standards for fish screening (NMFS 1994). However, the screening system may not meet the increasingly stringent criteria (via NOAA addendums). In addition, it is preferred to have the fish screening occur at the initial point of diversion and that is why LNFH developed the Water Supply System Rehabilitation Project. In the NOAA Biological Opinion (dated October 22, 2003) NOAA stated "it is NMFS' opinion that, although fish may enter the water intake and be displaced downstream, the system functions adequately to reduce the risk of injury and mortality, or other harm to any anadromous fish that may be entrained" (NMFS 2003). Previously, screened fish and debris exited the outside screen chamber into an open ditch which discharged back into Icicle Creek at rm 3.8. However, the bypass ditch for the outside screen chamber periodically would go dry during low summer flows or freeze during cold weather and this fish return method has been abandoned. Currently, the ditch which served as the bypass channel is blocked just below the screen chamber. The area above the blockage is monitored twice daily (once at the start and once at the end of the working day, typically 7:30AM to 4:00 PM). Observed fish are netted and returned to Icicle Creek below the spillway dam.

Screened fish and debris exit the inside chamber into the hatchery's discharge system which either empties into Icicle Creek at the base of the adult return ladder (rm 2.8) or the pollution abatement pond. Screened river water exiting the two chambers is used in the hatchery's rearing units and then enters the discharge system or is re-used in the adult holding ponds before entering the discharge system.

Maintenance of the gravity intake

Sediment settles in the conveyance channel from the diversion dam to the intake pipe and needs to be removed nearly every year to maintain the depth of the canal. The canal is approximately

100 feet long and 10 feet wide, and the depth of the sediment to be removed annually varies. In years with high discharge more sediment settles in the canal. Sediment removal can be accomplished using either of two methods; by flushing or mechanical removal and these methods are described below. Sediment removal will typically occur in late–June or early-July, on the down side of the typical peak flow period and before water conditions are less favorable for fish on station. However, an emergency canal cleaning could occur at any time as the result of a flood event which fills the canal with sediment.

Flushing: Removal of the sediment from the intake canal is accomplished by first reducing the amount of flow entering the canal by placing plywood boards at the outside trash rack. These boards also increase the velocity of the water remaining in the canal which helps move the sediment more effectively. The slide gate at the intake is completely closed shutting off all water to the irrigation district and hatchery. Fresh and reused well water is supplied to fish at this time and the irrigation district temporarily shuts off. At the downstream end of the canal a series of dam boards used to adjust the water level in the intake building are removed. Water and sediment from the canal exit the intake building where the boards are removed. The sediment settles in a pool which has formed below the intake building while the water and any fish continues to flow back to Icicle Creek. After approximately two days the canal is sufficiently flushed of accumulated sediment. Dam boards are put back in place, the slide gate is opened, and the plywood boards at the outside trash rack are removed.

Mechanical: Removal of the sediment from the intake canal is accomplished by first isolating the work area by placing plywood boards at the outside trash rack. This dewaters the intake canal and any fish are netted and relocated back to Icicle Creek. A walking excavator and a crane/clamshell are used to remove the sediment. The walking excavator gains access to the canal by entering from the north bank of Icicle Road and moves down the bank and behind the intake building. Sediment removal is accomplished in the “dry” as the excavator traverses on land and moves to an area of land adjacent to the south wall of the intake canal for removal operations. The excavator moves along the south wall of the canal and removes the sediment from the canal. The sediment removed is placed on land and removed by a crane with a concrete bucket. The crane is positioned above the canal, and the walking excavator transfers the sediment to a concrete “hopper-type” bucket, open on the top with an arm or lever attached which opens the bucket via two doors at the bottom.

The crane is operated from a gravel road work site that sits above the north bank of the existing rack structure at the head of the intake canal. This road is shored up with ecology blocks on the south and western edges. From the road down to the intake canal and rack structure is approximately 15- 20 feet. The crane parked inside the ecology blocks and a truck parked in front of the crane. The dredged material is removed from the intake area and transferred to the dump truck and deposited on LNFH property which is about 2.0 miles from the work site. This operation takes less than one week to complete. Removal of the sediment is coordinated with Washington Department of Fish and Wildlife via a Hydraulic Project Approval permit.

Additional and more regular maintenance associated with the intake include covering the diversion dam with tarps and securing the tarps with sand bags. This is done during the low flow

period in the summer to maintain the water surface elevations necessary to meet diversion needs. Tarps are removed in early fall when stream flow increases.

To assist fish passage (upstream and downstream) at the diversion dam, particularly during low flow periods, a flash board is removed or replaced with a V-notched board to concentrate flow going over the diversion dam. This adjustment occurs in the center of the dam / creek where the downstream portion of the dam is smoother and less likely to injure fish passing over it. Removing board(s) at other location may be tried (e.g. along upstream most section of dam) if it may assist with fish passage during low flow periods as long as such alterations do not negatively impact water diversions. Additionally, in the fall a debris boom is secured approximately twenty yards upstream and remains into the winter to deflect leaves from entering the trash rack.

2. Snow / Nada Lake Supplementation Water Supply Reservoirs

During construction of the hatchery, it was recognized that surface flow and temperatures in Icicle Creek might at times be insufficient to meet production demands. A supplementary water supply project in Snow Lake and Nada Lake was therefore developed and a water right to 16,000 acre feet of Snow Lake was obtained (Table 1). These lakes are located approximately 7 miles from the hatchery and about 1 mile above it in elevation. A ½ mile tunnel was drilled through granite to the bottom of Upper Snow Lake and a control valve was installed at the outlet end of the tunnel. Water drained from Snow Lake enters Nada Lake which drains into Snow Creek, a tributary to Icicle Creek that enters at rm 5.5. Thus, supplemental flows from Snow Creek enter Icicle Creek one mile above LNFH's intake system. Icicle Peshastin Irrigation District has rights to 600 acre feet of natural flow from Snow Creek.

The lakes are accessed by helicopter or foot at least twice a year to open and close the control valve. More trips may occur to adjust releases from the lakes and to perform maintenance. A few years ago the USFWS installed static, stilling well flow recorders at four different locations to help manage the reservoirs: 1) the mouth of Snow Creek; 2) the effluent of Nada Lake; 3) the outlet valve for Upper Snow Lake, and; 4) the mouth of main tributary entering Upper Snow Lake. Data from the recorders is managed by the USFWS Region 1 Water Rights Division in Portland, OR.

Recent reports by Wurster (2006) and Montgomery Water Group (2004) describe water use from the reservoirs. Both reports indicate that in most years the reservoirs are capable of providing the hatchery's full water right (42 cfs) from approximately early July to October with a reasonable expectation of refilling the withdrawn amount by July of the following year.

Starting in July 2006 LNFH will operate the Snow / Nada Lake Supplementation Water Supply Reservoirs to fully account for its 42 cfs water right from approximately 20 July to 30 September (a usual period of operation). This commitment equates to a release of nearly 7,000 acre feet of storage, a volume recommended by Wurster (2006; 70 days at 50 cfs) with an estimated 60% probability that inflows to Upper Snow Lake will meet or exceed the released volume (Figure 2). Events such as equipment malfunction or consecutive years of drought (two or more years)

would alter the standard release operations. In 2006 LFNH will convene a working group consisting of representatives of other resource agencies (NOAA, USFWS, WDOE, etc.) to develop a Snow Lakes water release plan. This plan will lay out reservoir water release specifics (volumes and times) to minimize LNFH impacts on the environment. The goal would be to assure hatchery water needs, increase summertime stream flows below the LNFH diversion, dilute nutrient loading from LNFH effluent, all while balancing the reservoir recharge (i.e. refill) risk.

Maintenance of Water Supply Reservoirs
Maintenance involves periodically (approximately a couple times per year) servicing the flow gages, removing debris from the dams and flow meters, replacing batteries and conducting safety inspections when the valve is adjusted. The equipment and facilities at the lakes / reservoirs usually require minimal maintenance. Access to the facilities and equipment is either by foot or helicopter. Recently, the USFWS, under its' Safety of Dams Program, inspected the Snow/Nada lakes facilities. Any projects deriving from this program will be completed under a separate consultation.

3. Well System

Groundwater provides the third major component of LNFH's water delivery system. The LNFH operates seven wells, which produce the quality of water needed to sustain the current fish production program. The wells are located on the west bank of the hatchery's bypass canal. These wells draw water from two aquifers, one deep and one shallow. The deepwater aquifer is not influenced locally by surface water. Well 5 delivers water from this aquifer while Well 6 has the capacity to draw water from both aquifers. The shallow aquifer is influenced by surface water. Wells 1-4 and 7 draw water from the shallow aquifer. Recharge of the shallow aquifer is affected by how much water is present, and thus percolates into groundwater, in the historic channel and the bypass canal. Water pumped from wells 4, 5, and 6 passes through an aeration chamber before entering the hatchery's pipeline system. Water from wells 1, 2, 3, and 7 enter a series of aeration screens prior to entering the hatchery's pipeline system at the inside screen chamber. Well water is used to supplement and temper river water to meet production goals. Hatchery production could not be sustained year-around or for long periods of time on either river water or well water alone. When sufficient water is not available for hatchery operations, water may be re-used several times and flow rates in the rearing raceways may be reduced for a limited period of time.

4. Water Discharge

Water diverted into LNFH's water delivery system is discharged into Icicle Creek at one of four locations: (1) through the open bypass ditch (rm 3.8); (2) at the base of the adult return ladder (rm 2.8); (3) through the adult return fish ladder (rm 2.8); or (4) through the pollution abatement pond (rm 2.7). The majority of river and well water used for hatchery operations returns to Icicle Creek at the base of the adult return ladder except during pond cleaning and maintenance activities when all water is routed through the pollution abatement pond. All of the river water

and groundwater used at the hatchery is returned to Icicle Creek, minus any leakage and evaporation.

The LNFH submitted an application for a new NDDES discharge permit on November 15, 2005. The Environmental Protection Agency (EPA) is expected to send a proposed permit for hatchery discharge out for public review in the summer of 2006. The LNFH operates and monitors its water discharge in compliance with the original (1974) NPDES permit (NPDES permit No. WA-000190-2). The permit contains limits concerning discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not degrade water quality or people's health. In essence, the permit translates general requirements of the Clean Water Act into specific provisions tailored to the specific hatchery operations and the discharge of pollutants. The following parameters are currently monitored at LNFH:

Total Discharge
Flow measured daily in m^3/day (MGD).
Suspended Solids sampled once per month in kg/day and ml/l.
Settleable Solids sampled twice per month in ml/l.

Cleaning Effluent
Suspended Solids sampled twice per month in mg/l.
Settleable Solids sampled once per week in ml/l.

The pollution abatement pond is cleaned approximately every 5 to 10 years depending on the depth of the accumulated sediment. The Washington Department of Ecology and US Environmental Protection Agency are consulted to make sure appropriate regulations are followed when the pond is cleaned and the sediment is disposed. The last time the abatement pond was cleaned was in August of 1998.

D. Historic Channel (Structures 2 and 5)

Structure 2 is located at the upstream end of the historic channel (rm 3.8) and was designed to control flow in that portion of the creek. Structure 5 (rm 2.8) is a bridge with a foundation to support racks and / or dam boards. Historically, and with few exceptions, the operations of both structures blocked fish passage year round. Additionally, structure 2 severely limited flows into the historic channel throughout the year. For a detailed description of these structures see the Icicle Creek Restoration Project EIS (USFWS 2002a). For information on the recent (2001 through 2005) operations of structures in the historic channel refer to Appendices B and C.

Starting in 2006 LNFH will operate structures 2 and 5 as follows:

During periods when broodstock activities are not occurring (generally 8 July – 30 September, and 1 December to 15 May) all racks and dam boards will be removed at structure 5, and at least one of the two radial gates at structure 2 will be maintained in an open position with a minimum 4 foot opening to promote passage of fish. An adaptive management approach will be used to limit, to the extent practical, the May 15 – July 7 broodstock collection period. LNFH will

consider annual run timing of spring Chinook at Columbia River dams (e.g. Priest Rapids, Rock Island) to adjust the May 15 date. For example, early run timing may require installation of racks slightly earlier than May 15 while later run-timing may allow for a slightly later installation. An attempt will also be made to minimize the duration fish passage is blocked through the historic channel. Again, this will require an adaptive management approach. It may be possible to open passage earlier than July 7 when Chinook returns are not excessive and brood and harvest needs have been satisfied. At non-broodstock collection times the radial gates may be operated differently (one open and one closed) to concentrate low flows to benefit fish passage.

During the May 15 – July 7 broodstock collection period LNFH will use two methods to improve interim passage opportunities by capturing and transporting bull trout upstream of the hatchery. First, all adult bull trout collected in the spring Chinook holding pond will be released upstream of the hatchery at specific locations described in Section V.B.8 "Handling Bull Trout." Second, LNFH will develop and implement a trapping operation at structure 5. Any adult bull trout captured at the trap will be released upstream of the hatchery as per V.B.8. The trap at structure 5 has not been tried before and its success at attracting and capturing bull trout is unknown. Very few fluvial sized bull trout are captured in the adult holding pond in a given year – most years none are encountered. Without a genetics baseline LNFH is assuming that bull trout captured with either of the above two methods are trying to migrate upstream. These two methods may facilitate relocation of an unknown number of bull trout to upstream areas which may benefit the Icicle Creek subpopulation.

Adaptive management approaches will also be used to investigate other alternatives to achieve passage in this interim period including such ideas as opening the structures for a short time during the broodstock collection window or capturing and transporting bull trout upstream. Decisions will be based on flow conditions, bull trout return dates and rates, Chinook salmon return dates and rates, tribal fishery needs, disease risks, and habitat conditions.

Note that during the summer of 2006 LNFH intends to remove the rack structure in front of the north gate which would allow for the opening of the 2nd gate. LNFH will maintain the radial gate(s) in the open position during the non-broodstock collection period unless emergency conditions require gate closure. Emergency conditions which may require a gate closure include:

1.) Flood
2.) Smolt emigration
3.) Canal water recharge
4.) Maintenance of flow characteristics into the spillway pool during the broodstock collection period.

Gate closure is necessary under the above conditions and is directly linked to maintaining hatchery operations. If emergency conditions continue we will consult with ES on an emergency basis. These emergency conditions are more fully described below.

<u>1. Flood Control</u>

Headgate closure allows the majority of high or flood flows to bypass the historic channel, and move down the canal. Developments adjacent and downstream of structure 5 could be threatened during high and/or flood flows. Flood and or high flow events are expected to occur in the spring and fall, but can also occur in winter with a rain on snow event and are not expected to last for long periods of time, less than two weeks.

2. Smolt Emigration

Salmon smolts use physiological and environmental cues to initiate their migration downstream. High spring time flows facilitate the migration. With the radial gates open and at lower than normal spring flow the majority of flow will move though the historic channel and not the canal. This was the condition in April 2006 and fish released from LNFH did not quickly emigrate. Headgate closure directs flow movement through the canal and down stream into the spillway pool where smolts are released prompting outmigration. Closing the radial gates for this activity is only expected to last for a few days in mid to late April.

3. Canal Water Recharge

At the upper end of the historical channel a headgate structure controls flow into an artificially excavated canal and the historic stream channel. With the headgate open, at high flows, the flow splits into the canal and historic channel, but at low flows (due to an elevation difference between the canal and historic stream channel) most of the water flows into the historic channel. Water in the canal plays a role in the recharge of the shallow aquifer located adjacent to it.

Directing the majority flow through the historic channel creates the potential for a dewatered canal leading to lower water table elevations and decreased pumping capacity from the LNFH production wells. LNFH operates seven wells, which produce the quality of water needed to sustain the current fish production program. These wells draw water from two aquifers (underground reservoirs). One aquifer is described as a deepwater aquifer, not influenced locally by surface water. Well 5 delivers water from this aquifer while Well 6 has the capacity to draw water from both aquifers. Wells 1-4 and 7 draw water from the shallow aquifer. These wells are influenced by the interaction of surface water and the water held in the shallow aquifer.

Water temperature is critical to hatchery operations and the tempering benefits well water provides are utilized year round. The optimum rearing water temperature for salmonids is 50º F. Problems arise due to stress associated with a reduction in oxygen and the activity of other organisms detrimental to fish health when temperatures rise above 50º F. At water temperatures below 50º F, fish growth is reduced, feeding rates decline, and fat reserves diminish (Piper et. al.1982). In order for LNFH to reach its program target of releasing 1.625 million smolts at an average size of 5.5 inches, cool ground water is required. Surface water (river) temperatures fluctuate from 32º F to 68º F causing the problems identified above. Ground water (well water) provides water at a constant temperature especially during incubation and early rearing when surface water temperatures are declining towards 32º F. At 50º F optimum growth is achieved and early rearing survival rates are maintained.

Currently, LNFH requires between 1,060 gallons per minute (gpm) and 6,590 gpm of ground water during its fish production cycle (Sverdrup, 2000). The most critical usage begins in December (6110 gpm), when young salmon fry begin to feed. Ground water usage continues throughout the winter months in order to temper cold surface water used on yearling salmon in outside ponds. Conversely, the ground water is used to cool surface water in the summer months as surface water temperatures begin to rise.

Considering the Icicle canal's role of recharge for the shallow aquifer, concerns related to effects of the Icicle Creek Restoration Project on the production wells were raised and studied (FEIS,2002). To assess the effects of a dewatered canal a ground water flow model MODFLOW was used to simulate ground water conditions in the shallow aquifer. Information from this data represents the predicted amount of water available from each well in the shallow aquifer given an eight week modeling scenario. Three conditions were applied to the model:

1.) Condition I is a wet canal, normal water recharge and wells pumping.
2.) Condition II is a dry canal, normal water recharge and wells pumping.
3.) Condition III is a dry canal, low water recharge and wells pumping.

LNFH operates annually between Conditions I and II with ground water production at or near 5300 gpm, from wells 1-4, and 6-7. The most critical time would be during the late fall and the early winter months when river conditions will be low and the canal will be dry (Condition III). Based upon the simulated assessment of ground water levels, under Condition II or III, LNFH would lose between 510 gpm and 1960 gpm from wells 1-4 and 6-7, a 10% to 37% decrease.

Ground water modeling was compared to actual well pumping conditions during the winter of 2001 when LNFH operated under Condition III. Data collected by the Leavenworth NFH fish production supervisor confirmed the predicted decrease of 28% in supply of ground water from LNFH's wells. Wells 1 and 5 were near capacity, Wells 4, 6, and 7 were below capacity, and Wells 2 and 3 produced no water by February 28, 2001.

As indicated by the surface water/ground water modeling scenarios, the diversion of surface water into the historic stream channel would have an effect on the ground water levels of the production wells. Modeled Conditions II and III would prevail in the late summer and fall if the radial gates remained open.

There is the potential for a 28% reduction in ground water supplies during low recharge conditions when the canal is dry. Wells 2, 3A and 7 would be dewatered during extreme low surface water conditions. This reduction in ground water supplies could lead to a decrease in fish production by 24%.

Given these circumstances, the LNFH proposes that in situations such as Condition III, where water flow and recharge is low, we exercise an "emergency" option of closing the radial gates for a period not to exceed two weeks in order to increase water recharge into the canal and shallow aquifer.

4. Maintenance of Flow Characteristics into the Spillway pool

Flow characteristics in the spillway pool relate to the LNFH's ability to attract and maintain spring Chinook salmon in the pool adjacent to the fish ladder. Sufficient spring time flows through the canal and over the spillway provide the attraction flow and olfactory cues for the adults to ascend the fish ladder. With the radial gate(s) open increased flow through the historic channel may decrease attraction capabilities of the spillway pool and attract the spring Chinook up the historic channel. Maintaining sufficient flow in the spillway pool during the broodstock collection period also facilitates the tribal fishery. Radial gate(s) closure during the broodstock collection period should maintain sufficient flows into the spillway pool.

Radial Gate Operation During Broodstock Collection Period

During spring Chinook salmon broodstock collection, generally starting May 15, racks and dam boards are installed at structure 5 and remain in place for the duration of the broodstock collection period until July 7. As described earlier, LNFH will consider annual run timing of spring Chinook at Columbia River dams (e.g. Priest Rapids, Rock Island) to adjust the May 15 date. For example, early run timing may require installation of racks slightly earlier than May 15 while later run-timing may allow for a slightly later installation. An attempt will also be made to minimize the duration fish passage is blocked through the historic channel. Again, this will require an adaptive management approach. It may be possible to open passage earlier than July 7 when Chinook returns are not excessive and brood and harvest needs have been met. Just prior to the installation of the racks at structure 5 in May the radial gates at structure 2 will be closed to minimize flow into the historic channel allowing for the installation and maintenance of the racks at structure 5.

During the May 15 – July 7 broodstock collection period LNFH will develop and implement a trapping operation at structure 5. Any adult bull trout captured at the trap will be released upstream of the hatchery as per V.B.8. The trap at structure 5 has not been tried before and its success at attracting and capturing bull trout is unknown. Adaptive management approaches will also be used to investigate other alternatives to achieve passage in this interim period including such ideas as opening the structures for a short time during the broodstock collection window or capturing and transporting bull trout upstream. Decisions will be based on flow conditions, bull trout return dates and rates, Chinook salmon return dates and rates, tribal fishery needs, disease risks, and habitat conditions.

Whenever the radial gates are closed or lowered to reduce flows into the historic channel, LNFH will meet a ramping rate of 1" per hour (i.e. the flow level or stage in the historic channel will be decreased 1" per hour) to minimize the potential stranding of fish. The ramping rate is recommended for streams with salmon fry present and complex habitats. The historic channel will then be surveyed to confirm absence of fish stranding. If the surveys confirm an absence of fish stranding within the historic channel then subsequent surveys would not be necessary. The canal area will be surveyed for fish when radial gate adjustments decrease canal flow. The proposed ramping rate (1"/hour) will be followed unless emergency conditions #1 and 3 above

(i.e. flood and canal recharge) require more immediate radial gate closures. Emergency conditions #2 and 4 above (i.e. smolt emigration and maintenance of spillway pool characteristics) can be anticipated and will not preclude the proposed ramping rate.

The racks at structure 5 are maintained nearly every day to remove accumulated debris. During this time the fish ladder is operated to remove hatchery origin spring Chinook salmon from Icicle Creek while maintaining a quality fishery. Limiting fish passage of hatchery origin spring Chinook salmon above LNFH intake significantly reduces the disease risk to fish reared at LNFH because the number of pathogens from adult spring Chinook salmon potentially entering the LNFH's water supply is greatly reduced.

Soon after spring Chinook salmon broodstock collection ceases (e.g. 7 July) personnel from MCRFRO will estimate, using the most appropriate method available given river conditions at that time, the number of adult spring Chinook salmon remaining in the spillway pool. If the snorkel counts estimate the number of remaining adult spring Chinook salmon are excessive (e.g. $\geq$ 500 fish) then LNFH will continue to block fish passage at structure 5 for up to two more weeks. LNFH will contact the Ecological Services office to confirm this extended blocking period. Only two times did fish counts (snorkel data) indicate 500 plus adult spring Chinook salmon in Icicle Creek after broodstock collection activities ceased (Table 3). This occurred in 2001 and 2002 when adult escapement was nearly three times the average escapement of the last 25 years.

It also should be noted that the Yakama Nation (YN) may collect adult Coho for broodstock at structure 5 from approximately 1 October through 30 November. During this time the YN closes the radial gates to minimize flow into the historic channel and installs dam boards and adult fish traps at structure 5. The YN has the ability to pass non-target fish upstream of structure 5 and coordinates with NOAA and USFWS on this topic.

When making adjustments to structures 2 and 5 (raising or lowering gates at structure 2, installing or removing dam boards or weirs at structure 5) LNFH staff will collect water samples to measure in nephelometric turbidity units (NTU) to document compliance with Water Quality Standards for Surface Waters WAC 173-201A. The information recorded includes sampling location, date, time, investigator, NTU, field conditions (weather, temperature, other in-river disturbances) and any other informational comments. The most recent adjustment and current setting for structures 2 and 5 are described when samples are collected (Appendix B).

Two water samples are collected prior to making an adjustment to either structure; one less than one hundred feet upstream, and the other less than three hundred feet downstream of the structure being adjusted. All sites are located within the historic channel of Icicle Creek. Water samples are collected as close to the center of the water body as possible and the downstream site is sampled first to avoid contamination.

Additional water samples from both the upstream and downstream location are collected one hour after the adjustment. If sampling results indicate non-compliance with water quality - standards actions are implemented to remedy the non-compliance. Water samples continue until

compliance is achieved. The results, duration, time of day, and characteristics of the activity causing the non-compliance are noted. Compliance criteria indicate that turbidity shall not exceed 5 NTUs above background when the background is 50 NTUs or less; or, when the background turbidity is greater than 50 NTU a 10 percent increase in turbidity is considered compliant. Washington Department of Ecology (WDOE) is contacted when compliance is not achieved.

Adjustments to structures 2 and 5 may increase flow and sediment movement in the historic channel and this sediment may deposit and fill downstream pools. To monitor sediment movement from the historic channel additional water samples are collected once a week from East Leavenworth Road Bridge, the downstream site and from the LNFH's intake, the upstream site. Daily samples at these sites are collected during times when river flow is significantly increasing, as determined by reading a staff gage at the intake, and when structure 5 is not operated to limit fish passage. Water samples and the resultant data are processed in the same way as described previously. The U.S. Fish and Wildlife Service consults with Department of Ecology if monitoring indicates that sediment input from the historic channel appears excessive.

Trapping at structure 5

A fish trap will be operated at structure 5 during the spring Chinook salmon broodstock collection period. The trap will be checked twice daily, once in the morning and once at the end of the working day. The trap will be serviced more often if the number of fish in the trap approaches its capacity. The CWFO will be contacted every Monday to determine where to release the bull trout captured during the week. All spring Chinook salmon will be placed downstream of the trap and other species will be released above the trap. LNFH will coordinate with CWFO to discuss any significant modifications to the trap or its operation. Operating a trap at this location during this time is new and an adaptive management approach will be used when operating and, if necessary, modifying the trap. The specific design of the trap will be shared with CWFO once complete.

VI. SPECIES/CRITICAL HABITAT DESCRIPTION

A. Fish

1. Bull Trout (Salvelinus confluentus)

Status

Bull trout are listed as threatened throughout the coterminous United States. For consultation purposes, five distinct population segments (DPSs) are considered: Columbia River and Klamath River DPSs June 10, 1998; Jarbidge River DPS April 8, 1999; Coastal-Puget Sound and St. Mary-Belly River DPSs December 1, 1999. Bull trout are threatened by habitat degradation and fragmentation from past and ongoing land management activities such as mining, road construction and maintenance, timber harvest, hydropower, water diversions/withdrawals, agriculture, and grazing. Bull trout are also threatened by interactions with introduced non-native fish such as brook trout (S. fontinalis) and lake trout (S. namaycush).

Bull trout are estimated to have occupied about 60% of the Columbia River Basin, and presently occur in 45% of the estimated historical range (Quigley and Arbelbide 1997). Bull trout have declined in overall range and numbers of fish. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. Although some strongholds still exist, bull trout generally occur as isolated subpopulations in headwater lakes or tributaries where migratory fish have been lost.

The Columbia River is not known to be used for spawning. Recent studies have verified that adult bull trout use the mainstem Columbia River as a migratory corridor and for overwinter habitat. Detections of bull trout have been greatest in the Columbia River in the vicinity of the Wenatchee and Entiat Rivers, with somewhat fewer near the Methow River. This may reflect the strength of the populations in the respective core areas. There have been fewer detections below Rock Island Dam, but a small number of bull trout have been detected recently as far downstream as Priest Rapids Dam (CCPUD 2003).

Different bull trout tagged at the mainstem dams have migrated into all three core areas in the Recovery Unit, and some migrated past more than one mainstem dam (BioAnalysts, Inc. 2004). Bull trout monitoring also strongly suggests that the Columbia River serves as overwintering habitat for individuals from all three core areas. After spawning in September and October in tributaries, some migratory bull trout have been tracked all the way downstream into the Columbia River, where they remained until the following June (BioAnalysts, Inc. 2004).

The Upper Columbia Recovery Unit Team originally identified six migratory local populations within the Wenatchee River, including the Chiwawa River (including Chikamin, Phelps, Rock, Alpine, Buck and James Creeks), White River (including Canyon and Panther creeks), Little Wenatchee River (below the falls), Nason Creek (including Mill Creek), Chiwaukum Creek, and Peshastin Creek (including Ingalls Creek). A seventh migratory population, in Icicle Creek, has recently been identified by the Upper Columbia Recovery Unit Team (Judy De La Vergne, USFWS, pers. comm.. 2006). Adfluvial, fluvial, and resident forms of bull trout currently exist in the Wenatchee River Core Area (WDFW 1998). The majority of the spawning and fry rearing habitat are within U.S. Forest Service lands, including the Glacier Peak and Alpine Lake Wilderness areas. Data collection for bull trout redds has become standardized since about 2000, and since then the total number of redds detected in the Wenatchee Core Area has fluctuated between about 300 and 600.

The Chiwawa River local population complex is the strong-hold for bull trout in the upper Wenatchee (WDFW 1998). Rock Creek represents the strongest population in this basin, and since 1995, annual surveys have documented between 250 and 440 redds. The combined Little Wenatchee River and White River redd counts have been between 20 and 125 over the same period. All bull trout in the Wenatchee River watershed are native. No hatchery introduction of bull trout has occurred (WDFW 1997).

Below Lake Wenatchee additional spawning areas in the Wenatchee Core Area include Nason, Chiwaukum, and Peshastin Creeks. Limited redd surveys have detected up to 15 redds in Nason

Creek and its tributary Mill Creek, 25 to 40 redds in Chiwakum, and up to 10 in Peshastin Creek. Redd surveys have not been conducted in Icicle Creek.

Range

Bull trout, members of the family Salmonidae, are char native to the Pacific Northwest and western Canada. Bull trout historically occurred in major river drainages in the Pacific Northwest from about 410 N to 600 N latitude; from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in Northwest Territories, Canada (Cavender 1978; Bond 1992). To the west, bull trout range includes Puget Sound, various coastal rivers of Washington, British Columbia, and southeast Alaska (Bond 1992; McPhail and Carveth 1992; Leary and Allendorf 1997). Bull trout are wide-spread throughout tributaries of the Columbia River basin in Washington, Oregon, and Idaho, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and the MacKenzie River system in Alberta and British Columbia (Cavender 1978; McPhail and Baxter 1996; Brewin and Brewin 1997).

Habitat Requirements

Bull trout exhibit resident and migratory life history strategies through much of their current range (Rieman and McIntyre 1993). Resident bull trout complete their life cycle in tributary streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear from one to four years before migrating to either a lake (adfluvial); river (fluvial), or in certain coastal areas, to saltwater (anadromous), where maturity is reached in one of the three habitats (Fraley and Shepard 1989; Goetz 1989).

Bull trout have relatively specific habitat requirements compared to other salmonids (Rieman and McIntyre 1993). Habitat components that appear to influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrates, and migratory corridors (Oliver 1979; Pratt 1984, 1992; Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Rieman and McIntyre 1993, 1995; Rich 1996; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the necessary habitat requirements for bull trout to successfully spawn and rear and that the characteristics are not necessarily ubiquitous throughout watersheds in which bull trout occur. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), they should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997).

Bull trout are found primarily in colder streams, although individual fish are often found in larger river systems. (Fraley and Shepard 1989; Rieman and McIntyre 1993 and 1995; Buchanan and Gregory 1997; and Rieman et al. 1997). Water temperatures above 15ºC (59º F) limit bull trout distribution, which partially explains their generally patchy distribution within a watershed (Fraley and Shepard 1989; Rieman and McIntyre 1995). Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992; Rieman and McIntyre 1993; Rieman et al. 1997).

All life history stages of bull trout are closely associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Oliver 1979; Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Thomas 1992; Rich 1996; Sexauer and James 1997; Watson and Hillman 1997). Jakober (1995) observed bull trout overwintering in deep beaver ponds or pools containing complex large woody debris in the Bitterroot River drainage, Montana, and suggested that suitable winter habitat may be more restrictive than summer habitat. Maintaining bull trout populations requires high stream channel stability and relatively stable stream flows (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit complex cover associated with side channels, stream margins, and pools (Sexauer and James 1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989; Pratt1992; Pratt and Huston 1993).

Preferred spawning habitat consists of low gradient streams with loose, clean gravel (Fraley and Shepard 1989) and water temperatures of 5 to 9ºC (41 to 48ºF) in late summer to early fall (Goetz 1989). Pratt (1992) summarized information indicating that increases in fine sediments are related to reduced egg survival and emergence. High juvenile densities were observed in Swan River, Montana, and tributaries with diverse cobble substrate and low percentage of fine sediments (Shepard et al. 1984). Juvenile bull trout in four streams in central Washington occupied slow moving water less than 0.5 m/sec (1.6 ft/sec) over a variety of sand to boulder size substrates (Sexauer and James 1997).

The size and age of maturity for bull trout is variable depending upon life history strategy. Growth of resident fish is generally slower than migratory fish and resident fish tend to be smaller at maturity and less fecund (Fraley and Shepard 1989; Goetz 1989). Individuals normally reach sexual maturity in four to seven years and are known to live as long as 12 years. Repeat and alternate year spawning has been reported, although repeat spawning frequency and post-spawning mortality are not well known (Leathe and Graham 1982; Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1996).

Bull trout typically spawn from August to November during periods of decreasing water temperatures. However, adult migratory bull trout frequently begin spawning migrations as early as April, and have been known to move upstream as far as 250 kilometers (km) (155 miles (mi)) to spawning grounds (Fraley and Shepard 1989). In the Blackfoot River, Montana, bull trout migrate to spawning areas in response to increasing temperatures (Swanberg 1997). Temperatures during spawning generally range from 4 to 10ºC (39 to 51ºF), with redds often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992) and after hatching juveniles remain in the substrate. Time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May depending upon water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

Growth varies depending upon life-history strategy. Resident adults range from 150 to 300 millimeters (mm) (6 to 12 inches [in.]) total length and migratory adults commonly reach 600 mm (24 in.) or more (Pratt 1984; Goetz 1989). Boag and Hvenegaard (1997) also indicate resident adult fish range from 6 to 12 inches but note that they can be bigger.

Bull trout are opportunistic feeders with food habits primarily a function of size and life-history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro zooplankton, amphipods, mysids, crayfish, and small fish (Wyman 1975; Rieman and Lukens 1979 in Rieman and McIntyre 1993; Boag 1987; Goetz 1989; Donald and Alger 1993). Adult migratory bull trout are primarily piscivorous, known to feed on various trout (Salmo spp.), salmon (Oncorhynchus spp.), whitefish (Prosopium spp.), yellow perch (Perca flavescens), and sculpin (Cottus spp.) (Fraley and Shepard 1989; and Donald and Alger 1993).

Icicle Creek Bull Trout

Key factors affecting Icicle Creek's bull trout population are angling, passage barriers, high water temperature, inadequate fish protection facilities (screens and ladders), water withdraws, extensive human and natural impacts in the watershed, and competition and hybridization with introduced fish species (WDFW 1997).

The Icicle Creek bull trout population is one of ten stocks in the Wenatchee River watershed. Stock status is unknown (WDFW 1997). Recent surveys indicate that their population numbers are low (USFWS 1997 and 2005). Most of bull trout located by snorkeling surveys in the upper Icicle during 1995 and 2004 were found in Jack Creek (Kelly Ringel 1997, USFWS 2005). In both years the relative abundance and density of bull trout was low while the relative abundance and density of rainbow trout was high. The snorkeling method used in each study was different, preventing comparison of the abundances between the studies. However, a recently published evaluation of the efficiencies of day and night snorkeling (Thurow et al. 2006) allows us to apply a "back of the envelope" comparison of the number of bull trout counted in Jack Creek between 1995 and 2004. In 1994, during day snorkeling Kelly Ringel (1997) counted 4 bull trout in reaches 1 and 2, while in 2004 USFWS (2005) counted 13 in the same reaches. The average bull trout snorkeling efficiencies are 12.5% for day and 33.2% for night (Thurow et al. 2006). Thus, in 1994 the estimated number of bull trout was 32 and in 2004 the estimated number of bull trout was 39. Resident and migratory life histories exist in this population. Resident fish are primarily located above rm 5.8 and adult fluvial bull trout (20 inch plus) are primarily observed below rm 5.8 with the largest concentration at the base of the spillway dam (rm 2.8; see Subpopulation size section below; Table 2). Adults observed at the base of the spillway dam may be recruits from resident fish above the dam or adults holding or straying from the Wenatchee River (WDFW 1997).

A report by Bryant and Parkhurst (1950) has been cited as evidence that anadromous fish historically had access to all of Icicle Creek however this report should be viewed with caution. The original surveys compiled in the report were undertaken to provide data to determine the value of each stream in the maintenance and restoration of salmon resources in the Columbia

River. These surveys were primarily of manmade barriers: dams for power and diversions for irrigation (with notes on screening), which were known at the time to be among the major causes in the precipitous declines of anadromous salmon runs. While the report does not contain any descriptions of the methods employed by the surveyors, it does not appear that they made any attempt to locate, quantify, and measure any natural obstacles other than high waterfalls. Instead, the method appears to have been to walk portions or all of the stream and note dams, diversions, and steambed conditions until they encountered a high falls they considered impassable. Therefore the report should be interpreted with caution, as it is apparent that the limited information on some natural barriers identified in the report is merely opinion and should be considered suspect without modern verification.

The Icicle Creek section of Bryant and Parkhurst (1950, pages 66-67) does not contain any mention of natural obstacles or barriers except for the impassable series of high falls at rm 24. It does mention a rugged canyon (i.e. the boulder field, boulder area, boulder falls, boulder cascades) but does not offer an opinion on passage. However, the Icicle irrigation dam, constructed prior to LNFH and upstream of the boulder falls, is called a barrier during the irrigation season. While the section states that the hatchery does not allow salmon to pass the rack, the report does not state that if so allowed they would be able to migrate to rm 24. The survey identified the lowest 2 miles of Icicle Creek as having the best spawning area, but makes no mention of any spawning areas upstream. The 1935 surveyors of Icicle observed spawning salmon but they are not recorded in Bryant and Parkhurst. On September 27, 1935, the survey party noted 21 Chinook salmon resting in pools or spawning in lower Icicle Creek but none were recorded upstream of the "rugged canyon" (Craig and Suomola 1941).

Prior to the construction of LNFH, fishery biologists considered the boulder falls an impassable barrier during the migration season:

> *"About 3 miles upstream a falls made further passage upstream impossible for salmon or steelhead at the stage of water existing during the time of this investigation. The 3 miles of creek thus fenced off was nearly equally divided between a rugged canyon and a flat lowland. Where the upper part of the enclosed section of the stream ran through the canyon the grade of the creek was precipitous, the bed was made up of large granite boulders, and in between the deep pools were swift running cascades with no gravel bars"*. (Brennan 1938, page 22)

None of the salmon held in the experimental area downstream of the boulder falls passed the falls. The boulder falls are discussed again later in the report:

> *"The experimental area used this summer was terminated at its upper end by a falls below the diversion dam of the Icicle ditch. In the next seven miles examined above this point the bed of the stream was uniformly rugged, scattered with large granite boulders and without either large or gravel riffles. No place in this section is suitable for holding large numbers of adult fish…The ruggedness of the canyon renders this section of the creek inaccessible for trucking in and out without expensive road construction."* (Brennan 1938, page 46)

Brennan (1938) identifies that the boulder falls area was considered a major obstruction to migration before roads were constructed.

Upstream of the falls, a trap operated in the Icicle Creek irrigation diversion bypass during 1937 did not capture any juvenile anadromous salmonids. The section of Icicle Creek downstream of the boulder falls is reported as where Chinook and steelhead spawned in former years:

> *"This is the section of the creek, according to all available information, in which Chinook and steelhead formerly spawned."* (Brennan 1938, page 46).

Brennan (1938) operated a bypass trap in the Icicle irrigation diversion for 17 weeks during the late spring, summer and fall of 1937 and captured juvenile "steelhead, Dolly Varden, and lamprey". However, these fish all have resident forms: rainbow trout, resident bull trout and western brook lamprey. The low and constant number of "steelhead" caught suggests they were resident rainbows. A total of 107 "steelhead" were caught (Table 32 in Brennan); contrast this low number with the 2,237 "steelhead" caught in diversion traps on Peshastin Creek (Tables 33 – 37 in Brennan). Information in the report also indicates they were what we now call rainbows: "the results are confused by the movements of the landlocked "rainbow" form of this species" (Brennan 1938, page 60), so no size data was recorded on any fish in the Icicle Creek diversion trap. A total of 13 "lamprey" were trapped at Icicle, but the age, stage or size class is not given, and the column heading in Table 32 is "Lamprey" while at other diversion traps the column heading is "Sea-run Lamprey", perhaps indicating the Icicle lamprey were western brook (western brook lamprey were once abundant in the Wenatchee sub-basin (USFWS 1959)). At any rate, Pacific lampreys are well known for using their buccal disks and serpentine bodies to navigate obstacles impassable to other anadromous fish (Wydoski and Whitney 2003).

Abundance of bull trout, especially fluvial bull trout, in Icicle Creek was never likely very high and information contained in Brennan (1938) indicates this is indeed the case. At Rock Island, no "Dolly Varden" were captured ascending the ladder from 1934-1936 (Tables 1 and 2 in Brennan, as well as text). In 1937, 6 Dolly Varden were counted (Appendix A in Brennan). At Tumwater Dam on the Wenatchee River, only 9 Dolly Varden were counted ascending the ladder in 1935, and none were counted in 1936 and 1937 (page 12 in Brennan). Fluvial bull trout numbers in the lower Wenatchee basin increased slowly, as 16 Dolly Varden were counted ascending Tumwater Dam and only 6 juveniles were captured in the Tumwater juvenile trap in 1955 (USFWS 1959). Thus, it seems unlikely that the 12 bull trout in the Icicle trap were fluvial in origin. In fact, information in Brown (1992a) indicates that there are resident bull trout in Icicle Creek as low as Eight Mile Creek, 3 river miles upstream of the boulder falls.

In 1942, affidavits from 3 local men stated that previous to the building of the Lumber Company dam at Leavenworth in 1904 and 1905, salmon and steelhead came up the Wenatchee River in large numbers, but very few salmon were found in Icicle Creek (BOR 1942, reproduced in Mullan et al. 1992). One would expect that if salmon and steelhead had unimpeded access to upper Icicle Creek large numbers of them would have been noted by settlers prior to the destruction of all runs in the basin.

The original source for the modern assertion that "historically, anadromous salmonids had access to RM 24.0" of Icicle Creek prior to the construction of the LNFH dam appears to be Mullan, Rhodus, and Williams (1992) (Appendix D, quotation from page D-214). After Mullan et al., most modern recitations of the effect of the LNFH barrier dam or the limit to anadromy in Icicle Creek contain the words historic or historically. Some of the information in their stream catalog came directly from maps and text in Bryant and Parkhurst, and contains the same misinformation on limits to anadromy in the Entiat sub-basin as described above. Interestingly, Mullan et al. missed an opportunity to correct the Fishtail Falls error, as Brown (1992a, page 92) recorded an adult Chinook salmon upstream of Fishtail Falls in 1989. There is no indication that Mullan et al. or anyone else made any attempt to use modern survey techniques to judge the degree of passage of any of the falls recorded in Bryant and Parkhurst (1950).

Many times an obstacle has been considered a barrier by the professional opinion of fishery biologists who sized up the situation and then made a judgement call. To date, the only scientific study in Icicle Creek was undertaken in 1999 and 2000, when MCRFRO conducted a radio-telemetry study of bull trout, spring Chinook salmon and steelhead to determine how far fish will migrate upstream if allowed to pass LNFH (Cappellini 2001). None of the radio-tagged steelhead, Chinook salmon, or bull trout passed the boulder falls, and the study concluded the area is a substantial velocity and gradient obstacle to fish migration. The study also noted there may be other limiting factors to fish migration, including stream flow, water temperatures, availability of spawning gravels, and sedimentation.

In summary, there is no historical evidence at all that anadromous salmonids were ever abundant in the upper Icicle and the evidence indicates that they were not present.

2. Icicle Creek Bull Trout Diagnostics

Following is a discussion of the USFWS Matrix of Diagnostic/Pathways, Subpopulation Characteristics and Species and Habitat Conditions, in relation to Icicle Creek bull trout.

a. Subpopulation Characteristics Within Subpopulation Watersheds

1. Subpopulation Size

The Icicle Creek bull trout subpopulation is one of ten stocks in the Wenatchee River watershed. Four of the ten stocks have been rated as healthy (Chikamin, Rock, and Phelps Creek – Chiwawa River watershed; and Panther Creek – tributary to the White River). The remaining six stocks, including Icicle Creek, are listed as unknown (WDFW 1997, 1998, 2004, and USFWS 2002c). Past surveys provide some very limited indication of subpopulation size. In 1938, twelve Dolly Varden (bull trout) were collected in the bypass trap of the Icicle irrigation ditch at river mile 5.7. (Brennan 1938) (see also discussion on page 35). Presence and absence surveys in upper Icicle Creek reported very few juvenile bull trout in the Eightmile and French Creek tributaries (Brown 1992).

In the mid 1990's, USFWS conducted day time snorkel surveys in the upper Icicle Creek Basin and observed 11 bull trout which represent less than 1% of the total fish observed (USFWS 1997). In 2004, 18 bull trout were observed in Jack Creek and four (one approximately 20 inches) bull trout were observed during nighttime snorkel surveys in upper Icicle Creek: bull trout represented approximately 2% of the total fish observed (USFWS 2005). It is evident that only limited surveys have been conducted for abundance and distribution of bull trout (Free 1995, Kelly Ringel 1997, Kelly Ringel and Murphy 1999, USFWS 2005). Bull trout redds have not been detected in Icicle Creek but that is because no spawning surveys have been conducted.

Most of the bull trout located by snorkeling surveys in the upper Icicle during 1995 and 2004 were found in Jack Creek (Kelly Ringel 1997, USFWS 2005). In both years the relative abundance and density of bull trout was low while the relative abundance and density of rainbow trout was high. The snorkeling method used in each study was different, preventing comparison of the abundances between the studies. However, a recently published evaluation of the efficiencies of day and night snorkeling (Thurow et al. 2006) allows us to apply a "back of the envelope" comparison of the number of bull trout counted in Jack Creek between 1995 and 2004. In 1994, during day snorkeling Kelly Ringel (1997) counted 4 bull trout in reaches 1 and 2, while in 2004 USFWS (2005) counted 13 in the same reaches. The average bull trout snorkeling efficiencies are 12.5% for day and 33.2% for night, and the average rainbow/cutthroat snorkeling efficiencies are 32.3% for day and 18.0% for night (Thurow et al. 2006). Thus, in 1994 the estimated number of bull trout was 32 and in 2004 the estimated number of bull trout was 39. It appears the bull trout population in Jack Creek is low but stable.

Judging from the data from all snorkeling surveys, it appears the habitat conditions in upper Icicle Creek favor rainbow trout. Rainbows accounted for 99.8 % of all fish species in Jack Creek reaches 1 and 2 in 1994, with an average of 121.9 rainbows/100m in reach 1 and an average of 162.4 rainbows/100m in reach 2. Similar dominance is noted in 2004, and when the data is adjusted for day and night snorkeling efficiencies as above, the average number of rainbows/100m in each reach is similar to 1994.

A factor that deserves investigation as the cause of low abundance of bull trout in the upper Icicle Creek drainage is competitive exclusion of bull trout by rainbow trout/steelhead (Brown 1992b, Williams and Mullan 1992, Wydoski and Whitney 2003):

> *"In the Methow River watershed, Williams and Mullan (1992) found that rainbow/steelhead replaced the first two or three year classes of cutthroat, brook, and bull trout through competitive exclusion, as far upstream as where annual heat budgets are only 1,600 TUs (thermal units as cumulative degree-days above 0° C), regardless of gradient. Cutthroat and bull trout spawning generally occurs upstream of the thermal limit of O. mykiss. They postulate that preferred temperature may increase for cutthroat trout and bull trout as they grow older, which may explain how fluvial and adfluvial bull trout can live in sympatry with steelhead parr. However, achieving some critical size from extended rearing in isolation is first required."* (page 22 in Brown 1992b).

The data in Kelly Ringel (1997) indicates this is the case for cutthroat trout. In reaches 1-3 of Jack Creek, rainbow trout dominated the relative and numerical abundance and only 1 cutthroat was observed, but in reach 4 the numerical abundance of rainbow was low and 45 cutthroat were observed.

Ecological interactions between steelhead and bull trout have been suggested to be a threat to bull trout (McMichael and Pearson 2001):

> *"Stocked steelhead that became residuals (fish that did not emigrate to sea) moved over 7.5 miles upstream in the North Fork Teanaway River, Washington, where they may adversely affect a threatened bull trout stock through ecological interactions"* (page 97 in Wydoski and Whitney 2003).

Stream temperature is a factor in the distribution and abundance of bull trout, rainbow trout, and cutthroat trout (Williams and Mullan 1992, Haas 2001), and may have a significant impact in the upper Icicle Creek drainage:

> *"Cold water may be limited in this basin above rm 9 where bull trout are likely to spawn because the basin elevation is relatively low, glaciers are absent, and there are many lakes. Conversely, the Stuart Range has high elevation and contains 14 glaciers, but the streams that drain the glaciers are too steep for fish and enter Icicle Creek below the bull trout zone"* (WDFW 2004).

From 1937 to 1992, extensive stocking of rainbow trout has occurred in the Icicle Creek drainage (partial list in Table 1 of Kelly Ringel and Murphy 1999). In 1937, the ratio of rainbow trout to bull trout in the lower river was 9:1 (trap data from Brennan 1938). In 1994, the ratio in upper Icicle Creek was 616:1 and in Jack Creek reaches 1 and 2 was 529:1 (unadjusted data from Kelly Ringel 1997).

Bull trout have specific habitat requirements but we do not know if habitat is limiting the distribution and abundance of bull trout in Icicle Creek. Habitat was measured during surveys in 1994 and included as an appendix in Kelly Ringel (1997) but no analysis was conducted as to the suitability for bull trout. Habitat was not measured in 2004 (USFWS 2005).

The work of Kelly Ringel (1997), Kelly Ringel and Murphy (1999), and USFWS (2005) imply that the LNFH barriers are a lead causative factor for the population status of the resident bull trout in Icicle Creek. There has been however no description and analysis for any other possible factors (temperature, nutrient, competition, hybridization) which may be affecting their abundance and distribution. We believe it is important to consider these other viable factors to understand what may be limiting the resident population of bull trout.

Fluvial bull trout in Icicle Creek (upstream of the boulder falls)

The spot check observations of migratory sized bull trout upstream of the boulder falls occurred 1 and 3 years after LNFH provided passage in 2001. There are at least 6 possible explanations for these occurrences:

1. The bull trout passed LNFH and ascended the boulder falls during the years they were observed.
2. The bull trout passed in 2001 when LNFH opened passage and resided in the Icicle upstream of LNFH for 1 to 3 years before ascending the boulder falls.
3. The bull trout passed LNFH in 2001, immediately ascended the boulder falls and resided in the upstream Icicle for 1 to 3 years.
4. Juvenile bull trout emigrated from the upper Icicle and reared to migratory size upstream of the boulder falls.
5. Juvenile bull trout emigrated from the upper Icicle, descended the falls, reared to migratory size between LNFH and the falls, and then ascended the boulder falls on their spawning migration.
6. Any combination of the above possibilities.

It is possible that # 1 occurred which suggests that under some set of circumstances passage is possible. If possibility # 1 occurred, then passage may not be as rare as previously thought. The probability of the rare event of migratory bull trout being observed upstream of the boulder falls during both of the only spot checks conducted and performed 2 years apart would seem to be very low, unless occasional passage does occur during regular operations and maintenance of LHFH.

In regards to possibilities # 2 and 3; Adult migratory bull trout are now known to spend 1 to several years in smaller tributaries in the mid-Columbia sub-basins (BioAnalysts 2004, Kelly Ringel and DeLaVergne 2005, Nelson and Nelle *in prep*). The prey base between LNFH and the boulder falls, as well as above the falls appears large enough to support several migratory sized bull trout (Free 1995, Kelly Ringel 1997, MCRFRO unpublished data from files). In August and September, cold water refugia are available in Snow Creek and in Icicle Creek when LNFH supplements the water supply from Snow Lakes. If # 2 occurred, it indicates the boulder falls is a formidable obstacle and may take a very long residence downstream of the falls before conditions allow passage. If # 2 or 3 (or any of the possibilities) occurred, it indicates there are other formidable obstacles upstream (as noted in Cappellini 2001) which prevent further upstream migration, since both observations occurred near the spawning period and the bull trout were a long way from suitable spawning gravels.

Possibility # 4 is known to occur in the West Castle River, Alberta, Canada (Boag and Hvenegaard 1997). The resident bull trout population in West Castle River was cut off from the migratory component when an impassable dam was built on the lower river. Resident bull trout were radio-tagged to monitor movements and locate spawning areas. Tagged adult bull trout ranged from 300 – 380 mm and were tracked moving 2 - 8 km to and from spawning areas. Most bull trout captured in the river were considered juveniles (FL <300 mm), and the occasional adult greater than 400 mm was captured (largest was >600 mm). Radio-telemetry and a weir trap monitored upstream and downstream movements, and results confirmed the population was resident. Note that the size range of these adults would be classified as migratory under the

definitions commonly used (residents 150 – 300 mm and migratory >300 mm). The size range of bull trout observed in West Castle River are similar to those observed in Icicle Creek, including the spot check observations above the boulder falls. Kelly Ringel (1997) records one 350 mm bull trout in reach 4 of Icicle Creek and one >300 mm (300 – 370 mm size class) bull trout in reach 1 of Jack Creek. USFWS (2005) records one 508 mm bull trout in the pool above the boulder falls. This suggests that further investigation is needed to determine if there is a resident population migrating within Icicle Creek. It also suggests there is a lot not known about resident bull trout populations, how far they move, or how big they grow. The largest resident bull trout measured in the Methow River system was 324 mm (Mullan et al. 1992). The USFS considers resident bull trout to be < 400 mm (USFS 2006).

Fluvial bull trout in Icicle Creek (downstream of LNFH)

Since 1996, MCRFRO has conducted annual snorkel surveys in the spillway pool during the summer months (July – September) (Table 2). Surveys during May and June are not viable due to high flow velocities and turbulence. These summer snorkel surveys revealed maximum counts of 8 bull trout in 1996, 6 bull trout in 1997, 40 in 1998, 7 in 1999, 40 in 2000, 100 in 2001, 75 in 2003, 125 in 2004, and 46 in 2005. Most of these fish were larger than 12 inches. During some years snorkel counts were made in both July and August and abundance was greater in August. Adult fluvial bull trout returning to the base of the spillway dam may be recruits from resident fish above the dam but the evidence indicates they are more likely adults holding and straying from the Wenatchee River (WDFW 1997).

The story of bull trout in Icicle Creek and the LNFH spillway pool is not straight forward and it is not definitively known why fluvial bull trout enter the Icicle. However, radio telemetry data from several studies indicate that all (7 of 7) of the radio-tagged adult fluvial bull trout located in the spillway pool were from other populations and are not migrating to the Icicle to spawn. Five of the bull trout tagged in the Columbia River (BioAnalysts 2004) or in the Entiat River (Nelson and Nelle *in prep*) that entered the Wenatchee River or Icicle Creek have been documented on spawning grounds in the Entiat River system. Two bull trout captured in the spillway pool and radio-tagged migrated to Chiwaukum Creek (upper Wenatchee basin) and were tracked on the spawning grounds (Kelly Ringel and DeLaVergne 2005).

The lower Icicle Creek provides abundant forage (MCRFRO 2004 unpublished data from files) and the spillway pool at LNFH provides a cold water refuge (MCRFRO 2005 unpublished data) for bull trout in August and September. The lower Icicle and spillway pool also provide bull trout a seasonal refuge from contaminants such as PCBs that are known to be more elevated in the Wenatchee River (WDOE 2004). Bull trout observed during snorkel surveys of the spillway pool vary between a wide range of size and age classes. In other areas where we have observed migrating adult fluvial bull trout schooling downstream or upstream of obstacles (Entiat River, Mad River, Twisp River, Lost River, and Skagit River), most of the bull trout have been adult mature fluvial bull trout, with no or very few small immature bull trout observed. The Icicle Creek situation appears unique in the Upper Columbia Recovery Unit and we have not yet located other areas where different age class bull trout from so many local populations congregate. One should carefully consider the effects of changing the dynamics of the spillway

pool as it and lower Icicle Creek may play an important role as seasonal rearing habitat for lower Wenatchee basin juvenile and sub-adult bull trout. Any alterations of the spillway pool and lower Icicle Creek may have negative effects on other populations with in the Upper Columbia Recovery Unit.

Timing of bull trout arrival to Icicle Creek

Telemetry studies have recorded entry dates of tagged fluvial bull trout into the Wenatchee River (BioAnalysts 2004). Bull trout, that were later located in or near Icicle Creek and were tracked to other tributaries in other years, passed the fixed receiver station at Monitor (rm 6) on June 22, 25, 27; July 1, 6; August 1, 2002 (BioAnalysts 2004, Table 7), and June 16, 18, 22, 2003. (BioAnalysts 2004, Table 8). The Monitor fixed site is 19.5 river miles downstream of the confluence of Icicle Creek. Nelson and Nelle (*in prep*) tracked an Entiat River bull trout tagged in 2003 that entered the Wenatchee River in 2004. It passed the receiver station on June 28, 2004, was located in the Wenatchee River at rm 25.6 off the mouth of Icicle Creek July 7 – 15, arrived at the spillway pool on August 4, left the spillway pool on August 5 or 6, passed the station at Monitor on August 11, resided in the lower mile of the Wenatchee River from August 13 – October 15, and then over-wintered in the Columbia River near Rock Island.

"Dolly Varden" counts from 1955 – 1957 at Tumwater dam indicate "June to September, with most passing in July" (USFWS 1959, page 5). More recent data collected by WDFW at Tumwater Dam indicate peak upstream movement of bull trout occurs mid-June through July with fish continually observed through the summer months (August – September). It appears that peak run timing is approximately one month after the peak flows during the decreasing hydrograph.

Because the listed species is rare in upper Icicle Creek where this species likely reproduces, this indicator is considered "Functioning at Unacceptable Risk."

2. Growth and Survival

Stock status is unknown (WDFW 1997 & 1998, USFWS 2002c) however the snorkel data presented above indicate population size is low in Icicle Creek. It is not known where bull trout in Icicle Creek reproduce but it is assumed to occur in upper Icicle Creek and tributaries such as Jack Creek, French and Leland Creeks (WDFW 1998).

Resident bull trout exhibit a trout like diet feeding mainly on macroinvertebrates. As bull trout grow larger, fish are a more common prey item, and usually forage fish such as mountain whitefish, sculpins, suckers, sticklebacks, and dace are eaten (Brown 1992b). However, large bull trout do shift to salmon and steelhead juveniles during the smolt outmigration (Brown 1992b), precisely when large numbers of hatchery salmon are in the rivers. Most adult migratory bull trout are in the Columbia River at this time (BioAnalysts 2004, Nelson and Nelle *in prep*), coinciding with the smolt migration, and are rarely present in the Icicle or lower Wenatchee rivers (Kelly Ringel and DeLaVergne 2005). Bull trout are known to focus on hatchery reared fish (Thompson and Tufts 1967). Thus, it is evident that hatchery fish have a beneficial impact

on the prey base of migratory bull trout. Adult bull trout may prey on juvenile salmonids in tributaries during migration to spawning areas, but they relatively quickly pass through the salmon rearing areas on their way to the colder headwaters (Nelson and Nelle *in prep*). The two places where adult bull trout congregate to feed on salmonids are Icicle Creek, where large numbers of "wild" juveniles derived from hatchery stocks of Chinook and coho salmon are available downstream of LNFH (MCRFRO 2004 unpublished data from files), and in Lake Wenatchee, where they congregate near the sockeye rearing pens (Kelly Ringel and DeLaVergne 2005).

The growth and survival is considered "Functioning at Unacceptable Risk" because the listed species is rare in upper Icicle Creek, where most reproduction is likely to occur and the condition of the habitat, particularly in the lower portion of Icicle Creek, is not conducive to spawning due to temperature conditions.

3. Life History Diversity and Isolation

There is a resident and fluvial life history component to bull trout in Icicle Creek. The resident component inhabits the upper portion of Icicle Creek (above rm 5.8). The fluvial component is largely observed in the pool downstream of the spillway dam at rm 2.8. Recently, fluvial sized bull trout have been observed above the spillway dam (rm 2.8) and in portions of upper Icicle Creek (USFWS 2005 a and b; personnel communication Judy Delavergne, USFWS, Wenatchee, WA). It is not known the extent of interaction between these two life forms (USFWS 2002c).

Fish passage in Icicle Creek has been seasonally impeded since construction and operation of water diversion structures in the early 20th century (Bryant and Parkhurst 1950). Since the late 1930's LNFH operated various structures in Icicle Creek which blocked, with few exceptions, fish passage year round. More recently, the operations of LNFH structures have changed affording improved fish passage. Anthropogenic actions (physical barriers and water withdraws) and natural barriers influenced the connection of the resident and fluvial populations.

Because of these passage impediments in the lower portion of Icicle Creek this indicator is considered "Functioning at Unacceptable Risk."

4. Persistence and Genetic Integrity

The bull trout population in upper Icicle Creek is dominated by the resident form. Structures associated with irrigation diversions, LNFH, and natural features impeded passage in Icicle Creek for decades. Recently LNFH operations were modified to improve fish passage conditions in lower Icicle Creek. Logging, recreation, low instream flows, fire and other types of human development also impact bull trout in Icicle Creek yet they still persist. A significant stochastic event poses one of the larger threats to the persistence of bull trout in Icicle Creek. Fortunately, information from radio-telemetry indicates that the upper Wenatchee River population of bull trout is large and very resilient, bull trout reside in the lake for several years at a time between spawning migrations, there is an abundance of prey, all life history forms are present, with few

barriers to their movements and adult bull trout move among several streams containing several spawning populations and even between core areas (Kelly Ringel and DeLaVergne 2005).

The genetic integrity of bull trout in Icicle Creek may be affected by competition and hybridization with introduced non-native fish species (WDFW 1997 & 1998). Eastern brook trout, rainbow trout, and lake trout have been planted in the Icicle Creek drainage. The presence of brook trout suggests hybridization as well as increased competition for habitat and forage may occur (Rieman and McIntyre 1993).

The genetic effects of long term passage impediments in Icicle Creek are not known. Genetic examination of the resident or fluvial components of bull trout in Icicle Creek has not been done but LNGH, in coordination with other entities, will be exploring funding to develop genetic baseline data for the population.

The information provided above suggests that the persistence and genetic integrity of bull trout in Icicle Creek is considered "Functioning at Unacceptable Risk."

B. Wildlife
1. Bald Eagle (Haliaeetus leucocephalus)

Status
In 1978, the bald eagle was federally listed throughout the lower 48 States as endangered except in Michigan, Minnesota, Wisconsin, Washington, and Oregon, where it was designated as threatened (USDI 1978). In July 1995, the USFWS reclassified the bald eagle to threatened throughout the lower 48 states. In 1999, the bald eagle was proposed for de-listing, recovered throughout the lower 48 States. This proposal is currently under review (USFWS 1999). Eagles are further protected under the Bald and Golden Eagle Protection Act (BGEPA 1940) and the Migratory Bird Treaty Act of 1918 (MBTA 1918). Bald eagle populations have increased in number and expanded their range. The improvement is a direct result of recovery efforts including habitat protection and the banning of DDT and other persistent organochlorines. The 1996 information provided by the Washington Department of Fish and Wildlife (WDFW unpub. data) indicates that 589 nests were known to be occupied and 0.93 young/nest were produced. This is well above the recovery goal of 276 pairs for Washington, but below the recovery criteria of an average of 1.00 young/nest.

Habitat loss continues to be a long-term threat to the bald eagle in the Pacific Recovery Area of Washington, Idaho, Nevada, California, Oregon, Montana, and Wyoming. Urban and recreational development, logging, mineral exploration and extraction, and other forms of human activities are adversely affecting the suitability of breeding, wintering, and foraging areas.

Range
The bald eagle is found throughout North America. The largest breeding populations in the contiguous United States occur in the Pacific Northwest states, the Great Lake states, Chesapeake Bay and Florida. The bald eagle winters over most of the breeding range, but is most concentrated from southern Alaska and southern Canada southward. Most nesting

territories in Washington are located on the San Juan Islands, the Olympic Peninsula coastline, and along the Strait of Juan De Fuca, Puget Sound, Hood Canal, and the Columbia River. In addition, bald eagle nesting territories are found within southwestern Washington, the Cascade Mountains, and in the eastern part of the state where adequate sources of prey are available. Most bald eagles winter on river systems in the Puget Trough and the Olympic Peninsula, along the outer coast and Strait of Juan De Fuca, or in the Columbia River Basin.

Habitat Requirements

In Washington, bald eagles are most common along the coasts, major rivers, lakes and reservoirs (USFWS 1986). Bald eagles require accessible prey and trees for suitable nesting and roosting habitat (Stalmaster 1987). Food availability, such as aggregations of waterfowl or salmon runs, is a primary factor attracting bald eagles to wintering areas and influences the distribution of nests and territories (Stalmaster 1987; Keister et al. 1987).

Bald eagle nests in the Pacific Recovery Area are usually located in uneven aged stands of coniferous trees with old growth forest components that are located within one mile of large bodies of water. Factors such as relative tree height, diameter, species, form, position on the surrounding topography, distance from the water, and distance from disturbance appear to influence nest site selection. Nests are most commonly constructed in Douglas fir or Sitka spruce trees, with average heights of 116 feet and size of 50 inches diameter breast high (Anthony et al. 1982 in Stalmaster 1987). Bald eagles usually nest in the same territories each year and often use the same nest repeatedly. Availability of suitable trees for nesting and perching is critical for maintaining bald eagle populations. Nest sites are generally within one mile of water (USFWS 1986). The average territory radius ranges from 1.55 miles in western Washington to 4.41 miles along the lower Columbia River (Grubb 1976, Garrett et al. 1988). In Washington, courtship and nest building activities normally begin in January, with eaglets hatching in mid-April or early May. Eaglets usually fledge in mid-July (Anderson et al. 1986).

A number of habitat features are desirable for wintering bald eagles. During the winter months bald eagles are known to band together in large aggregations where food is most easily acquired. The quality of wintering habitat is tied to food sources and characteristics of the area that promote bald eagle foraging. Key contributing factors are available fish spawning habitat with exposed gravel bars in areas close to bald eagle perching habitat. Bald eagles select perches that provide a good view of the surrounding territory, typically the tallest perch tree available within close proximity to a feeding area (Stalmaster 1987). Tree species commonly used as perches are black cottonwood, big leaf maple, or Sitka spruce (Stalmaster and Newman 1979).

Wintering bald eagles may roost communally in single trees or large forest stands of uneven ages that have some old growth forest characteristics (Anthony et al. 1982 in Stalmaster 1987). Some bald eagles may remain at their daytime perches through the night but bald eagles often gather at large communal roosts during the evening. Communal night roosting sites are traditionally used year after year and are characterized by more favorable microclimatic conditions. Roost trees are usually the most dominant trees of the site and provide unobstructed views of the surrounding landscape (Anthony et al. 1982 in Stalmaster 1987). They are often in a ravine or draw that offer shelter from inclement weather (Hansen et al. 1980; Keister et al.1987). A

communal night roost can consist of two birds together in one tree, or more than 500 in a large stand of trees. Roosts can be located near a river, lake, or seashore and are normally within a few miles of day use areas but can be located as far away from water as 17 miles or more. Prey sources may be available in the general vicinity, but close proximity to food is not as critical as the need for shelter that a roost affords (Stalmaster 1987).

Bald eagles utilize a wide variety of prey items, although they primarily feed on fish, birds and mammals. Diet can vary seasonally, depending on prey availability. Given a choice of food, however, they typically select fish. Many species of fish are eaten, but they tend to be species that are easily captured or available as carrion. In the Pacific Northwest, salmon form an important food supply, particularly in the winter and fall. Birds taken for food are associated with aquatic habitats. Ducks, gulls and seabirds are typically of greatest importance in coastal environments. Mammals are less preferred than birds and fish, but form an important part of the diet in some areas. Deer and elk carcasses are scavenged, and in coastal areas, eagles feed on whale, seal, sea lion and porpoise carcasses (Stalmaster 1987).

Icicle Creek Bald Eagle

The project area is part of the Pacific States Recovery Plan for bald eagle (USFWS 1986). A species management guide has been developed for the Wenatchee National Forest (Rees 1989) that identifies potential recovery territories for nesting bald eagles. The project area was not included as a recovery territory; the nearest recovery area is in the Tumwater Canyon less than five miles from the LNFH.

Bald eagles are frequent users of the upper Wenatchee Valley and have been seen in the forests and riparian areas within and adjacent to the project area. Foraging occurs along the Wenatchee River and the flat water of lower Icicle Creek, including on the LNFH grounds. Nest sites in Chelan County are typically in areas with little human disturbance (Heather Murphy, USFS, Leavenworth, pers. comm. 2001). Known nests in Chelan County are located near Fish Lake and Lake Wenatchee, 20-21 miles from the project area, above the Columbia River north of the town of Entiat, and on the Stehekin River at Lake Chelan. In 2002, a new nest site was identified along the lower portion of Icicle Creek, more than one mile downstream from LNFH (Jannet Millard, USFS, Leavenworth, pers. comm. 2002). A winter roost site has been located near LNFH's intake (Heather Murphy, USFS, Leavenworth, pers. comm. 2001). Bald eagles winter along the lower Wenatchee River (from Leavenworth to Wenatchee) and the Columbia River. Near the project area, bald eagles winter in the Mountain Home/Boundary Butte and Wedge Mountain/North Basin areas. It is possible that the Lake Wenatchee area eagle’s winter along the Wenatchee River including Icicle Creek, however since these birds are not banded, radio tagged, or otherwise definitively marked, it is not known for certain.

2. Gray Wolf (Canis lupus)

Status

The gray wolf is listed as threatened under the Endangered Species Act. Gray wolves originally occupied much of the continental Unites States, but currently occupy a small portion of their former range (Laufer and Jenkins 1989). In 1930, it was believed that breeding populations of

wolves in Washington were extinct because of fur trading pressure in the 1800's followed by the establishment of bounties on all predators in 1871 in the Washington Territory (Young and Goldman 1944). The last reported wolf shot in the North cascades was in 1975 (WDW 1975, as reported in Almack et al. 1994). Recent observations indicate that wolves exist in Washington, likely in small numbers, and mostly as individuals. However, several family units have been documented, indicating that some level of reproduction has occurred recently (Almack and Fitkin 1998).

Range

The probable range of gray wolves in Washington is in the Cascade Mountains and northeastern Washington (Almack and Fitkin 1998). In northeastern Washington, the majority of the reported wolf activity is in the eastern half of the Colville National Forest and Colville Indian Reservation and also adjacent private and public lands (Hansen 1986).

Habitat Requirements

The habitat of the gray wolf is listed as open tundra and forests (Whitaker 1980). However, gray wolves can use a variety of habitats as long as cover and a food supply are available (Stevens and Lofts 1988). They tend to focus on areas that are free from human disturbance and harassment, have low road densities and which support large numbers of prey species (deer, elk, goat, moose, and beaver). While they may consume some small mammals, most of their diet consists of deer (Peterson 1986).

Wolves follow the movements of ungulate herds (deer, elk, moose) across openings and through forested areas. The major tree species in these areas include white pine, lodge pole pine, Douglas fir, larch, subalpine fir, grand fir, and a number of less common species including ponderosa pine, whitebark pine, spruce, hemlock, and red cedar (Hansen 1986). Wolves have territories ranging from 70-800 square miles. Wolves general live in packs made up of 2 to 12 or more family members and individuals, lead by a dominant male and female. In other locations, denning by wolves generally occurs between April and June. Den sites are often characterized by having forested cover nearby and by being distant from human activity. The pups remain at the denning site for the first six to eight weeks, and then they move to a rendezvous site until they are large enough to accompany the adults on a hunt (Peterson 1986). Once the pups are large enough to go hunting, the pack travels throughout its territory.

Icicle Creek Gray Wolf

The project area lies within habitat for gray wolves in the conterminous (lower 48) states, in Washington State. There have been no confirmed sightings of gray wolves in the project area. In 1992, a solicited howling response of an individual was confirmed as a Class I sighting in the Alpine Lakes Wilderness, approximately 15 miles from the project area (Gaines et al. 1995). There is no known denning or rendezvous sites present in the project area. There are potential denning sites available less than 1 mile to the southwest of the project area, in the boulder fields at the base of Wedge Mountain, and 4.5 miles to the southwest in the Alpine Lakes Wilderness, which may also provide potential rendezvous sites.

Prey base for gray wolf includes deer and elk and smaller mammals including beaver and marmot, which are found readily throughout the project area and surrounding landscape. Deer and elk use the hatchery grounds for transition habitat between winter and summer habitats. Wolves are also affected by human disturbances such as roads and habitation. Currently, the open road density in the Icicle Creek watershed averages 0.4 road miles per square mile (Diane Driscoll, USFS, Leavenworth, WA pers. comm. 2001), which is better than the desired condition of 1 mile/sq. mi. However, in the project area, there is no refugia/security habitat and the road density is much higher due to the amount of private lands and residences. Under current zoning regulations there are approximately 29 more residences that could be constructed in the Icicle Creek watershed on private lands, however, development of these parcels are continuing at a slow pace (USFS 1995).

3. Grizzly Bear (Ursus arctos)

Status
The grizzly bear was listed as a threatened species in the conterminous United States in 1975. Livestock depredation control, habitat deterioration, commercial trapping, unregulated hunting, and protection of human life were leading cause of the decline of grizzly bears (USFWS 1993). Two of the six ecosystems identified in the grizzly bear recovery plan (USFWS 1993) include areas in Washington, the Northern Cascades and the Selkirks. Almack et al. (1994) estimated the 1991 grizzly bear population in the North Cascades recovery area at less than 50, and perhaps as low as 5 to 20. Wielgus et al. (1994) estimated a density of one bear per 27 mi^2 (71 km^2) for the U.S. portion of the Selkirks Ecosystem and one per 17 mi^2 (43 km^2) for the Canadian portion of the Selkirks Ecosystem.

Range
In Washington, the grizzly's range is limited to the Northern Cascades and the Selkirk mountains.

Habitat Requirements
Grizzly bear habitat use is determined by isolation from human disturbance, food distribution, food availability, and denning security. In general, grizzly bears move seasonally, using low elevation riparian areas and meadows in the spring, higher elevations during the summer and fall months, and high isolated areas for winter denning.

Little is known about the grizzly bears residing in the North Cascades. It is suspected that their habits are similar to bears from other areas, but telemetry studies are needed. Information presented here is from studies in the Selkirk Mountains and other areas. Denning occurs most commonly on north-facing slopes above 6000 feet elevation in areas where snow drifts and remains through warm spells (USFS 1994b). Grizzly bears leave their den sites after the cubs are born in February. They move quickly down to low elevation areas and feed on winter-killed ungulates and new growth. Grizzly bears generally feed on emerging grasses, forbs, and budding shrubs in the spring. As green-up moves up-slope, the bears follow, foraging above 3000 feet in the summer. Grizzly bears breed on their summer range between May and July. In late summer and fall, bears forage on berries such as huckleberry, serviceberry, rose, and

strawberry. In September or October bears move to high elevations and denning sites. Grizzly bears may concentrate their use in mixed shrub fields, snow chutes, old burns, meadows, and cutting units.

Human disturbance, usually increased with road access into grizzly habitat, is known to affect bear use of seasonal habitat components. Habituation or avoidance may result. In general, roads increase the probability of bear-human encounters and human-induced mortality (USFS 1994b).

Icicle Creek Grizzly Bear

Historically, grizzly bears were found throughout the Wenatchee National Forest. Research has confirmed the presence of a small, reproducing, and well distributed number of grizzly bears within the North Cascades Grizzly Bear Ecosystem (NCGBE) (Almack et al. 1994); the project area lies within this recovery area. No estimates of density or total populations of grizzly bears have been made for this ecosystem.

No grizzly bears have been observed in the project area, though the nearest known occurrence was an autumn track observation in forested habitat less than three miles south (USFS 1991). Grizzlies are wide-ranging and the Peshastin and Icicle Bear Management Units (BMUs) should be considered occupied in the larger scale. However, it is unlikely that grizzly bears occupy the project area.

There are no known grizzly bear denning sites in the project area. The main hatchery grounds have food sources for grizzly bear including fawning habitat, spring emergence vegetation, and spawning salmon. The project area does not have any core habitat, areas with no motorized roads or trails, and no high use non-motorized roads or trails within 0.3 miles. The project is in a high use area except for the Snow Lakes Basin.

4. Northern Spotted Owl (Strix occidentalis caurina)

Status

The northern spotted owl was listed as federally threatened in June 1990. The Northern Spotted Owl Recovery Team reported a total of about 3,602 known pairs of spotted owls in Washington, Oregon, and California; with 671 pairs in Washington (USDI 1992b). Based on two sets of assumptions to develop estimates, Holthausen et al. (1994 in WDNR 1997) estimated 282 or 321 pairs of spotted owls on the Olympic Peninsula, which was higher than previous estimates.

A demographic analysis of results from 5 sites distributed throughout the spotted owls range indicated that female territorial spotted owls were declining between 6 to 16 percent per year (an average of 10 percent) at individual study sites (Anderson and Burnham 1992 in WDNR 1997). Burnham et al. (1994 in WDNR 1997) estimated an annual loss of 3-8 percent of the resident female owls on the Olympic Peninsula using unadjusted estimates of juvenile survival. Using an adjusted estimate of juvenile survival, they estimated an annual loss of 1 percent of the resident females. Threats to existing populations of spotted owls include declining habitat, low populations, limited and highly fragmented habitat, isolation of populations, predation and competition (USDI 1992b).

Range

The northern spotted owl is one of three subspecies (northern, California, and Mexican) and occurs from British Columbia to northern California. The northern spotted owl is associated with late successional and old growth forest habitats. The owl also occurs in some younger forest types where the structural attributes of old growth forests are present (WDNR 1997). The present range of the northern spotted owl is similar to the limits of its historic range (USDI 1992a).

Habitat requirements

Detailed accounts of the taxonomy, range, and habitat requirements of northern spotted owls may be found in the 1990 Fish and Wildlife Service status review (USFWS 1990); the 1987 and 1989 status review supplements (USFWS 1987, 1989), and the Interagency Scientific Committee Report (Thomas et al. 1990).

Spotted owls nest, roost, and feed in a wide variety of habitat types and forest stand conditions throughout their distribution, with most observations in areas having a component of old growth and mature forests. Owls in managed forests usually occupy areas with structural diversity and a high degree of canopy closure, containing large diameter or residual old trees, in stands more than 60 years old (USDI 1992b).

Nesting habitat is generally found in mature and old growth stands and contains a high degree of structural complexity (WDNR 1997). Cavities or broken-top trees are more frequently selected in older forests and platforms (mistle toe brooms, abandoned raptor and gray squirrel nests, and debris accumulations) tend to be selected more frequently in younger forests (Foresman et al. 1984, LaHaye et al. 1992). Roosting habitat has characteristics similar to nesting habitat, i.e., high canopy closure, a multi-layered canopy, and large diameter trees (WDNR 1997). Spotted owls roost in shady spots near streams in the summer (WDNR 1997). Spotted owls begin their annual breeding cycle in late winter (February or March) and dispersal of juvenile owls begins in early fall (USDI 1992b).

Feeding habitat appears to be the most variable of the major habitat categories (Thomas et al. 1990); however it is characterized by high canopy closure and complex structure (USDI 1992b). Spotted owls feed on a variety of small forest mammals, birds, and insects. Spotted owls on the Olympic Peninsula depend primarily on flying squirrels (Carey et al. 1992).

Although habitat that allows spotted owls to disperse may be unsuitable for nesting, roosting, or foraging, it provides an important linkage among blocks of nesting habitat both locally and over the range of the northern spotted owl. This linkage is essential to the conservation of the spotted owl. Dispersal habitat, at minimum, consists of forest stands with adequate tree size and canopy closure to protect spotted owls from avian predators and to allow the owls to forage at least occasionally (USDI 1995).

Icicle Creek Northern Spotted Owl

The project area lies within the range of the northern spotted owl. One half mile to the south of the LNFH on National Forest lands lays the Boundary Butte Late Successional Reserve (LSR). This LSR was burned over in the 1994 Rat Creek Fire, though it is still managed to protect and enhance conditions of late-successional forest ecosystems and related species. Prior to the 1994 fires there were three spotted owl activity centers within a 2 mile radius of the LNFH; there is now only one activity center within two miles of LNFH, SO-717 (Lower Mill Creek). The 1994 fires burned the activity centers and home ranges of SO-728 (Wedge/Icicle), SO-716 (Upper Mill Creek), and SO-717 (Lower Mill Creek). SO-728 (T24, R17, S34) was last located in 1994 and SO-716 (T23 R17 S3) in 1987. After consultation with USFWS (Bush 1995) these sites are no longer considered activity centers.

The Lower Mill Owl, SO-717 (T23 R17 S1) was last located in 1995, however, it is still considered an activity center and is still being monitored. The activity center for SO-717 is just over 1.8 miles from the main LNFH grounds. A nesting spotted owl pair (Wedge-Allen) was detected on Wedge Mountain in T23 R17 S10 NE ¼ in May 2001, approximately 3 miles S-SW of the project area (Rolf Larson, USFS, Leavenworth, WA, pers. comm. 2001). Surveys are still being conducted to determine reproductive status for this pair.

Most of the hatchery grounds are currently non-habitat for spotted owls. Northern spotted owl surveys were conducted to protocol (USFS 1992) in habitat within one mile of the project area and no spotted owls were detected. However, the forested lands adjacent to the project area provide connectivity for spotted owls moving across the landscape from the Swauk and Boundary Butte LSRs to the Icicle and Deadhorse LSRs.

5. Marbled Murrelet (Brachyramphus marmoratus)
Information not provided as the species does not occur in the action area and suitable habitat does not exist.

6. Canada Lynx (Lynx canadensis)
Status
On April 24, 2000 the Canada lynx was listed as threatened. The Canada lynx is known to occur in the state of Washington, with current population estimates of 100 to 200 individuals. In Washington, 115 Lynx Analysis Units (LAUs) were identified and lynx have been documented recently in 40, and at some time in 72 of these LAUs (Stinson 2000).

Range

Historically and currently, lynx were present in Alaska and Canada from the Yukon and Northwest Territories south to the U.S. border and east to Nova Scotia and New Brunswick. Lynx historically were found in sixteen states in the contiguous United States. They were present in the northeast in Maine, New Hampshire, Vermont, New York, Pennsylvania, and Massachusetts; in the western Great Lakes region in Minnesota, Wisconsin, and Michigan; in the Rocky Mountains in Oregon, Idaho, and Montana on into Utah and Colorado; and in the Cascade Mountain Range of Oregon and Washington (McCord and Cardoza 1982, Quinn and Parker 1987). In the Icicle Creek drainage three Lynx Analysis Units (LAU) are identified, Icicle Ridge, Enchantment, and Garland.

Habitat Requirements

Lynx are wide-ranging forest carnivores and occasionally move long distances away from typical habitat; these movements have been described as "exploratory movements" (Aubry et al. 2000, Squires and Laurion 2000). Mowat et al. (2000) also described long distance movements (>100km) by lynx. These movements are likely to result in observations of lynx out of "mapped" lynx habitat. Lynx habitat has been identified on the Okanogan/Wenatchee National Forests following the direction from the Regional Forester.

Lynx occur in moist, coniferous forests that have cold, snowy winters and provide habitat for snowshoe hares (Quinn and Parker 1987, Koehler 1990, Koehler and Aubry 1994, Mowat et al. 2000, McKelvey et al. 2000, Ruggiero et al. 2000). In the west these habitats are represented by subalpine fir forests (Aubry et al. 2000). On the Okanogan-Wenatchee National Forest, these habitats are generally above 4000 feet elevation.

Lynx prey primarily on snowshoe hares; hares comprised 35 to 97 percent of lynx diets throughout the range (Koehler and Aubry 1994). Primary forest types that support snowshoe hare are subalpine fir, Engelmann spruce, Douglas-fir, and lodgepole pine (Hodges 2000). Landscapes with various age classes, primarily mid to advanced successional stages resulting from burns or clearcuts that support dense understory vegetation, may be more likely to support high snowshoe hare populations (Poole et al. 1996). Hodges (2000) found certain successional stages were important to snowshoe hares and horizontal cover appeared to be the important component. Koehler (1990) suggested snowshoe hares avoided clearcuts and very young stands and Conroy et al. (1979) found areas with greater interspersion of habitats may receive greater use by hares. Population densities and overwinter survival are positively correlated with understory densities, particularly of conifers that provide winter forage, thermal cover, and escape cover (Adams 1959, Pease et al 1979, Wolff 1980, Litvaitis et al. 1985).

Lynx denning habitat is correlated with large woody debris, either down logs or root wads (Koehler 1990, Slough 1999, Mowat et al. 2000, Squires and Laurion 2000). These sites can be in regeneration forests (Slough 1999), or in mature conifer or mixed-conifer-deciduous forests (Koehler 1990). Stand structure appears to be of more importance than forest cover type (Mowat et al. 2000).

Lynx are generally tolerant of humans (Staples 1995). Other anecdotal reports suggest lynx are not displaced by human presence, including moderate levels of snowmobile traffic (Mowat et al. 2000). McKelvey et al. (2000) re-analyzed data collected by Koehler (1990) and Brittell (1989) in northcentral Washington and found habitat use by lynx was not influenced by logging roads. Apps (2000) found six lynx in the southern Canadian Rockies crossed highways within their home ranges less than expected.

Few studies have been conducted on the effects of recreational activities on lynx (Ruediger et al. 2000). Concerns exist regarding the potential effects of winter recreational activities. Specifically, snow compaction associated with grooming for snowmobiling and cross-country skiing may provide travel routes for competitors such as coyotes, bobcats, and cougars (Koehler and Aubry 1994, Buskirk et al. 2000, Ruediger et al. 2000). Other associated factors include disturbance of den sites during the young rearing period (Claar et al. 1999).

Icicle Creek Canada Lynx
There are no recorded Canada lynx sightings in the Icicle Creek Basin (Janet Millard, USFS, Leavenworth, WA, pers. comm. 2005).

7. Pacific Fisher (Martes pennanti)

Status
The Pacific fisher is a Candidate species under the Endangered Species Act of 1973, as amended. Fishers have been eliminated from much of their pre-settlement range by forest management and trapping (Powell and Zielinski 1994). It is currently a protected species under the Wildlife Code of Washington and cannot be legally trapped.

Range
Fishers are found as far north as northern British Columbia (Strickland et al. 1982). They occur from New England south to West Virginia, northern Wisconsin, Minnesota, and Michigan, northern Idaho, western Montana, and as far south as northern California along the west Coast (Rodrick and Milner 1991). The fisher was historically concentrated in remote portions of the Olympic Mountains, the Cascades, and as far east as the Okanogan Valley (Scheffer 1938). The current range of fishers in Washington includes the Olympic Mountains and the northern Cascade Range. The Pacific fisher appears to be absent from the southern and eastern portions of the state as well as the eastern edge of Puget Sound and the Kitsap Peninsula (Aubry and Houston 1992).

Habitat Requirements
The Pacific fisher prefers riparian areas in mature and old-growth coniferous forests (Powell and Zielinski 1994). Second-growth forests with low canopy cover may also be used (Rodrick and Milner 1991). Fishers generally avoid non-forested areas and forest stands with low canopy cover (Powell and Zielinski 1994). They are generally associated with low to mid elevation forests (Aubry and Houston 1992). Young fishers are reared in maternity dens, which are located high in hollow trees. Estimates of home range size vary from 4,695 to 19,521 acres for males and approximately one-third the size for females (Powell and Zielinski 1994). Fishers do

not limit their home ranges to a single major ridge or drainage, but may use more than one ridge as well as major and minor drainages (Buck et al. 1983).

Fishers are opportunists, feeding on a variety of small to medium-sized mammals and birds, and carrion (Strickland et al. 1982). Snowshoe hares are the most common prey and have been reported in fisher diets in virtually all food habit studies (Powell and Zielinski 1994).

Icicle Creek Pacific Fisher
Fishers are thought to have been extirpated from Washington state in the 1930's. There are no recorded fisher sightings in Icicle Creek or in the Wenatchee National Forest (Janet Millard, USFWS, Leavenworth, WA., pers. comm. 2004).

8. Yellow-billed Cuckoo (Coccyzus americanus occidentalis)

Status
The western continental U.S. DPS is a Candidate species under the Endangered Species Act of 1973, as amended. The western Yellow-billed cuckoo has been eliminated from much of its historical range through habitat degradation and loss.

Range
Historically, the western Yellow-billed cuckoo's range within the continental United States included Arizona, California, western Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, and western Wyoming. In Washington State the species was historically common in the Puget Sound lowlands and along the lower Columbia River. The species was rare east of the Cascade Mountains (Hughes 1999). There is no documentation of Yellow-billed cuckoo breeding in Washington State since the 1930's. This species may now be extirpated in this area (USDI 2001).

Habitat Requirements
The preferred habitat of the Yellow-billed cuckoo is riparian areas along streams. The species require large blocks of riparian habitat for nesting and breeding. Riparian habitat containing cottonwoods and willows (average tree height of 10-15 meters) with dense (greater than 40% canopy closure) understory foliage is preferred (Anderson and Laymon 1989). In two separate studies along the Sacramento River in California, nesting cuckoo home ranges included 25 acres or more (Gaines 1974) and 99 acres (Halterman 1991) of riparian habitat. This species migrates south to neotropical wintering areas and migrates north to nesting areas in the spring. Nesting peaks from mid-June through August. Breeding seems to be triggered by the appearance of large numbers of cicadas or other large insects (Ehrlich et al. 1992).

Icicle Creek Yellow-billed Cuckoo
There are no recorded Yellow-billed cuckoo sightings in Icicle Creek or in the Wenatchee National Forest. The proposed project area does not meet the habitat requirements for this species. The closest potential area where Yellow-billed cuckoos might occur is Douglas County (Jannett Millard, USFS, Leavenworth, WA., pers. comm. 2004).

C. Plants

1. Wenatchee Mountain checker-mallow (Sidalcea oregana var. calva)

Status
The Wenatchee Mountain checker-mallow is listed as endangered under the Endangered Species Act.

Range
Although the species of Sidalcea oregana (Oregon checker-mallow) occurs throughout the western United States, S. oregana var. calva is known only in the Wenatchee Mountains of central Washington. Five known populations, totally 3,300 plants, occur in the Pendleton Creek and Camas Creek watersheds. The primary threats to this species include alterations of hydrology, rural residential development and associated activities, competition from native and alien plants, recreation, fire suppression, and activities associated with fire suppression. To a lesser extent, threats include livestock grazing, road construction, and timber harvesting and associated impacts including changes in surface runoff in the small watersheds in which the plant occurs (USDI 1997).

Habitat Requirements
The Wenatchee Mountain checker-mallow is most abundant in moist meadows that have surface water or saturated upper soil profiles during spring and early summer. It may also occur in open conifer stands dominated by Pinus ponderosa and Pseudotsuga menziesii and on the margins of shrub and hardwood thickets. Populations are found at elevations ranging from 1,900 to 4,000 feet. Soils are typically clay-loam and silt-loams with low moisture permeability. The Wenatchee Mountain-checker mallow is a perennial plant with a stout taproot that branches at the root crown and gives rise to several stems that are 20 to 150 centimeters in length. Pink flowers begin to appear in middle June and peaks in the middle to end of July. Fruits are ripe by August (USDI 1997).

Icicle Creek Wenatchee Mountain Checker-Mallow
Review of the Washington Natural Heritage Database and field surveys in 1999 and 2002 resulted in no Wenatchee Mountain checker-mallow's occurring within the project planning area.

2. Ute Ladies'tresses (Spiranthes diluvialis)

Status
Ute Ladies' tresses was federally listed as threatened in 1992. The main threat factors cited were loss and modification of habitat, and modification of the hydrology of existing and potential habitat. The orchid's pattern of distribution as small, scattered groups, its restricted habitat, and low reproductive rate under natural conditions make it vulnerable to both natural and human caused disturbances (USFWS 1995). These life history and demographic features make the species more vulnerable to the combined impacts of localized extirpations, diminishing potential habitat, increasing distance between populations, and decreasing population sizes (Belovsky et al. 1994; USFWS 1995).

Range
In the state of Washington, Ute Ladies' tresses is located in Okanogan County.

Habitat Requirements
Ute ladies' tresses is a perennial, terrestrial orchid that is endemic to moist soils in mesic or wet meadows near springs, lakes, or perennial streams (USFWS 1995). Observations by Jennings (1990) and Coyner (1989 and 1990) indicate that the Ute ladies'-tresses requires soil moisture to be at or near the surface throughout the growing season, indicating a close affinity with the floodplain. These observations were corroborated by Martin and Wagner (1992) with monitoring research at the Dinosaur National Monument. However, Riedel (1992) reported that once established it appears to be tolerant of somewhat drier conditions, but loses vigor and may gradually die out if the groundwater table begins to consistently drop during late summer (Riedel 1992; Arft 1994 pers. comm. in USFWS 1995).

Ute ladies' tresses were originally reported to occur at elevations between 4,300 and 7,000 feet in eastern Utah and Colorado (Stone 1993). However, recent discoveries of small populations in the Snake River Basin (1996; southeastern Idaho) and in Okanogan County, Washington (1997) indicates that orchids are found at lower elevations (1,500-4,000 feet) in the more western part of their range (USFWS 1995). Ute ladies'-tresses are found in a variety of soil types ranging from fine slit/sand to gravels and cobbles (USFWS 1995). They have also been found in areas that are highly organic or consist of peaty soils. Ute ladies'-tresses are not found in heavy or tight clay soils or in extremely saline or alkaline soils (pH>8.0; USFWS 1995).

Ute ladies' tresses occur primarily in areas where vegetation is relatively open and not overly dense or overgrown (Coyner 1989 and 1990; Jennings 1989 and 1990). A few populations have been found in riparian woodlands of eastern Utah and Colorado (USFWS 1995). However, the orchid is generally intolerant of shade, preferring open, grass and forbs dominated sites (USFWS 1995).

The associated plant community composition and structure is frequently a good indicator across the range of the orchid (USFWS 1995). For example, beaked spikerush (Eleocharis rostellata) appears to dominate the plant community in areas occupied by the orchid (Washington State). In Idaho, Ute ladies'-tresses occupies areas dominated by silverleaf (Elaeagnus commutata) and creeping bentgrass (Agrostis stolonifera). The USFWS (1995) reported that species most commonly associated with Ute ladies'-tresses throughout its range include creeping bentgrass, baltic rush (Juncus balticus), long-styled rush (J. longistylis), scouring rush (Equisetum laevigatum), and bog orchid (Habenaria hyperborea). Coyote willow (Salix exigua) and yellow willow (S. lutea) are commonly present in small numbers as saplings and small shrubs (USFWS 1995). The USFWS (1995) reported that other species commonly associated with the Ute ladies'tresses throughout its range include paint-brush (Castilleja spp.), thinleaf alder saplings (Alnus incana), narrowleaf cottonwood saplings (Populus angustifolia), sweet clover (Melilotus spp.), sedges (Carex spp.), red clover (Trifolium pratense), and western goldenrod (Solidago occidentalis).

The Ute ladies' tresses appear to be tolerant and well adapted to disturbances, especially those caused by water movement through floodplains over time (L. Riedel, USFWS, Denver, CO., 1994 pers. comm. in USFWS 1995). Habitat alteration resulting from agricultural use (grazing, mowing, and burning) may be beneficial, neutral, or detrimental (McClaren and Sundt 1992). USFWS (1995) reported that grazing and mowing seem to promote flowering, presumably by opening the canopy to admit more light. However, these management practices may impede fruit set by directly removing flowering stalks, enhancing conditions for herbivory by small mammals and altering habitat required by bumble bees, the primary pollinator (USFWS 1995; Arft 1993)

Ute Ladies' tresses flower from mid-July to mid-August. Fruits mature and dehisce from mid-August into September. Plants may remain dormant for one or more growing seasons without producing above ground shoots. Orchids generally require symbiotic associations with mycorrhizal fungi for seed germination.

Icicle Creek Ute Ladies' tresses
Review of the Washington Natural Heritage Database and field surveys in 1999 and 2002 resulted in no Ute Ladies' tresses occurring within the project planning area.

3. Showy stickseed (Hackelia venusta)
Information not provide as the species does not occur in the action area and suitable habitat does not exist.

VII. CURRENT CONDITION OF HABITAT

Following is a discussion of the current habitat conditions in Icicle Creek from its confluence with the Wenatchee River to its headwaters located at Lake Josephine. The current condition of habitat is evaluated in terms of the USFWS Matrix of Diagnostics/Pathways and Indicators. For a summary of baseline habitat conditions see Table 4.

A. Water Quality

1. Temperature

High and low temperature extremes occur in all reaches of Icicle Creek. Icicle Creek is on the Washington State 303(d) Clean Water Act list for not meeting temperature criteria (WRWSC 1998). Water temperatures in summer months can exceed 15ºC (59ºF) and during the winter temperatures can fall below 1ºC (34ºF) (WRWSC 1998). Temperatures as high as 21ºC (70ºF) have been recorded in Icicle Creek (Mullan et al. 1992). The USFS 1994 stream survey conducted from August 13 - October 17 reported a maximum temperature of 18ºC (64ºF) and a minimum of 8ºC (47ºF) with temperatures in river miles 4.8 to 17 not meeting Forest Plan standards. The USFS stream temperature monitoring (1997) information indicates that temperatures in Icicle Creek exceeded the Wenatchee National Forest and Washington State Water Quality standards on 15 days for the maximum temperature and 37 days for the seven day average temperature. This happened in 1997 when flows were above average all year due to the

extensive snow pack received the previous winter. Water temperatures are highest in August. Water temperatures at the Chatter Creek station, located 10 miles upstream of all water diversions, do not consistently meet requirements for bull trout incubation, rearing, spawning, or migration and may limit bull trout production.

Fish may migrate downstream to the Wenatchee River to avoid unfavorable conditions; however, this river is also on the state's 303(d) list for not meeting temperature standards. Water temperatures in the mainstem Wenatchee River may fall below 10ºC during the winter and rise above 15ºC during the summer (WRWSC 1998).

The MCRFRO initiated additional monitoring of water temperatures in Icicle Creek in 2005 at ten stations between the boulder falls area to below LNFH (rm 5.6 – 2.2). Daily mean water temperatures from mid-July to mid-November 2005 are provided in Appendix D. The data indicate that during August and September water temperatures in Icicle Creek downstream of LNFH (rm 0.2) are cooler (up to 1.9ºC) than water temperatures at rm 5.5 – an area upstream of LNFH influence. This decrease in temperature is likely due to Snow Lakes augmentation discharge to Icicle Creek and the LNFH's use of well water. Water temperatures in Snow Creek are consistently cooler (up to 4.0ºC) than Icicle Creek during July through September and well water used by LNFH ranges from approximately 7 - 10ºC (45 – 50ºF). Well water can account for approximately 10% of the hatchery's total discharge to Icicle Creek during the summer months.

As Icicle Creek water temperatures upstream of all diversions exceed various standards during summer months and downstream water withdraws exacerbate it, this indicator is considered "Functioning at Unacceptable Risk."

2. Sediment/Turbidity

High sediment loads occur, and historically occurred, in Icicle Creek. All of the dominant land types in the Icicle Creek watershed have high sediment delivery hazards and background hill slope erosion rates for the watershed are high and estimated to total over 4,500 tons/year (USDA 1995). Sediments are filling pools and embedding channel substrates. USFWS biologists conducted five Wolman (1954) pebble counts in the stream restoration project below LNFH in 1998 and 1999. The amount of substrate less than 2mm in size ranged from 13 to 32% with an average of 24% in 1998, and 6-26% with an average of 18% in 1999. Additionally, pebble counts were conducted in spawning gravel patches in the lower reach. Substrate less than 2 mm in size in these patches ranged from 3 to 9%. Sediment in spawning gravels was not assessed during the USFS 1994 stream survey. However, high sediment delivery rates were reported in a majority of the upper reaches surveyed. The surveyors also reported that sedimentation appeared to be a problem throughout the system. USFWS biologists conducted four pebble counts in the upper reaches of the Icicle in 1999 during a spawning gravel survey. The amount of substrate less than 2mm in size recorded in these counts ranged from 0 to 15 percent.

Sediment loading is mainly due to urbanization, clearing of riparian zone vegetation, recreational use, road building, logging, landslides, fires, and flooding. Eleven percent of the riparian

vegetation along the lower portion of Icicle Creek, below LNFH, has been removed for housing developments (WRWSC 1998). Approximately 12% of Icicle Creek's watershed was burned by forest fires in 1994 (USFS 1994). These forest fires have and will continue to increase sedimentation in Icicle Creek (WRWSC 1998). Approximately 5% of the Icicle Creek watershed, outside of the Wilderness boundary, has been impacted by logging (USFS 1994). Also, natural landslides often occur in this drainage. Recently, in June 1999, a landslide occurred in the watershed on a flanking slope of the draw that descends from Icicle Ridge. The failure was approximately 120 feet wide and 300 feet long with a slide plane that was 10-15 feet below the pre-failure surface. The slide began at an elevation of 4800 feet. Consequently, the resulting volume of material delivered to the valley bottom (Icicle Creek) was many times greater than the initial failure. The main body of the failure remains unstable (M. Karrer, USFWS, Leavenworth, WA., pers. comm.).

Temporary increases in turbidity may also occur downstream of water diversion structures during operational adjustments (i.e., adding / removing dam boards, raising / lowering gates). However, theses infrequent (few times a year) adjustments usually only disturb minor amounts of sediments with limited spatial effect.

Anthropogenic activities throughout the watershed are the primary reasons this indicator is "Functioning at Risk."

3. Chemical Contamination/Nutrients

Icicle Creek is on the Washington State 303(d) Clean Water Act list for not meeting temperature, dissolved oxygen, pH, in-stream flow (WRWSC 1998), and total PCB concentration (WDOE 2004) criteria. Water quality data for Icicle Creek has been collected over the years as a component of the Wenatchee Watershed Planning Project. Water quality samples were collected from Icicle Creek (rm 1.5 & rm 9.3) on the same day and at least once per month. The data for 1992 - 1993 and 1995 - 1996 indicates similar profiles with respect to dissolved oxygen, pH, and temperature between both stations. Minimum dissolved oxygen levels (> 9.5 mg/L) were met 69% of the time at the upper station and 72% of the time at the lower station. The standard range of pH (6.5 - 8.5) was achieved 28 of 30 times (93%) at both stations. Temperature standards (< 16 ºC) were met in all samples (WRWSC 1996). Between 1997 and 1999, the Environmental Protection Agency and WDOE sampled fish tissue from Icicle Creek spring Chinook salmon and mountain whitefish for contaminants (WDOE 2004). Total PCB concentrations in the fish (white fish) tissues exceeded DOE's Water Quality 303(d) listing policy. The PCB concentration from white fish tissue in the Wenatchee River resulted in higher levels than those from Icicle Creek. DDT analogs were also detected but concentrations did not exceed criteria.

In 2005, the USFWS conducted a study to determine the extent of PCB and pesticide concentrations in Leavenworth NFH fish. In addition, the study assessed PCB and pesticide concentrations in Icicle Creek sediment above and below the LNFH, and in the pollution abatement pond. Data show that LNFH is not adversely impacting the PCB or pesticide concentrations in Icicle Creek below the hatchery and hatchery fish are not accumulating PCB or pesticides to levels of concern (USFWS 2005a).

The Washington Department of Ecology (DOE) indicated that LNFH is a point source for phosphorus loading into Icicle Creek (Washington Department of Ecology, May 2005). Sampling conducted by the DOE in August and September 2002 indicated that most of the flow and inorganic phosphorus (inorganic-P) load in lower Icicle Creek came from the hatchery main outfall. The inorganic-P concentration in the hatchery main outfall was approximately 13 ug/L in both August and September 2002, a three-fold increase over the inorganic-P concentration of the intake water. Accounting for discharge volume, the hatchery was identified as the point source contributing a critical-condition inorganic-P load of 1.25 kg/day or 86.3% of the total load in Icicle Creek. The DOE states that to meet water quality standards in lower Icicle Creek, the hatchery main outfall would need to reduce its inorganic-P effluent concentration to less than 5.0 ug/L. Organic-P concentrations in the main outfall were below reporting limits. There were significant observed increases (200% to 1500% increases) in ammonia and nitrate (N) concentrations in the main outfall discharge compared to the below-reporting-limit levels of the Icicle Creek water at the hatchery diversion. An increase in inorganic-P and ammonia within the hatchery facility is most likely due to the products of fish metabolism and P addition from fish feed, although groundwater augmentation may contribute additional P and N (the hatchery well water was not sampled).

This indicator is considered “Functioning at Risk.”

B. Habitat Access

1. Physical Barriers

Since the 1939-1941 construction period, the LNFH has maintained and/or operated various structures that restricted fish passage in Icicle Creek. Several structures (non-passage barriers) were removed from the historic channel in 2003 (Phase I of the Icicle Creek Restoration Project) but four structures remain today. Three of these are seasonal barriers (depending on operation) to fish migration and one is a complete barrier. These structures are the spillway dam at rm 2.8, the racks / dam boards at structure 5, structure 2 at rm 3.8, and the water intake dam at rm. 4.5. Additional potential upstream barriers include a boulder cascade area at rm 5.6 and the Icicle Peshastin Irrigation Diversion Dam at rm 5.7. Each of these structures, their operation, and effect to fish movement (upstream and downstream) is described in more detail below. (Figure 1.)

The concrete spillway dam has been a complete barrier to upstream fish passage since construction of the dam and canal (1939-1941). This statement however is somewhat misleading as the canal was never part of any natural fish migration corridor. The spillway dam is located adjacent to the hatchery at the downstream terminus of the canal. The canal has conveyed most of the flow of Icicle Creek from structure 2, across the LNFH grounds, over the dam crest and into a large pool below the dam which is commonly referred to as the spillway pool. Downstream passage of fish at this location occurs when the canal has sufficient flow to overtop the dam crest. Hatchery spring Chinook salmon and other fish, including many large migratory bull trout are observed in this pool during the late summer months (July – September). Snorkel fish count data provided by the MCRFRO and LNFH indicate peak abundance of bull trout

occurs here in late August. However, high springtime flows and the Yakama Nation fishery during May and June limit snorkeling efficacy and/or opportunities, respectively, resulting in a data gap regarding bull trout abundance at that time.

What is unclear however is to what degree presence of large bull trout in the spillway is either related to their attempt to access upstream areas for reproduction or to other factors such as the temperature benefit the pool provides or to prey abundance. In all likelihood, all of these factors probably play a role.

Structure 5 is located on the downstream end of the historic channel of Icicle Creek. This channel spanning structure is about 200 meters upstream of the spillway pool and, depending on operation, represents the first fish passage impediment in the natural or historic channel of Icicle Creek. This structure, essentially a bridge with a foundation built to accept installation of boards and weirs (or racks), has blocked all adult upstream fish passage nearly year-round since the hatchery was built. At times relatively small fish (<12") are able to move upstream through the racks (Jim Craig, personal observations, USFWS, Leavenworth, WA). Downstream migration through the racks may be possible for small fish however impingement on the upstream side of the racks has been observed. The use of dam boards and racks at this structure was done historically to retain adult Chinook in the historic channel to facilitate the hatchery's early and innovative attempts to create natural-type holding and spawning conditions. In 1979, those practices were discontinued because of problems with water temperature regulation, disease, and predators. Continued use of the dam boards / racks was done to facilitate broodstock collection for spring Chinook salmon by keeping fish in the spillway pool area and near the hatcheries fish ladder and adult holding pond, which were constructed in 1979. Retention of spring Chinook salmon in the area also benefited the tribal fishery. The dam / boards racks were largely left in place outside of the broodstock collection and tribal fishing period.

Structure 2 is located at rm 3.8 at the upstream end of the historic channel, about 1 mile upstream from structure 5. Upstream and downstream fish passage at this structure is dependant on operation of the two radial gates. The radial gates are operated to control the flow split between the historic channel of Icicle Creek and the LNFH canal. Historically, and with few recent exceptions that are described below, the radial gates have remained in the closed or only partially opened position year-round directing most stream flow into the canal. This gate configuration prevents upstream or downstream passage of fish into and/or through the historic channel. Controlling (i.e., reducing) flows in the historic channel was done to facilitate the natural-type spawning environment utilized up to 1979. In 1979 the hatchery constructed on-site adult holding ponds and began operating a conventional fish ladder adjacent to the spillway pool for broodstock collection. As mentioned above however, the racks / dam boards at structure 5 remained in-place. And in order to maintain the rack / dam boards the radial gates were kept closed virtually all of the time. It should be noted that even with the radial gates closed some water remains in the historic channel due to leakage around the gate seals and due to infiltration from flows in the higher elevation canal. The amount of flow in the historic channel with gates closed varies in relation to flow in the canal. Flow volumes in the historic channel increase as one proceeds in a downstream direction due to accumulating accretions from the canal.

Again, structure 2 was historically operated with the radial gates primarily in the closed position thus preventing any upstream or downstream passage of fish through the historic channel. Those fish able to access the historic channel area by passing through the racks at structure 5, or during periods the racks were not in-place, could only access up to structure 2. With the radial gates closed, downstream passage of fish from the upper Icicle Creek to areas below the hatchery was only possible when flows in the canal were sufficient to overtop the spillway crest. Overtopping of the spillway dam crest typically occurs from April through early August and again during the fall months after upstream irrigation diversions conclude and/or in response to rain on snow events. The proposed increased releases of water from Snow lakes during the summer months will assist downstream migration of fish.

Starting in 2000 and to date, the purpose and need to operate both structures 2 and 5 were modified slightly. From 2000 through 2004, the dam boards and racks were maintained at structure 5 from mid-March to mid-April to maintain a pool on the upstream side of the structure. The Yakama Nation used this pool to acclimate coho salmon pre-smolts prior to release. From 2000 to date, the Yakama Nation used the dam boards and fish traps at structure 5 from mid-September through November as a means to collect adult coho salmon. The Yakama Nation, and BPA as the funding entity, established and maintain section 7 consultations with the FWS and NOAA on the effects of these operations.

On a few occasions, dam boards and rack structures at structure 5 were removed and at least one of the radial gates at structure 2 were opened allowing upstream and downstream passage of fish through the historic channel. This happened during the summers of 1993, 1997, 2001 and again in 2005. However, passage at structure 2 is only possible when upstream river flows are low. When Icicle Creek flows upstream of structure 2 are substantially greater than flows in the historic channel a hydraulic barrier at structure 2 precludes most upstream passage.

However, when passage opportunities are provided at structure 5 (racks / dam boards removed), radial gate is opened at structure 2, and flow conditions at structure 2 allow, substantial immigration of fish into the historic channel and upstream has occurred. In 1997 surveys in late September noted numerous sockeye salmon from the historic channel to near the hatchery water intake. In July of 2001 racks were removed and a radial gate was opened. The return of adult spring Chinook to the hatchery that year was substantial and over 1,000 spring Chinook salmon moved into areas upstream of structure 5 (MCRFRO internal memorandums). Large, presumably fluvial bull trout were also occasionally observed upstream of LNFH during these times. Other than these few times however, other opportunities for fish passage were accidental and very rare for several decades.

Moving in an upstream direction, the next impediment to fish passage is the LNFH intake diversion dam at rm 4.5. And this intake dam, which is shared with Cascade Orchards Irrigation Company, is a low head cobble and concrete structure which inhibits fish passage to many species especially during late summer flow conditions. In 2001, a drought year, over 100 adult Chinook were counted in the area upstream of the intake dam indicating passage was possible during July. In addition to the physical impediment the dam presents during low flow conditions, the withdrawal of water at this location exacerbates high water temperatures downstream of this

structure. Thus a thermal barrier to migration may occur during the late summer months between the spillway pool and the intake dam. This temperature issue is discussed in more detail in the appropriate section (VII. Current Condition of Habitat, A. Water Quality, 1. Temperature). Downstream passage of fish at this structure is possible year-round except during flow conditions when most of the available water is withdrawn by LNFH and Cascade. During low flow periods, water does not spill over the dam crest thus impeding downstream passage. The area downstream of the dam still contains some minimal flow even in the drought years (a minimum flow of 12 cfs was measured on September 5, 2001) as water leaks through the dam.

Moving in an upstream direction, the next impediment to fish passage is a boulder field which begins about rm 5.6. This boulder area has a steep gradient, very large boulders and substantial falls, is a significant impediment to upstream fish passage particularly during low flows. In 1999 and 2000 the USFWS conducted a fish migration study to assess passage conditions upstream of LNFH (USFWS 2001). Radio-transmitters were implanted in 20 adult steelhead, 15 adult spring Chinook and five large presumably fluvial bull trout. The fish were all released upstream of the structure 2. None of the radio-tagged fish moved above the boulder field during the wide range of flow conditions.

However, several migratory-size bull trout were observed upstream of the boulder area near the USGS gauging station (rm 5.8) during a September 2002 snorkel survey (Judy De La Vergne, USFWS, Wenatchee, WA, pers. comm.). This observation indicates that passage is possible under some conditions, or larger sized bull trout descended from the resident population upstream. If the fish ascended the boulder cascade area, it is surmised that the bull trout observed in 2002 originally accessed the area upstream of LNFH during the summer of 2001 when racks / dam boards at structure 5 were removed and a radial gate was opened. At some point, likely in the fall of 2001 or the following spring during higher flow conditions, these fish were able ascend the boulder falls area and the upstream irrigation intake dam (rm 5.7). In 2004, during a brief spot-check of the same area snorkeled in 2002, a migratory-sized bull trout was observed (D. Morgan, USFWS, Wenatchee, WA, pers.com). It is unknown if the 2004 observation was of the same fish observed in 2002.

The 2002 and 2004 observations of migratory-size bull trout above the boulder area were made during opportunistic samples and no systematic efforts have been attempted to look for migratory fish above the boulder area. Apparently, under some conditions fish passage is possible at both the dams in the historic channel at LNFH, at the LNFH intake dam, as well as the boulder area and the irrigation district dam.

The final man-made fish passage impediment in Icicle Creek above LNFH is the irrigation diversion intake dam owned and operated by the Icicle/Peshastin Irrigation District at rm 5.7. This dam presents a passage barrier during low flow conditions during the summer and early fall until the irrigation season concludes (Bryant and Parkhurst 1950). In addition to the physical impediment the dam presents during low flow conditions, the withdrawal of water at this location exacerbates high water temperatures downstream. Thus, a thermal barrier to migration may occur during the summer months from the intake dam to the confluence of Snow Creek at rm 5.5 where LNFH augments Icicle Creek with water released from Snow Lakes. This water

temperature issue is discussed in more detail in the appropriate section (VII. Current Condition of Habitat, A. Water Quality, 1. Temperature).

To summarize, migratory bull trout and many other native fish have been generally limited to the lower 2.8 miles of Icicle Creek by dams at LNFH that have potential to block upstream fish passage in Icicle Creek. Once beyond the hatchery barriers, there are additional fish passage barriers. It is assumed that juvenile and mature resident fish can leave the system (move downstream into lower Icicle), but that they cannot usually access areas above the hatchery as large migratory adults to reproduce.

Therefore this indicator is considered "Functioning at Unacceptable Risk."

C. Habitat Elements

1. Substrate

High sediment loads occur and historically occurred in Icicle Creek. All of the dominant land types in the Icicle Creek watershed have high sediment delivery hazards, and background hill slope erosion rates for the watershed are high and estimated to total over 4,500 tons/year (USDA 1995). Sediments are filling pools and embedding channel substrates. Visually assessed substrate embeddedness in the lower reaches of Icicle Creek is greater than 30%. The USFS 1994 Icicle stream survey of the upper Icicle reported that all reaches had embedded substrate with the percentage of units embedded per reach ranging from 31 - 100%.

In late August of 2005 a multiple agency group conducted a course scale evaluation of anadromous salmonid spawning habitat in Icicle Creek from structure 5 (rm 2.8) to the Snow Creek confluence (rm 5.5). The vast majority of potential spawning habitat for anadromous salmon (Chinook, coho and steelhead) occurs in the historic channel between structures 2 and 5 (Thomas 2005). There was almost no potential spawning habitat between structure 2 and the confluence with Snow Creek (Thomas 2005).

Therefore this indicator is considered "Functioning at Unacceptable Risk."

2. Large Woody Debris

In the winter of 1998, USFWS biologists surveyed the lower 2.8 miles of Icicle Creek. In this section, woody material is limited with only 4-10 pieces of wood observed. Urbanization, livestock grazing, and road building in the lower part of Icicle Creek has reduced the riparian zone in structure and function. Eleven percent of the riparian vegetation along the lower portion of Icicle Creek, below LNFH, has been removed for housing developments (WRWSC 1998). Thus, sources for short and long-term recruitment of large woody debris are lacking. Stream reaches in upper Icicle Creek do not meet Northwest Forest Plan standards for large woody debris per mile (USFS 1994). Higher elevation stream reaches contain more woody debris. However, these reaches are in the Alpine Lakes Wilderness and must meet west side criteria (USFS 1994). In the USFS 1994 stream survey, LWD was measured in terms of Northwest

Forest Plan standards. From information presented in the survey report, it appears that three of the six reaches surveyed meet the matrix criteria for LWD. Sources for short and long-term recruitment have been reduced by human and natural activities in the upper Icicle.

This indicator is considered "Functioning at Risk."

3. Pool Frequency and Quality

The wetted width of lower Icicle Creek ranges from 40 to 65 feet. Recommended pools per mile for streams this wide are 23 to 26. This criterion is not met. The pools that do exist are deep, > 1 meter; however, there is no cover for fish other than depth. Lower Icicle Creek lacks features such as woody debris and large boulders that function in pool creation and maintenance. Pool volume has been reduced by deposition of fine sediments. Summer pool water temperatures are not known but temperatures in excess of 21ºC have been reported for Icicle Creek (Mullan et al. 1992). The pool frequency and quality in the upper Icicle does not meet Forest Plan standards (USFS 1994). Additionally, a review of the 1994 stream survey data shows that all reaches of the upper Icicle do not meet the matrix criteria for pool frequency. Portions of the upper Icicle lack in woody debris which promotes pool creation and maintenance. Pool water temperatures are not known, but low and high temperatures have been recorded in the watershed.

This indicator is considered "Functioning at Unacceptable Risk."

4. Large Pools

Even though Icicle Creek does not meet pool frequency and quality standards (see above), the available data shows that all reaches of Icicle Creek contain a few large pools with residual depths greater than 1 meter deep.

Icicle Creek is "Functioning at Risk" for this indicator.

5. Off-channel Habitat

In lower Icicle Creek there are few backwater areas and low energy off-channel areas. Off-channel habitat in the lower Icicle is limited mainly by residential development and road building. For example, there are several off-channel areas along East Leavenworth Road that are no longer connected to the stream. USFS stream survey data (1994) shows that 72% of upper Icicle Creek contains an adequate and diverse amount of off-channel habitat. Many side-channels, backwater areas, ponds, wetlands, and oxbows occur.

Overall, this indicator is considered as "Functioning Appropriately". However, in lower Icicle Creek, below rm 2.8, this indicator is considered "Functioning at Unacceptable Risk."

6. Refugia

This indicator is directly related to the off-channel habitat indicator above. This indicator also considers human impacts and habitat connectivity within the watershed. In the lower Icicle off-channel habitat is limited in quantity and connectivity and there is a high rate and potential of human impacts. In the upper Icicle there is an adequate and diverse quantity of off-channel habitat. Distribution and connectivity of high quality habitat is moderate and the level of human activity, mainly recreation, is high.

Overall, this indicator is considered "Functioning at Risk." However, in lower Icicle Creek, below rm 2.8, this indicator is considered "Functioning at Unacceptable Risk."

D. Channel Condition and Dynamics

1. Width/Depth Ratio

Data on width/depth ratios has not been fully documented in Icicle Creek. Related information is presented below.

Rivers and streams act as indicators of environmental stress when sediment supply and channel adjustments occur due to deforestation, changes in vegetation composition, urbanization, road building, and other watershed activities that create their cumulative impacts on river and stream systems. For example, in the lower reach of Icicle Creek, channel features are not being maintained over time and deposition and erosion are occurring causing it to be in a state of flux. This instability is a result of Icicle Creek adjusting to natural and human impacts to achieve a stable dimension, pattern, and profile that are in equilibrium with its gradient, sediment supply, and discharge. Channel width/depth ratios in lower Icicle Creek are increasing and entrenchment ratios are decreasing in response to increases in sediment supply and bank instability, decreases in riparian vegetation structure and function, and changes in flow regime. Consequently, the creek is becoming shallower and wider. Reaches in upper Icicle Creek are functioning adequately except in areas where roads and bridges confine the stream channel and where riprap has been placed. Five site specific areas, at road mile 4.6-5.1, 9.9-10.1, 10.7-10.8, 13.6-14.1, and Ida Campground, exist where the road system has confined the stream channel and has cut off the floodplain.

This indicator is considered "Functioning at Risk."

2. Stream Bank Condition

Urbanization, livestock grazing, and road building in the lower part of Icicle Creek has reduced the riparian zone in structure and function. Eleven percent of the riparian vegetation along the lower portion of Icicle Creek, below LNFH, has been removed for housing developments (WRWSC 1998). Many large areas of the stream's banks were eroded during the 1995/96 winter floods (WRWSC 1998). In upper Icicle Creek, bank erosion ranges from minimal in most reaches to 11% in one reach (USFS 1994).

From the available qualitative and quantitative data, this indicator is considered, overall, as "Functioning Appropriately." However, in lower Icicle Creek, below rm 2.8, this indicator is considered "Functioning at Unacceptable Risk."

3. Floodplain Connectivity

This indicator is strongly related to the off-channel and refugia indicators.

Off-channel habitat in the lower Icicle is limited mainly by residential development and road building. For example, there are several off-channel areas along East Leavenworth Road that are no longer connected to the stream. In several areas of the lower reach, riprap has been placed on stream banks and berms have been built to confine the stream and limit flood damage. Additionally, in several areas of the lower reach, wetlands have been reduced either through draining and/or filling them. Floodplain connectivity is limited in upper Icicle Creek in areas where roads and bridges confine the stream channel and where riprap has been placed. Five site specific areas, at road mile 4.6-5.1, 9.9-10.1, 10.7-10.8, 13.6-14.1, and Ida Campground, exist where the road system has confined the stream channel and has cut off the floodplain.

Overall, this indicator is considered "Functioning at Risk."

E. Flow/Hydrology

1. Change in Peak/Base Flows

Icicle Creek is listed under the Washington State 303(d) Clean Water Act for not meeting in-stream flow standards (WRWSC 1996). In-stream flow standards for Icicle Creek are a Class AA stream. Information in the Watershed Ranking Project shows that measured flows did not meet surface water quality standards contained in Chapter 173-201A of the Washington Administrative Code (WAC) almost 45% of the time. The assessment found that WAC in-stream flow levels are not met for 66 days on average from August to October. However, these flow standards were set in 1983 and priority water right holders, which include LNFH, Cascade, City of Leavenworth, and the Icicle Peshastin Irrigation District, are not constrained by these requirements. The WAC in-stream flow standards were established as the basis from which future (post-1983) water acquisition request would be evaluated.

Surface flows of Icicle Creek are continuously measured at a USGS gauge station (# 12458000) located at rm 5.8. This gauging station is located above all water withdrawal operations in the watershed. This is the only consistently monitored flow data available for Icicle Creek. Daily mean flow data for water years 1936 to 1971 and from 1993 to present are available from the USGS office in Spokane. Real-time data are currently not available. There is no gauging station data available for the 1971 - 1992 water years. The available data from water years 1937-1999 show the annual mean flow of Icicle Creek, at the gauging station, to be 630 cfs. The lowest daily mean flow at this location was 44 cfs, recorded on November 30, 1936, and the highest daily mean was 14,100 cfs, recorded on November 29, 1995. In general, lowest daily flows are

experienced during September and October although daily mean flows of less than 100 cfs have occurred September through February. Most high flow events occur in May-June (95%) with 5% in late fall (USFS 1995).

The discharge of Icicle Creek is altered by water diversions, which can reduce the flow in the lower reaches to very low levels during the summer and early fall (WRWSC 1998). The City of Leavenworth (3 cfs year round) and the Icicle-Peshastin Irrigation District (117 cfs irrigation season) divert water above the Snow Lakes trailhead (rm 5.7) and LNFH (42 cfs year round) and Cascade Irrigation Company (12 cfs irrigation season) divert water below the trailhead (rm 4.5). Irrigation diversions can remove 48% and 79% of the mean August and September flows, respectively (Mullan et al. 1992). To assure water for LNFH in the summers, a supplementary water supply (16,000 acre feet) was developed in Snow / Nada Lake Basin, about seven miles from LNFH and one mile above it in elevation. Icicle Peshastin Irrigation District may also supplement flows from other high elevation lakes (see Appendix A).

The amount released from the Snow / Nada Lake Basin generally accounted for a portion and some times all of the water used at LNFH (Montgomery Water Group 2004). Based on the raw flow data, releases from Snow Lakes varied between 15 and 45 cfs. Generally releases were less than 30 cfs. The initial date of water release varies from late June to early September, and releases end from late September to mid-October determined by flow conditions in Icicle Creek. But on average, water is released from Snow lakes from about mid-July through September 30. Water released flows down Snow Creek into Icicle Creek where it remains for approximately one mile before it is diverted at the LNFH diversion dam. This operation alters the natural runoff pattern for Snow Lakes, which would be a snowmelt pattern with peak discharge in late spring followed by a gradual decrease. The natural baseflow of Snow Lakes appears to be about 3-5cfs. Water released from Snow Lakes provides less water to Icicle Creek for most of the year than it would under a natural regime (as the Snow Lakes are filling up and storing water), but that which is released augments flow in lower Icicle with more than the natural flow (at least for the short reach before it is taken out at LNFH's intake and below where it is returned at LNFH's point of discharge) during a time of year when flows are critically low (USFWS 2004b, Montgomery Water Group 2004).

There are also potential changes to peak/base flows in Icicle Creek due to increases in surface runoff from residential development, roads and trails, logging, landslides, and fires. Some change in flow is likely to have occurred due to recent forest fires (44,500 acres burned in the Icicle Creek watershed during July, 1994), but flow data from the USGS gauging station shows no greater variation in flow during the two years following the fires than has occurred since 1936.

A key point to remember is that discharge data from the USGS station represents flow in Icicle Creek before any substantial consumptive use occurs and in fact, during some summer months may reflect some level of water supplementation from storage lakes. In addition, the USGS gauge data does not reflect natural and supplementation flows from Snow and Nada Lakes which enter Icicle Creek through Snow Creek at rm 5.4, downstream of the gauging station. All water

diversions and supplementations in Icicle Creek have occurred since 1942 (Cascade Orchards 1905, District 1910, City of Leavenworth 1912, LNFH 1942).

Operations at structure 2 do not increase or decrease the amount of water in Icicle Creek however it does influence the amount of water in the historic channel or the spillway canal. Structure 2 is capable of passing approximately 2,600 cfs with both gates fully opened. The gate opening at structure 2 is generally set by the arrangements of structure 5 (i.e. racks / dam boards in or out) and some flood control.

Overall, this indicator is considered "Functioning at Unacceptable Risk."

2. Increase in Drainage Network

No data is available describing increases in the drainage network of Icicle Creek. Related information is presented below.

There is a strong correlation between increases in roads and other hard surfaces (i.e. buildings, parking lots, roof tops etc.) and increases in drainage network. In Icicle Creek commercial and residential development and road and trail building has likely increased the drainage network.

Overall, this indicator is considered "Functioning at Risk."

F. Watershed Conditions

1. Road Density and Location

Currently, the open road density in the Icicle Creek watershed averages 0.4 road miles per square mile (Driscoll, USFS, Leavenworth, WA), which is better than the recommendation for no more than 1 mile per square mile. However, in the lower Icicle the road density is much higher than the watershed average. There are many valley bottom roads in all reaches of Icicle Creek.

Based on professional judgment, this indicator, at a watershed scale, is considered "Functioning Appropriately."

2. Disturbance History

The Icicle Creek watershed has a long history of human impacts beginning with sheep herding and mining in the late 1800s. Recent uses include timber harvest, road building, fire suppression, campground development, private residences, commercial development, and recreation. Five percent of Icicle Creek's watershed, outside of the Wilderness boundary, has been directly impacted by logging (USFS 1994). Road building has occurred for development, recreation, and timber harvest. Over 11% of the vegetation along lower Icicle Creek has been removed from private property (WRWSC 1998). The Icicle Creek watershed is a popular recreation area for hikers, rock climbers, fishermen, and many others. Sport and Tribal fisheries for spring Chinook salmon occur annually in lower Icicle Creek from May through July when escapement numbers

allow. A general trout fishery is open above LNFH from June through October. Natural disturbances such as fires and landslides are prevalent in the watershed. Recently, the 1994 forest fires burned 12% of the watershed (USFS 1994). In 1999, a landslide introduced a large quantity of sediment into the Icicle just above Snow Creek. In the Icicle Creek watershed, land development, road and trail building, natural disturbances, and the majority of recreation occur within riparian reserves and along side Icicle Creek and its tributaries.
Overall, this indicator is considered "Functioning at Risk."

3. Riparian Conservation Areas

This indicator is related to several habitat elements already discussed such as large woody debris, refugia, road density and location, and habitat connectivity. These elements are functioning between appropriately and at risk within the watershed.

The structure and function of the riparian zone has been reduced throughout the watershed. Riparian vegetation has been reduced and removed from urbanization, commercial development, roads and trails, timber harvest, campground development, and other human impacts. Natural disturbances such as fires and landslides have also impacted the riparian zone. In impacted areas, cover from shade and large woody debris recruitment as been reduced (USFS 1994). In many impacted areas, especially along roads, invasive weeds (ex. knapweed) have been established.

At a watershed scale, this indicator is considered "Functioning at Risk."

4. Disturbance Regime

In the Icicle Creek watershed natural disturbances are prevalent. Wildfires are common in portions of the drainage. There have been three large fires in the past 11 years (1994, 2001, 2004) that have burned approximately 15 percent of the Icicle watershed. From 1996 to 1999, five landslides/avalanches occurred in the watershed. The flow regime of Icicle Creek is variable and flashy. Floods and droughts occur frequently. The measured flow in Icicle Creek ranges from a minimum of 44 cfs to a maximum of 14,100 cfs according to readings taken from the USGS gauging station located above all the major water diversions. Pool habitat is limited in Icicle Creek and off-channel habitat is limited except in the upper reaches. Natural processes are unstable in the lower reaches and in several areas of the upper Icicle. Icicle Creek has a long and continuing history of human impacts in the watershed.

At a watershed level, this indicator is considered "Functioning at Risk."

VIII. INTEGRATION OF SPECIES AND HABITAT CONDITION

The population of bull trout in Icicle Creek is considered small and insufficient information is available to reliably assess population trends. This population has been impacted by natural disturbance events in the upper watershed as well as human developments in the lower reaches of the stream. Although most of the watershed is managed as wilderness, many habitat

indicators are “Functioning at Risk” or at Unacceptable Risk” in the upper watershed with more indicators functioning at “Unacceptable Risk” in the lower watershed which is more heavily impacted. Resilience of this local population may improve with increased access to upstream habitat by migratory fish. However, currently the population size and genetic makeup of the population is unknown and substantial natural passage impediments exist upstream of the LNFH. Overall the integration of species and habitat condition is considered “Functioning at Unacceptable Risk.”

IX. ANALYSIS OF POTENTIAL EFFECTS TO ESA LISTED SPECIES

The following provides an analysis of potential effects to ESA listed species from the proposed operations and maintenance of LNFH as described in section V (Proposed Action: Operation and Maintenance of LNFH).

A. Fish

1. Bull Trout (Salvelinus confluentus)

2. Icicle Creek Bull Trout Diagnostics

a. Subpopulation Characteristics Within Subpopulation Watersheds

1. Subpopulation Size

There are several potential affects to subpopulation size from LNFH operations. The following discusses each of these.

Passage:
Several instream structures LNFH operates and maintains prevent or impede upstream fish passage at certain times of the year. These passage impediments may negatively affect bull trout subpopulation size by reducing opportunity for fluvial bull trout to access spawning areas upstream of LNFH where a small resident population exists. The LNFH will continue efforts to develop and implement long-term solutions for fish passage through the historic channel. The LNFH has been working on long-term solutions since 1998 and completed an Environmental Impact Statement in 2002. Projects to provide passage have been postponed due to delays in receiving needed consultations and permits and due to questions that have been raised about other possible alternatives. The Service is committed to working with the Bureau of Reclamation and other affected parties (with a coordination meeting scheduled July 14, 2006) to explore use of the Bureau’s Project Alternative Solution Study (PASS) process as a way to resolve outstanding issues and move forward with effective strategies.

The LNFH will also continue efforts to develop and implement long-term solutions for fish passage and screening at the intake. Until these long-term solutions are implemented however the LNFH has proposed to modify operations of certain structures and incorporate several

additional measures which will substantially increase passage opportunity for bull trout and other fish species.

In identifying the operation plan for the next five years, the LNFH analyzed several alternatives for improving passage during the broodstock collection season including minimizing the broodstock collection window and evaluating several alternatives for short term interim or cyclical passage at structure 2 and 5 during the broodstock season. After considering the various alternatives, the LNFH proposes several things to improve passage.

During the May 15 – July 7 broodstock collection period LNFH will use two primary methods to improve interim passage opportunities by capturing and transporting bull trout upstream of the hatchery. First, all adult bull trout collected in the spring Chinook holding pond will be released upstream of the hatchery at specific locations described in Section V.B.8 "Handling Bull Trout." Second, LNFH will develop and implement a trapping operation at structure 5. Any adult bull trout captured at the trap will be released upstream of the hatchery as per V.B.8. The trap at structure 5 has not been tried before and its success at attracting and capturing bull trout is unknown. Very few fluvial sized bull trout are captured in the adult holding pond in a given year – most years none are encountered. Without a genetics baseline LNFH is assuming that bull trout captured with either of the above two methods are trying to migrate upstream. These two methods may facilitate relocation of an unknown number of bull trout to upstream areas which may benefit the Icicle Creek subpopulation. In addition, the broodstock collection window has been reduced to an approximate two month period to provide more passage when peak migrations of bull trout are expected to return.

Operations of structures 2 and 5 in the historic channel during the spring Chinook broodstock collection period (approximately May 15 through July 7) prevent fish migration upstream of LNFH during a portion of the time that adult bull trout would be expected to be migrating upstream to spawning areas. Adult bull trout in the Wenatchee Basin migrate upstream toward spawning areas from June through August as determined through video counts at the fish ladder at Tumwater Dam on the Wenatchee River. These Tumwater Dam video counts provide a reasonable basis for estimating run timing in the Icicle. Upstream movement of adult bull trout at Tumwater Dam peaks from mid-June through July with the annual timing of peak movement occurring about one month after the peak hydrograph. Annual peak discharge in Icicle Creek typically occurs in early June which would suggest peak movement of bull trout into Icicle Creek would occur about early July. By opening the structures in early July, the proposed operations at structure 5 and 2 will allow passage roughly concurrent with expected peak movement patterns of bull trout in most years. This should facilitate passage opportunities for the majority of bull trout that return to the spillway pool and that want to go upstream.

The proposed open passage date of July 8 may exacerbate passage problems upstream at the LNFH intake dam during very low flow years but flows should be sufficient most years to allow passage (bull trout did pass upstream of the intake dam in July 2001 which was an extremely dry year). In addition, the hatchery will be changing operations to provide additional flow releases (see discussion under Water Withdrawal) from Snow and Nada Dams which should improve passage opportunities at the intake structure during July and August. Delays may also impact

upstream passage at the boulder falls however it is unknown what flow conditions may facilitate passage there.

We will continue to consider additional or alternative approaches to achieving interim passage based on new information, specific conditions each year, and coordination with other parties looking for solutions that provide effective passage opportunities while not having significant adverse impacts on hatchery operations or the tribal fishery. An adaptive management approach will be used to limit, to the extent practical, the May 15 – July 7 broodstock collection period and to pursue other options to provide bull trout genetic exchange during this window. LNFH will consider annual run timing of spring Chinook at Columbia River dams (e.g. Priest Rapids, Rock Island) to adjust the May 15 date. For example, early run timing may indicate installation of racks slightly earlier than May 15 while later run-timing may allow for a slightly later installation. In some years, it may be possible to open the structures earlier than July 7 when Chinook returns are not excessive and brood and harvest needs have been satisfied.

Decisions will be based on flow conditions; bull trout return dates and rates, Chinook salmon return dates and rates, tribal fishery needs, disease risks, and habitat conditions. To reduce the number of spring Chinook salmon in the spillway pool, LNFH will operate the adult pond fish ladder more frequently during the broodstock collection period, particularly in years with large escapement (more than 5,000 adults) and increase surplus opportunities.

In an effort to provide additional passage during the closed period, we evaluated several scenarios to reduce the broodstock collection window and/or to provide cyclical passage during the period the gates are closed. We looked most closely at a scenario that would provide opening of structures 2 and 5 for a 3-5 day window in mid-late June as a means to potentially provide passage opportunities while reducing significant risks to hatchery operations. After looking at the plan in detail, it was not incorporated into the 5-year plan for the following reasons:

In summary, this plan would not guarantee passage of bull trout and because of velocity barriers at structure 2 passage would be unlikely under most flow conditions. There would also be a high potential for loss of spring Chinook salmon for both hatchery broodstock and for the tribal fishery. In addition the plan would potentially result in juvenile fish stranding and isolation of adult fish in the historic channel which would place individual bull trout at increased risk of harm. The plan would also increase the disease risk to LNFH and degrade the characteristics of the spillway pool (depth, velocities, turbidity) that make it attractive to fish.

The interim passage proposal was developed to allow bull trout access into the historic channel and potentially into habitats upstream of structure 2 (the headgate). Species present during this time potentially benefiting from this action would include spring Chinook salmon, bull trout, mountain whitefish and other native non-salmonid species (suckers). This proposal would not provide much if any benefit to steelhead as most spawning in Icicle Creek has concluded by the start of the broodstock collection period. This action would however potentially result in large numbers of spring Chinook salmon accessing the historic channel which would significantly decrease broodstock availability, tribal harvest opportunity, and the number of surplus Chinook distributed to tribes. Additionally, if the Chinook were able to pass upstream of the headgate they

would present a disease risk to the production fish being reared at LNFH (as was evidenced in 2001). This proposal does not however guarantee successful passage upstream of the headgate as hydraulic conditions at the headgate would likely preclude further upstream passage until flows in Icicle Creek drop significantly. Thus for most of the broodstock collection period most fish, including bull trout, passing upstream of structure 5 would remain in the historic channel and be highly prone to isolation once flows were reduced.

During the broodstock collection period the flows in Icicle Creek are at springtime peak discharges. Average peak flows during June are approximately 2,000 cubic feet per second. During the typical broodstock collection period the radial gates at the headgate are both closed to maintain minimal flows (20-40 cfs) through the historic channel which facilitates the use of racks (to block passage) at structure 5 in the lower end of the historic channel. Thus most of the discharge in Icicle Creek during this period is conveyed through the canal and into the spillway pool adjacent to LNFH. The resulting spill maintains characteristics (velocities, turbulence, temperature and depth) of the spillway pool which keeps the area attractive to the returning adult fish. This in turn facilitates broodstock collection, a successful tribal fishery and surplus fish distribution program.

Opening up the radial gates during the broodstock collection window would allow virtually all of the discharge in Icicle Creek to flow through the historic channel (headgate capacity is approximately 2,400-2,600 cfs). Therefore, under this plan the flow in the historic channel would go from low (20-40 cfs) to extremely high (2,000+ cfs) in an extremely short period of time. This artificial flow change would have significant negative effects on the biotic community within the historic channel area. Juvenile fish abundance in the historic channel during this time is quite high. Species present include coho salmon fry and multiple age classes of steelhead parr not to mention other fishes. The resulting flow increase would cause these fish to either be flushed out of the historic channel or they would seek slower velocity habitats often associated with channel margins thus increasing potential for stranding when flows are decreased. Studies have also shown that invertebrate communities do respond to rapid, large increases in flow in the form of catastrophic drift. This flow alteration would also largely eliminate the flow over the spillway dam crest and into the pool below. Thus, conditions in the spillway pool would go from being highly attractive to Chinook to a virtually stagnant pool with very little flow. Chinook may then leave the pool seeking the higher velocity flows in the historic channel thus compromising broodstock collection and the tribal fishery. Under such conditions Chinook may also migrate downstream and out of the Icicle into the Wenatchee River leading to increased straying.

Once the 3-5 day period of “open passage” was over staff would be required to close the radial gates and re-install racks downstream at structure 5. To reduce potential of stranding of juvenile fish in the historic channel, (which would likely be situated in edge habitats increasing potential for stranding) the radial gates would need to be incrementally closed following ramping rates which are 1” per hour given the type of channel configuration in the historic channel and life stages of fish present. Given that spring flows are so high and ramping rates so subtle it could take several days to make the necessary adjustments at the radial gates. Once the gates were finally closed racks could be re-installed at structure 5.

In summary, the proposed interim fish passage plan would not guarantee passage of bull trout upstream of the headgate and therefore would not provide much if any benefit to the bull trout subpopulation in Icicle Creek. The plan would however have a significant negative effect to the biotic community in the historic channel, potentially compromise the tribal fishery, the surplus program, LNFH broodstock collection and may present substantial disease risk to production at LNFH. For these reasons this plan was not adopted in this operations and maintenance plan.

The LNFH intake diversion dam may impede upstream and downstream fish passage particularly at low flow levels and LNFH will continue pursuit of long-term solutions aimed at resolving passage and screening conditions at its intake diversion. But in the interim and until long-term solutions are achieved LNFH will improve downstream fish passage conditions at the intake diversion during low flow periods by removing a dam board and/or replacing a dam board with a V-notch weir. In addition, LNFH will increase releases from the Snow and Nada lakes during the summer low flow periods which will increase the amount of flow going over the diversion dam therefore improving both upstream and upstream fish passage conditions. In 2006 LFNH, in coordination with other entities, will develop a Snow Lakes water release plan. This plan will lay out reservoir water release specifics (volumes and times) to minimize LNFH impacts on the environment. The goals would be to assure hatchery water needs are met, increase summertime stream flows below the LNFH diversion, dilute nutrient loading from LNFH effluent, all while balancing the reservoir recharge (i.e. refill) risk.

It must be noted, although it is not part of LNFH operation and maintenance, that the Yakama Nation also blocks fish passage at structure 5 from approximately October through November. The Yakama Nation is able to place trapped bull trout upstream of structure 2 (see consultation between BPA/ Yakama Nation and USFWS; FWS Reference Number 01-I-EO231).

Intake Screening

Inadequate fish screening at the intake continues to be problematic as entrained fish have to travel approximately a mile of pipe before they are returned back to the Icicle Creek and one of the fish bypass returns is inoperable part of the year. Fish also have to be removed with a net prior to cleaning the sand settling basin. The LNFH will also continue efforts to develop and implement long-term solutions for fish passage and screening at the intake.

Incidental Harvest

Additional effect to subpopulation size may occur from incidental take during the tribal and sport fishery. The Service does not regulate this harvest and is not considered a part of the LNFH operation and maintenance; however, the operation and maintenances of LNFH create this situation and it is worth noting its potential effects. Recent harvest reports from sport surveys indicate bull trout are not captured during the spring Chinook salmon sport fishery (WDFW, 2001, 2003, 2004, 2005). Personal communications between Dan Davies (USFWS, Leavenworth, WA) and Roger Dick (Yakama Nation, Toppenish, WA) indicate that bull trout are not captured during the tribal spring Chinook salmon fishery.

Additional information was used to further assess and describe the potential of incidental harvest of bull trout. Most upstream movement of fluvial bull trout in the Wenatchee River, as

documented at the Tumwater Dam fish ladder, occurs mid-June through July with the peak detection at Tumwater consistently occurring about 1 month after annual peak daily discharge (WDFW 2005b). Peak fishing effort for both tribal and sport fisheries occurs from mid-May through June. Annual snorkel surveys of the Icicle Creek spillway pool indicate peak bull trout abundance in August after the sport and Tribal fisheries conclude. Therefore, peak fishing effort occurs before large numbers of bull trout would be expected in the spillway pool area. While there is some risk of incidental harvest of bull trout during the sport and tribal fisheries the dissimilar timing between peak fishing effort and peak bull trout abundance would suggest the incidence of incidental take is low. Additional support for this limited impact assertion can be made with the following information. Angling for bull trout was conducted in the spillway pool by the USFWS in August and September of 2001and 2002 in an attempt to capture fish for a Wenatchee Basin radio-tagging study. This effort targeted bull trout during their observed peak abundance period in the spillway pool. Despite this "targeting," only 11 bull trout were captured in 48 hours of directed effort for a catch rate of 0.2 fish an hour. There has also been very few observations (few fish) of hook scarring (around the mouth) of bull trout made during the snorkel surveys of the spillway pool. And there has been no observation of hook scarring of body tissues indicative of snagging.

Hatchery/Wild Fish Interactions

Direct competition for food and space between hatchery and natural fish (bull trout) may occur in spawning/or rearing areas and the migration corridor, but often more intensely between individuals of the same species. These impacts are assumed to be greatest in the spawning and nursery areas and at points of highest fish density (release areas) and to diminish as hatchery smolts disperse (BAMP 1998). However, LNFH spring Chinook would not to be expected to spawn in areas typically associated with bull trout spawning and thus there is little to no effect to the bull trout subpopulation.

Release of hatchery smolts that are physiologically ready to migrate is expected to minimize competitive interactions as they should quickly migrate out of the spawning and rearing areas (NMFS 1995). Competition continues to occur at some unknown, but probably lower level as smolts move downstream through the migration corridor (BAMP 1998). Rearing and release strategies are designed to limit the amount of ecological interactions occurring between hatchery and naturally produced fish. Fish are reared to sufficient size that smoltification occurs within nearly the entire population, which reduces retention time in the streams after release (Bugert et al. 1991). Witty et al. (1995) state they did not find any literature or data to demonstrate functional relationship between numbers of juvenile migrants moving through reservoirs and impacts on smolt survival attributable to competition.

Hatchery fish may prey upon natural fish. There is currently no evidence that hatchery released fish prey on bull trout, or prey species for bull trout, and it is likely that hatchery fish may provide a substantial prey base for bull trout. Due to their location, size, and time of emergence, newly emerged Chinook salmon fry are likely to be the most vulnerable to predation by hatchery released fish (USFWS 1994). Emigration out of hatchery release areas and foraging inefficiency of newly released hatchery smolts may minimize the degree of predation (USFWS 1994).

Witty et al. (1995) conclude that the potential impact of hatchery salmonid predation on natural salmonids in the mainstem corridor is not a significant factor. Steward and Bjornn (1990) state that large concentrations of hatchery fish may adversely affect wild juveniles by stimulating functional responses from bird and non-salmonid fish predators. On the other hand, a mass of fish moving through an area may confuse or distract predators and may provide a beneficial effect (BAMP 1998).

Hatchery-reared salmon and steelhead released into spawning and rearing areas of natural species may fail to emigrate (residualize), and may negatively interact with natural fish (BAMP 1998). Releases from Leavenworth NFH are timed to mimic the out-migration of naturally produced salmon to further reduce potential residuals. Precocious maturation of male stream-type (spring Chinook) Chinook salmon is common, suggesting that it is a characteristic of this behavioral form (Mullan et al. 1992). They also indicate that precocious maturation of male spring Chinook salmon is common in the mid-Columbia Basin and is characteristic of both hatchery and wild stocks. Examination of 3,443 juveniles from the Lemhi River, Idaho, showed that precocious development existed in 2.6% of the sample (Gebhards 1960). Precocious males constituted about 1% of 20,000 wild Chinook salmon examined in tributary streams of the mid-Columbia River 1983 - 1988 (Mullan et al. 1992). Precocious males tend to have a higher mortality rate than non-maturing juveniles (Chapman et al. 1995). Mullan et al. (1992) found that precocious males made up a greater percentage of the fish that died at Leavenworth NFH. Precocious males also tend to be less nomadic than other juveniles. In Icicle Creek, Mullan et al. (1992) report that males generally remained in the test area, while female migrated.

Water Withdrawal

Potential effects to bull trout population, from the LNFH's water withdrawal operations, could occur between rm 2.8 and 4.5. LNFH water withdrawal operations would have no effect on bull trout activities below rm 2.8 as all surface and well waters used at LNFH are returned there. Operations are unlikely to negatively affect bull trout spawning below river mile 4.5 as spawning does not occur in the affected reach. Additionally, bull trout spawning habitat is not present in the historic channel and future management activities in this area are unlikely to create or allow for the natural creation of suitable condition for bull trout spawning. Habitat in these two reaches does not meet the preferred bull trout spawning habitat requirements of low gradient areas with loose, clean gravel (Fraley and Shepard 1989) and water temperatures of 41 to 48 ºF (5 to 9 ºC) in late summer and early fall (Goetz 1989). However, a reduction in flow in the historic channel and the intake reach, through hatchery operations, has the potential to affect juvenile bull trout migration, rearing habitat and water temperatures. Additionally, bull trout migrating downstream could become trapped on the intake's bar rack or entrained in the water delivery system. Greater use of Snow Lakes water during the summer months will improve habitat conditions (quantity and improved water temperatures) below rm 4.5 and will benefit the Icicle Creek bull trout subpopulations.

Operations of structure 2 influence flow regime in the historic channel and spillway canal. When the spillway canal flows decrease there is potential to strand fish in the canal. However, as flows decrease all water flows toward the historic channel thus lessening the likelihood of stranding. Further, the uniform gradient of the spillway canal largely precludes formation of isolated pools

and stranding of fish. Leakage at structure 2 (radial gates) and groundwater infiltration prevent the historic channel from completely dewatering.

In summary, the proposed operation and maintenance of LNFH will improve fish passage and habitat conditions in Icicle Creek from previous times. However, passage is still impeded part of the time that adult bull trout may be attempting upstream migrations and sport and tribal harvest in Icicle Creek are expected to continue. Thus this indicator is considered "Degraded."

2. Growth and Survival

LNFH's operations and maintenance may improve condition of bull trout foraging due to the release of juvenile salmon. The proposed operation and maintenance of LNFH will improve fish passage and habitat conditions in Icicle Creek from previous times which should improve growth and survival. However, passage is still impeded part of the time that adult bull trout may be attempting upstream migrations and sport and tribal harvest in Icicle Creek are expected to continue thus this indicator is considered "Degraded."

3. Life History Diversity and Isolation

LNFH's operations and maintenance influence bull trout life history diversity and isolation due to fish passage impediments from the hatchery dam (structure 2/spillway dam) to the Icicle Peshastin Irrigation District (IPID) dam. The IPID dam was constructed and described as a barrier prior to the construction of LNFH, and based on the timing of most anadromous runs, would necessarily have to be considered the historical man made barrier to migratory access of upper Icicle Creek. Therefore, blockage has existed since at least 1915 not 1940.

The upstream and downstream passage provisions proposed herein for current and future operations will increase passage potential and opportunity for this subpopulation to connect with other subpopulations in the Wenatchee River Basin. However, passage is still impeded in Icicle Creek part of the year at upstream areas and thus this indicator is considered "Degraded."

4. Persistence and Genetic Integrity

LNFH's operations and maintenance influence persistence and genetic integrity of bull trout in Icicle Creek due to fish passage impediments. Proposed upstream and downstream passage provisions increase passage potential for this subpopulation which may benefit persistence and genetic integrity of the species. Additionally, LNFH does not raise or release fish species which would hybridize with bull trout. However, passage is still impeded in Icicle Creek part of the year and thus this indicator is considered "Degraded."

B. Wildlife
1. Bald Eagle (Haliaeetus leucocephalus)

The LNFH is not located within a bald eagle recovery territory by the USFS. The nearest recovery area is in the Tumwater Canyon less than five miles from the LNFH. Day to day

hatchery operation and maintenance activities do not disrupt bald eagle activities such as foraging and roosting. The hatchery may have a beneficial effect by increasing bald eagle prey base fishery. The temporary noise disturbance from few helicopter flights a year to adjust the valve on Snow Lake may minimally and temporarily affect bald eagle activities in the area. However, these flights occur outside the winter roosting season. Flights also occur between 9 am and 3 pm, the recommended time period for reducing the potential effects from noise. Operation and maintenance of LNFH is not likely to adversely affect the bald eagle population.

2. Gray Wolf (Canis lupus)

The hatchery is located within habitat for gray wolves in the conterminous (lower 48) states; however, there have been no confirmed sightings of gray wolves in or near the LNFH. LNFH's operations have no effect on denning or rendezvous sites for gray wolves, as there are no known denning or rendezvous sites within or adjacent to the hatchery. Day to day operations have no effect on potential gray wolf prey. The temporary noise disturbance from few helicopter flights a year, from the heli-pad at LNFH to the vicinity of Snow Lake and back, to adjust the valve on Snow Lake may minimally and temporarily affect prey species and their activities. However, this is unlikely. Operation and maintenance of LNFH has “no effect” on the gray wolf.

3. Grizzly Bear (Ursus arctos)

Hatchery operations are not likely to affect the grizzly bear as it is unlikely that grizzly bears occupy the project area. Also, hatchery operations would not cause any direct effect from disturbance to grizzly bear denning or foraging sites. Day to day hatchery operations have no effect on potential grizzly bear prey. The temporary noise disturbance from few helicopter flights year to adjust the valve on Snow Lake may minimally and temporarily affect prey species and their activities. However, this is unlikely. Operation and maintenance of LNFH has “no effect” on the grizzly bear.

4. Northern Spotted Owl (Strix occidentalis caurina)

Hatchery operations have no effect on nesting, roosting, foraging, or dispersal habitat for spotted owls. Most of LNFH grounds are non-habitat for spotted owls. However, the forested and private lands adjacent to LNFH property may provide connectivity for spotted owls moving across the landscape from the Swauk Late Successional Reserve (LSR) to the Icicle LSR and the Deadhorse LSR. Operation and maintenance of LNFH has “no effect” on the northern spotted owl.

5. Marbled Murrelet (Brachyramphus marmoratus)

There are no recorded Marbled Murrelet sightings in the Icicle Creek Basin. LNFH grounds do not meet the habitat requirements for this species. Operation and maintenance of LNFH has “no effect” on the Marbled Murrelet as they are not present in the area or vicinity.

6. Canada Lynx (Lynx canadensis)

There are no recorded Canada Lynx sightings in the Icicle Creek Basin (Jannet Millard, USFS, Leavenworth, WA). LNFH grounds do not meet the habitat requirements for this species; however, the Snow / Nada Lakes Basin might. Day to day hatchery operations have no effect on Canada lynx or their potential prey. The temporary noise disturbance from few helicopter flights a year to adjust the valve on Snow Lake may minimally and temporarily affect prey species and their activities. The operation and maintenance of LNFH has "no effect" on the Canada lynx.

7. Pacific Fisher (Martes pennanti)

Pacific Fishers are thought to have been extirpated from Washington State in the 1930's. There are no recorded fisher sightings in Icicle Creek or in the Wenatchee National Forest (Jannet Millard, USFS, Leavenworth, WA). LNFH operations and maintenance have "no effect" on the Fisher as they are not present in the project area or vicinity.

8. Yellow-billed Cuckoo (Coccyzus americanus occidentalis)

There are no recorded Yellow-billed cuckoo sightings in Icicle Creek or in the Wenatchee National Forest. LNFH grounds do not meet the habitat requirements for this species. The closest potential area where Yellow-billed cuckoos might occur is Douglas County (Jannet Millard, USFS, Leavenworth, WA). Operation and maintenance of LNFH has "no effect" on the yellow-billed cuckoo as they are not present in the area or vicinity.

C. Plants

No federally listed plants occur on LNFH grounds. Therefore, there would be no direct effects on federally listed plants through hatchery activities. Likewise, these activities would have no effect on critical habitat for listed plant species as there is none in the project area. Operation and maintenance of LNFH has "no effect" on federally listed plant species or critical habitat.

X. ANALYSIS OF POTENTIAL EFFECTS TO THE CURRENT CONDITION OF HABITAT

A. Water Quality

1. Temperature

Operation of LNFH's water delivery system, along with other water users, can potentially degrade this indicator in the stream reach between rm 2.8 and 4.5 during low flows periods. However, the hatchery's release of supplemental water from Snow and Nada Lakes minimizes this potential. In fact, if LNFH were not present, flow and water temperature conditions would be highly degraded throughout the lower 5.7 miles of Icicle Creek. Operations of LNFH (use of Snow Lakes) increase stream flows and reduce or maintain temperatures from the confluence of Snow Creek (rm 5.5) to the intake (rm 4.5). The proposal to greater utilize Snow Lakes water to supplement flows in Icicle Creek during the summer months will benefit water quality in Icicle Creek from rm 5.5 downstream to the Wenatchee River confluence. The LNFH water return flows at rm 2.8 substantially increase stream flow and decrease water temperatures downstream

of the hatchery. Overall, the proposed operations of LNFH improve flow and temperature conditions in lower Icicle Creek, especially in the critical late summer period, compared to what would be occurring if LNFH were not operating. Therefore this indicator is considered to be "Maintained."

2. Sediment/Turbidity

The LNFH intake system and withdrawal of 42 cfs year-round does not increase the sediment input into Icicle Creek or affect factors which contribute to sedimentation. Sampling results indicate LNFH meets all NPDES permit requirements. Reducing flows may increase the amount of sediment settling out in these areas, however, this is unlikely as sediment moves through this system at high flows. Operation and maintenance of LNFH's intake system does decrease the amount of sediment entering areas below rm 4.5 as the water entering the intake flows through a sediment settling basin and potentially a pollution abatement pond before re-entering Icicle Creek. Although sediment is disturbed during maintenance of the intake canal most if not all of the disturbed sediment settles in the sand settling basin or pollution abatement pond. The operations and maintenance of LNFH have minimal effect on the sediment / turbidity in Icicle Creek and therefore this indicator is considered "Maintained."

3. Chemical Contamination/Nutrients

In 2005 the USFWS conducted a study to determine the extent of PCB and pesticide concentrations in hatchery fish from different rearing units, in Icicle Creek above and below the hatchery, and in the pollution abatement pond. Data show that LNFH is not adversely impacting the PCB or pesticide concentrations in Icicle Creek below the hatchery and hatchery fish are not accumulating PCB or pesticides to levels of concern (See USFWS 2005a for specific details).

The LNFH contributes phosphorus into Icicle Creek. Phosphorus is the limiting nutrient for the production of periphyton. Phosphorus controls periphyton growth which in turn controls excessive pH and DO diel swings. The DOE stated that the months of July through October is the period of concern as enough light is available for photosynthetic productivity, flows are low, and water temperatures are warm enough for productivity. The highest diel pH values (and only exceedances) measured in Icicle Creek during 2002-2003 were at the mouth of the creek during the August and September synoptic surveys. Opportunities to reduce discharge of nutrients are currently being explored such as use of low phosphorus feed. In addition, Aquamats will be installed to further reduce nutrient discharge. The potential to increase use storage water from Snow Lakes, as a means to reduce nutrient loading in Icicle Creek, is also being explored. Current activities will not change the creek's Clean Water Act 303(d) water quality designations.

The operations and maintenance of LNFH inputs nutrients into Icicle Creek and therefore this indicator is currently considered "Degraded." Proposed actions described above will improve this indicator in the future.

<u>B. Habitat Access</u>

1. Physical Barriers

Currently, upstream and downstream fish passage at all flows does not occur through the main hatchery complex beginning at rm 2.8. Fish passage is blocked at rm 2.8 (structure 5) during broodstock collection (May 15 – July 7). Outside this period when passage is open at structure 5 fish passage may be impeded upstream at structure 2 during high flows due to the velocity barrier. It is possible however for fish to pass through the structure when water elevations are equal or nearly so on both sides of the structure. Passage during low flows is possible with a single gate opened. Passage may also be impeded at the intake dam during low flow periods although, as described earlier, components to the dam structure itself will be modified to improve up and downstream passage. Greater use of Snow Lake water will also improve passage conditions during the summer and early fall. While improved from past conditions, the amount, timing, and duration of fish passage that may be possible is less than preferred for threatened and endangered fish species and most other fish species present and that is why LNFH is seeking long-term solutions to fish passage problems.

The proposed operation and maintenance of LNFH have improved habitat access compared to previous operations but problems remain and therefore this indicator would be “Degraded.”

C. Habitat Elements

1. Substrate

The operation and maintenance of LNFH have negligible effects on substrate and therefore this indicator would be “Maintained.”

2. Large Woody Debris (LWD)

LWD recruitment may be reduced in the historic channel as LWD removed from structure 2 is placed in the bypass canal. LWD may settle in the canal and what is transported downstream by flows is available to lower Icicle Creek. Overall, hatchery operations and maintenance are unlikely to have an effect on LWD recruitment or abundance in Icicle Creek.

The operation and maintenance of LNFH have negligible effects on LWD and therefore this indicator would be “Maintained.”

3. Pool Frequency and Quality

The operation and maintenance of LNFH have negligible effects pool frequency and quality, and therefore this indicator would be “Maintained.”

4. Large Pools

The operation and maintenance of LNFH have negligible effects on large pools and therefore this indicator would be “Maintained.”

5. Off-channel Habitat

The operation and maintenance of LNFH will improve fish access and habitat conditions in the historic channel compared to past operations. The historic channel habitat provides off-channel habitat which is beneficial to fish and wildlife species and therefore this indicator would be "Maintained."

6. Refugia

The operation and maintenance of LNFH have negligible effects on refugia and therefore this indicator would be "Maintained."

D. Channel Condition and Dynamics

1. Width/Depth Ratio

The operation and maintenance of LNFH have negligible effects on width to depth ratio and therefore this indicator would be "Maintained."

2. Stream Bank Condition

The operation and maintenance of LNFH have negligible effects on stream bank condition and therefore this indicator would be "Maintained."

3. Floodplain Connectivity

The operation and maintenance of LNFH have negligible effects on floodplain connectivity and therefore this indicator would be "Maintained."

E. Flow/Hydrology

1. Change in Peak/Base Flows

The operation and maintenance of LNFH have a positive and negative effect on flow in Icicle Creek. Positive effects occur when release are made for the Snow / Nada Lake reservoirs in July, August and September which effectively increase base flow around 42 cfs between Snow Creek confluence (rm 5.5) and LNFH intake (rm 4.5); and downstream of the LNFH's discharge (rm 2.8) to the mouth. Negative effects occur during other times of the year when water is not augmented through reservoir releases between rm 2.8 to 4.5 and when the reservoirs fill.

The operation and maintenance of LNFH has a negative effect to base flow conditions in Icicle Creek from approximately October through July. However, this effect is minimized as this is a period of increased flow conditions in the creek. Conversely, LNFH's Snow Lake augmentation of Icicle Creek from July through September benefits the stream environment, in areas described

above, at the most critical flow period of the year. Although augmentation of Snow Lakes causes a slight decrease to peak springtime flows in Icicle Creek (as the lake is re-filling), this is a minor relative effect. Although LNFH operations and maintenance activities do provide some benefit during the summer months, the rest of the year up to 42 cfs is diverted and while the reservoirs are filling and therefore this indicator would be "Degraded."

2. Increase in Drainage Network

The operation and maintenance of LNFH have negligible effects on drainage network and therefore this indicator would be "Maintained."

F. Watershed Conditions

The operation and maintenance of LNFH have negligible effects on the watershed condition and therefore this indicator would be "Maintained."

XI. CUMULATIVE EFFECTS

Current conditions in the area of LNFH for Icicle Creek bull trout are, for the most part, degraded and the population size is low. No major changes (housing developments, road building, etc.) are anticipated, however, typical development will likely continue in the Icicle Creek watershed. Several projects are proposed (see Foreseeable Future Actions) for LNFH which could offset detrimental impacts to the environment. The proposed operations and maintenance of LNFH should improve passage and habitat conditions.

XII. EFFECT DETERMINATIONS AND RESPONSE REQUESTED

Bull Trout (*Salvelinus confluentus*)

Determination:	Response Requested:
____No Effect	____ *Concurrence
___Is Not Likely to Adversely Affect	_____Concurrence
	_____*Formal Consultation
__X__Is Likely to Adversely Affect	_X___Formal Consultation

Gray Wolf (*Canis lupus*)

Determination:	Response Requested:
__X__No Effect	____ *Concurrence
____Is Not Likely to Adversely Affect	__X___Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Bald Eagle (*Haliaeetus leucocephalus*)

Determination:	Response Requested:
___No Effect	____ *Concurrence
__X__Is Not Likely to Adversely Affect	_X___Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Grizzly Bear (*Ursus arctos horribilis*)

Determination:	Response Requested:
__X__No Effect	____ *Concurrence
_____Is Not Likely to Adversely Affect	__X__Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Northern Spotted Owl (*Strix occidentalis caurina*)

Determination:	Response Requested:
__X__No Effect	____ *Concurrence
____Is Not Likely to Adversely Affect	__X__Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Marbled Murrelet (*Brachyramphus marmoratus*)

Determination:	Response Requested:
__X__No Effect	____ *Concurrence
____Is Not Likely to Adversely Affect	__X__Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Canada Lynx (*Lynx canadensis*)

Determination:	Response Requested:
__X__ No Effect	____ *Concurrence
____Is Not Likely to Adversely Affect	__X__Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Pacific Fisher (*Martes pennanti*)

Determination:	Response Requested:
__X__ No Effect	____ *Concurrence
____Is Not Likely to Adversely Affect	__X__Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*)

Determination:	Response Requested:
__X__ No Effect	____ *Concurrence
____Is Not Likely to Adversely Affect	__X__Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Wenatchee Mountains checker-mallow (*Sidalcea oregana var. calva*)

Determination:	Response Requested:
__X__ No Effect	____ *Concurrence
____Is Not Likely to Adversely Affect	__X__Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Ute ladies' tresses (Spiranthes diluvialis)

Determination:	Response Requested:
__X__ No Effect	____ *Concurrence
____Is Not Likely to Adversely Affect	__X__Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

Showy stickseed (*Hackelia venusta*)

Determination:	Response Requested:
__X__ No Effect	____ *Concurrence
____Is Not Likely to Adversely Affect	__X__Concurrence
	_____*Formal Consultation
_____Is Likely to Adversely Affect	_____Formal Consultation

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XIV. TABLES

Table 1. Leavenworth National Fish Hatchery's Water Rights

CERTIFICATE #	PRIORITY DATE	SOURCE	AMOUNT
1824	03/26/1942	Icicle Creek	42 cfs (18,851 gpm)
1825	03/26/1942	Snow & Nada Lakes	16,000 acre feet
016378	08/01/1939	Groundwater (1 Wells)	1.56 cfs (700 gpm)
016379	06/01/1940	Groundwater (1 Wells)	2.01 cfs (900 gpm)
3103-A	10/16/1957	Groundwater (1 Wells)	2.67 cfs (1200 gpm)
G4-27115C	10/20/1980	Groundwater (4 Wells)	8.69 cfs (3900 gpm)

Table 2. USFWS snorkel survey counts of bull trout in the spillway pool adjacent to LNFH 1994-2005.

Year	July	August	September
1994	N/C	3	N/C
1995	3	N/C	N/C
1996	N/C	10	N/C
1997	N/C	11	N/C
1998	1	1	41*
1999	N/C	2	7
2000	6	45	N/C
2001	4	40	N/C
2002	11	16	N/C
2003	N/C	75	N/C
2004	N/C	125	N/C
2005	12	46	N/C

N/C = no survey. * In 1998, a count of 41 bull trout was made on 9/9, fourteen bull trout were observed on 9/28, and three bull trout were observed on 10/13.

Table 3. USFWS survey counts of adult spring Chinook salmon adjacent to LNFH and the associated annual escapement 1994-2005.

Year	Count	Escapement
1994	102	1124
1995	N/A	484
1996	N/A	1327
1997	63	4533
1998	60	2158
1999	N/A	2073
2000	140	9464
2001	1229	15082
2002	564	12281
2003	225	8161
2004	196	3732
2005	49	3793

N/A = no count data

Escapement is the sum of all LNFH fish taken in at the hatchery, sport and tribal harvest, and in-river spawning.

Counts represents sum of fish in the spillway pool and areas upstream if passage was provided (as it was in 2001 and 2005). Counts were made late July to early August in all years after fish ladder was closed.

Note: in 1994 five more adult Chinook were counted between the spillway pool and river mouth; in 2001 the number of Chinook counted between the pool and river mouth was 197 and in 2002 this number was 264. In 2005 there were five additional Chinook counted below the hatchery pool.

Table 4. Checklist for Documenting Environmental Baseline and Effects of Proposed Action(s) on Relevant Indicators.

Diagnostics/ Pathways:	Population &	Environmental	Baseline	Effects	Of The	Action(s)
Indicators	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk	Restore	Maintain	Degrade
Subpopulation Characteristics: Population Size			X			X
Growth and Survival			X			X
Life History Diversity and Isolation			X			X
Persistence and Genetic Integrity			X			X
Water Quality: Temperature			X		X	
Sediment		X			X	
Chem. Contam./Nutrients		X				X
Habitat Access: Physical Barriers			X			X
Habitat Elements: Substrate Embeddedness			X		X	
Large Woody Debris		X			X	
Pool Frequency and Quality			X		X	
Large Pools		X			X	
Off-channel Habitat	X		X (below rm 2.8)		X	
Refugia		X	X (below rm 2.8)		X	
Channel Cond. & Dynamics: Wetted Width/Max. Depth Ratio		X			X	
Streambank Condition	X		X (below rm 2.8)		X	
Floodplain Connectivity		X			X	
Flow/Hydrology: Change in Peak/Base Flows			X			X
Drainage Network Increase		X			X	
Watershed Condition: Road Density & Location	X				X	
Disturbance History		X			X	
Riparian Conservation Areas		X			X	
Disturbance Regime		X			X	
Integration of Species and Habitat Conditions			X		X	

Table 5. Documentation of Expected Incidental Take

Name and location of actions(s): Operations and Maintenance of Leavenworth National Fish Hatchery, Leavenworth, WA

Species: Bull trout (*Salvelinus confluentus*)

(1) The proposed action may result in incidental take through which of the following mechanisms (**bold** as appropriate)

> **Harm:** Significant impairment of behavioral patterns such as breeding, feeding, sheltering, and others (identify). **Migration**
>
> **Harass:** Significant disruption of normal behavior patterns which include, but are not limited to, breeding, feeding, sheltering, or others (identify). **Migration**
>
> Pursue, Hunt, Shoot, Wound, Capture, Trap**, Collect.**

(2) What is the approximate duration of the effects of the proposed action(s) resulting in incidental take?

The operation and maintenance of LNFH occur year round so the duration of the effect could also be year round. However, there are certain periods of hatchery operation and maintenance (i.e., broodstock collection) where take is more probable.

(3) Which of the following life stages will be subject to incidental take (**bold** as appropriate)?

> Fertilization to emergence (incubation)
>
> Juvenile rearing to adulthood
>
> **Adult holding and overwintering**
>
> **Adults migrating**
>
> **Juveniles migrating**

(4) Which life form and subpopulation status are present in the watershed or downstream of the watershed where the activities will take place (circle as appropriate)?

Life Form:	Subpopulation status:
Resident	**Unknown**
Adfluvial	Depressed population
Fluvial	**Unknown**
Anadromous	

(5) What is the location of the expected incidental take due to the proposed action(s)?

Basin and watershed: Wenatchee River Basin, Icicle Creek Watershed

Stream reach and habitat units: Icicle Creek (rm 2.8-4.5)

(6) Quantify your expected incidental take:

Length of stream affected (miles): Approximately 1.7 river miles.

Individuals (if known): Potentially up to 15 adults and an unknown number of juveniles. During some years over 100 bull trout may return to the base of the LNFH spillway dam (rm 2.8) and some of these may migrate upstream when passage is provided.

XV. FIGURES

Figure 1. Leavenworth National Fish Hatchery and Vicinity.

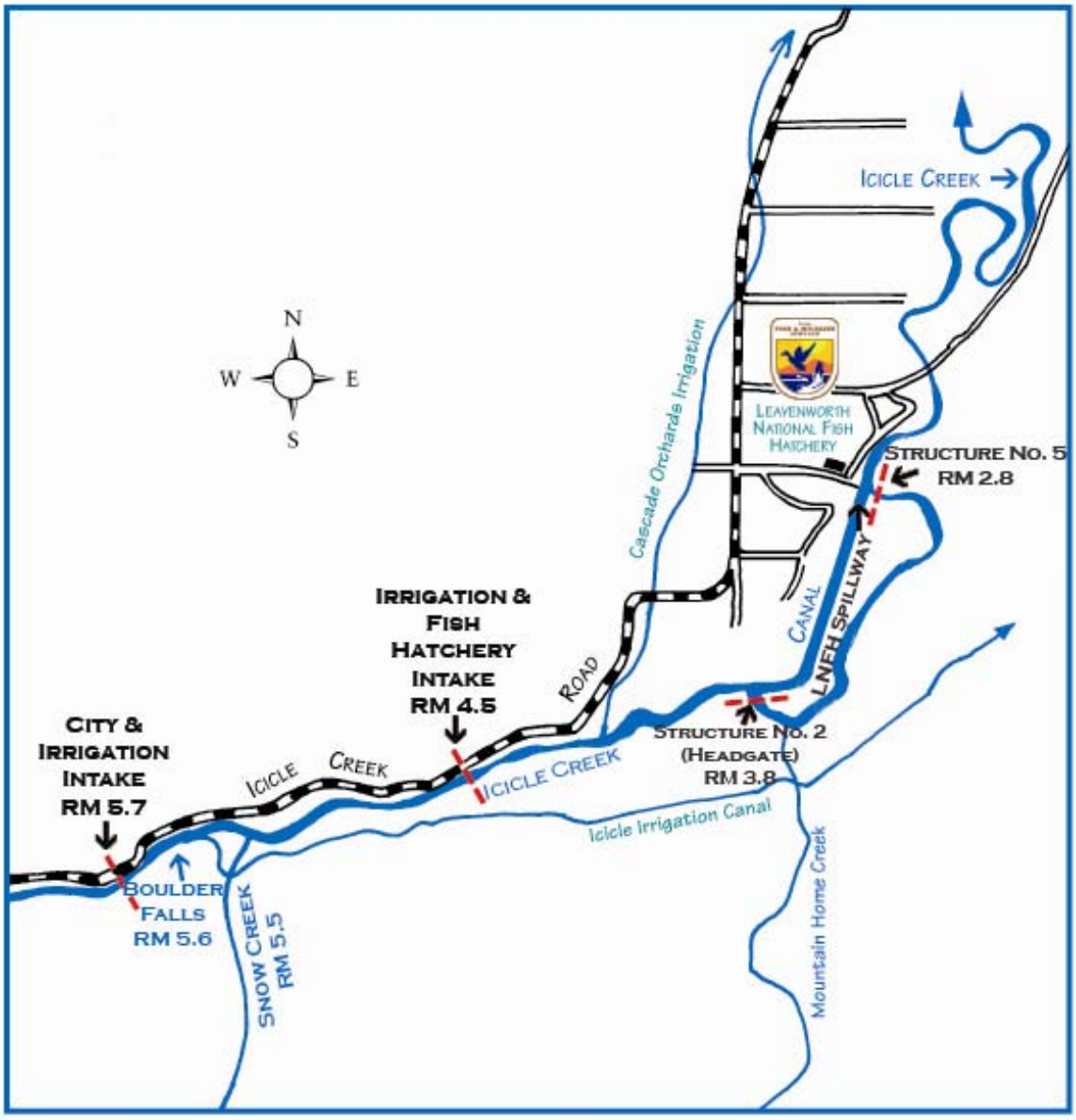

Figure 1. Leavenworth National Fish Hatchery and Vicinity

Figure 2: Information from Wurster (2006) regarding water release from the Snow / Nada Lakes Reservoirs.

Table 5: A) Volume of water (ac-ft) removed from Upper Snow Lake for different flow scenarios. B) estimated probability that inflows to Upper Snow Lake will meet or exceed the released volumes from 5A. The row corresponding to average hatchery diversions from Icicle Creek is shaded (40 cfs). Total lake volume is about 12,450 ac-ft.

A

Days Upper Snow Lake Valve is Open

Average Release from Upper Lake (cfs)	40	50	60	70	80	90	100	110	120
20	1580	1980	2380	2770	3170	3560	3960	4360	4750
30	2380	2970	3560	4160	4750	5350	5940	6530	7130
40	3170	3960	4750	5540	6340	7130	7920	8710	9500
50	3960	4950	5940	6930	7920	8910	9900	10890	11880
60	4750	5940	7130	8320	9500	10690	11880		
70	5540	6930	8320	9700	11090	12470			
80	6340	7920	9500	11090	12670				
90	7130	8910	10690	12470					
100	7920	9900	11880						
110	8710	10890							
120	9500	11880							

Exceeds Total Volume of Lake

B

Days Upper Snow Lake Valve is Open

Average Release from Upper Lake (cfs)	40	50	60	70	80	90	100	110	120
20	> 92	> 92	> 92	> 92	> 92	> 92	> 92	91	86
30	> 92	> 92	> 92	93	86	79	72	65	58
40	> 92	> 92	86	76	67	58	48	39	29
50	> 92	83	72	60	48	36	25	13	< 8
60	86	72	58	43	29	15	< 8		
70	76	60	43	27	10	< 8			
80	67	48	29	10	< 8				
90	58	36	15	< 8					
100	48	25	< 8						
110	39	13							
120	29	< 8							

ExceedsTotal Volume of Lake

XVI. APPENDICES

Appendix A: Upstream Water Withdrawal

The upstream-most diversion dam on Icicle Creek is maintained and operated by the Icicle-Peshastin Irrigation District. Surface waters are withdrawn at this location to supply the City of Leavenworth (City), the Icicle Irrigation District, and the Peshastin Irrigation District. The Icicle Irrigation District and Peshastin Irrigation District (District) share ownership of some canals and water rights to storage lakes and surface waters of Icicle Creek. An agreement between the two irrigation districts governs operations. The District and City divert Icicle Creek surface water from opposite sides of the creek, at a diversion dam (rm 5.7) upstream of the Snow Lakes trailhead. The City has a surface water right of 3 cfs and withdraws water year-round (Valentine pers. comm. 2001). The District holds a combined water right to Icicle Creek flow of nearly 118 cfs. In general, the District diverts creek water from April to October, although operations may begin as early as mid-March and last until mid-October in some years (Teeley pers. comm. 2001 & 2002). Peak irrigation use is from June through August (Leonoff 1992).

The District's water delivery system takes water from behind the diversion dam and conveys it through a gravity-run open canal system. The ability of fish to migrate both upstream and downstream past this diversion dam is unknown. A rotating drum screen is located near the top-end of the irrigation canal and provides for fish screening. The drum screen does not meet current fish screening criteria, however the District is actively researching upgrading options. Any fish or debris encountered at the drum screen is shunted back into Icicle Creek.

The District normally operates with natural flows in Icicle Creek. However, the District may release supplemental water from storage lakes in the upper watershed, now a part of the Alpine Lakes Wilderness Area. The District holds a 1929 adjudicated water right for 2,500 acre feet each on Colchuck, Eight Mile, and Klonaqua Lakes. However, the recharge capacity of the storage lakes may not be as large as the water rights that are assigned to them (Leonoff 1992). Additional water rights were granted to the District for Square Lake (2,000 acre feet) and Snow Lake (600 acre feet) subsequent to the 1929 adjudication (Leonoff 1992). The District typically begins release of water from one upper basin lake (Colchuck, Eight Mile, Klonaqua, or Square Lake) in the beginning of August and releases from a second lake towards the end of August. The District will rotate usage between all four lakes, using no more than two lakes in a single year to ensure sufficient storage for the following year (Teeley pers. comm.). Water released from these upper basin lakes is eventually diverted into the District's water delivery system at the diversion dam or directly into their irrigation canal. Water released from the lakes are used to satisfy the District’s water rights in Icicle Creek and the rights are not in addition to the 118 cfs water right currently held (Leonoff 1992). The District returns excess “carrying” water to the Wenatchee River at several locations.

Appendix B: Sediment monitoring data associated with the operation of structures 2 and 5.

SEDIMENT MONITORING

'05

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
10/28	ABOVE DAM 5	3:00	COMPLIANCE	51°	P. CLOUDY	3.41	SL	RAIN OVERNIGHT
10/28	BELOW DAM 5	3:05	"	51°	"	3.84	SL	CONTRIBUTING TO
10/28	ABOVE HG	3:10	"	51°	"	1.37	SL	TURBIDITY
10/28	BELOW HG	3:15	"	51°	"	1.50	SL	
11/4	INTAKE	0900	WEEKLY	38°	P. SUN	.39	SL	
11/4	E LEAV BRIDGE	0910	"	38°	"	1.30	SL	
11/13	INTAKE	1105	"	39°	SNOW	.57	SL	
11/13	E. LEAV BRIDGE	1115	"	39°	SUN	.93	SL	
12/1	INTAKE	1:00	"	28°	SNOW	.37	SL	
12/1	E. LEAV BRIDGE	1:15	"	28°	SNOW	.32	SL	
12/12	Intake	9:15	"	10°	mostly Sunny	.86	LK + GM	Ice in river
12/12	E. Leav Bridge	9:25	"	10°	mostly Sunny	.44	LK + GM	Ice in river
12/23	INTAKE	10:50	"	30°	FOG	1.38		
12/23	E. LEAV BRIDGE	11:00	"	30°	FOG	2.73		
12/26	INTAKE	0900	HIGH WATER	33	RAIN	3.39		CONTINUOUS RAIN ALL WEEKEND ICE @ INTAKE HAS MELTED - STAFF GAUGE READS 1.8 - HEAVY AMOUNTS OF DEBRIS FLOATING IN RIVER & STUCK ON RACKS @ INTAKE.
12/26	E. LEAV BRIDGE	0910	"	33	RAIN	5.51		

SEDIMENT MONITORING

'05

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
9-22	INTAKE	300p	WEEKLY	71°	P. CLOUDY	1.09	SL	
9-22	E. LEAN BRIDGE	310p	"	"	"	.40	SL	
9-29	INTAKE	1100	"	66°	"	.39	SL	
9-29	E. LEAN BRIDGE	1110	"	66°	"	.51	SL	
10. 7	INTAKE	1:20p	"	60°	"	.53	SL	
10-7	E. LEAN BRIDGE	1:30p	"	60°	"	.40	SL	
10-12	INTAKE	0835	"	46°	"	.40	SL	
10-12	E. LEAN BRIDGE	0850	"	46°	"	.46	SL	
10-20	INTAKE	1:00	"	67°	SUN	1.09	SL	
10-20	E. LEAN BRIDGE	1:10	"	67°	"	.46	SL	
10-27	INTAKE	0830	"	27°	CLEAR	.30	SL	
10-27	E. LEAN BRIDGE	0840	"	27°	COLD	.36	SL	
10-28	ABOVE HEADGATE	0800	REMOVE RACKS	42°	RAIN	.35	SL	
10-28	BELOW "	0805	"	42°	"	.45	SL	
10-28	ABOVE DAM 5	0810	"	42°	"	.81	SL	
10-28	BELOW "	0815	"	42°	"	1.40	SL	

SEDIMENT MONITORING Icicle Creek

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
7-22-05	INTAKE	1:00p	WEEKLY	71°	RAIN	.52	SL	
7-22-05	E LEAU BRIDGE	1:10p	WEEKLY	71°	"	1.18	SL	
7-28-05	INTAKE	0830	"	69°	SUN	.63	SL	
7-28-05	E. LEAU BRIDGE	0840	"	69°	"	.91	SL	
8-4-05	INTAKE	0955	"	71°	SUN	.73	SL	
8-4-05	E. LEAU BRIDGE	1005	"	71°	"	.73	SL	
8-11-05	INTAKE	0820	"	66°	"	.70	SL	
8-11-05	E. LEAU BRIDGE	0830	"	66°	"	.57	SL	
8-19-05	INTAKE	1205	"	86°	"	.29	SL	
8-19-05	E LEAU. BRIDGE	1220	"	86°	"	1.36	SL	
8-25-05	INTAKE	1000	"	73°	"	.66	SL	
8-25-05	E. LEAU. BRIDGE	1010	"	73°	"	.54	SL	
9-1-05	INTAKE	0830	"	54°	"	.37	SL	
9-1-05	E. LEAU BRIDGE	0840	"	54°	"	.70	SL	
9-8-05	INTAKE	1000	"	70°	"	.31	SL	
9-8-05	E. LEAU BRIDGE	1010	"	70°	"	.42	SL	

SEDIMENT MONITORING

2005 DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
6/24	Intake	10:55A	weekly	72°	cloudy	.37	GM	
6/24	E.Leav. Bridge	10:40A	weekly	72°	cloudy	.43	GM	
6/30	Intake	12:40	weekly	82°	Few clouds Sunny	.46	GM	
6/30	E.Leav. Bridge	12:30	weekly	82°	Few clouds Sunny	.54	GM	
7/7	Intake	12:30	weekly	77°	Few clouds Sunny	.45	GM	
7/7	E.Leavi Bridge	12:10	weekly	77°	Few clouds Sunny	.58	GM	
7/11	Above Dam #5	7:00AM	Before Removing Racks at #5	52°	Sunny	.67	Terri	
7/11	Below Dam #5	7:00AM	Before Removing Racks at #5	52°	Sunny	.84	Terri	
7/11	Below Headgate	10:00	Before opening Headgate	70°	Sunny	.44	Terri	
7/11	Above Headgate	10:00	" "	70°	Sunny	.58	Terri	
7/11	Above Dam #5	11:45	@ 3 hrs after Removing Racks	75°	" "	.97	Terri	
7/11	Below Dam #5	11:40	" "	75°	" "	1.29	Terri	
7/11	Below Headgate	12:00	opened 1 hr after Headgate	75°	" "	.66	Terri	
7/11	Above Headgate	12:15	after 1 hr opening headgate	75°	" "	.73	Terri	
7/11	Below Headgate	2:15	opened Headgate @ 1 hr After	78°	Sunny	.94	Terri	opened a total of 10"
7/11	Above Headgate	2:18	" "	78°	Sunny	.47	Terri	" "
7/11	Above Dam #5	2:00	1 hr after Removing Boards & Racks	78°	Sunny	1.12	Terri	
7/11	Below Dam #5	2:05	" "	78°	Sunny	1.37	Terri	

SEDIMENT MONITORING

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
5/17/05	Above D#5	12:00	putting racks in #5		Cloudy	2.23	T.S.	
5/17/05	Below D#5	12:05	" "		" "	2.03	T.S.	"
5/17/05	Above H/G	2:20	Closing H/G		Cloudy	0.65	L.S.	
5/17/05	Below H/G	2:20	Closing H/G		Cloudy	0.63	L.S	
5/18/05	Above H/G	12:30	Closing H/G		Rain	0.66	DD	
5/18/05	Below H/G	12:30	Closing H/G		Rain	0.65	DD	
5/18/05	Below H/G	2:PM	Closing H/G		Rain	0.65	DD	
5-24-05	INTAKE	1:45p	WEEKLY	69°	VERY NICE	0.54	SL	
5-24-05	E.LEAV. BRIDGE	1:50p	"	69°	INDEED	0.81	SL	
6-2-05	INTAKE	0840	"		SUN/WARM	0.72	SL	
6-2-05	E.LEAV. BRIDGE	0845	"		"	0.77	SL	
6-9-05	INTAKE	1145	"	71°	sun/cloud	0.34	GM	
6-9-05	E.LEAV. Bridge	1130	"	71°	sun/cloud	0.51	GM	
6-16-05	INTAKE	1100	"	71°	P. CLOUDY	0.65	SL	SG READS 1.5
6-16-05	E. LEAV BRIDGE	1110	"	71°	"	0.91	SL	

SEDIMENT MONITORING

2.41
9.00

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
5-11	ABOVE HG	1:00	COMPLIANCE ✓	75°	SUN	5.56	SL	SG 3.5'
	BELOW DS	1:05	"		"	12.5		
	ABOVE HG	2:10	"		"	2.73		SG 3.3'
	BELOW DS	2:15	"		"	9.53		
	ABOVE HG	3:15	"		"	3.01		
	BELOW DS	3:20	"		"	9.00		
5-12	ABOVE HG	08:10	"	62	"	1.40	SL	SG. 3.3'
	BELOW HG	08:15	"		"	2.67		
	BELOW DS	08:20	"		"	7.52		
	ABOVE HG	2:15	RAISED HG	75°	"	1.41		
	BELOW HG	2:20	"	1	"	1.26		
	ABOVE HG	4:00	COMPLIANCE ✓	77°	"	2.24		
	BELOW HG	4:05	"	77°	"	1.92		
5-13	ABOVE HG	0800	"		"	.86	SL	SG. 3.1'
	BELOW HG	0805	"		"	3.81	SL	
	BELOW DS	0810	"		"	2.39	SL	

SEDIMENT MONITORING

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
5-10	INTAKE	1:45	HIGH WATER	56°	RAIN	11.3	SL	
	E. LEAH BRIDGE	1:50	↓			5.87		
	ABOVE HG	2:10	CHANGING RACKS AGAIN!!			8.47		S.G. READS 4.8'
	ABOVE DS	2:00	"			12.3		
	BELOW DS	1:55	"			12.9		
5-10	ABOVE HG	3:20	COMPLIANCE ✓	57°	P. CLOUDY	6.85	SL	SG READS 4.7'
5-10	BELOW DS	3:15	"	57°	"	6.27	SL	
5-11	ABOVE HG	0800	BEFORE HG ADJUST		SUN	2.05	SL	SG. READS 4.0'
5-11	BELOW HG	0805	"		"	2.76	SL	
5-11	BELOW DS	0810	"		"	3.70	SL	
	ABOVE HG	11:00	COMPLIANCE ✓	60°	"	3.72	SL	SG READS 3.8'
	BELOW HG	10:55			"	2.38	SL	
	BELOW DS	10:50			"	10.3	SL	
	ABOVE HG	11:55			"	3.6	SL	
	BELOW HG	11:50			"	4.15		
	BELOW DS	11:45			"	21.5		
	E LEAH BRIDGE	11:35				7.64		

SEDIMENT MONITORING

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
4-29	Intake	10:40	Open Headgate	54°	cloudy	.82	L.S	
4-29	Above H.G.	10.40	"	54°		.71	L.S.	
4-29	Below H.G.	10.40	"	54°		.81	L.S	
4-29	Above H.G.	12:45	Compliance ✓	56°		.63	L.S.	
4-29	Below H.G.	12:45	Compliance ✓	56°		1.08	L.S	
5-6-05	Intake	1:50	Weekly	76°	Sunny	.76	T.S.	
5-6-05	East. Leav. Brid	2:00	Weekly	76°	Sunny	1.02	T.S	
5-6	Below Dam 5	3:30	Removed 3 Racks	76°	Sunny	.93	SL	*Head Gate 5.6. 2.8'
5-9	Above Headgate	3:00	Add Racks @ D5	59°	Cloudy	1.70	SL	
5-9	Above D 5	3:05	"		And	2.40	SL	
5-9	Below D 5	3:10	"		Rain	1.99	SL	
* 5-10	Above HG	0820	High Water	50°	"	20.2	SL	*Headgate 5.6. 5.0'
5-10	Above D5	0805	"		"	19.8	SL	
5-10	Below D5	0810	"		"	11.1	SL	
5-10	Intake	0840	"		"	14.0	SL	Can't read staff Can't see staff
5-10	E Leav Bridge	0850	"		"	18.7	SL	

SEDIMENT MONITORING

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
3-24-05	INTAKE	12:50	WEEKLY	45°	P. CLOUDY	.28	SL	STAFF GAUGE 1.5'
3-24-05	E LEAD BRIDGE	1:00	"	"	"	.58	SL	STAFF GAUGE 3.1'
4-1-05	INTAKE	1:40	"	54°	"	.45	SL	S. GAUGE 1.5'
4-1-05	E LEAD BRIDGE	1:50	"	"	"	.92	SL	S. GAUGE 3.2'
4-7-05	INTAKE	11:25	"	51°	CLOUDY SPRINKLE	.48	SL	
4-7-05	E LEAD BRIDGE	11:10	"	51°	"	.51	SL	
4-14-05	INTAKE	1:50	"	54°	SUN	.31	SL	S. GAUGE 1.4'
4-14-05	E. LEAD BRIDGE	2:00	"	"		.46	SL	
4-27-05	INTAKE	11:00	HIGH WATER	64°	PARTLY	1.79	SL	S. GAUGE 2.6'
4-27-05	E. LEAD BRIDGE	11:10	"	64°	CLOUDY	1.45	SL	
4-27-05	ABOVE HG	1:00	"	67°		1.10	SL	
4-27-05	BELOW HG	1:05	"	67°		1.20	SL	
4-27-05	ABOVE DAM 5	1:10	"	67°		2.70	SL	
4-27-05	BELOW DAM 5	1:15	"	67°	↓	1.96	SL	
4-29-05	E. Lead Bridge	10:40	Opening Headgate	54	cloudy	0.84	L.S	
4-29-05	ABOVE DAM 5	10:48	"	54	↓	1.56	L.S	
4-29-05	BELOW DAM 5	10:48	"	54		0.75	L.S	

SEDIMENT MONITORING

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U. (so Funny)	INVESTIGATOR	COMMENTS
1-27-05	E LEAN BRIDGE	1:45	WEEKLY	37.2	OVERCAST WET UNSEASONABLY WARM WITH A SLIGHT BREEZE FROM THE NORTH	1.42	SL	
1-27-05	INTAKE	1:30	"	37.2		1.04	SL	
2-4-05	INTAKE	11:00	"	40°	P. CLOUDY	.42	SL	
2-4-05	E. LEAN BRIDGE	11:10	"	40°	RAIN	1.10	SL	STAFF GAUGE UNDER BRIDG READS 4'
2-10-05	E LEAN BRIDGE	11:00	"	33°	CLEAR	.67	SL	
2-10-05	INTAKE	10:45	"	33°	SUNNY	.90	SL	
2/17/05	Intake	1:00	Weekly	43°	clear Cloud	.64	Terri	
2/17/05	E. Lean. Br.	1:10	Weekly	43°	clear Cloud	.59	Terri	
2/28/05	INTAKE	1:45	"	46°	P/CLOUDY	.43	SL	
2/28/05	E LEAN BRIDGE	2:00	"	46°	P/CLOUDY	.91	SL	
3/3/05	INTAKE	1:30	"	57°	SUN	.40	SL	
3/3/05	E LEAN BRIDGE	1:45	"	57°	NY	.97	SL	
3/10/05	INTAKE	3:00	"	68°	VERY	.49	SL	
3/10/05	E. LEAN BRIDGE	3:15	"	68°	NICE	.99	SL	
3/17/05	INTAKE	1:00	"	63°	P CLOUDY	.77	SL	
3/17/05	E. LEAN BRIDGE	12:45	"	63°	WINDY	.44	SL	STAFF GAUGE UNDER BRIDGE READS 3.4 FT.

SEDIMENT MONITORING

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
12-16-04	INTAKE	8:50A	WEEKLY	33°F	CLOUDY/COOL	.66	SHAUN / GARY	
12-16-04	E. LEAV BRIDGE	9:10A	WEEKLY	33°F	"	2.77	SHAUN / GARY	
12-23-04	Intake	8:10A	Weekly	23°F	clear	.86	Shaun/LanceK	
12-23-04	E. Leav Bridge	8:20A	Weekly	23°F	"	1.01	Shaun/LanceK	
12-28-04	Above headgate	11:28	head gate Adjustment	34°F	overcast	0.48	Travis/Lance	"
12-28-04	below headgate	11:45	"	34°F	"	0.48	Travis/Lance	
12-28-04	Above headgate	1:30	"	34°F	"	0.58	Travis/Lance	headgate open 2"
12-28-04	below headgate	1:30	"	34°F		0.67	Travis/Lance	
12-30-04	E. LEAV BRIDGE	11:00	WEEKLY	34°F	SNOW	1.14	SHAUN	
12-30-04	INTAKE	11:15	"	34°F	SNOW	.60	SHAUN	
1/6/05	E. Leav. Bridge	10:40	Weekly	16°F	cloudy/cold	1.21	Terri	
1/6/05	Intake	11:00	Weekly	16°F	cloudy/cold	.49	Terri	
1/19/05	INTAKE	11:30	Flood	35°	cloudy	8.74	Lance e/Shaun	
1/19/05	E. Bridge	11:30	Flood	35°	cloudy	10.6	Lance/Shaun	
1/19/05	BELOW DAM 5	1:00p	FLOOD	34°	CLOUDY	8.27	SHAUN	

SEDIMENT MONITORING

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
12/10/04	Below Dam #5	10:25 AM	1 hr after Removing Boards Dam 5	34°	Rain	6.50	Shawn + Terri	*SEE BACK
12/10/04	Above Dam #5	10:30 AM	1 hr after Removing Boards Dam 5	34°	Rain	6.36	Shawn + Terri	OF PAGE *
12/10/04	Below Dam #5	2:50 P.M.	1 hr after Removing Boards Dam #5	34°	Rain	10.5	Shawn + Terri	
12/10/04	Above Dam #5	2:55 P.M.	1 hr after Removing Boards #5	34°	Rain	9.38	Shawn + Terri	
12/11/04	Intake	10:30 AM	River Flooding	46°	Clear	12.3	Terri	
12/11/04	E. Leaven. Bridge	10:30 AM	River Flooding	46°	Clear	14.8	Terri	
12/12/04	Intake	8:30 AM	River Flooding	23°	Foggy Cold	2.62	Terri + Lance K.	River Dropped 1 Ft from 12/11
12/12/04	E. Leaven. Bridge	8:40 AM	River Flooding	23°	Foggy Cold	2.48	Terri + Lance K.	River Dropped 1 Ft from 12/
12/12/04	Above #5	12:30 PM	Before Removal of Stop Logs	23°	cloudy	3.02	Lance	4.5/3.86 2nd reading (P.E.
12/12/04	Below #5	12:30 PM	Before Removal of Stop Logs	33°	cloudy	24.5	Lance	27.3/38 2nd reading (P.E.
12/13/04	Above #5	2:00 pm	After Removal of Stop Logs	33°	cloudy	7.4	Lance + Gary	Heavy Sediment pass
12/13/04	Below #5	2:00 pm	After Removal of Stop Logs	33°	cloudy	5.33	Lance + Gary	through Dam #5
12/14/04	Above Dam #5	9:15 AM	Before Removal of Stop Logs	31°	Snowing	7.53	Lance + Terri	
12/14/04	Below Dam #5	9:20 AM	Before Removal of Stop Logs	31°	Snowing	5.21	Lance + Terri	
12/14/04	Above #5	10:30 AM	After Removal of Stop Logs	33°	cloudy	8.30	Lance + Terri	
12/14/04	Below #5	10:30 AM	After Removal of Stop Logs	33°	cloudy	7.36	Lance + Terri	

7 hours Removal

5 hours Removal

Sediment Monitoring

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
12/7/04	Below Dam #5	12:45 A.M.	Before Removing Structure at Dam 5	32°	Snowing cold	1.72	Shaun + Terri	
12/7/04	Bad Above Dam #5	12:50 A.M.	Before Removing Structure at Dam 5	32°	Snowing Cold	.68	Shaun + Terri	
12/7/04	Below Dam #5	1:50 PM	After 1 hr After Removing Rack at Dam #5	33°	Snowing + cold	.94	Shaun + Terri	
12/7/04	Above Dam #5	2:00 PM	1 HR after removing 1 Rack at Dam #5	33°	snowing cold	.60	Shaun + Terri	
12/9/04	Below #5 Dam	1:00 pm	Before removal of racks at #5	34°	clear	0.64	Lance	
12/9/04	Above #5 Dam	1:00 pm	Before removal of racks at #5	34°	clear	0.36	Lance	
12/9/04	Below Dam #5	2:30 pm	After removal of racks #5	34°	cloudy	0.58	Lance + Gary	
12/9/04	Above Dam #5	2:30 pm	After removal of racks #5	34°	cloudy	0.6?	Lance + Gary	
12/9/04	Below #5 Dam	4:00 pm	After removal of Boards	34°	rain	5.88	Lance + Gary	Sample pair
12/9/04	Above #5 Dam	4:00 pm	After removal of Boards	34°	rain	4.82	Lance + Gary	to 1 hour
12/9/04	Above Dam #5	4:30pm	"	34°	Rain	4.23	Dan	Pulled Last Dam Board 320 pm
12/9/04	Below Dam 5	4:20 pm	"	34°	Rain	3.14	Dan	pulled last Dam Board 320
12/10/04	Lee E. Leavy Bridge	8:10 A.M.	Weekly	33°	Rain	2.18	Shaun + Terri	
12/10/04	Intake	8:20 A.M.	Weekly	33°	Rain	2.92	Shaun + Terri	
12/10/04	Below Dam #5	8:40 A.M.	Before Removal of Boards @ D5	33°	Rain	3.05	Shaun + Terri	
12/10/04	Above Dam #5	8:50 A.M.	Before Removal of Boards @ D5	33°	Rain	4.82	Shaun + Terri	

(4)

DATE	SAMPLE LOCATION	TIME	TYPE OF SAMPLE	AIR TEMP.	WEATHER	N.T.U.	INVESTIGATOR	COMMENTS
10/29/04	E. LEAVENWORTH BR.	10:25	WEEKLY	45°	SUNNY/COLD	.48	CREW	
10/29/04	INTAKE	10:40	"	45°	"	.49	"	
11/2/04	E. LEAV. BR.	8:05	Heavy Rain + Snow	34°	Raining + snow	1.69	TRAVIS + TERRI	
11/2/04	INTAKE	8:20	Heavy Rain + Snow	34°	Raining + snow	2.88	TRAVIS + TERRI	
11/3/04	INTAKE	8:35A	HIGH WATER	33°	CLEAR/COLD	2.31	SHAUN	INTAKE LOST 2.25"
11/3/04	E. LEAV BR	8:50A	HIGH WATER	33°	CLEAR/COLD	2.63	SHAUN	
11/3/04	ABOVE STR #2	9:10A	1ST READING	33°	CLEAR/COLD	2.02	SHAUN	
11/3/04	BELOW STR #2	9:20A	"	33°	CLEAR/COLD	1.73	SHAUN	
11/3/04	ABOVE DAM #5	9:30A	"	33°	CLEAR/COLD	2.46	"	
11/3/04	BELOW DAM #5	9:35A	"	"	"	1.42	"	
11/9/04	E. LEAVENWORTH BR	8:15A	WEEKLY	29°	CLEAR/COLD	.45	LANCE + TERRI	
11/9/04	INTAKE	8:30A	WEEKLY	29°	CLEAR/COLD	.41	LANCE + TERRI	
11/23/04	E. LEAVN. BRANCH	8:55A	WEEKLY	31°	CLOUDY/COLD	.43	SHAUN + TERRI	
11/23/04	INTAKE	9:05A	WEEKLY	31°	CLOUDY/COLD	.60	SHAUN + TERRI	
12/02/04	INTAKE	11:00	"	27°	CLOUDY COLD	.52	SHAUN LANCE	I HAVE A HOLE IN MY GLOVE
12/02/04	E LEAV BRIDGE	11:20	"	27°	"	.33	"	

#1

Appendix C: Notes from logbook for adjustments made to structures 2 and 5.

August 24 & 25 2000
opened the head gate 50 turns
& lowered the boards in dam 5.

August 28 2000
opened the headgate another
50 turns for a total of 100
Canal is dry all flow is
going down the original channel.

Sept. 2 or 3 Keilly Murdock (Coho
program) had Ben help her
close the head gate.

11-29-00 9:00 am gate opened - 200 fall
turns - estimate 18-5"
Dan Davies

11/29/00 Lance, LeRoy + Dan
open the head gate 300
teens in the afternoon.

3/21/01 - Keely Murdock + YN
install of screens in Icicle River
original channel for Coho.
close headgate to install screens

5/21/01

Dick Rieman Requested Through Greg P. to close the head gate. Dick R. stated "they" had an agreement with Don Diggs to only allow 200cfs Through the back channel. (Flow Management WCMD 12/0000)

Dick R. opened the gate to Remove a log from under the south gate. Lance + Don helped lower the gate all the way. We marked the cable + raised the gate 15 turns = 1.5"; then another 15 turns = 3.0" then another 15 turns = 4¼"

The up stream head level was 6.5' @ 1.20 PM 5/21/01 When gates were opened 4'14."

5/29/01 -
Dick Rieman opened gate another 2 inchs. Total about 6½ inchs open. (Talked to Greg P. About doing this). TS

6/27
Dan + Brett closed the head gate 28 turns. Too much water for dam 5. Rain + Stormy weather.

7/5/01
Closed head gate all the way Removed all Racks + Made North + South Bays Fish passable Blocked water in most Bays will adjust water after forebay pool goes down.

7-6-01 14:00 $.5 \times 16 \times .75 \times \sqrt{2(32)} \times 5.8 = Q$

Opened south gate of headgate dam so it is open a total of 9"
Estimated volume in the original channel at 114 cfs
Water slightly turbid at dam #5. No noticable
turbidity in Icicle Creek at the public boat ramp.
Approximately 50 chinook salmon at the base of
the headgate dam. Approximately 5" of water
cresting the spillway dam. Headgate head = 5.8'

Dick Rieman

7-6-01 19:00 $.5 \times 16 \times 1.2 \sqrt{2(32) \times 5.5} = Q$

Opened south gate another 5" for a total width of 14"
Observed stream for one hour and no noticable turbidity
at dam #5. Fish trying to exit through the headgate but

7-7-01 09:30 $.5 \times 16 \times 1.6\sqrt{2(32) \cdot 5.3} = Q$

Opened southgate another 6" for a total width of 20. Noticed a slight increase in turbidity coming from the sandbar just up stream of the headgate dam. Watched the stream for one hour at dam #5 and noticed no increase in turbidity at dam #5. Between 40 & 70 fish are holding in the pool at the base of the headgate dam. A maximum of 10 fish are holding at the base of dam #5. Fish are still trying to get through the headgate dam but to no avail. Estimated flow in the old channel = 2300 cfs. We are trying to get the south gate open wide enough to see fish get through and not increasing the turbidity of the water.

7-7-01 18:30 $.5 \times 16 \times 2.2\sqrt{2(32) \times 4.5} = Q$

Opened south gate of the headgate dam another 6" for a total open width of 26". Observed suspended sediment coming from the sand bar above the headgate dam. Observed fish swimming through the south gate [illegible]

7-8-01 0900 $.5 \times 16 \times 2.3\sqrt{2(32) \times 4.0} = Q$

Raised southgate at the headgate dam another 2½" for total width of 28½". Observed water in the hatchery canal. Fish swimming through the southgate of the headgate dam. Estimated flow through the headgate dam to be approximately 290 cfs. Approximately 50 fish holding above the headgate dam. Also observed approximately 50 fish holding above dam #5. Fish holding above dam #5 appear to be in good shape (no white marks). Fish holding above headgate dam appear to be in good shape (no white marks). Approximately 70 fish holding at the base of the headgate dam. 60% of these fish appear to be in bad shape (heads entirely white) Observed no fish trying to jump through the headgate, all appear to be swimming through at flows approaching 300 cfs. Wetlands at dam #4 are still above the water level. Pool level behind dam #5 is within an estimated 2' of approaching maximum. Water clear at all points.

Dick Kinman

7-9-01 15:00 $5 \times 16 \times 2.7\sqrt{2(32)} \div 3 = 9$

Opened South gate of headgate dam another 4" for a total width of 32½". Flow in old channel estimated at 291 cfs. Because of the way water flows through the South bay, the South ½ of the gate is submerged but the North ½ is above the water by at least one foot. Fish easily move through. Water is still standing in the canal.

Observed several brook trout going through the dam. Also observed fish moving over the intake diversion dam where one board is missing. Fish swim up a 45° ramp of water and slip into the reservoir behind the dam. Observed fish holding in the pool below the steep downdrop. Estimate over 300 fish above the headgate dam. Tried to lower the headgate dam gate. Gate will not move down.

Dick Reiman.

Dec 17, 2001
Lance + Don opened the head gate 22". Aprox 24" of snow on the ground. 22" = 480 cfs. ~~Cb~~ measured flow over boards & dam 5. Closed head gate to 12½" will measure water over boards again. 2:10 PM. (Lance + Brett) 12½" = 376 CFS at @ 3:30 PM.

DP.

Dec. 18, 2001 830 AM water measured over Dam 5 15" BAY 1, 16", Ø, 15", 11", 12", 10.5", Ø 7", 8", 11," + 13.5" = 345 CFS. with Head gate open 12.5". GP. said to Leave as is until farther notice.

Mar. 6, 2002
Coho crew has key to head gate. Taking out portion of fish trap that is still installed in preperation for smolt acclimation. Turning down back channel flow.

4/25/01 - Steve Mallas - YNF
opened headgate 30 turns to
help flush coho and facilitate
upstream passage for steelhead

4/27/01 - Steve Mallas - YNF
opened headgate 30 more turns
for reasons above.

5/9/01 - Dan Davies - Closed
headgate 125 turns so that
installation of adult barriers
could be completed.

11/10 Radial Gate @ structure 2 open 4'.

8-7-01

lowered South gate to within 6" of Y to weir crest. Opened gate as far as it would open, 4'-7". Water at weir crest 6" deep.

$Q = 3.8 \times 16 \times .5^{1.5}$ $Q \cong 20$ cfs

10/9/01

STEVE MALLAS - YAKAMA NATION FISHERIES

0800 - LOWERED HEADGATE ALL THE WAY (375 CRANKS ↓) TO INSTALL V-TRAPS @ DAM 5.

10/10/01

STEVE MALLAS - Y.N. FISHERIES

1300 - RAISED HEADGATE (375 CRANKS ↑) RETURNED TO NORMAL

10/1/2002 9AM
Greg Claeine + Dan Davis open the lead gate 50 turns waited awhile then in 25 turn increments to 100 turns. we will wait until the canal depth lowers to make further adjustments.
10/1/2002 1PM
Brett, Terri + Dan open lead gate another 60 turns. Total of 160 turns opened about 14."

12/16/02 Brett, Terri, Lance + Leroy. were ask by Julie Collins to remove one board across Dam #5. (total of 8 boards). Reason being was there was a 2ft drop for fish to jump. Washington trout ask it be adjusted to at least a [illegible] passage.

4/30/02 opened gate 34 cranks to release cond. -KM

5/20/02 closed head gate all the way. Icicle Creek came up 2-3 feet + muddy. Dan D. measured flow over boards 150 cfs.

3/10/03

closed headgate 206 turns to install Dam 5 coho Screens. – Keely Murdock

3/14/03 opened headgate 38 turns for coho Acclimation - Keely Murdock

4/30/03 opened headgate 21 turns during coho release – KM

May 5/19 lowered (south) head gate all the way. Kids in the creek 5/20 – 5/21. Dan

ok

10/16/03 Closed head gate all the way Rocky McClary

-5/5/04 - Cory Kamphaus YN Fisheries Opened the headgate a bit. Unclear on the amount opened due to automatic operation. will possibly adjust on Thurs 5/6

-5/6/04 - Adjusted headgate 3½". No increase yesterday due to mislabeled toggle switch. Measure from marks on cables attached to the headgate.
Cory Kamphaus YN Fisheries

-5/10/04 - Cory Kamphaus YN Fisheries. Adjusted headgate another 2½". Fish seemed to leave over the weekend but large numbers still exist in the side-channel.

4/29/05 1045 AM
Open head gate 4" D. cable
Took turb. samples D. Travis Lance

5/06/05 open head gate another
5" took turb. samples
saw one steelhead go down
stream while placing racks
in dam 5. Could not open
head gate any further due to Turb.
@ Dam 5. Head gate forebay 2.8
V. Notch Boards in place 3 Bays - No Racks
5/9 Water Level forebay 3.2 headgate
5/10 placed Racks in 10 Bays on
Bottom Board with 2 Boards on Top. 10.
5/10 Took Racks & Boards out of three
Bays, High water due to Rains.
Took Turb. Samples
5/11 Steve + Dan open head gate an additio
1 foot estimated headgate opening
2 feet 925am. Shaun took

5/17/05

Put Barrier Rock in Dam 5 took sed. samples. Lowered Headgate about 11 inches took samples.

5/18 Lower Headgate 4" took sed. samples Reduced approach velocity somewhat at Dam 5

Headgate staff gage 5/12 3.4 ft.

5/17	2.8	5/18	2.8	5/24	2.3
5/25	2.26	5/26	2.26	5/31	3.0
6/2	2.58	6/3	2.33	6/4	2.25
6/5	2.24	6/6	2.06	6/7	1.92
6/8	1.82	6/9	1.74	6/10	1.7
6/11	1.71	6/12	1.68	6/13	1.66
6/14	1.60	6/15	1.59	6/16	1.56
6/17	1.68	6/18	1.72	6/19	1.65
6/20	1.63	6/21	1.63	6/22	1.70
6/24	1.56	6/25	1.50	6/26	1.42
6/28	1.39	6/29	1.34	7/11	9" below gage

7/12 2' below gauge

10/27 lowered

16"

Appendix D. Daily mean water temperature data for nine locations on Icicle Creek and one location on Snow Creek during July through November 2005.

Daily mean water temperatures

date	rm 8.2 mean oC up Boulder Falls	rm 5.5 mean oC up Snow Cr	rm 0.2 mean oC in Snow Cr	rm 5.4 mean oC down Snow Cr	rm 4.55 mean oC up Intake	rm 4.45 mean oC down Intake	rm 3.8 mean oC upper O. Channel	rm 2.85 mean oC lower O.Channel	rm 2.8 mean oC Spillway Pool	rm 2.6 mean oC down LNFH	at LNFH mean oC Air Temp
7/16/2005		15	14.3	15							22.8
7/17/2005		15.1	14.4	15.1							18.6
7/18/2005		16.4	15.6	16.4							22.8
7/19/2005		16.4	15.1	16.2	16.8	16.7	17.4	18		17.3	24.7
7/20/2005		16.1	14.9	16	16.5	16.5	17.2	17.7		16.9	22.5
7/21/2005		15.9	14.6	15.8	16.2	16.2	17	17.7		16.7	21.7
7/22/2005		16.2	16.3	16.2	16.7	16.7	17.1	17.5		16.8	26.1
7/23/2005		15.3	15.2	15.3	15.7	15.7	16.2	16.6		16.1	18.6
7/24/2005		15.2	14.5	15.1	15.5	15.5	16.1	16.6		15.9	20
7/25/2005		15.9	15.1	15.7	16.1	16.2	16.8	17.4		16.6	20.3
7/26/2005		16.3	15.2	16	16.4	16.5	17.1	17.7		16.9	21.9
7/27/2005		16.3	15	16	16.4	16.4	17.1	17.5		16.9	22.8
7/28/2005		17.1	15.6	16.7	17.2	17.2	17.8	18.4		17.6	25
7/29/2005		17	15.1	16.4	17	17	17.7	18.3		17.4	24.7
7/30/2005		16.9	14.7	16.2	16.7	16.8	17.5	18.2	15.9	17.2	22.8
7/31/2005		17.2	14.9	16.5	17	17	17.8	18.5	16.1	17.4	23.6
8/1/2005		16.6	14.6	15.9	16.5	16.5	17.1	17.6	15.7	16.7	24.7
8/2/2005		15.1	12.8	14.3	14.8	14.9	15.7	16.5	14.3	15.4	18.1
8/3/2005		15.4	13.1	14.4	14.9	14.9	15.7	16.5	14.4	15.6	20.3
8/4/2005		15.5	13.1	14.4	14.8	14.9	15.7	16.4	14.4	15.4	20.6
8/5/2005		16.6	13.7	15.1	15.7	15.7	16.6	17.3	15.1	16.4	23.3
8/6/2005		17.3	13.9	15.6	16.2	16.3	17.2	18.1	15.6	16.9	25.6
8/7/2005		17.3	13.6	15.4	16	16.1	17.2	18.1	15.5	16.8	25
8/8/2005		17.3	13.6	15.3	15.9	16	17.2	18.1	15.4	16.7	24.4
8/9/2005		17.3	13.7	15.3	16	16	17.2	18	15.4	16.6	25.3
8/10/2005		17.2	13.3	14.9	15.7	15.8	17	18	15.2	16.5	24.4
8/11/2005		16.1	12.7	14.1	14.7	14.7	15.9	16.9	14.4	15.5	22.2
8/12/2005		16.4	13.1	14.4	15	15.1	16.3	17.4	14.6	15.7	21.1

8/13/2005		16.6	12.5	14	14.8	14.9	16.4	17.7	14.5	15.7	21.9
8/14/2005		16.6	12.8	14.1	14.7	14.8	16.4	17.7	14.4	15.4	20.6
8/15/2005		17.1	13.2	14.5	15.2	15.3	17	18.4	14.7	15.7	22.5
8/16/2005		17.2	13.1	14.2	15.1	15.4	17.5	19.2	14.5	15.7	25.3
8/17/2005		16.4	12.7	13.7	14.4	14.6	16.7	18.4	13.9	14.9	24.7
8/18/2005		16.2	12.2	13.3	14.1	14.3	16.4	18	13.6	14.8	19.4
8/19/2005		15.9	12.1	13.1	13.8	14	16.3	18	13.3	14.3	20
8/20/2005		16.5	12.5	13.5	14.2	14.4	16.7	18.5	13.6	14.6	20.3
8/21/2005		17.1	13.3	14.1	14.9	15.1	17.5	19.4	14.2	15.2	22.5
8/22/2005		16.7	12.6	13.4	14.4	14.6	17	18.9	13.9	15	24.4
8/23/2005		15.3	11.3	12.1	12.9	13.1	15.6	17.4	12.6	13.6	22.5
8/24/2005		14.4	10.8	11.5	12.3	12.5	14.9	16.6	12	12.9	15.6
8/25/2005		14.6	11.2	11.8	12.5	12.6	14.3	16	12.1	13.1	18.1
8/26/2005		15.2	11.6	12.4	12.9	13	14.5	15.9	12.5	13.5	19.2
8/27/2005	14.7	15.6	11.7	12.8	13.5	13.6	14.9	16.1	13	14.2	21.9
8/28/2005	14.8	15.6	11.9	12.9	13.4	13.4	14.6	15.7	12.9	13.9	21.7
8/29/2005	14	15.1	11	12	12.9	13	14.8	17.1	12.6	13.9	21.1
8/30/2005	13	13.7	10.5	11.3	11.8	11.9	12.9	14	11.7	12.6	15.3
8/31/2005	13.4	14.2	10.5	11.4	12.1	12.1	13.3	14.4	11.9		
9/1/2005	13.8	14.5	10.9	11.6	12.2	12.3	13.6	14.8	12.1		
9/2/2005	14.5	15.3	11.4	12.2	12.8	12.9	14.4	15.6	12.7		
9/3/2005	13.4	14.6	10.5	11.2	12.1	12.2	14	15.5	12		
9/4/2005	12.1	13.3	9.7	10.3	11	11.2	12.7	14.1	11		
9/5/2005	11.7	12.6	9.3	10	10.6	10.6	12	13.1	10.5		
9/6/2005	11.8	12.7	9.5	10.1	10.7	10.7	12.1	13.1	10.6		
9/7/2005	12.3	13.2	10	10.6	11.2	11.2	12.7	13.9	11		
9/8/2005	13.3	14	10.7	11.3	11.9	12	13.5	14.8	11.7		
9/9/2005	12.4	13.4	9.7	10.3	11.1	11.2	12.6	13.8	11.2		
9/10/2005	11.3	12	9.1	10	10.3	10.4	11.1	11.9	10.3		
9/11/2005	10.9	11.6	9.3	10	10.4	10.4	11	11.5	10.3		
9/12/2005	11.3	12	9.4	10.2	10.7	10.7	11.6	12.3			
9/13/2005	11.1	11.9	9.1	9.8	10.3	10.4	11.6	12.6			
9/14/2005	11.9	12.6	9.6	10.2	10.8	10.9	12.4	13.5			
9/15/2005	11.9	12.8	9.3	9.8	10.5	10.6	12.4	13.6			
9/16/2005	10.6	11.8	9	9.3	9.8	9.9	11.1	12.1			

9/17/2005	10.8	11.4	9	9.4	9.9	10	11.4	12.7		
9/18/2005	10.9	11.6	8.8	9.2	9.7	9.7	11.3	12.5	9.7	
9/19/2005	11.4	12.3	9	9.5	10.1	10.2	12	13.4	10.1	
9/20/2005	10.7	11.7	8.3	8.8	9.4	9.5	11.1	12.3	9.4	
9/21/2005	9.4	10.4	7.4	7.8	8.3	8.4	10.2	11.3	8.4	
9/22/2005	9	10	7.5	7.8	8.2	8.3	9.5	10.3	8.3	
9/23/2005	8.8	9.8	7.2	7.6	8.1	8.1	9.7	10.8	8.2	
9/24/2005	8.5	9.4	7.2	7.7	8	8	8.9	9.8	8.1	
9/25/2005	9.1	9.8	7.8	8.3	8.6	8.6	9.4	10.1	8.7	
9/26/2005	9.4	10.1	8.2	8.7	9	9	9.8	10.4	9	
9/27/2005	10	10.8	8.5	9.1	9.5	9.5	10.4	11.1	9.5	
9/28/2005	9	9.8	7.8	8.3	8.6	8.6	9.5	10.3	8.7	
9/29/2005	10.7	11.1	10.1	10.4	10.4	10.5	10.9	11.5	10.3	
9/30/2005	11	11.7	10.4	11.3	11.6	11.6	11.7	12.1	11.5	
10/1/2005	9.2	9.9	8.2	9.5	9.8	9.8	9.8	11	9.9	
10/2/2005	7.6	8.4	7	7.9	8	8.1	8.1	10.8	8.2	
10/3/2005	7.4	8.2	7	7.8	7.9	7.9	8	10.6	8.1	
10/4/2005	6.5	7.5	6.6	7	7.5	7.2	7.7	9.1	7.6	7
10/5/2005	7	7.4	7.4	7.4	7.5	7.6	7.7	8	7.7	7.9
10/6/2005	8	8.4	8.1	8.4	8.5	8.6	8.7	8.9	8.5	8.7
10/7/2005	8.3	8.8	8.2	8.8	9	9	9.1	9.5	9.1	9.3
10/8/2005	7.3	7.8	7.4	7.7	7.9	7.9	8	8.4	8.1	8.2
10/9/2005	7.2	7.6	7.3	7.6	7.7	7.7	7.8	8.1	7.9	8
10/10/2005	6.9	7.4	7.5	7.4	7.5	7.6	7.7	8	7.7	7.8
10/11/2005	7.7	8.1	7.9	8.1	8.2	8.2	8.4	8.7	8.3	8.5
10/12/2005	7.4	8	7.8	7.9	8.1	8.2	8.3	8.6	8.2	8.4
10/13/2005	7.9	8.4	8.1	8.4	8.5	8.5	8.7	9	8.5	8.8
10/14/2005	8	8.5	8.3	8.5	8.6	8.6	8.8	9.1	8.6	8.9
10/15/2005	8.6	9.1	8.9	9.1	9.3	9.3	9.4	9.6	9.2	9.5
10/16/2005	8.7	9.1	8.6	9	9.1	9.2	9.3	9.5	9.1	9.4
10/17/2005	9.7	10.1	9.7	10.2	10.3	10.3	10.5	10.5	10.1	10.4
10/18/2005	9.5	10.1	9.5	10	10.2	10.2	10.3	10.5	10.4	10.6
10/19/2005	9.5	10.1	10	10.1	10.3	10.3	10.4	10.5	10.3	10.5
10/20/2005	9	9.5	9.3	9.5	9.7	9.7	9.8	10.1	9.8	10
10/21/2005	8.2	8.8	8.8	8.7	8.8	8.9	9	9.4	9.1	9.3

10/22/2005	7.2	8	8.1	7.7	7.8	7.8	7.8	8.4	8.1	8.2
10/23/2005	7	7.7	8.2	7.5	7.6	7.7	7.7	8.2	7.8	7.9
10/24/2005	7.3	7.8	8.2	7.7	7.7	7.8	7.8	8.3	7.9	8
10/25/2005	7	7.6	8	7.5	7.5	7.6	7.7	8.2	7.8	7.9
10/26/2005	6.9	7.6	7.7	7.4	7.6	7.6	7.7	8.4	7.9	8
10/27/2005	5	6	6.1	5.5	5.7	5.7	5.8	6.8	6.1	6.2
10/28/2005	5.6	6.2	6.6	6	6.1	6.1	6.2	6.8	6.3	6.4
10/29/2005	5.5	6.1	6	5.7	5.8	5.9	5.8	6.1	6.1	6.1
10/30/2005	5	5.7	5.5	5.3	5.4	5.4	5.5	5.7	5.6	5.7
10/31/2005		4.7	5.1	4.1	4.4	4.4	4.5	4.8	4.8	4.7
11/1/2005		3.8	4.4	3.4	3.4	3.5	3.6	3.7	3.7	3.7
11/2/2005		4.1	4.2	3.7	3.9	3.9	4	4.2	4.2	4.2
11/3/2005		3.8	4	3.5	3.6	3.6	3.7	3.8	3.8	3.8
11/4/2005		4	3.8	3.6	3.8	3.8	3.8	4	4.1	4
11/5/2005		3.3	3.3	2.7	2.9	2.9	3	3.2	3.2	3.2
11/6/2005		2.9	3.1	2.4	2.5	2.6	2.6	2.8	2.9	2.8
11/7/2005		2.7	2.6	2.3	2.3	2.3	2.3	2.4	2.6	2.5
11/8/2005		2.8	2.9	2.5	2.6	2.6	2.7	2.8	2.8	2.8
11/9/2005		3.3	3.1	3	3.1	3.1	3	3.1	3.2	3.2

Appendix E: Guidance for Compromised Water Quantity and Quality Situations at the Leavenworth National Fish Hatchery Complex

Updated: April 27, 2005

All environmental indicators suggest most of Washington State will experience drought conditions in 2005. Information from the Natural Resource Conservation District's Washington State Basin Outlook Report for April, 2005 projected stream flows for the Methow and Entiat Rivers, and Icicle Creek to experience critical water shortages for the summer of 2005. Extremely low snow pack will result in summer stream flow for the Methow River to be 34% of normal, the Entiat River is projected to have 46% of normal flows and projections for Icicle Creek indicate stream flow should be approximately 57% of normal. According to National Oceanic and Atmospheric Administration climatologists, little chance exists for late season snowfall to restore the snow pack to 100%.

Background

Emergency or unusual environmental conditions occasionally occur and compromise the quality and quantity of the water which supply the facilities of the Leavenworth National Fish Hatchery Complex (Complex). Protocols are currently in place to address emergency situations when answering alarms initiated by low water levels. In some years environmental conditions result in droughts which affect the water supply to the Complex's facilities. The Natural Resource Conservation District provides information on the winter snow pack and uses that information to project summer-time stream flows. When information suggests low stream flow conditions, which also compromise the quality of the water, special measures are need to maintain fish health. General guidance to address low stream flow and accompanying compromised water quality is described in the following paragraphs.

Purpose

This document is intended to provide general guidelines to manage fish health in the event of reduced water availability or compromised water quality. The document is designed to address predicted and longer duration situations such as droughts; however, much of the information could be applicable to "emergency" situations (i.e. pump failure, chemical spill in water supply). During emergencies or when low water alarms sound, the situation should be dealt with immediately in the usual manner. For impending concerns with water quantity and quality the HET should have timely discussions to develop appropriate options considering the situation at hand. Topics described include: Priority Species and Life Stages; Monitoring; and, Remedial Actions.

Priority Species and/or Life Stages

Different life stages have varying levels of tolerance to stressful environments. In the event sufficient water quality or quantity is not available to meet usual hatchery production needs water will generally be distributed to provide the best quality and quantity to early life stages first (eggs or alevin), followed by fry, fingerling, smolts then adults.

When multiple species are on station the best quality and quantity of water will generally be afforded to, in order of priority: spring Chinook salmon, Steelhead then Coho salmon. Priority for species is based on Endangered Species Act status; a more critical status resulted in a higher

priority to provide protection. Steelhead are generally more tolerant than spring Chinook salmon and thus slightly lower in priority. Life stage will generally hold precedence over species if remedial action is necessary.

Monitoring

When approaching typical low flow periods of the year, monitoring the quantity and quality of water to the fish will be critical. Significant declines in stream flow, ground water discharge and weather forecast will indicate that additional monitoring is necessary. The minimum parameters which should be monitored regularly in each bank of rearing units are dissolved oxygen, water temperature, pond turn-over rate, density index and fish appearance. Nitrate-Nitrogen should be monitored if reuse water is used for an extended amount of time. The weather forecast should be considered during any low water situation.

Early and often communication by members of the HET is crucial as key parameters approach critical levels. The critical "trigger points" when remedial actions should be implemented, occur when:

Parameter	Critical Reading
Dissolved Oxygen	<80%
Water Temperature	>62°F
Turn-over Rate	>45 minutes in laminar flow raceway
Density Index	>0.10 for spring Chinook
	>0.20 for Steelhead and Coho
Nitrite-Nitrogen	0.06 ppm
Weather Forecast	Continued hot and/or dry
Fish	Any odd behavior or appearance

Multiple parameters exceeding critical readings warrant timely actions. The weather forecast and condition of the fish will be considered in any decision.

Remedial Actions

The first action as low flow periods approach is to check all sources of water to ensure that their output is maximized. This would include examining: pumps to make sure they are on and opened to the maximum allowable setting; all screens to remove any debris and / or ice; the intake barrier dam to seal leaks while still providing some stream flow; and other water delivery facilities for proper function. Work in the stream channel requires letters of concurrence from the U.S. Fish and Wildlife Service and NOAA Fisheries, and an approved Washington State Joint Aquatic Resource Permits Application (JARPA). Additionally Leavenworth NFH should work closely with the Regional Office's Water Right's Branch to best manage water releases from Snow / Nada Lakes. Management of the water resources should consider other users who share the water delivery facilities so not to affect their water right. Forecasted weather, and priority life stages and species should always be considered. Fish appearance and fish health should always be taken into account.

Temperature

Water from wells, infiltration galleries and springs should be managed to temper water as it reaches critical levels. Priority life stages and species should be considered when managing these water sources. If available, and possible, water chillers should be used. Contact local vendors to determine if water chillers are available for temporary rental.

Dissolved Oxygen / Total Gas
When dissolved oxygen levels reach critical levels mechanical aeration should be provided where convenient and effective. Contact local vendors to determine if water aeration units are available for temporary rental. Oxygen injection should be considered but may be cost prohibitive. Total dissolved gas should be measured for supersaturation in locations where water is pumped to the fish.

Turnover Rate / Density Index
Sustained turn-over rates of 45 minutes or greater in raceways may warrant adjustments to pond configuration. Large re-circulating ponds should maintain adequate turn-over rates. The first step is to reduce pond volume while maintaining a Density Index of less than 0.10 lbs/ft^3/inch for spring Chinook salmon and less than 0.20 lbs/ft^3/inch for Coho and Steelhead. If density exceeds those values with full utilization of first pass water, reusing water should be considered.

Nitrate-Nitrogen
Measurements of Nitrate-Nitrogen level should be made on ponds subjected to an extended use of reused water. The Nitrate-Nitrogen level serves as a substitute / surrogate measurement for ammonia level which is a more difficult parameter to measure.

Fish Health
The appearance and / or health of the fish should always be considered when making adjustments to the flows, pond volumes, water temperature, etc. Fish may appear healthy even though the critical parameters are exceeded or they may be showing signs of stress or high mortality even though critical parameters were not reached. Paying close attention to the fish's behavior and appearance, and employing sound fish culture techniques is necessary as environmental conditions deteriorate.

Fish Release
Although early releases are undesirable, they may be mandated or warranted because of deteriorating conditions. If all other options to improve environmental conditions have been explored, and if unfavorable weather is predicted, then fish must be selected from the appropriate raceways/ponds and released in sufficient numbers to benefit any fish remaining on station. Priority species and life stage should be considered. The impact of an unscheduled release may be significant to naturally produced fish and other aquatic organisms. Current Biological Opinions for the operations of the Leavenworth National Fish Hatchery Complex allow for emergency release of fish. **NOAA Fisheries and the US Fish and Wildlife Service need to be contacted within one day after an emergency release.**

Other Considerations

In an emergency or an atypical environmental situation all options should be considered to maintain fish health. Options which may not seem appropriate at this time may be applicable at a later date. If possible, moving fish to other rearing units on station or moving them to another facility may be worth considering. Other options include leasing water from a local water rights holder; reducing production; using water chillers, and installing an oxygen injection system.

All remedial actions implemented should be documented for future reference.

Specific plans / protocols for Winthrop, Entiat and Leavenworth National Fish Hatcheries are included. These plans generally follow the guideline describe in this document.

Appendix 1

2005
Low Water Contingency Plan for Winthrop NFH

The potential for water shortages at Winthrop NFH exist in some form each year. This plan is being updated due to the high potential for drought conditions in 2005. Poor water conditions could result in an emergency release situation and this plan gives guidance on proper procedures should such an event occur. Events that could create an emergency include extreme drought conditions, excessively high water temperatures, extremely low flows, freeze-up conditions, power outages, back-up generator failure, blocked intakes, pump failure, or any combination of the above.

Personnel at the facility must first determine that all alternative water sources have been exhausted and as an absolute last resort, some or all fish must be released to the river (refer to checklist below).

Checklist for Emergency Water Shortages:

1. If power outage, is emergency generator running to supply power to pumps? If not, try to start with manual switch on the Generator.

2. Power is available. Check each gallery pump to make sure it is running. Turn switch to "hand" operation, if not working on "auto". Gallery #1 has a back-up pump, if needed.

3. Water is not getting to incubation units inside the nursery. Not much time for those fish(maybe 30 minutes for alevin). Trim flows on D and E-banks to get some water pressure to the hatchery building. If that does not work, turn on the river valve at the end of each row of stacks and turn off the river excess valve down in the trough near the last row of stacks.

4. Power is not available or all 3 galleries have been evaluated as not operable or insufficient and cannot relieve the problem. Go on to item 5.

5. River intake at screen chamber has been checked for debris or ice problems. If plugged and not able to clear, raise screen inside the screen chamber using attached chain hoists.

6. Foghorn diversion/intake has been checked for debris or ice problems. Blockages are cleared, if possible.

7. Methow State Fish Hatchery has been called (996-3144) to see if they can help by sending more water past their intake on the Foghorn Ditch.

8. Flows are still inadequate. Switch boards in D and E-bank headboxes to one inflow board per raceway. Trim flows in C-bank to about half of normal using individual raceway valves.

9. Flows are still inadequate. Turn on 10HP recirculation pump, switch located in hatchery by the East door. Consider the fish health of A-bank and the tankhouse since the pump pulls effluent water from these two sources and pumps it to either D-bank or the valve chamber for distribution.

10. Flows are still dangerously low. Switch boards in tailbox of D-bank to send used water to E-bank, then shut down E-bank headbox valve. Before doing this, consider the fish health in D-bank and E-bank, since the pathogens from D-bank will be passed on to E-bank raceways.

11. Flows remain extremely low throughout the facility, and dissolved oxygen levels are below 6ppm or the fish are obviously stressed or dying from other water problems, such as high temperatures. Contact NOAA fisheries at (503) 230-5409, if possible, prior to emergency release. According to NOAA, fish should be released as follows.

- **Coho** are not listed under the ESA and should be released **first** in an emergency.

- **Steelhead** would be retained over coho, but should be released **next** if absolutely necessary.

- **Spring Chinook(Methow Composite stock)** are the number one priority fish on station and should be **retained** if at all possible. Highest Carson ancestry (Met-Comp-2's) are not a listed stock and should be released ahead of steelhead.

12. Document events which took place that led up to the emergency release. Be detailed in your write up with date, times, steps taken in the above checklist and everything you can think of that led to your decision to release fish. Identify which fish were released and in what order, based on what you saw happening.

Appendix 2

2005
Low Water Contingency Plan for the Entiat NFH

Current fish production for SCS at the Entiat NFH is 400K SCS yearlings. Two new ground water sources have not produced the necessary water to allow for an increase in smolt production. Sub-yearling releases have been discontinued beginning with brood year 2000. Ground water wells #1 thru #4 have been rehabilitated in the last three years and are producing less water than when originally built.

Fish are reared on 100% ground and spring water from February of each year until release in April of the following year. Target size at release is 18 fish per pound (f/lb). The most recent annual average amount of ground water available is 1600 gpm. Peak fish production occurs in March when over 800K fish are on feed, and ground water is re-used three times. At 1600 gpm, our raceways have a turnover rate of just over 41 minutes and in our holding ponds the turnover rate is nearly 90 minutes. We are very aware that these turnover rates are poor, and probably contribute to problems with Bacterial Kidney Disease (BKD). It is important to remember that not only is the turnover rate poor, the quality of the water has been degraded due to re-use.

Water shortages can occur due to drought conditions, power failures, emergency generator failure and/or well outages. Personnel have been instructed to take specific action depending upon the cause of the shortage of water.

1. **Power Failure**: Our spring water source is gravity fed to the raceways and to the nursery which provides a small but vital safety net for the fish. It allows personnel time to diagnose a problem before making adjustments.
    a. The facility has an emergency backup generator that's supplies power to the wells in the event of a commercial power outage. We try and maintain 48 hours of fuel to operate the generator.
    b. If the **emergency power fails** after several attempts then raceways will be continually monitored for oxygen saturation. Often PUD outages are short in duration and commercial power is restored before oxygen levels fall below 80%.
    c. If oxygen saturation levels fall below or are approaching 80%, add surface water to the raceways.
    d. If surface water is not available due to cold temperatures, i.e. intake is frozen then emergency release conditions will exists.

2. **Well Outages**: Emergency or planned outages obviously reduces the amount of ground water. Outages can last for several months depending on the type of repairs.
    a. When on Re-Use raceways are cleaned one at a time and allowed to fill before another pond is cleaned.
    b. Ponds are cleaned several hours after feeding.
    c. If two wells are down the raceways are cleaned with a vacuum.

3. **Drought Conditions:** As per the body of this document, low mountain snow pack has a direct effect upon ground water supplies which in turn reduces the amount of water available for fish production. Depending on the severity of the drought, water availability can behave

like a well outage to extreme conditions where to possibility of an emergency release could occur. All of the above methods will be used and documented prior to any early fish releases.

Appendix 3

2005
Low Water Contingency Plan for the Leavenworth NFH

Background

Leavenworth National Fish Hatchery (Hatchery) principle limitations are water quantity and quality. The Icicle water delivery system is gravity fed through a 6,500-foot long supply pipe. The hatchery is extremely dependent on surface water levels to drive the system. Surface water (42cfs) is 75 percent of the hatchery's water right and the ground water wells (14.2 cfs) are mostly in the shallow aquifer that is dependent on Icicle Creek water levels.

Water quantity in particular is a concern during summer low flow periods August through September. The summer of 2005 appears to be a very low water flow year due to 22 percent of normal snow pack as of March 23.

Cascade Orchards Company has the first water right on Icicle Creek and takes its full complement of water (7-12 cfs) from the Hatcheries supply pipe.

Facts

1. In order to provide Cascade Orchard Company their share of water, the Hatchery has to restrict the main supply valve and back water up to their diversion. Low flow years the Hatchery cannot receive their water right and provide Cascade Orchard Company water at the same time. The replacement of the supply pipe and intake structures in 2005 and 2006 will correct this situation.

2. Other than the 5-10 cfs leaking through the intake dam the hatchery has only one method to address the dewater issue below the intake and that is to restrict the main supply pipe valve and back water up to the intake. However, this action may initiate a fish release. Dewatering of Icicle Creek from the intake to our outfall has been an issue with Washington Trout over the years and one item targeted for a lawsuit.

3. Snow Lakes cannot provide enough water for full production needs.

4. Well water availability will be limited due to reduced flows in Icicle Creek. Well water is used on holding adult fish to keep water temperature between 45-50°F from July through August and for egg incubation. Additional use of well water for fish production would exhaust ground water supplies.

5. Brood year 2004 spring Chinook numbers were reduced by 49 percent in preparation of the pipeline replacement October through December of 2005. A temporary water supply will provide fresh river water from Icicle Creek (20 cfs), which will combine with

approximately 20 cfs hatchery drain water during construction. An unscheduled release of fish may occur if sufficient Icicle water is not available during construction.

Trigger Mechanisms to Initiated Action

One rearing strategy for a drought year would be to raise a smaller fish. When a flow index is used to determine water flows a smaller fish decreases the amount of water needed and lowers densities. The table below is based on a 0.6 flow index, 805,000 fish and illustrates what effects of a smaller fish has on gpm required.

Month	Normal Fish size	GPM Required	Adjusted fish size	GPM Required
May	90	4910	100	4577
June	52	7078	62	6292
July	34	9396	44	7912
Aug	28	10694	38	8724
September	24	11852	34	9396
October	22	12560	24	11852

The below calculations are based on the adjusted fish size of 24 fpp in October.

1. The hatchery will follow procedures agreed upon by Olympia Fish Health and the Hatchery staff preparing for the recirculation system scheduled for October through December of 2005. This includes a density index of 0.1, a turnover rate of two for each pond, with four banks of raceways containing about 805,000 fish. The Hatchery will manage its water system including the release of water from Snow and Nada appropriately to obtain this goal. The Hatchery will follow these recommendations as long as possible requiring a total flow of 18,000 gpm (40 cfs). The Hatchery will not exhaust Snow Lakes water to obtain a turn over rate of two but will manage its water reservoir to maintain a 0.6 flow index as long as possible.

2. When the Hatchery cannot maintain a turnover rate of two per raceway a flow index of 0.6 will begin.
   Water usage and total flows are:
   *Two banks of 8x80's (30) are using 6181 gpm (13.7cfs).
   *Two banks of 10x100's (14) are using 5656 gpm (12.6cfs).
   *Total flows from the four banks are 11,837 gpm (26.3cfs).

3. When the hatchery cannot maintain a flow index of 0.6 per raceway a second use water system will begin on two banks of raceways (lower bank of 8x80's and the lower bank of 10x100's). Depending on water availability, the Hatchery may place one bank at a time on the second use system. The second use water system increases the risk of wide-spread Bacterial Kidney Disease, lowering fish quality, and risk of increased parasitic infection. The survival of the cultured fish could be jeopardized and the return rate of adults

reduced if reusing of water is used for an extended period. The below calculations are based on both banks on the second use system.

Water usage and total flows are from single pass water:
*Upper bank of 8x80's uses 3090 gpm (6.9cfs).
*Upper bank 10x100's uses 2828 gpm (6.3cfs).
*Total flows for two banks are 5918 gpm (13.2cfs).

4. When the hatchery cannot maintain a flow index of 0.6 per raceway with two banks on the second use water system a fish release of 196,000 fish will occur from seven middle (64-70) and seven lower (49-55) 8x80 raceways into the Icicle Creek.

Usage and total flows are from single pass water:
*Eight middle bank 8x80's (56-63) uses 1648 gpm (3.7cfs) of water.
*Water use for two banks of 10x100's are 2828 gpm (6.3cfs).
*Total water flow given above conditions is 4476 gpm (10.0cfs).

5. When the hatchery cannot maintain a flow index of 0.6 given the above conditions the remainder of the fish (224,000) in the 8x80 raceways are released into Icicle Creek.

Water flow requirements after release are:
*One bank of 10x100's is 2828 gpm (6.3cfs).
*Total water flow on single pass is 2828 gpm (6.3.0cfs).

6. Low dissolved Oxygen levels are given the same importance as other criteria for releasing fish. Food intake of fish reduced when oxygen saturation levels of water fell below 60% and growth and feeding effectiveness appear to be affected when saturation levels fell below 70%. Piper et al (1983).

The hatchery alarm system has the capability to continuously record oxygen levels. Oxygen probes are on hand and have to be installed and calibrated prior to June 2005. The most reliable place to install the oxygen probes are the head boxes of each raceway bank. Low dissolved oxygen values in the incoming water will begin further testing of rearing unit outfall water. If rearing unit outfall water approaches 80% saturation potential action taken. When pond outfall water is below 70% saturation, a fish release should occur in sufficient numbers for the remaining fish to realize an increase in water flows and additional oxygen. If water saturation above 70% cannot be maintained, all fish could be released. The table below describes the oxygen saturation at different levels and different water temperatures.

TEMPERATURE & SATURATION

temp in C	temp in F	80% saturation 1.04c.f. @ 980 ft.	70% saturation 1.04c.f. @ 980 ft.	60% saturation 1.04c.f. @ 980 ft.
0	32.0	12.0	10.5	8.9
1	33.8	11.8	10.3	8.8
2	35.6	11.5	10.1	8.6
3	37.4	11.1	9.9	8.4
4	39.2	10.8	9.7	8.2
5	41.0	10.6	9.4	7.9
6	42.8	10.8	9.0	7.5
7	44.6	10.2	8.8	7.3
8	46.4	10.0	8.6	7.1
9	48.2	9.7	8.4	6.9
10	50.0	9.4	8.2	6.8
11	51.8	9.3	8.1	6.7
12	53.6	9.0	8.0	6.6
13	55.4	8.9	7.8	6.4
14	57.2	8.7	7.6	6.3
15	59.0	8.4	7.4	6.1
16	60.8	8.3	7.3	6.0
17	62.6	8.2	7.2	5.9
18	64.4	8.0	7.0	5.8
19	66.2	7.9	6.9	5.7
20	68.0	7.7	6.8	5.6
21	69.8	7.6	6.7	5.4
25	77.0	7.1	6.2	5.0

conversion factor @ 980 ft. = 1.04

7. During summer low flow periods, Icicle Creek water temperatures generally approach 70°F. The warmest water temperature occurs from 4pm to midnight. Our alarm system takes water temperature readings every hour and can monitor this situation. However, what criterion to use to prompt action regarding water temperature is puzzling. The Hatchery realizes elevated water temperature is just one stressor effecting fish. The combined effects of low dissolved oxygen, elevated water temperature, parasite load and a whole host of other environmental contacts can lead to a fish release.

   At this time, a water temperature value cannot be put in place to trigger a fish release.

8. The Hatchery has water rights for 14.2 cfs of ground water. Unfortunately, most wells are in the shallow aquifer and affected the most by low Icicle Creek water flows. Ground water usage has a predetermined course during the summer, which is to provide cool water for holding adult salmon and egg incubation. There is not enough remaining

ground water for fish production. It may be necessary to reduce adult numbers to match available water flows. Critical water flow times are generally July 10th through October 15th.

9. Good pond management can promote disease control. This involves maintaining fish in a good environment, reduce stress and provide good nutrition. However, during drought years environmental factors effecting fish health changes our normal course of rearing fish. Low flow years are when external parasites are particularly troublesome. The Hatchery and Olympia Fish Health personnel will monitor fish health more frequently July through October. Recommendations from Olympia Fish Health personnel could initiate a fish release.

If possible, contact NOAA Fisheries at (509) 230-5409 prior to an emergency release, if not contact them as soon as possible.

References

Piper, R.G., and five coauthors. 1983. Fish hatchery management. U.S. Fish and Wildlife Service, Washington, D.C.