PRELIMINARY DRAFT

NEEDS AND ALTERNATIVES ANALYSIS

ICICLE CREEK SUB-BASIN STORAGE STUDY

Prepared for

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1 INTRODUCTION

The purpose of this study is to determine water needs for the Icicle Creek sub-basin in the Wenatchee Watershed, compare those needs to the available water supply and analyze alternatives to meet any shortfalls in water supply.

For the purposes of determining the available water supply and discussing shortfalls, Icicle Creek was divided into four reaches:

1. Reach 1 – Upstream of the Icicle and Peshastin Irrigation District Diversion Dam (RM 5.7-head)
2. Reach 2 – Between the irrigation district diversion dam and the Leavenworth National Fish Hatchery (LNH) and Cascade Orchards Diversion (RM 4.5-5.7)
3. Reach 3 – Between the LNH diversion and the hatchery outflow (RM 2.7-4.5)
4. Reach 4 – Downstream of the hatchery outflow to the confluence of Icicle Creek and the Wenatchee River (RM 0-2.7)

2 WATER SUPPLY

Icicle Creek drains an area of 211 square miles, most of which is located in the Alpine Lakes Wilderness Area (Map 1). Water supply in the sub-basin is dependent on snowfall and snowmelt. Icicle Creek and Snow Creek are the primary surface water sources within the sub-basin. Flows in those two creeks are augmented with releases from lakes located within the Alpine Lakes Wilderness Area. Six lakes are used to supplement water supply; Snow, Nada, Colchuck, Square, Klonaqua and Eightmile lakes. The following sections describe the water supplied by Icicle Creek and Snow Creek.

2.1 Icicle Creek

Flow in Icicle Creek is measured at a gage (#12458000) maintained by the U.S. Geological Survey (USGS). The gage is located at River Mile (RM) 5.8 above Snow Creek. Daily data have been collected at this site for water years 1937-1971 and 1994-2006. Table 2-1 presents 10 percent, 50 percent, and 90 percent exceedence flows by month and Table 2-2 presents the exceedence flows by week from the USGS flow data. The flow exceedence indicates the probability a flow in a given time period will be exceeded. For example, the 90% flow exceedence for October refers to a flow that is exceeded 90% of the time in October.

Table 2-1
Icicle Creek Flow Exceedence by Month

Month	90% Exceedence (cfs)	50% Exceedence (cfs)	10% Exceedence (cfs)
Oct	79	167	464
Nov	103	233	699
Dec	110	253	645
Jan	114	220	531
Feb	110	200	565
Mar	141	236	500
Apr	264	568	1221
May	717	1465	2926
Jun	842	1730	3070
Jul	277	681	1663
Aug	127	208	463
Sep	93	133	248

Table 2-2
Icicle Creek Exceedence Flows by Week

Week Starting	90% Exceed-ence (cfs)	50% Exceed-ence (cfs)	10% Exceed-ence (cfs)	Week Starting	90% Exceed-ence (cfs)	50% Exceed-ence (cfs)	10% Exceed-ence (cfs)
1-Oct	79	117	354	31-Mar	219	325	735
8-Oct	79	155	464	7-Apr	248	461	904
15-Oct	78	156	497	14-Apr	310	610	1320
22-Oct	80	218	522	21-Apr	322	774	1335
29-Oct	92	221	580	28-Apr	461	908	1635
5-Nov	94	216	588	5-May	630	1045	2505
12-Nov	103	237	681	12-May	748	1420	2845
19-Nov	107	247	805	19-May	984	1815	3310
26-Nov	113	263	830	26-May	1220	1950	3310
3-Dec	120	262	648	2-Jun	1105	2130	3470
10-Dec	106	243	728	9-Jun	1050	1840	3100
17-Dec	120	241	642	16-Jun	845	1685	3195
24-Dec	110	245	527	23-Jun	700	1390	2525
31-Dec	101	240	544	30-Jun	543	1150	2040
7-Jan	118	230	554	7-Jul	399	904	2115
14-Jan	120	228	532	14-Jul	304	671	1620
21-Jan	115	210	479	21-Jul	236	504	1250
28-Jan	114	196	639	28-Jul	187	371	758
4-Feb	113	206	591	4-Aug	152	267	571
11-Feb	110	200	472	11-Aug	134	218	410
18-Feb	110	198	565	18-Aug	120	180	323
25-Feb	117	200	500	25-Aug	117	162	296
3-Mar	123	213	397	1-Sep	105	148	241
10-Mar	134	221	464	8-Sep	99	133	206
17-Mar	147	241	504	15-Sep	90	132	327
24-Mar	178	280	629	22-Sep	79	123	246

High flows in Icicle Creek typically extend from April to mid-July. The lowest flows typically occur from mid-August to mid-October. The flows shown in Table 2-2 are

supplemented during the irrigation season with discharges from Square, Klonaqua, Eightmile and Colchuck lakes operated by the Icicle and Peshastin Irrigation Districts.

2.2 Snow Lakes

Water from the Snow Lakes feeds into Icicle Creek via Snow Creek. Snow Creek enters Icicle Creek at RM 5.4, about 2,100 feet downstream of the Icicle Creek gage. The USFWS has collected flow data in four places along Snow Creek. Flow data are collected where Snow Creek enters Snow Lake, at the Snow Lake Drain, at the outlet to Nada Lake, and at the confluence with Icicle Creek. Table 2-3 shows the estimated average monthly flow in Snow Creek at its confluence with Icicle Creek. The data was collected during the period of 1994 to 2002 (Montgomery Water Group, 2004).

Table 2-3
Snow Creek Monthly Average Flow

Month	Average Flow (cfs)	Average Volume (AF)
Oct	33.5	2,060
Nov	3.9	232
Dec	9.0	553
Jan	9.0	553
Feb	32.3	1,794
Mar	21.6	1,328
Apr	23.7	1,410
May	56.0	3,443
Jun	29.6	1,761
Jul	43.5	2,675
Aug	36.6	2,250
Sep	43.3	2,577

An estimate of total annual runoff by water year in the Upper Snow Lake Watershed was prepared by Wurster (USFWS, 2006). Those estimates are shown in Table 2-4.

Table 2-4
Total Annual Runoff – Upper Snow Lake Watershed

Year	Total Annual Runoff (AF)	Total Oct-July Runoff (AF)
1994	5,600	5,300
1995	8,900	8,200
1996	13,000	11,800
1997	11,600	10,700
1998	8,200	7,100
1999	10,900	9,700
2000	8,600	7,900
2001	4,400	3,800
2002	9,900	9,200
2003	6,400	6,000
2004	8,300	7,200
2005	6,900	6,400
Average	**8,600**	**7,800**
Maximum	**13,000**	**11,800**
Minimum	**4,400**	**3,800**
Median	**8,500**	**7,600**

Upper Snow Lake is managed to augment streamflow in Icicle Creek in the late summer and fall, when flows are low. Upper Snow Lake can store approximately 12,450 AF at full capacity. Water is released from the lake by opening a valve mounted on a pipe in the tunnel below the lake. Between 1998 and 2005, the valve was open for an average of 77 days, usually between mid-July and mid-October (Wurster 2006). Table 2-4 shows the amount of water released from Upper Snow Lake from 1998-2005.

Table 2-4
Annual Upper Snow Lake Releases

Year	Amount Released (AF)
1998	6,260
1999	4,890
2000	Reading not taken
2001	1,100
2002	1,460
2003	Reading not taken
2004	2,790
2005	5,490

Wurster (2006) analyzed the likelihood of Upper Snow Lake refilling for a range of flow rates and the number of days flow was supplemented. LNFH averages a diversion of 40 cfs from Icicle Creek in August and September. There is an 86 percent probability that Upper

Snow Lake will completely refill in this situation. If additional flow is released to supplement Icicle Creek flow, the probability of complete refill will decrease. If an additional 20 cfs are released for supplemental flow (60 cfs total), the probability of Upper Snow Lake completely refilling is about 60 percent. If an additional 40 cfs are released for supplemental flow (80 cfs total), the probability of refill is about 30 percent (Wurster 2006).

3 WATER DEMAND

Water demand in the Icicle Creek subbasin is derived from several sources, including municipal and domestic demand, irrigation demand, fish propagation demand, and instream flow to protect instream resources. Data for each relevant source of demand is described in detail for the subbasin.

3.1 Municipal and Domestic

Domestic demand is based on population estimates, water service types, and water use groups. Water demands were developed in the Wenatchee River Basin Watershed Assessment (MWG, 2003) and the Wenatchee Watershed Management Plan (Chelan County, 2006). The demand is calculated using the following assumptions:

- Population converts into connections using 2.62 people/connection (the mean Chelan County household size)
- Future population estimates are for 2025 and are based on "high growth" projections from the Office of Financial Management
- Full-time connections use 380 gallons per day (gpd) and part-time connections use 95 gpd, unless data from water purveyors are available
- The maximum daily demand (MDD) is 2.5 times the average daily demand (ADD)
- The Department of Health in-house water system data determines water use beyond residential use (recreational uses are part-time use and all other uses are full-time use)

Population estimates were estimated from Chelan County parcel data, U.S. Census Bureau data, Washington State Department of Health in-house water system data, and Chelan County Urban Growth Area (UGA) and non-UGA reports. Water service types were divided into Group A service (system serving more than 15 connections or 25 people for at least 60 days per year), Group B service (system serving less than 15 connections or 25 people or more than 25 people for less than 60 days per year), and exempt well service (domestic well where a permit from Ecology is not required). Group A and B service populations were determined using the Department of Health in-house water system data, and exempt well service was assumed to be the remaining population. Water use groups were divided into full-time and part-time service and were determined from U.S. Census Bureau data and Chelan Country parcel data.

The overall current average demand from domestic sources in the Icicle Creek sub-watershed is 1.828 cfs, which converts to an annual demand of 1,324 AF/yr. The overall average future demand from domestic sources is estimated to be 3.731 cfs or 2,704 AF/yr. The current maximum daily demand (MDD) is 4.57 cfs and the future MDD is estimated at 8.49 cfs. The current demand was estimated using a full-time population of 723 people and a part-time population of 404 people. That population leads to an estimate of 449 full-time and 3 part-time connections. The future demand uses projected population increases of 1.18 percent per year for all non-UGAs in the Leavenworth-Lake Wenatchee County Census Division (CCD).

The Icicle Creek subbasin domestic demands also include demand from the City of Leavenworth. Although the City is located within the Chumstick Creek subbasin, their water supply comes from Icicle Creek. The City currently has a water right of 3 cfs for surface water diversions from Icicle Creek. From their Water System Plan, the City of Leavenworth has 2,028 connections and has an average current demand of 1.564 cfs of the 1.828 cfs total domestic water demand in the Icicle Creek sub-watershed. The City of Leavenworth is projected to increase in population by 3.4 percent compounded annually, leading to the future average demand of 3.396 cfs of the 3.731 cfs total domestic water demand in the Icicle Creek sub-watershed. (*Monthly demands have not yet been obtained from the City of Leavenworth and a table of monthly demands will be prepared once that data is obtained).*

3.2 Irrigation

Irrigation demand is established from water use from irrigation districts and water right data from Ecology's Geographic Water Information System (GWIS) in 2002. Irrigation is assumed to occur from April 1-September 30. The Icicle and Peshastin Irrigation Districts divert water from Icicle Creek, and daily data from 2003-2006 has been obtained for this analysis from the Department of Ecology. The GWIS data includes both instantaneous quantity (in cfs) and annual quantity (in acre-feet per year).

The Peshastin and Icicle Irrigation Districts diverts an average of 30,770 AF/yr of water into the Icicle Canal at the Icicle Diversion Dam on Icicle Creek (RM 5.7). They generally divert water from the beginning of April to the end of September, although some diversions may

start as early as mid-March and go until as late as mid-October. Table 3-1 shows the average monthly diversions for the Districts from 2003-2005.

Table 3-1
Icicle Canal Average Monthly Diversions from Icicle Creek

Month	2003	2004	2005	Average
Apr	58.8	52.1	60.2	57
May	74.5	76	77.3	75.9
Jun	97.4	90.5	96.5	94.8
Jul	100.9	96.8	102.7	100.1
Aug	102	94.5	105.4	100.6
Sep	82.6	78.7	76.9	79.4
Total AF	31,267	29,604	31,449	30,766

The Cascade Orchards Irrigation Company diverts water from Icicle Creek at RM 4.5. It is estimated that the Cascade Orchards Irrigation Company diverts 7 cfs from May-September annually (MWG, 2004). That volume equates to a volume of 2,125 acre-feet on an annual basis.

In addition to the irrigation districts, individual property owners have water rights for irrigation in the Icicle Creek subbasin. The actual use is not known but the water rights can give a conservative estimate of water use. Those water rights total 986 AF of surface water and 106 AF of groundwater. These uses are assumed to occur in Reach 4, since the population is greatest in this reach.

Combining these values leads to an average irrigation demand of 33,877 AF for surface water and 106 AF for groundwater in the Icicle Creek subbasin.

3.3 Leavenworth National Fish Hatchery

The Leavenworth National Fish Hatchery (LNFH), which is located at RM 2.7 along Icicle Creek, diverts water from Icicle Creek for fish propagation purposes. The hatchery's diversion is located at RM 4.5. The LNFH also uses groundwater from wells to supplement surface water flow when quantities are limited or temperatures are inappropriate. In a previous study, Montgomery Water Group presented surface water diversions from Icicle Creek and groundwater use from wells by the LNFH (MWG 2004). Table 3-2 shows the monthly usage previously presented and the calculated annual volumes for surface water and groundwater use.

Table 3-2
Leavenworth National Fish Hatchery Average Monthly Water Use

Month	Surface Water Diversion (cfs)	Groundwater Use (cfs)
Oct	38.8	3.5
Nov	38.0	3.3
Dec	38.9	4.8
Jan	33.4	6.4
Feb	36.7	8.8
Mar	37.3	8.8
Apr	27.4	10.3
May	20.3	5.1
Jun	28.9	1.4
Jul	35.4	4.3
Aug	35.5	5.3
Sep	29.8	6.5
Total (AF)	24,155	4,120

The total annual average surface water diversion by the LNFH is 24,155 AF, and the total annual average groundwater use by the LNFH is 4,120 AF. These flows are returned to Icicle Creek at the beginning of Reach 4, at RM 2.7.

The LNFH is working on a Water Supply System Rehabilitation Project to provide year-round fish passage past the dam at its gravity intake facility. The project will include construction of a roughened channel, replacement of fish screens at the intake's point of diversion, and replacement of components of the system that are degraded and failing.

The current flow conditions between the diversion dam at RM 4.5 and the return from the hatchery at RM 2.8 may not be adequate for fisheries. An agreement on flow released downstream of the dam has not been reached between LNFH, USFWS and NOAA Fisheries (Craig, pers. corr. 2006). LNFH has included a pump-back system in their rehabilitation project to return up to 20 cfs to Icicle Creek at RM 4.5. Project implementation is pending completion of permitting requirements. If 20 cfs was returned to Icicle Creek during August and September, this would be the equivalent of 2,420 acre-feet returned to Icicle Creek.

The USFWS released a Biological Opinion (BiOp) in August 2006 regarding the LNFH (USFWS, 2006). One aspect regarding flows included releasing the equivalent of 50 cfs from the Snow Lakes reservoir system between July 20 and September 30. This is an equivalent of 7,240 acre-feet during that period.

3.4 Instream Flow

Instream flows are regulatory flows designed to protect instream resources such as fish, wildlife, and recreation. Instream flows in the Icicle Creek sub-watershed were initially established in 1983. Instream flows do not affect water rights with priority dates senior to the date the rule was set. As part of the Wenatchee Watershed Management Plan, the WRIA 45 Planning Unit has proposed to update the instream flows due to increased knowledge of flow needs for aquatic species. Table 3-3 lists the instream flows for Icicle Creek set in 1983. The control point for these flows is located at RM 1.5 (within Reach 4), but the flows are relevant for all four reaches of Icicle Creek.

Table 3-3
Icicle Creek Instream Flows – 1983

Dates	Flow (cfs)
Oct 1-31	130
Nov 1-Dec 31	150
Jan 1-Feb 29	120
Mar 1-15	150
Mar 16-31	170
Apr 1-15	200
Apr 16-30	300
May 1-15	450
May 16-31	660
Jun 1-15	1000
Jun 16-30	660
Jul 1-15	450
Jul 16-31	300
Aug 1-15	200
Aug 16-31	170
Sep 1-30	130

A technical memorandum completed by the U.S. Bureau of Reclamation (Reclamation) summarizing an instream flow assessment performed in 2004 and 2005 on Icicle Creek was included as Appendix B in the Final Wenatchee Watershed Management Plan. That memorandum formed the technical basis for revising the instream flows for Icicle Creek.

Reclamation studied the reach of Icicle Creek from its confluence with the Wenatchee River to the LNFH at RM 2.7. Icicle Creek has a flat slope and a meandering pattern in the study area. Chinook and coho salmon and steelhead and bull trout use the area for upstream and downstream movement, migration, and juvenile rearing. Chinook salmon, steelhead trout,

and bull trout are federally listed species and were chosen by the WRIA 45 Planning Unit as species of interest.

Reclamation used the U.S. Fish and Wildlife Service Physical Habitat Simulation System (PHABSIM) to study Icicle Creek. The PHABSIM quantifies habitat availability over a range of flows based on streamflow, substrate, cover type, and habitat suitability. It is not designed to be used as a set value but as a range of values to be used as a tool for determine relative amounts of habitat available.

Eleven transects in three study sites were chosen within the project area for data collection. Water depths and velocities were collected at various discharges. Cover codes and substrate codes were determined using standard codes given in the Instream Flow Guidelines Report (Washington Department of Fish and Wildlife & Washington Department of Ecology, 2004). The habitat suitability was determined for each species (chinook salmon, steelhead trout, and bull trout) and life stage (spawning and juvenile) of interest using existing Washington State habitat suitability criteria.

The data collected was analyzed by the PHABSIM model to estimate the weighted usable area (WUA) for each site for each species and life stage of interest. A composite WUA of all three sites was also determined. The WUA was calculated for discharges ranging from 20 to 800 cfs. The highest WUA denotes the discharge where the habitat is optimized for the specific species and life stage. Table 3-3 shows the discharge where the habitat is optimized for each species and life stage of interest based on the composite output.

Table 3-3
Habitat Optimization Discharge

Species/Life Stage of Interest	Discharge of Highest WUA (cfs)
Chinook Salmon/Spawning	400
Chinook Salmon/Juvenile	250
Steelhead Trout/Spawning	650
Steelhead Trout/Juvenile	550
Bull Trout/Spawning	70
Bull Trout/Juvenile	40

The proposed instream flows are shown in Table 3-4 along with the percent of maximum WUA for each species and life stage of interest.

Table 3-4
Icicle Creek Recommended Instream Flows with Corresponding WUA

Time Period	Instream Flow (cfs)	WUA % Chinook Spawning	WUA % Chinook Juvenile	WUA % Steelhead Spawning	WUA % Steelhead Juvenile	WUA % Bull Spawning	WUA % Bull Juvenile
10/1-2/14	267	89.4	98.0	61.4	81.8	45.3	74.5
2/15-2/28	566	93.4	63.6	98.0	99.5	18.1	56.5
3/1-3/31	518	96.6	67.3	95.5	100.0	20.4	60.1
4/1-6/15	650	85.9	59.4	100.0	95.1	13.5	49.3
6/16-7/31	550	94.7	64.5	97.5	100.0	19.1	57.7
8/1-8/15	400	100.0	81.7	84.2	95.2	29.8	68.8
8/16-8/31	343	97.3	88.6	78.0	91.0	36.0	72.4
9/1-9/30	275	90.5	97.1	63.4	83.0	44.1	74.1

These instream flows were recommended based on maximizing the habitat available for species and life stages of interest during the period when they will occur in Icicle Creek. Moderate chinook spawning occurs from Aug 15-Sept 15, and moderate incubation occurs from Aug 15-Mar 31. Moderate steelhead spawning occurs from Mar 1-May 31, and moderate incubation occurs from Mar 1-Jul 31. Moderate bull trout spawning occurs from Sep 15-Oct 31, and moderate incubation occurs from Sep 15-Apr 15.

In some time periods, the discharge of optimum habitat for species of interest occurs less than 10 percent of the time (10% exceedence). When this is the case (Feb 15-Mar 31 for steelhead spawning and Aug 16-Sep 30 for chinook spawning), the 10% exceedence flow is chosen as the recommended instream flow.

The new instream flows will have a priority date of 1983, except for proposed instream flows higher than 1983 instream flows. Those flows will have a priority date of when a new instream rule is adopted.

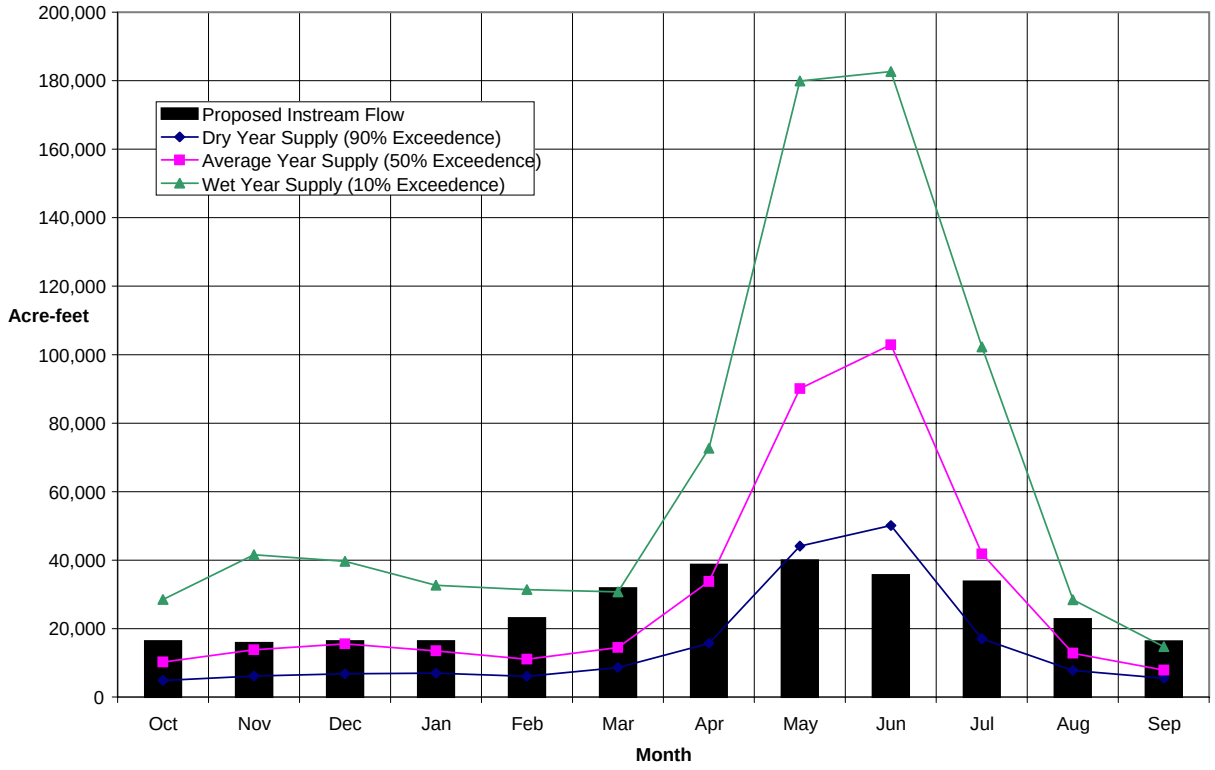
4 WATER NEEDS

Water needs are estimated by comparing the available water supply to the water demands in the Icicle subbasin. The water demands include irrigation diversions, municipal and domestic demand, LNFH diversions and instream flows. A comparison was completed for each of the four reaches of Icicle Creek described in Section 1. The comparisons are made for dry (90% exceedence), average (50% exceedence) and wet (10% exceedence) water years.

4.1 Reach 1 – Upstream of Icicle Irrigation District Diversion Dam

Reach 1 is the most upstream reach of Icicle Creek, upstream of the Icicle Diversion Dam. There is little demand due to lack of population in this reach and no other diversions. The primary water demand is the instream flow needs. A comparison of the water supply available to the proposed instream flow is shown in Figure 4-1.

Figure 4-1 Comparison of Water Supply and Demand – Icicle Creek, Reach 1



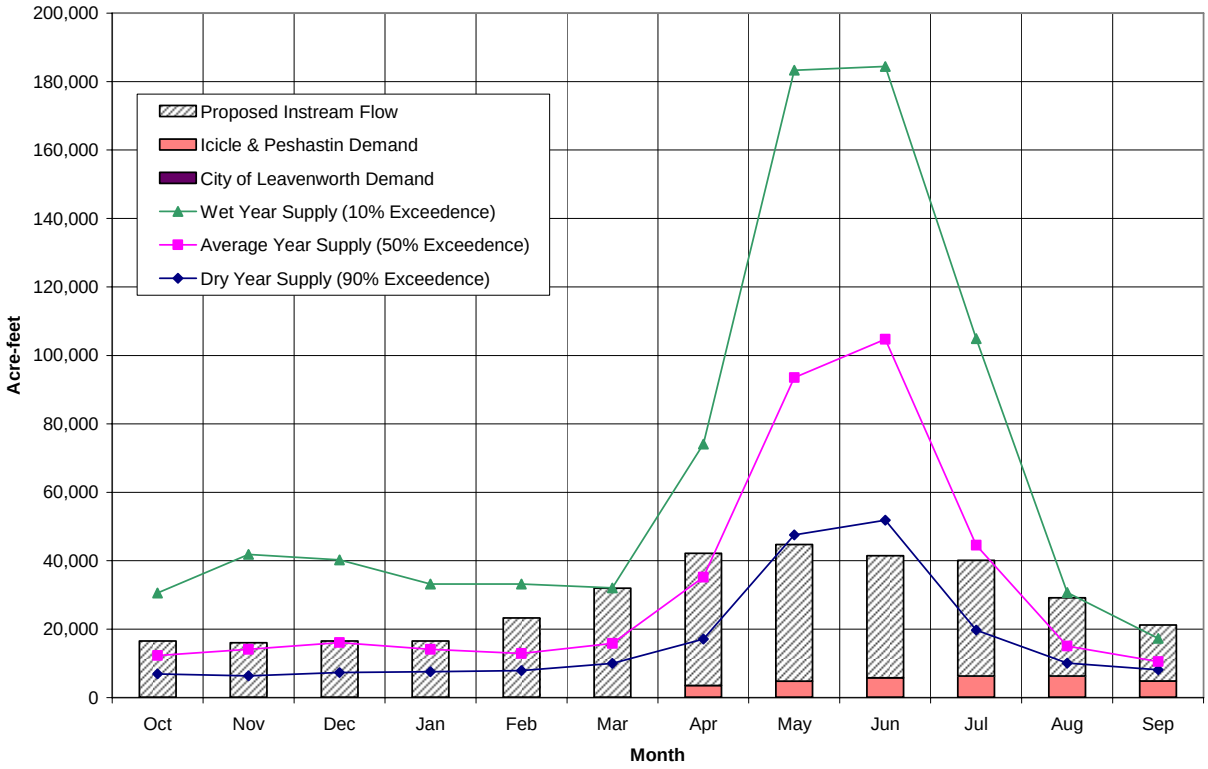
A surplus of water occurs during the spring melt while a deficit occurs in August through October during the period of annual low flows. However the flows in this reach are natural

and slightly enhanced by discharge from high alpine lakes operated by the Icicle and Peshastin Irrigation District. No action is needed for this reach to enhance streamflow.

4.2 Reach 2 – Between Icicle Irrigation District Diversion Dam and Leavenworth National Fish Hatchery Diversion Dam

Reach 2 has a large seasonal demand coming from the Icicle and Peshastin Irrigation Districts at their diversion dam (RM 5.7). Reach 2 also contains the City of Leavenworth's surface water diversion (at RM 5.5). Snow Creek flows into Icicle Creek in this reach and its water supply was added to the water supply provided by Icicle Creek. Figure 4-2 shows a comparison of water supply and demand for Reach 2.

Figure 4-2 Comparison of Water Supply and Demand – Icicle Creek, Reach 2

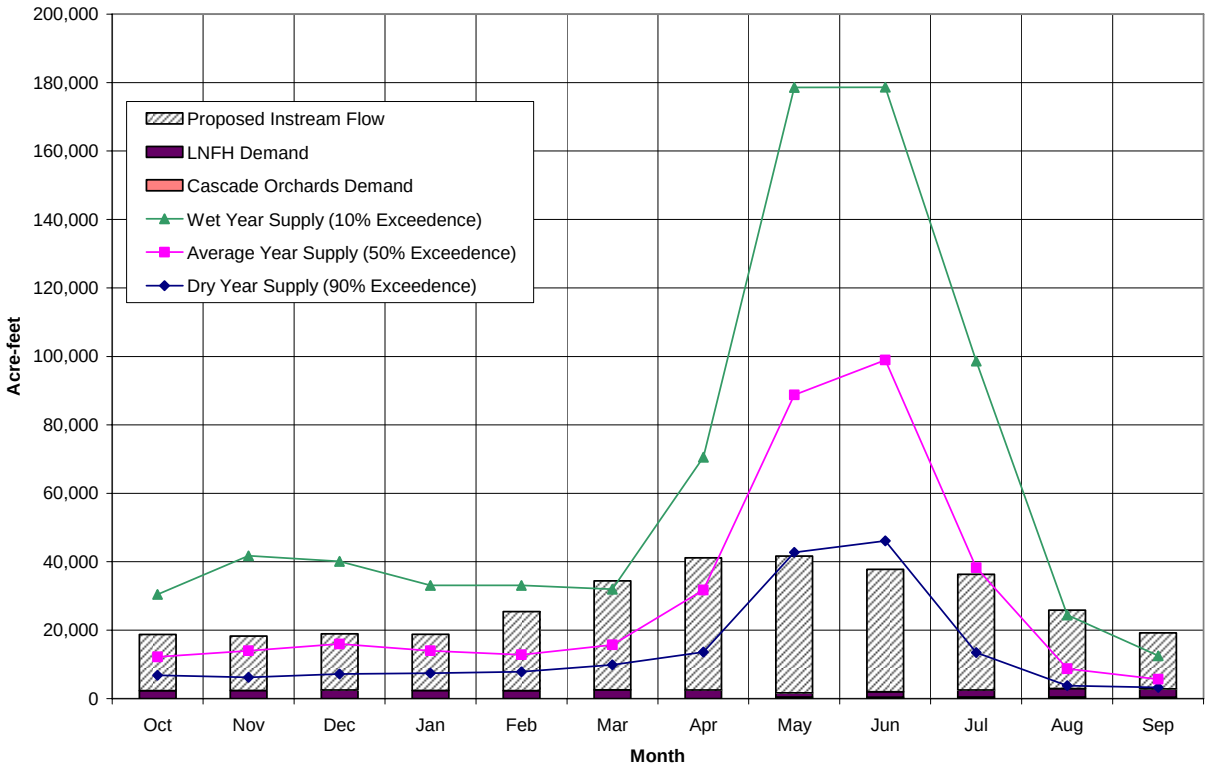


A surplus of water occurs during the spring melt while a deficit occurs in August through October during the period of annual low flows. Slight deficits also occur in January through April. The primary need is for additional water in August and September.

4.3 Reach 3 – Between Leavenworth National Fish Hatchery Diversion Dam and Hatchery Outflow

Reach 3 has a large demand from the LNFH and a seasonal demand from the Cascade Orchards Irrigation Company (both at RM 4.5). Although the LNFH demand is non-consumptive, Reach 3 flow is reduced. Figure 4-3 shows a comparison of monthly supply and demand for Reach 3. The instream flows plotted on Figure 4-3 are the proposed flows for Icicle Creek and do not represent the flow that may be provided by LNFH in this reach as a result of negotiations with USFWS and NOAA Fisheries that is discussed in Section 3. The proposed instream flows are much higher than those flows, but are shown to be consistent with the discussion about other reaches along Icicle Creek.

Figure 4-3 Comparison of Water Supply and Demand – Icicle Creek, Reach 3

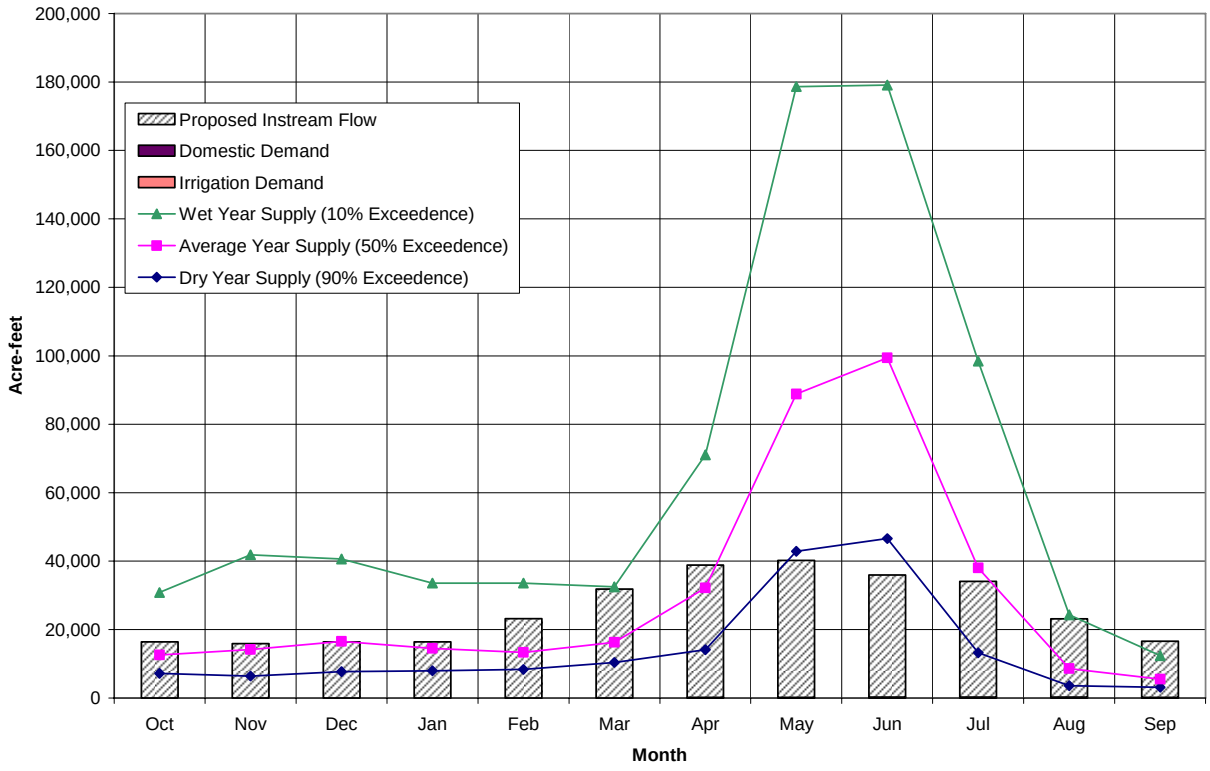


A surplus of water occurs during the spring melt while deficits occur in other months. The largest deficits occur in the August through October time period, with the primary need is additional flow in August and September.

4.4 Reach 4 – Downstream of Hatchery Outflow to Wenatchee River

Reach 4 has no major diversions but all non-purveyor domestic water use and all non-district irrigation use are assumed to take water from Icicle Creek in this reach due to the majority of population being located within this reach. The LNFH outflow adds supply to Icicle Creek at RM 2.7. Figure 4-4 shows the monthly supply and demand for Reach 4.

Figure 4-4 Comparison of Water Supply and Demand – Icicle Creek, Reach 4



Domestic irrigation demands are small enough that neither can be visibly seen on the graph. A surplus of water occurs during the spring melt while deficits occur in August through October during the low flow period. Deficits also occur during the February through April time period. The primary need is for additional water in August and September.

5 REFERENCES

Craig, Jim L. 2006. E-mail communication. December 11, 2006.

Montgomery Water Group. 2004. Water Management Plan for Leavenworth National Fish Hatchery. December 2004.

Montgomery Water Group, in association with Economic and Engineering Services and Pacific Groundwater Group. 2003. Wenatchee River Basin Watershed Assessment. August 2003.

United States Bureau of Reclamation. 2005. Instream Flow Assessment of Icicle Creek, Washington. December 2005.

United States Geological Survey. 2007. USGS Water Data for the Nation. http://waterdata.usgs.gov/nwis/.

Washington State Department of Ecology. 1982. Wenatchee River Basin Instream Resources Protection Program. WIRPP Series No. 26. December 1982.

WRIA 45 Planning Unit. 2006. Final Wenatchee Watershed Management Plan. April 26, 2006.

Wurster, Fred. 2006. Management Recommendations for Reservoir Releases from Upper Snow Lake: Leavenworth National Fish Hatchery. Report LE-008. 2006.