3.0 EXISTING CONDITIONS, ENVIRONMENTAL IMPACTS, AND MITIGATION MEASURES

A Summary comparing the environmental impacts of the alternatives described in this chapter is included at the end of Chapter 2 in Table 2-11.

3.1 WATER QUANTITY

3.1.1 EXISTING CONDITIONS

3.1.1.1 Surface Water

Okanogan River

Watershed Characteristics

The 8,340 square mile Okanogan River watershed is the largest of the four main mid-Columbia River tributaries. About 75 percent of the watershed lies in the Canadian province of British Columbia, with the remaining 25 percent in north-central Washington state (FEMA 1995a). The eastern and western boundaries of the watershed are steep with jagged ridgelines at elevations ranging from 1,500 feet to more than 5,000 feet above the Okanogan River valley floor (WDOE, 1995). The high relief of the Okanogan River basin and arid climate of the eastern Cascades produce a hydrologic regime with large variability in annual and monthly streamflow. Streamflow patterns are affected by reservoir regulation at Okanogan and Skaha Lakes in Canada for flood control and irrigation, by natural storage associated with other lakes in the U.S. and Canada, and by numerous irrigation diversions supporting about 55,000 acres in Canada and 22,000 acres in the U.S.

Annual Runoff and Water Year Types

Okanogan River streamflow records since 1958 are available for the USGS station at Malott (#12447200). The Malott station is located at river mile 17.0 (upstream of the Columbia River), about 10 miles downstream of Salmon Creek, and has an upstream watershed area of 8,080 square miles (**Figure 3-1**). The watershed area is 8,900 square miles at the Columbia River. Okanogan River streamflow data are available since 1911, with a continuous record since 1929, for the USGS station at Tonasket (#12445000). The Tonasket station is located at river mile 50.8, with an upstream watershed area of 7,260 square miles (**Figure 3-1**). Comparison of the overlapping records at the Malott and Tonasket demonstrates that flows at Malott are approximately 4 percent higher than the flows at Tonasket. Based on this relationship, the flow record at Malott can be extended to include the Tonasket period of record (1911 through 1957) using a factor of 1.04.

Annual streamflow volume (runoff) at the Malott gage station averages 2.2 million AF/year (3,100 cfs), but varies considerably, with a minimum of 0.9 million AF (1,200 cfs) in 1931 and maximum of 4.6 million AF/year (6,350 cfs) in 1972 (**Figure 3-2**). The long-term pattern of annual runoff generally shows wetter and drier cycles of several years duration, with very wet conditions only for a couple of years at a time.

Water year typing describes how wet or how dry a given year is in relation to all years on record. The annual runoff volumes at Malott were ranked to determine exceedence probabilities[1] and establish approximate runoff volume breaks between the five water year types (**Table 3-1**).

Table 3-1. Okanogan River Water Year Types.

Okanogan River Runoff[a] (Acre-feet/year)	Water Year Type	Probability Flow is Equaled or Exceeded
>2,800,000	Wet	0% to 19%
2,300,000 to 2,800,000	Above Normal	20% to 39%
2,000,000 to 2,299,999	Normal	40% to 59%
1,600,000 to 1,999,999	Below Normal	60% to 79%
<1,600,000	Dry	80% to 100%

[a] Runoff at Malott USGS #12447200

Monthly Streamflow and Minimum Instream Flow Requirements

Monthly streamflow on the Okanogan River displays the large seasonal variation typical of major snowmelt river systems (**Figure 3-3**). Winter low flows are followed by rising streamflow in late spring, large snowmelt peaks in May and June, and a return to low flows by August (**Figure 3-3**). Approximately half of the annual runoff volume on the Okanogan River occurs during snowmelt in the months of May and June. Only a small amount of precipitation makes it to the streams outside of the spring and early summer months. Streamflow is consistently low September through March. The spring and early summer months experience a wide range from year to year, with a large variation between minimum, median and maximum streamflows.

The Washington Department of Ecology oversees both the appropriation of water for out-of-stream uses (e.g., irrigation, municipalities, commercial and industrial uses) and the protection of instream uses (e.g., water for fish habitat and recreational uses). Minimum instream flows for the Okanogan River were established by the Washington Administrative Code (WAC 173-549) in 1976 (**Table 3-2**). Although WAC minimum instream flows have been set by rule, these

[1] An exceedence probability is the statistical likelihood that an event will be equaled or exceeded during a given time period. For example, the probability that in any given year the annual runoff at Malott will exceed 2,800,000 AF/year is less than 20 percent, or less than two out of every ten years.

Table 3-2. Okanogan River Monthly Streamflow Statistics and WAC Minimum Flows.

Okanogan River Monthly Streamflow Statistics and WAC Mimimum Flows(1911-1925 and 1929-2002)*

Monthly Runoff (Acre-Feet)

Years Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1%	182,299	168,077	242,213	816,864	1,022,063	1,739,826	674,428	254,727	187,717	181,368	281,952	270,171
10%	115,672	119,941	158,083	251,797	804,910	955,350	423,399	188,912	113,771	113,369	137,214	147,253
20%	100,089	96,386	121,040	213,721	677,695	841,500	364,577	137,740	86,878	91,763	109,055	112,020
30%	88,628	85,461	105,822	187,803	627,521	736,452	316,170	115,645	75,181	84,592	97,338	90,296
40%	78,547	76,601	85,180	176,022	577,482	661,353	257,935	102,939	70,322	78,170	88,130	76,911
50%	72,813	69,121	79,753	146,957	519,671	579,727	225,304	81,095	63,914	75,140	77,834	67,597
60%	63,390	62,319	68,924	129,571	459,408	489,595	170,646	70,219	54,585	68,765	72,093	63,856
70%	58,762	57,913	60,499	108,417	434,115	428,293	148,448	58,415	48,969	60,664	64,588	59,737
80%	50,074	51,249	54,171	93,496	356,756	346,282	117,366	45,385	38,684	51,482	55,310	55,094
90%	42,709	38,187	44,963	77,714	303,052	260,390	87,615	32,183	27,924	45,352	46,700	45,671
99%	22,977	30,956	33,518	47,576	241,935	155,905	38,620	14,777	14,272	25,736	25,505	25,460
Mean	66,777	65,765	79,285	145,132	485,872	544,065	221,572	86,753	60,721	68,899	78,929	74,443
WAC Minimum Instream Requirement	51,866	46,706	54,628	60,143	170,330	225,720	101,277	42,966	39,204	52,480	56,430	56,163

Monthly Streamflow (CFS)

Years Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1%	2,965	3,000	3,939	13,728	16,622	29,239	10,969	4,143	3,155	2,950	4,738	4,394
10%	1,881	2,141	2,571	4,232	13,091	16,055	6,886	3,072	1,912	1,844	2,306	2,395
20%	1,628	1,720	1,969	3,592	11,022	14,142	5,929	2,240	1,460	1,492	1,833	1,822
30%	1,441	1,525	1,721	3,156	10,206	12,376	5,142	1,881	1,263	1,376	1,636	1,469
40%	1,277	1,367	1,385	2,958	9,392	11,114	4,195	1,674	1,182	1,271	1,481	1,251
50%	1,184	1,234	1,297	2,470	8,452	9,743	3,664	1,319	1,074	1,222	1,308	1,099
60%	1,031	1,112	1,121	2,178	7,472	8,228	2,775	1,142	917	1,118	1,212	1,039
70%	956	1,034	984	1,822	7,060	7,198	2,414	950	823	987	1,085	972
80%	814	915	881	1,571	5,802	5,819	1,909	738	650	837	930	896
90%	695	682	731	1,306	4,929	4,376	1,425	523	469	738	785	743
99%	374	552	545	800	3,935	2,620	628	240	240	419	429	414
Mean	1,088	1,176	1,292	2,443	7,916	9,159	3,610	1,413	1,022	1,123	1,329	1,213
WAC Minimum Instream Requirement	845	835	890	1,013	2,775	3,880	1,650	700	660	855	950	915

Shaded areas represent flow exceedences where WAC minimum instream flows are not met.

*Streamflow measured at Mallot gage from 1958 to 2002. Comparison of overlapping flow records at the Mallot and Tonasket gages demonstrates that flows at Mallot are approximately 4% higher than the flows at Tonasket. Based on this relationship, the flow record at Mallot can be extended back prior to 1958 by multiplying measured flows at the Tonasket gage (which began operating in 1911, and has continuously recorded flows since 1929) by 1.04.

flows do not constrain senior water rights and the Okanogan River streamflow periodically falls below these levels. Monthly streamflow statistics for the Okanogan River at Malott (**Table 3-2** and **Figure 3-3**) can be compared to the WAC minimums to indicate the percent of years in which flows are below the thresholds. As might be expected, WAC minimum flows are consistently met in May, and are met for over 90 percent (9 out of 10 years) in April (93 percent) and June (94 percent). For the low flow months, an increased proportion of years that fall below the WAC minimum increases. Only 80 percent of the years meet the WAC minimums in September through January, and in March.

Review of the monthly Okanogan River streamflow record (**Appendix B-1**), indicates that flows fall below the monthly WAC minimums more often in drier water year types (**Table 3-3**). Dry water years are below the minimum flows set by rule for over half of the year, while normal and below normal water years may experience one or up to two months below minimum flows set by rule. Flows below WAC minimums are atypical in wet or above normal years.

Table 3-3. Instream Flow Below WAC Minimum Water Year Type (Existing Conditions).

Water Year Type	Average number of months per year WAC minimum instream flows are not met[a]	Probability Flow is Equaled or Exceeded[b]
Wet	Less than 1 (0.4)	0% to 19%
Above Normal	Less than 1 (0.3)	20% to 39%
Normal	~ 1 (1.2)	40% to 59%
Below Normal	1 to 2 (1.4)	60% to 79%
Dry	6 to 7 (6.4)	80% to 100%

[a] For all years in the water model, simulated Okanogan River streamflow between Shellrock and Salmon Creek was evaluated on a monthly basis to determine if WAC minimum instream flows were met. The number of months that WAC minimum instream flows were not met in a given year were totaled, and then ranked by water year type and averaged to calculate the mean number of months for a certain water year type that WAC standards were not met.

[b] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Salmon Creek

Watershed Characteristics

Salmon Creek has a 167 square mile watershed and enters the Okanogan River at the town of Okanogan (**Figure 3-1**). Elevations in the Salmon Creek watershed range from a maximum of 8,242 feet at Tiffany Mountain to 2,318 feet at Conconully Reservoir and 810 feet at the confluence with the Okanogan River (USFS, 1997). The upper Salmon Creek watershed (above Conconully Reservoir) is bordered by the Chewuch (to the west), Middle Methow (to the southwest), and the Similkameen (to the north and east) watersheds (USFS, 1997). Downstream of Conconully Reservoir, Salmon Creek watershed is bordered by the Johnson Creek watershed to the north and east.

The watershed is elongate in shape and generally oriented on a northwest-southeast axis (**Figure 3-1**). The broad upper watershed contains about 70 percent of the drainage area and has a width of about eight to ten miles. Major tributaries in the upper watershed are the North, West, and South Forks of Salmon Creek. Runoff from the upper watershed is the primary water supply for the Okanogan Irrigation District (OID), and is stored in Salmon Lake and Conconully Reservoir.

Salmon Creek's watershed downstream of Conconully Reservoir is about 15 miles long and has several short side tributaries. The middle reach of Salmon Creek is about 11 miles long and conveys regulated flows downstream from Conconully Reservoir to the OID Diversion Dam (**Figure 3-1**). The lower reach of Salmon Creek extends for about 4.3 stream miles from the diversion dam through the City of Okanogan to the Okanogan River. For more than 80 years, the lower 4.3 stream miles of Salmon Creek have been dewatered under normal irrigation operations, except during spring runoff events that result in uncontrolled spill at the reservoirs and diversion dam.

Annual Runoff and Water Year Types

Annual runoff of the Salmon Creek watershed has not been recorded systematically. However, records of inflow to the water supply reservoir, limited streamflow data, and long-term precipitation data relationships can provide estimates of the magnitude of unregulated runoff and its pattern from year-to-year. Since the early 1900s, irrigation diversions have prevented much of the runoff produced in the Salmon Creek watershed from reaching the Okanogan River.

Streamflow measurements of Salmon Creek are limited to a station near the City of Okanogan for the period from 1903 to 1910, and a station near Conconully for the period from 1910 to 1922. The Okanogan station provides some data prior to dam construction, and the Conconully station data represent the early years of dam construction (Walters, 1974). Salmon Creek annual runoff near Okanogan for the period 1904-1909, when the creek was unregulated and had only a few small diversions for irrigation, ranged from about 25,300 AF/year (35 cfs) to 57,800 AF/year (80 cfs), with an average of 35,400 AF/year (49 cfs) (WDOE, 1976). Salmon Creek annual runoff near Conconully during the period 1910 to 1922 averaged about 22,400 AF/year (31 cfs). The slightly reduced contributing area at Conconully, some drier water years, initial OID diversions, and evaporative losses from the newly constructed Conconully Reservoir all contribute to the decreased runoff measured from 1910 to 1922 (Walters, 1974).

Although measurements of unregulated streamflow upstream of Conconully Reservoir and Salmon Lake only exist for these few years in the early 1900s, records of reservoir operations were collected beginning around 1904. Continuous records of monthly reservoir releases are available since 1947 (**Appendix B-2**). These data were analyzed in relation to precipitation records to estimate reservoir inflow for the entire study period from 1904 to 2002. Reservoir inflow is used to represent unregulated runoff from the upper watershed for the entire 1904 to 2002 study period (**Appendix B-3**). It is estimated as being equal to the monthly reservoir outflow plus or minus changes in reservoir storage. This simplified estimation has several sources of imprecision, but provides a valid means of reconstructing runoff and streamflow values for the ungaged upper watershed.

The estimated annual unregulated runoff for the Salmon Creek watershed over the 1904 through 2002 period ranges from a minimum of 1,500 AF (2 cfs) in 1931 to a maximum of 67,000 AF (93 cfs) in 1983, with an average of 21,700 AF (30 cfs) (**Figure 3-4**). The large differences between minimum, median, and maximum annual runoff indicates the high variability of watershed runoff production. This natural variability in water supply is not unusual for the region, and formed part of the rationale to construct reservoirs and provide year-to-year carry over storage. The range of runoff produced by the Salmon Creek watershed can be extreme. For example, just 7,000 AF of total inflow to the reservoirs occurred during the 3-year period of 1929 through 1931, whereas 4,000 AF of inflow occurred in just one day on May 29, 1948 (Yates, 1968).

Water year typing for Salmon Creek (1904 through 2002) is based on the estimated unregulated upper watershed runoff (**Appendix B-3**). The annual runoff volumes were ranked to determine exceedence probabilities and establish approximate runoff volume breaks between the five water year types (**Table 3-4**).

Table 3-4. Salmon Creek Water Year Types.

Salmon Creek Unregulated Runoff (Acre-feet/year)	Water Year Type	Probability Flow is Equaled or Exceeded
>33,000	Wet	0% to 19%
21,000 to 32,999	Above Normal	20% to 39%
14,000 to 20,999	Normal	40% to 59%
10,000 to 13,999	Below Normal	60% to 79%
<10,000	Dry	80% to 100%

Monthly Streamflow

Monthly streamflow patterns on Salmon Creek can be described using limited historical gage records, relationships to precipitation patterns, and water system model estimates based on measured reservoir and diversion operations. No minimum instream flow requirements exist for Salmon Creek.

The seasonal streamflow pattern observed on Salmon Creek near Okanogan for the period 1904 through 1909, when the creek was unregulated, featured a low flow of about 15 cfs from August through March, and a high flow of about 114 cfs from April through July (Walters, 1974).

Annual average precipitation in the upper Salmon Creek watershed ranges from about 15 inches near Conconully to 30 inches in the mountains along the western edge of the watershed (Dames and Moore 1999). At elevations above 1,500 feet, precipitation as snowfall occurs from October through April in amounts about two to four times greater than those at lower elevations nearer the Okanogan River. Snowmelt is concentrated in late spring and early summer. Rainfall precipitation from May through September is typically less than one inch. Only a small amount of rainfall makes it to the streams. At lower elevations in Salmon Creek's middle and lower reaches, annual precipitation diminishes towards 12 inches.

The monthly estimates of unregulated upper watershed runoff for Salmon Creek are displayed in terms of exceedance probabilities in **Figure 3-5** (**Appendix B-3**). The figure demonstrates the large seasonal variation typical of snowmelt river systems. Winter low flows are followed by rising streamflow in late spring, snowmelt peaks in May and June, and a return to low flows by August. Most of the annual runoff occurs during snowmelt from April and through July. Peak runoff occurs in May and June, which have median streamflows about 100 cfs each, but maximum streamflows of near 450 cfs and 600 cfs, respectively. Streamflow is consistently low August through March, with average streamflow estimated to be less than 10 cfs. The spring and early summer months experience a wide range from year to year, indicated by the range between minimum and maximum values. The estimated unregulated Salmon Creek streamflow into the reservoir represents both existing and historical conditions[2] for the upper reach of Salmon Creek.

The two reaches of Salmon Creek downstream of Conconully Dam are affected by irrigation deliveries and diversion. Reservoir and diversion operational data has been used to calculate historical monthly streamflow for the middle and lower reaches of Salmon Creek.

Streamflow in the middle reach occurs almost exclusively during the months of April through September, the irrigation release period (**Figure 3-6**). Historical land uses on uplands, combined with dewatering of the channel, have altered stream hydrology, reduced groundwater recharge, decreased riparian vegetation, and increased sediment production. The result is an adverse affect on the channel geometry and permeability, streambank stability, and riparian area, which has greatly decreased the habitat quality of lower Salmon Creek. Under existing conditions there is a streamflow loss of approximately 5 cfs over the lower 4.3 miles of Salmon Creek. During the remainder of the year, flow in the stream is limited to seepage from the dam and local unregulated inflow entering the stream below the dam. Seepage from the dam is on the order of 100 AF per month, or about 1.7 cfs (as determined during Salmon Creek Phase 1 studies from USBR data; reported Dames and Moore, 1999). Median streamflow in the middle reach of Salmon Creek is lower than for the unregulated inflow in May (when runoff is being captured for storage), but higher than the unregulated streamflow in July through September (when releases are conveyed for diversion downstream). Reservoir operations have little effect on major streamflow events; maximum flows in the middle reach are similar in magnitude and month (June) to unregulated reservoir inflow (**Figure 3-5**).

The lower reach of Salmon Creek is essentially dry during most months of most years (**Figure 3-7**). Almost all water released from Conconully Reservoir is diverted for irrigation needs at the OID diversion dam. Even during peak snowmelt months of May and June, the median flows in the lower reach are less than 50 cfs. Maximum flows in the lower reach are similar to, but slightly lower than the unregulated reservoir inflows (**Figure 3-5**) (reservoir operations have little effect on major streamflow events, and OID would attempt to recover as much spill as feasible at the diversion dam). Some sub-reaches of the lower 4.3 miles have surface water present in the stream due to local contributions from groundwater, even when no streamflow is conveyed across the OID diversion dam. The magnitude of these contributions has not been gaged but has

[2] The terms "existing" and "historical" refer to two similar but distinct data sets and simulations. "Existing" conditions are based on modeling streamflow for the 100-year period of record, and irrigation demand for the next five years based on current crops and water use as reported by OID. "Historical" conditions are actual data for streamflow and irrigation use based on records since 1904. Historical conditions do not quite match "existing" conditions because the historical data includes periods when the Okanogan Irrigation District operated less efficiently than it does today (before the main canal was lined and other conservation improvements were undertaken), and other changes in faciltities, water management, and operations. "Existing" conditions are a better simulation of likely a "no action" baseline going forward than strict reliance on historical averages would provide.

been observed to be less than 5 cfs (Dames and Moore 1999). Downstream of Watercress Springs, Salmon Creek evapotranspiration and percolation losses dry up the stream.

Johnson Creek

Johnson Creek has a 68.2 square mile watershed and is located northeast of the middle and lower reaches of Salmon Creek (**Figure 3-1**). Johnson Creek captures water from Scotch Creek east of Conconully Reservoir, and flows southeast towards Duck Lake, then northeast to meet the Okanogan River near the town of Riverside (**Figure 3-1**). Although the OID water system depends primarily on Salmon Creek, OID has a small (6 cfs maximum capacity) diversion on Johnson Creek about 4 miles upstream of its mouth. OID began diverting flows from Johnson Creek in the 1920s (Tom Sullivan, OID, personal communication, 2000). Diversion records are compiled and available for the period since October 1986. A U.S. Bureau of Reclamation stream gage near Riverside Wash recorded flows on Johnson Creek from May 1903 to September 1962 (USBR, 1962). The gage was just upstream of the confluence with the Okanogan River, downstream of the points of diversions for all water rights on the stream, including OID and other users. The unregulated natural streamflow of Johnson Creek is not known.

For the 1904 through 1961 period of record, Johnson Creek annual runoff ranged from a minimum of about 2,500 AF/year (3.5 cfs) in both 1929 and 1931 to a maximum of 7,800 ac-ft/yr (10.8 cfs) in 1948, with an average of 3600 AF/year (5 cfs) (**Figure 3-8**). Johnson Creek runoff is approximately 10 to 20 percent that of the estimated unregulated runoff from Salmon Creek for the same period. This ratio seems reasonable, since Johnson Creek has less than half the drainage area, much lower headwater elevations, and is on the leeward side of the major ridge lines.

For the period of record prior to increased irrigation use (1903 through 1917), Johnson Creek runoff is slightly higher than during the subsequent period (1918 through 1962) (**Table 3-5**). The reduction in mean and median streamflow may be due to natural environmental factors, but it is more likely the combined effect of multiple diversions, including OID. Comparison of the mean and median values suggests that 15 to 20 percent of the natural streamflow was diverted.

OID diversions from Johnson Creek between 1987-1998 averaged 1,483 AF/year (2 cfs), with a maximum of 2,156 AF/year (3 cfs), respectively. Typically, the maximum monthly diversion has occurred during the winter and spring, not in the summer (because OID has the most junior water right on the creek, and summer flows are not normally available). Exceptions occurred in 1997 and 1998 when there were no diversions during a few winter months. For those years, the mean monthly diversions from Johnson Creek ranged from 0 cfs to as high as 5.5 cfs (333 AF). OID regulates diversion flow rates based on visual observation of the streamflow to ensure sufficient flow remaining in the channel to satisfy the water rights of downstream users (Tom Sullivan, OID, personal communication, 2000).

Table 3-5. Johnson Creek Annual Streamflow Statistics Near Riverside Wash (1904 through 1961)

1903 through 1962: Entire period of record		
Mean	3,593 ac-ft/yr	4.96 cfs
Maximum	7,825 ac-ft/yr	10.81 cfs
Minimum	1,312 ac-ft/yr	1.81 cfs
Median	3,363 ac-ft/yr	4.64 cfs
1918 through 1962: Subsequent to significant use as a water supply, including diversions by the Okanogan Irrigation District		
Mean	3,419 ac-ft/yr	4.72 cfs
Maximum	7,825 ac-ft/yr	10.81 cfs
Minimum	2,505 ac-ft/yr	3.46 cfs
Median	3,165 ac-ft/yr	4.37 cfs
1903 through 1917: Prior to significant use as a water supply, including diversions by the Okanogan Irrigation District		
Mean	4,114 ac-ft/yr	5.68 cfs
Maximum	6,270 ac-ft/yr	8.66 cfs
Minimum	1,312 ac-ft/yr	1.81 cfs
Median	4,005 ac-ft/yr	5.53 cfs

3.1.1.2 Flood Hazard

Flood hazard focuses on the risk to persons and property from peak streamflow and inundation. The Federal Emergency Management Agency (FEMA) 100-year flood boundary (**Figure 3-9**) represents the area identified as having flood hazard, and requiring flood insurance under the National Flood Insurance Program. This regulatory floodplain was delineated in 1973 and 1976, and revised in 1995 for the incorporated City of Okanogan (FEMA, 1995a and 1995b). The City of Okanogan is exposed to risks of flood hazards from Salmon Creek and the Okanogan River.

The City of Okanogan experienced flood damage in 1948, primarily from Salmon Creek, and in 1972, primarily from the Okanogan River (FEMA, 1995a). Flooding has and may occur in the unincorporated reaches of Salmon Creek, but due to the low density of population and residential properties, flood hazards have not been subject to detailed study by FEMA.

The flood of 1948 quickly filled reservoirs and 47,000 AF spilled over Conconully Dam and past the OID diversion to the Okanogan River. In 1948, flooding washed out bridges and roads, inundated farmland and caused heavy damage in the towns (Yates, 1968). The 1972 event resulted in the declaration of the Okanogan River Valley as a Federal Disaster Area. Levees and dikes near the City of Okanogan were overtopped, the sewage treatment plant flooded, and several city blocks were inundated (FEMA, 1995a).

Although no gage data exist, an historic flood on Salmon Creek in May 1894 (Work, 1894) was estimated to have a peak discharge over 2,000 cfs and the 1948 flood peak discharge was estimated at over 1,500 cfs (approximately a 30-year return interval event). FEMA (1995a) has estimated floodflows and frequencies for Salmon Creek near Okanogan using various methods to analyze and extrapolate from existing data at the reservoirs by Conconully (**Table 3-6**). Comparison of estimated flood flows for Salmon Creek to other gaged streams in the Okanogan basin having similar climate, topography, and vegetation indicates that the calculated flows are reasonable (FEMA, 1995a).

Table 3-6. Salmon Creek Flood Frequency Statistics[a]

Return Interval (years)	Peak Discharge (cfs)
10-year	1,100
50-year	1,700
100-year	3,700
500-year	4,500

[a] (Source: FEMA 1995a)

In response to the large flood in 1948, the U.S. Army Corps of Engineers channelized the downstream portion of Salmon Creek in the City of Okanogan (from the Okanogan River upstream to about River Mile 0.33), increasing hydraulic capacity and efficiency. Within the City of Okanogan, the 100-year flood is modeled to be entirely contained within the top of the leveed banks by FEMA (**Figure 3-9**). FEMA (1995a) reports that the channel modifications provide full protection against the 500-year flood, unless unusual blockage of the bridges over Salmon Creek occurs.

Most existing Salmon Creek flood hazards are erosion-related, and are focused within the leveed area. Inundation could be the principal flood hazard in the vicinity of the confluence with the Okanogan River (**Figure 3-9**). Historic flow regulation and channel modifications have resulted in substantial erosion during floodflows within and upstream of the City of Okanogan on lower Salmon Creek. The extreme flow regime of lower Salmon Creek, dominated by little or no flow but subject to infrequent uncontrolled spills, has inhibited riparian vegetation, decreased streambank stability, and contributed to streambed erosion. Riparian land uses that remove vegetation (e.g., grazing, fuel or timber harvest) have also reduced bank stability. The Salmon Creek channel continues to be vulnerable to streambank erosion during floods. Property loss can occur as a result of flood-related channel widening, and downstream sedimentation impacts may result from erosion of high streambanks.

3.1.1.3 Groundwater

Okanogan River Valley Aquifer

The Okanogan River valley is a wide glacially and fluvially-carved basin bounded by high bedrock-forming ridges and filled with successive layers of primarily glacial outwash and more recent alluvium. In the vicinity of Salmon Creek, the Okanogan River is incised within broad gently sloping terraces. The terraces and the current river channel are comprised of fine-grained silty to sandy alluvium overlying coarse-grained sandy gravelly glacial outwash. The deposits form the Okanogan River Valley aquifer. Groundwater levels in the aquifer are controlled mainly by the level of the river, and by groundwater gradients from adjacent tributary streams that recharge the aquifer.

Salmon Creek Valley Aquifer

The middle and lower Salmon Creek valleys are relatively narrow-elongated basins bounded primarily by bedrock, glacial outwash debris, and filled with relatively thin deposits of alluvium. Small unexplored shallow aquifers with little water yield likely occur along much of the valley. The small alluvial aquifer likely contributes about 0.1 to 2.0 cfs of flow to the Salmon Creek channel for much of the year. The small volume of flow maintained in the channel in the vicinity of Watercress Springs is evidence of this groundwater source.

A short distance downstream of Watercress Springs the Salmon Creek channel becomes dry as the flow maintained by groundwater goes subsurface and percolates down to the aquifer. The point at which the channel dries out depends on the time of year and the amount of flow in Salmon Creek. The depth to water in the Salmon Creek valley aquifer largely depends on Okanogan River levels. During spring floods on the Okanogan River and Salmon Creek, Salmon Creek aquifer levels reach their maximum and much closer to the ground surface. However, because of the high transmissivities of the alluvium, water levels decline rapidly to elevations below the creek grade.

Groundwater levels in the Salmon Creek aquifer are affected by pumping at Conconully, whose residents rely on the aquifer for rural agriculture and domestic uses. The City of Okanogan also affects groundwater levels through pumping of the aquifer and consumption of spring water.

Duck Lake Groundwater Basin

Duck Lake is located about three miles directly north of the town of Omak (**Figure 3-1**). It is a small lake of about 88 acres at elevation 1,232 and 284 acres at its maximum elevation of 1,247 feet msl, and is situated among smaller lakes (Fry and Proctor lakes). Together the three lakes lie in a relatively large depression that does not have natural surface inflows or outflows, but is tied to groundwater levels in what is locally called the Duck Lake groundwater basin. The depression is referred to as a kettle, which was formed during the late Pleistocene by the melting of a large, detached block of stagnant ice that had been wholly or partly buried by glacial sediments.[3]

The Duck Lake groundwater basin has been delineated through well data collected since 1958 and refraction seismic surveys conducted in 1970 and 1971. Natural recharge to the aquifer occurs primarily through groundwater migration from the Johnson Creek valley (to the northwest), and through deep percolation. The sum of natural recharge from these sources is estimated to be about 2,000 ac-ft per year (Jackson, undated memorandum). Groundwater flow

[3] See undated memorandum by Randy Jackson, Central Region, Washington Department of Ecology for a review of the geology of the area and the kettle basin in which Duck Lake sits.

out of the kettle basin likely discharges in minor quantities to seeps and springs downstream in the Okanogan valley, as well as contributing a small amount of base flow to the Okanogan River. The amount of recharge is strongly dependent on lake level, which is influenced by OID spill from its main canal and diversion from Johnson Creek. Groundwater is also extracted from wells for irrigation and domestic purposes.

Water diverted from Salmon or Johnson creeks quickly recharge the Duck Lake groundwater basin. Recharge is typically seasonal, occurring from Salmon Creek primarily during the irrigation season, but from Johnson Creek during the non-irrigation season, when flows are high enough that OID may exercise its junior water right. In general, seepage to groundwater increases when Duck Lake water levels rise above a base level of about 1,228 feet msl, which is probably the long-term average natural groundwater elevation in the area. Seepage to groundwater increases dramatically when Duck Lake reaches 1,232 feet msl.

Reported mean monthly estimates of natural upstream groundwater recharge are 2.7 cfs, while discharge estimates have ranged from 1.7 to 8.3 cfs. However, it is not known how these values actually vary through the year. It is also likely that the discharge from the basin to springs and the Okanogan River would increase with increased water tables associated with higher Duck Lake water levels. Duck Lake water use and regulation is discussed further below, in relation to OID water use.

3.1.1.4 Okanogan Irrigation District Water Use

Historic Operations Data

The Salmon Creek Phase 1 report (Dames and Moore, 1999) compiles available OID water supply and use data for the period from 1987 to 1998, and discusses data gaps and inconsistencies. Irrigation diversion records prior the mid-1980s are not representative of current water use because extensive rehabilitation work was undertaken on the irrigation system in the mid 1980s. In 1977, only 18 percent of the OID's delivery system was piped and pressurized. During the rehabilitation the remainder of OID was converted to a pressurized system, the main canal was relined with reinforced concrete (except for a small portion passing through competent rock), and the Okanogan River pumping stations were either abandoned (Robinson Flats) or rebuilt (Shellrock). This resulted in a much more efficient delivery system. Greater detail on OID water supply and water use is provided in **Appendix C**. The Phase 1 Report also summarizes the 1987 through 1998 operation data provided by OID (Dames & Moore, 1999).

Historical Irrigation Water Use

Total irrigation water delivery is defined as the quantity of water delivered to the farmers via OID's distribution system. Due to the presence of Duck Lake, the quantity of irrigation water delivered to the fields is different from the total supply of irrigation water. *Water supply* is the amount of water obtained from OID's water sources. *Water delivery* is the amount actually delivered to irrigation. *District efficiency* (the efficiency of the overall water delivery system) is defined by the ratio of water delivery to water supply. *On-farm efficiency* is defined by the ratio of crop requirements to water delivery. For EIS analysis, conveyance loss was estimated at 0.4%

and on-farm efficiency varied from 66 percent to 85 percent, depending on weather conditions (temperature and precipitation).

Total annual quantities of annual irrigation water delivery during the period 1987 through 2002 were analyzed to prepare the summary in **Table 3-7**[4]. As shown in **Table 3-7**, the average annual delivery of water to farmers from 1987 to 2002 was 15,518 AF/year. This compares to the average OID water supply of 17,720 AF. Thus, the overall efficiency of the water supply system is about 88 percent. The difference between water supply and water delivery, about 2,177 AF/year, is equal to the amount of seepage loss from Duck Lake. A very small amount, about 34 AF/year, also is lost through seepage from the main canal. In many years the OID canal (Salmon Creek) supplies over 90 percent of the water to farmers, with Duck Lake providing the remainder. Salmon Creek diversions are as low as 60 percent of total irrigation demand during dry years, with most of the remainder supplemented by Shellrock pumping. Duck Lake pumping is relatively constant from year to year.

Table 3-7. Annual Quantities of OID Irrigation Delivery by Source, 1987 through 2002 (AF/year).

	Salmon Creek	Duck Lake Pumping	Shellrock Pumping (Okanogan River)	Total OID Water Supply	Canal Spill and Seepage	Total Irrigation Delivery
Average Available	14,886	1,101	1,733	17,720	-2,201	15,518
Percent of OID water	84.0%	6.2%	9.8%	100%		
Minimum	10,665	309	0	12,702	-1,447	10,901
Maximum	20,834	2,141	5,910	21,531	-2,919	18,623

Crop Irrigation Requirements

Irrigation demand in OID is highly variable. As shown in **Table 3-7**, recent annual irrigation deliveries ranged from a minimum of 10,901 AF (1993) to a maximum of 18,623 AF in 1998. Many factors can contribute to the variability of irrigation demand. Important variables include temperatures during the irrigation season, rainfall prior to and during the irrigation season, cooling, soil type, crop type, irrigation efficiency, delivery efficiency, and farmer's estimates on how much crop watering is needed during different climate conditions. Not all of these factors can be quantified.

During Phase 1 studies, variation in irrigation demand was assumed to be driven primarily by irrigation season temperatures. Irrigation delivery was correlated to temperature and rainfall was also evaluated, but by itself did not correlate well to irrigation demand. For EIS analysis, crop irrigation requirements were estimated separately for cool and warm years. For cool years, the irrigation requirement was calculated to be 10,701 AF for existing OID irrigation lands, and for warm years it was calculated as 11,350 AF.

[4] Note that the table adds from left to right only for the average year. The amounts shown in the various columns for minimum and maximum occur at different moments in time; hence, they don't add across the table.

Supply of Water to OID

As shown in **Table 3-7**, OID obtains its water supply from Salmon Creek via the OID canal, Duck Lake, and the Okanogan River via the Shellrock pumping station. Duck Lake is supplied by the Johnson Creek diversion, OID canal spill, and local runoff.

Salmon Creek

The amount of water diverted from Salmon Creek depends on two primary factors: the runoff volume in Salmon Creek and OID's overall water demand, which in turn primarily depends upon climatic conditions. The largest diversions occur during high runoff conditions combined with a hot summer, as occurred in 1998. Conversely, the lowest diversions occur when a lower runoff year combines with a cool summer, as occurred in 1992.

From 1987 to 2002 Salmon Creek provided 84 percent of the total water supply of OID. Over this period of record, the volume of Salmon Creek runoff used by OID ranged from a minimum of 10,665 AF/year in 2002 to a maximum of 20,834 AF/year in 1998 with an average 14,886 AF/year (**Table 3-7**). The proportion of unregulated runoff[5] diverted from Salmon Creek to support OID irrigation ranged from 40 percent in a wet year (1998) to 216 percent[6] in a dry year (2001) (**Table 3-8**). Since 1987, about 71 percent (i.e., 238,177 AF) of the total unregulated flow (i.e., 335,423 AF) has been diverted at the OID Diversion Dam. However, in an average year, about 95 percent of the unregulated runoff is diverted. The substantial difference between the long-term average and annual average reflects the large volumes of unregulated inflow water that occur in some wet years. During some dry years, there has not been sufficient inflow water to meet OID needs and as a result no flow was spilled over the weir and net storage in Conconully and Salmon reservoirs may have been less at the end of the year than the previous year. In some wet years, large amounts of runoff generated from spring snow melt or summer rainstorms filled the reservoirs and flowed over the weir to the Okanogan River.

Table 3-8. Summary of OID Demands on Salmon Creek, 1987 through 2002.

	Total Unregulated Inflow	Total Salmon Creek Diversion	Total Weir Spill	% of Unregulated Inflow to OID	Total Release From Conconully	% of Total Release to OID	% of Total Release Spilled Over Weir
1987-2002 Totals	335,423	238,177	104,829	71%	343,006	69%	31%
Average for 16 years	20,964	14,886	6,552	95%	21,438	81%	19%
Maximum single year	52,010	20,834	31,194	216%	52,028	100%	60%
Minimum single year	5,832	10,655	0	40%	10,655	40%	0%

Supplemental Pumping from Duck Lake and Shellrock

Duck Lake provided 6.2 percent and the Okanogan River provided 9.8 percent of the total water supply to OID from 1987 to 2002 (**Table 3-7**). Duck Lake pumping quantities do not vary

[5] Total outflow from Conconully Reservoir plus accumulated net storage in the reservoir.
[6] In a given year, the percent diverted may exceed 100% because of reservoir carryover storage.

significantly due to the pump size, water rights limitations, and the limited ability of the lake to store water. Since 1987, the volume pumped from Duck Lake has ranged from 309 AF in 1996 to 2,065 AF in 1987. Shellrock pumping, on the other hand, varies widely, supplementing Salmon Creek and Duck Lake during years of below average runoff. There was no water pumped at Shellrock during 8 of the previous 16 years, while pumping ranged from 4,499 to 5,910 AF during five years in the same period. At a current operating capacity of 25 cfs, Shellrock pumping station can potentially pump up to 7,800 AF during the irrigation season (under the No Action Alternative). Since the maximum annual quantity of pumping during 1987 through 1998 was only 5,910 AF, the total supply capability of Shellrock has been only partially used (although the entire capacity of the plant would be needed during a critical drought period).

Conconully Reservoir and Salmon Lake Reservoir Storage and Use

Figure 3-10 shows the amount of water in storage at different water surface elevations in Conconully and Salmon Lake Reservoirs. The maximum active storage capacity of Conconully Reservoir is about 13,000 AF, while that of Salmon Lake is about 10,500 AF. Conconully Reservoir surface area increases rapidly with elevation; Salmon Lake surface area increases more moderately.

Records of Conconully and Salmon Lake reservoir storage utilization for the period 1947 through 1998 show the amount of water in storage and the storage used by OID in each year (**Figures 3-11 and 3-12**). A large part of the storage in the reservoirs is used each irrigation season; remaining storage is available for carryover to the next year. Conconully Reservoir is drawn upon more frequently and to a greater magnitude than Salmon Lake reservoir. In many years the storage in Salmon Lake reservoir is not used at all, and is carried over into the next year. OID has relied upon Conconully Reservoir storage more heavily in part due to restrictions on the use of the Salmon Lake feeder canal, which increase the risk of not being able to refill Salmon Lake. The minimum Conconully Reservoir storage during the 1947-1998 period of record occurred in 1966 at about 2,000 AF. It was particularly low in 1966 due to two consecutive dry years and because it was completely drained in 1965 for outlet maintenance. Salmon Lake's minimum storage occurred in 1970 at just over 2,000 AF.

Duck Lake Storage and Use

Historical operations data for the period 1987 through 2002 were used to develop the parameters for the Duck Lake water budget contained in the water supply model. During 1987-2002 the magnitude of inflows to Duck Lake were substantially greater than outflows; the difference is the amount lost to seepage (and evaporation to a lesser degree). Total inflow averaged 3,684 AF/year, whereas total pumping to OID at the Duck Lake pump station averaged only 1,101 AF per year. Thus over the 16-year period, on average only 30 percent of the water entering Duck Lake has been used by OID for irrigation.

OID diverted large amounts of excess water to Duck Lake in the late 1990s when runoff in Salmon Creek was high. At the same time, Duck Lake pumping was cut back due to pump problems.

Between 1995 and 1998, 7% to 17% of the total inflow to Duck Lake was pumped by the OID. Because of the high volume of inflow and low pumping rates, the lake elevation rose above 1240 feet. As a consequence of the higher water elevations and high hydraulic heads that were established, seepage losses increased rapidly above an elevation of about 1232 feet. Thus, most of the added inflow during this time was lost to seepage and surcharging of the Duck Lake Groundwater Basin.

Greater operational efficiency of water use from Duck Lake (defined as the percent of the total inflow used by OID) could be achieved by managing water levels to minimize seepage loss. Water supply modeling conducted for the Phase I study (Dames and Moore, 1999) determined that the overall water use of Duck Lake could increase to about 60 percent if lake elevations were kept low (to minimize seepage) and if spill were limited only to that needed for operational requirements and water sale contracts. Since 1987, efficiencies above 60 percent have occurred only twice and generally are less likely due to unavoidable seepage losses that would occur when higher lake elevations are maintained. For example, annual seepage loss is estimated to be approximately 960 AF at an average lake elevation of 1228 feet; 1,332 ac-feet at 1233 feet; and 2,670 ac-feet at 1238 feet (see **Appendix C** for more detail**)**.

EIS analysis took account of opportunities for managing the Duck Lake impoundment in conjunction with other water supplies as part of setting Salmon Creek target flow volumes. Storage for use on a seasonal basis at Duck Lake is constrained by court-established minimum and maximum lake levels and by the hydrogeology of the area.

Since the basin receives artificial recharge, may require unique groundwater management, and could be defined as a separate aquifer system, it was designated as a groundwater subarea under RCW 90.44 and by Order DE 74-24 (October 18, 1974). The 3,320-acre Duck Lake Groundwater Management Subarea is defined in WAC 173-132. As allowed under RCW 90.44, OID filed a claim of ownership of artificially stored groundwater in the subarea and a claim for right to withdrawal of artificially stored groundwater. Order DE 85-20 presents Ecology's findings and order regarding the OID claim. In Order DE 85-20, Ecology defines Duck Lake as a "groundwater lake," with its water surface altitude reflecting the local ground water table and "an integral part of the principal aquifer underlying the subarea." OID sends water to Duck Lake during high water flows for recharge, but is limited by canal capacity. Order DE 85-20 foundthat in some years the District diverts more water into Duck Lake than it pumps out during the irrigation season, while in other years the reverse is true. Over a 50-year period, Duck Lake was found to vary between elevation 1226.75 and 1246.72, and these levels have been incorporated in the order as minimum and maximum lake levels which must be maintained as a constraint on pumping and storage.

Order DE 85-20 accepts OID ownership of artificially stored groundwater in the amounts of 3,780 AF (maximum) and 2,084 (mean annual) recharge. Withdrawals of artificially recharged groundwater may be made using the OID Duck Lake pump, at a rate not to exceed 10 cfs (4,488 gpm). Withdrawal is limited to 2,700 AF per year and is "limited to beneficial use; provided the district continues its historic recharge practices."

In addition to its right to artificially stored groundwater, OID has a 1992 Certificate of Adjudicated Water Right to 20 cfs and 6,356 ac-ft. The certificate states that this right is for supplemental irrigation of 1,589 acres from April 1 to October 31, with an August 23, 1918 priority. This water right probably has been reduced to 10 cfs based on non-use of the full water right. OID's 1992 Adjudicated Certificate is considered a supplemental supply, whether to OID's artificially stored groundwater or to its other sources.

Ecology has determined that no further public water (as opposed to OID's artificially stored groundwater) is available for appropriation in the Duck Lake Groundwater Management Subarea, and has closed the subarea and denied applications proposing further withdrawals from the Subarea.

Order DE 85-20 limits pumping to a total of 10 cfs, (i.e., OID cannot also pump 15 cfs diverted under the Johnson Creek water right). Capture and reuse of return flows is normally allowed within a user's boundaries, and water spilled to Duck Lake from OID operations would fall into this category. Spill under historic practices was used in establishing the district's ownership of artificially stored groundwater at Duck Lake, so any reduction in spill would reduce the 2,700 acre-foot water right for artificially stored groundwater. This could be offset, however, by diversion to Duck Lake during high flows in anticipation of recapturing and reusing spills, thus keeping the OID artificially-stored groundwater bank "whole." The reuse of water spilled to Duck Lake in excess of the allowed rate and annual volume of withdrawal under DE 85-20 is assumed maximized under current operations, so this is not considered a source of additional water.

3.1.2 WATER QUANTITY IMPACTS

3.1.2.1 Introduction

OID Water System Model

A water supply model was developed as part of the Phase I Joint Study on Salmon Creek (Dames & Moore, 1999) to simulate the current operations of the Salmon Creek and OID water supply systems, and to quantify how much additional water could be provided by various water supply alternatives. For the EIS, this model was updated and used again to examine water quantity differences among the four EIS alternatives. **Appendix C** provides a detailed description of model structure, parameters, and the assumptions used to describe all the alternatives.

Simulated Streamflow and Reservoir Levels

Water model output is provided in **Appendix D**. Statistical analysis of the water system model output has been used to compare monthly values of various hydrologic parameters for the No Action (baseline) and each Alternative at several locations of interest. All monthly data statistics and impact comparisons referred to in the following discussions are illustrated in the graphs provided in **Appendix D**. **Appendix D-1** provides a summary of model input and output data. Conconully Reservoir and Salmon Lake elevations exceedence curves are shown in **Appendix D-2** and simulated elevations for the two reservoirs are shown in **Appendix D-4**. All estimated flows in this section for Salmon Creek are displayed graphically in **Appendix D-5** and flow exceedence curves for the creek are presented in **Appendix D-3**. Estimated flows for Okanogan River are displayed in a summary table in **Appendix D-6**. **Appendix D-7** summarizes OID annual deliveries.

3.1.2.2 Alternative 1: Okanogan River Pump Station and Pipeline

Streamflow

Alternative 1 would provide overwintering flows in the middle and lower reaches of Salmon Creek that have not been provided under historic irrigation operations.

Middle Salmon Creek

Alternative 1 reduces the unnaturally high summer flows that occurred in the middle reach under historic irrigation operations.

The estimated median monthly streamflow in the middle reach of Salmon Creek under Alternative 1 would decrease in July through September, but increase for the months from November through May. The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel. Alternative 1 would decrease middle reach streamflows by about 25 cfs in July, August, and September, when Okanogan River pumping would replace the need to convey Salmon Creek water through the middle reach. Alternative 1 would provide overwintering flows for fish survival, increasing the median from nearly zero to 5-10 cfs in the months of November through March. Variability in streamflow magnitudes between the three fish passage flow regimes would be most evident in April, May, and August, but similar for all other months. The median streamflow in April would increase from about 15 cfs up to approximately 25 cfs, increase in May by 30 to 40 cfs, and decrease in August by 30-40 cfs, depending on which fish passage flow regime is assumed.

The estimated minimum monthly streamflow in the middle reach of Salmon Creek under Alternative 1 would increase about 2 to 6 cfs in the months November through March and 14 to 21 cfs in April, but decrease by up to 23 cfs in July, August, and September, when compared to current operations. Alternative 1 minimum streamflows in April, May, and June would be a function of both the instream flow requirements for fish passage in the lower reach and irrigation needs at the OID diversion dam. In May, minimum streamflow in the middle reach would increase by about 4 to 15-20 cfs. During June, minimum streamflow in the middle reach would increase about 8 cfs for the steelhead and chinook fish passage flow regime, but would be similar to the No Action Alternative for the other two fish passage flow regimes.

Lower Salmon Creek, Flow Below Wier

Alternative 1 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations.

The estimated median monthly streamflow on lower Salmon Creek below the weir under Alternative 1 would increase for all months. Alternative 1 would provide median monthly flows of about 5 to 12 cfs July through October to a channel reach that would remain dry under the No

Action Alternative. Alternative 1 would increase median flows from about 1 cfs to 7-10 cfs in November through March. Streamflow in April would increase from zero to about 15 to 23 cfs, and from 15 to roughly 42-55 cfs in May, depending on which fish passage flow regime is assumed. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, May, and August.

The estimated minimum monthly streamflow on lower Salmon Creek below the weir under Alternative 1 would increase for all fish passage flow regimes by about 3-7 cfs October through March, and by about 12 to 24 cfs in April, May, and June. Minimum monthly streamflow would decrease to zero in July and August for flow regimes designed to pass steelhead only. All fish passage flow regimes have zero cfs minimum flows in August. The steelhead and Chinook flow regime would maintain about 5 cfs more in the channel in June compared to the steelhead only flow regime, and would be the only regime providing flow in the channel in July.

Lower Salmon Creek, Flow at Mouth

Alternative 1 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations.

The estimated median monthly streamflow in the lower reach of Salmon Creek at the mouth under Alternative 1 would increase for all months. Median monthly streamflow would increase from 0-1 cfs to 3-8 cfs in the months of July through March, from zero to 12-18 cfs in April, and from 12 cfs to 33-43 cfs in May. The seasonal peak of about 38 cfs in June would not change substantially. The median monthly streamflow in the lower reach would be similar for all three fish passage regimes between June and March. The greatest variations would be in April and May, based on differences in the target species' migration requirements.

The estimated minimum monthly streamflow in the lower reach of Salmon Creek at the mouth would increase under Alternative 1 by about 3-5 cfs October through March, and by about 9 to 18 cfs in April, May, and June for all fish passage flow regimes. Minimum monthly streamflow would decrease to zero in July and August for steelhead only flow regimes. All fish passage flow regimes would have zero cfs minimum flows in August. Only the steelhead and Chinook fish passage flow regime would remain at zero through September. The steelhead and Chinook flow regime would maintain about 5 cfs more in the channel in June compared to the other fish passage flow regimes, and in the only scenario with flow in the channel in July.

Okanogan River, Shellrock to Salmon Creek

The average monthly percentage of the Okanogan River that would be pumped under Alternative 1 increases for all fish flow regimes over all water year types (**Table 3-9**). However, neither the magnitude nor the seasonality of the increased pumping would adversely affect streamflow in the Okanogan River in wet, above normal, normal or below normal water years. The number of months below WAC minimum flows in these water year types would be identical to the No Action Alternative (**Table 3-9**). However, pumping from the Okanogan River under Alternative 1 during dry water years would slightly increase the average number of months below WAC minimum flows (this increase may not be statistically significant, however).

Table 3-9. Percent of Okanogan River Pumped and Number of Months Below WAC Minimum Flows, No Action vs. Alternative 1.

Water Year Type	No Action Alternative		Alternative 1	
	Percent of Okanogan River Pumped [a]	Number of Months Below WAC Minimum Flows [b]	Percent of Okanogan River Pumped [a,c]	Number of Months Below WAC Minimum Flows [b]
Wet	0.01	0.4	0.42 to 0.45	0.4
Above Normal	0.10	0.3	0.63 to 0.68	0.3
Normal	0.06	1.2	0.82 to 0.92	1.2
Below Normal	0.21	1.4	0.96 to 1.09	1.4
Dry	0.83	6.4	1.82 to 2.13	6.5

[a] In the water model, the percent of flow pumped on a monthly basis from the Okanogan River at Shellrock was simulated for all years on record. The monthly percentages were averaged to determine the mean monthly percentage of flow pumped from the Okanogan River for a given year. The mean monthly percentage of flow pumped in a given year was then ranked by water year type and averaged again to calculate the mean monthly percentage of water pumped in a year for each of the five water year types.

[b] For all years in the water model, simulated Okanogan River streamflow between Shellrock and Salmon Creek was evaluated on a monthly basis to determine if WAC minimum instream flows were met. The number of months that WAC minimum instream flows were not met in a given year were totaled, and then ranked by water year type and averaged to calculate the mean number of months for a certain water year type that WAC standards were not met.

[c] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Table 3-10 indicates the water rights that exist in this reach of the Okanogan River. If the proposed Project pumps when minimum flows established under the WAC are not met, it could reduce water otherwise available to these water right holders.

Table 3-10. Okanogan River Water Rights in Affected Reach.

Control Number	Name	Priority Date	Flow (cfs)	Acre-Feet	Irrigated Acres	Purpose
S4-26334GWRIS	Dickson, Warren	8/14/79	0.87		39	IR
S4-29882	Dickson, Warren	12/22/88	0.87	4	40	IR
S4-*01799CWRIS-01464	Gillespie, David et al.	7/21/26	1.5		87	ST, IR
S4-*21369CWRIS-10746	Gillespie, David	12/13/68	0.46	59	23	IR
S4-CCVOL1-3P56	Gillespie, David	7/21/26	0.51			ST, IR
S4-CCVOL1-4P124	Gillespie, David	7/21/26	0.775			ST, IR
CS4-SWC357	Okanogan Irrigation District	12/21/79				none stated
S4-004273CL	Turner, Charles	0/0/1910			14	IR
S4-*01774CWRIS-00357	Twenty-Nine Pump Co	7/3/26	7.0		1200	IR
S4-*22043CWRIS-11228	Alta Vista Irrigation District	2/24/70	2.0	174	52	IR
S4-*02929CWRIS-00592	City of Okanogan	4/9/30	1.5			MU, CI
S4-*08571CWRIS-06610	Arnold, A.A.	8/23/48	0.05	21.6	5	IR
S4-01266CWRIS	Fowler, M.F.	7/8/71	0.12	9.7	3	IR

Okanogan River, Salmon Creek to Malott

Salmon Creek inflow to the Okanogan River would increase under Alternative 1 for all water year types (**Table 3-11**). The increase would double or triple the Salmon Creek inflow to the Okanogan in wet, above normal and normal water years. For below normal and dry water years, the increase would be four to five times that of the No Action Alternative.

Table 3-11. Salmon Creek Inflow to the Okanogan River as a Percentage of Okanogan River Streamflow at Malott, No Action vs Alternative 1.

Water Year Type	No Action Alternative [a]	Alternative 1 [a,b]
Wet	0.25	0.58 to 0.60
Above Normal	0.21	0.53 to 0.57
Normal	0.19	0.57 to 0.61
Below Normal	0.13	0.54 to 0.55
Dry	0.09	0.66 to 0.69

[a] In the water model, Salmon Creek inflow into the Okanogan River as a percentage of total monthly Okanogan River streamflow measured between Salmon Creek's mouth and Malott was simulated for all years on record. The monthly percentages were averaged to determine Salmon Creek's mean monthly percent contribution of flow to the Okanogan River for a given year. The mean monthly percent contribution of Salmon Creek inflow in a given year was then ranked by water year type and averaged again to calculate the mean monthly percent contribution of Salmon Creek inflow in a year for each of the five water year types.

[b] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Water right holders downstream of Salmon Creek also could be affected by reduced water availability if water is pumped during times when WAC minimum flows are not met.

Reservoir Levels

Salmon Lake

The estimated median monthly Salmon Lake reservoir water surface elevation under Alternative 1 would increase by 1 to 3 feet for the months of August through March. In March through July, median lake elevations for all three fish passage flow regimes and the No Action Alternative would be nearly identical. In May, June, and July, median Salmon Lake elevations would be at full active storage capacity (2,318 ft, 10,500 AF). Alternative 1 would reduce the seasonal fluctuation in lake level that has occurred under historic irrigation operations. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The high reservoir elevations would increase surface and groundwater availability along the margins of Salmon Lake reservoir.

The estimated minimum monthly Salmon Lake reservoir water surface elevation under Alternative 1 would increase in all months. Alternative 1 would reduce the seasonal variation of minimum reservoir elevations. The minimum monthly reservoir elevation varies for each of the three fish passage flow regimes, based on the different target species' migration requirements and simulated reservoir operations. The “steelhead only” fish flow regimes would have minimum Salmon Lake levels several feet higher than steelhead and Chinook flow regime. The increased minimum reservoir water levels would provide more seasonally and annually consistent surface and groundwater availability along the margins of Salmon Lake reservoir.

Conconully Reservoir

The estimated median monthly Conconully Reservoir water surface elevation under Alternative 1 would increase by ten to twenty feet for the months of August through April, such that the median reservoir elevation would be at full active storage capacity (elevation 2287 ft) in all months. Alternative 1 would eliminate the large seasonal fluctuation in median reservoir elevation that has occurred under the historic irrigation operations. The median reservoir elevation under Alternative 1 would be similar for the three fish passage flow regimes. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The reservoir water levels would provide more seasonally consistent surface and groundwater availability along the margins of Conconully Reservoir.

The estimated minimum monthly Conconully Reservoir water surface elevation Under Alternative 1 would be increased by ten to twenty feet for the steelhead only flow regimes, such that the minimum reservoir elevation remains within ten feet of the active storage capacity in all months. The minimum Conconully reservoir elevations under the steelhead and Chinook flow regime would decrease from January to July, but increase August to December compared to the No Action Alternative. Alternative 1 would eliminate the large seasonal fluctuation in minimum reservoir elevation that has occurred under the historic irrigation operations. The increased minimum reservoir water levels under "steelhead only" regimes would provide more seasonally and annually consistent surface and groundwater availability along the margins of Conconully Reservoir than the No Action Alternative.

Flood Hazards

Reservoir Margins

The estimated maximum monthly Salmon Lake water surface elevations under Alternative 1 would be comparable to the No Action Alternative from April to October of each year. From November to February the maximum monthly lake level would be reduced by as much as 1.2 feet, with the lowest elevation occurring during February. Alternative 1 would provide a slight benefit in reducing flood hazard from the No Action Alternative.

The estimated maximum monthly Conconully Reservoir water surface elevations Under Alternative 1 would be comparable to the No Action Alternative in all months except October. The maximum monthly Conconully reservoir spill volume and the 10% exceedence spill volume under Alternative 1 would decrease relative to the No Action Alternative in April, May and June. This would provide a minor beneficial flood hazard reduction. These small volume differences may reflect minor operational changes due to the release of fish flows in spring, but the available storage capacity created in the reservoir would be small enough that the monthly maximum elevation statistics do not change.

Middle Reach Salmon Creek

The estimated maximum monthly streamflow and the 10% exceedence streamflow in the middle reach of Salmon Creek would be similar to the No Action Alternative in magnitude and seasonality. No adverse or beneficial impacts to flood hazard would occur in the middle reach under Alternative 1.

Lower Reach Salmon Creek

The estimated maximum monthly streamflow streamflow and the 10% exceedence streamflow in the lower reach of Salmon Creek under Alternative 1 would be comparable to the No Action Alternative in both magnitude and seasonality. No adverse or beneficial impacts to flood hazard would occur in the lower reach under Alternative 1.

Flooding/Inundation

Reservoir Margins

Wetland inundation along the Salmon Lake reservoir margin would increase slightly under Alternative 1, since the lake would experience an increase in median elevation in most months, and the maximum elevations would remain similar to the No Action Alternative. Under the steelhead only fish flow regimes, minimum Salmon Lake elevation would also increase several feet in all months.

Wetland inundation along the Conconully Reservoir margins would increase in most months of the year under Alternative 1, since the median lake elevation would increase to near the maximum active storage elevation, and the maximum lake level remains similar to the No Action Alternative. Under the steelhead only fish flow regimes, minimum monthly Conconully reservoir elevation would also increase several feet in all months.

Middle Reach Salmon Creek

Flooding and riparian wetland inundation along the middle reach of Salmon Creek under Alternative 1 would be similar to the No Action Alternative since the magnitude, seasonality, and frequency of high streamflow volume would be similar to the No Action Alternative, and the channel capacity would not be modified.

Lower Reach Salmon Creek

Flooding and riparian wetland inundation along the river reach of Salmon Creek under Alternative 1 would be subject to the same magnitude, seasonality and frequency of high streamflow volumes as under the No Action Alternative.

Groundwater

Okanogan River Valley Aquifer

Groundwater recharge and levels along the Okanogan River Valley aquifer under Alternative 1 would experience a decrease in the vicinity of the new pump station and down gradient towards the mouth of Salmon Creek on average compared to the No Action alternative. These effects are not quantitatively modeled, but since the number of times flows would fall below WAC minimums would slightly increase in dry years, the effects may be measurable. However, the localized groundwater decreases would be partially offset by increased Salmon Creek inflow to the Okanogan River about 1.25 miles downstream of the new pump station. Average pumping from the Okanogan River would increase under Alternative 1 by between 6,600 AF for steelhead only to 7,100 AF for steelhead and Chinook over the No Action Alternative. Streamflow at the mouth of Salmon Creek would increase by about 5,100 AF, even in dry years. Therefore, the worst case decrease in potential groundwater recharge to this reach of the Okanogan River valley aquifer would be about 1,500 AF for steelhead only and 2,000 AF for steelhead and Chinook.

Reservoir Margins

The groundwater levels along the margins of Salmon Lake reservoir and Conconully Reservoir would be more consistent seasonally and from year to year under Alternative 1 compared to the No Action Alternative, as median lake levels are increased. During normal to wet years, groundwater levels around the reservoirs would experience less seasonal variability. For dry years, Salmon Lake and Conconully Reservoir would experience increased groundwater recharge and levels for the "steelhead only" fish flow regimes. The minimum lake levels under the steelhead and Chinook fish flow regime would not increase minimum lake levels substantially at Salmon Lake, and would decrease it slightly in some months at Conconully Reservoir. Overall, the impact to groundwater along the reservoir margins would be a substantial benefit, increasing recharge volumes and reducing fluctuations in local groundwater gradients.

Salmon Creek Valley Aquifer

Groundwater levels and recharge along the middle reach of Salmon Creek under Alternative 1 would likely experience a seasonal shift, since median and minimum streamflow would increase in fall, winter, and spring months, but would decrease in summer. The magnitude of flow volumes would be similar to the No Action Alternative, as indicated by consistent simulated average annual flow. The increase of base flows, distributing flow throughout more of the year may, result in more consistent groundwater levels.

Groundwater recharge potential in lower Salmon Creek under Alternative 1 would increase compared to the No Action Alternative, since median and minimum streamflow volumes increase and the total flow volume released/spilled over the OID weir would increase by a few thousand acre feet per year, in all water year types.

Duck Lake Aquifer

The Duck Lake maximum pumping rate and annual sales would not increase under Alternative 1, but the average annual volume pumped from Duck Lake would increase by about 200 AF for the "steelhead only" flow regimes and 300 AF for the steelhead and Chinook flow regime (**Appendix D-1**). The minimum and maximum Duck Lake elevations would be the same as the No Action Alternative, although the season and pattern of pumping may vary. No substantial impacts to the Duck Lake aquifer groundwater levels or recharge would occur under Alternative 1.

OID Water Availability

Alternative 1 would have no effect on critical period irrigation deliveries to OID members.

3.1.2.3 Alternative 1: Feeder Canal Upgrade

Streamflow

The feeder canal upgrade would increase the maximum rate of diversion from the North Fork Salmon Creek from 30 cfs under existing and historical conditions to 90 cfs. The frequency of feeder canal use would also be expected to increase, since its operational safety would be improved. Only limited data regarding historical operation of the feeder canal or records of North Fork Salmon Creek streamflow exist, and the monthly time-steps of the water system model provide only a rough representation of feeder canal operations. Therefore, the discussion of hydrologic impacts is based on qualitative analysis.

Operation of the upgraded feeder canal would potentially decrease streamflow for the short reach (4500 feet) of North Fork Salmon Creek within the town of Conconully between the OID feeder canal intake and the upstream end of Conconully Reservoir. This impact would be common to all alternatives. No operational schedule for the feeder canal has been established. Operation of the upgraded feeder canal diversion would likely be focused on moderate to high runoff events in the North Fork Salmon Creek, primarily in May and June of normal, above normal and wet years. However, operation of the feeder canal may occur in other months, and in other water year types. Operation of the feeder canal under OID water rights would allow the District to divert all flows above 1.33 cfs in the North Fork. If operated at maximum capacity, the upgraded feeder canal could decrease peak streamflow by as much as 60 cfs during moderate to high runoff events compared to existing and historical operations. The North Fork streamflow is a portion of total estimated unregulated watershed runoff (**Appendix B-3**). It is likely that operation of the upgraded feeder canal would decrease streamflow in the diverted reach of the North Fork to the legal minimum flow (1.33 cfs, as set by OID water rights) more frequently than under the existing and historical operations.

Reservoir Levels

Operation of the upgraded feeder canal would increase the ability of OID to reliably refill Salmon Lake reservoir using diversion from the North Fork Salmon Creek. The effects of the upgraded diversion have not been modeled discretely from the Alternatives. However, the increased median, minimum and maximum Salmon Lake reservoir water surface elevations simulated within each Alternative are facilitated by the upgrade to the feeder canal.

Flood Hazards

The increased capacity of the feeder canal intake could potentially decrease peak streamflow by as much as 60 cfs compared to existing and historical operations. Operation of the upgraded feeder canal during high flow events would therefore, reduce the potential flood hazards to persons and property adjacent to the quarter-mile long diverted reach between the OID feeder canal intake and the upstream end of Conconully Reservoir.

Flooding/Inundation

Operation of the upgraded feeder canal during moderate and high flow events would reduce the potential for overbank flow and inundation of riparian areas within the quarter-mile long diverted reach between the OID feeder canal intake and the upstream end of Conconully Reservoir.

Groundwater

Operation of the upgraded feeder canal on the North Fork Salmon Creek would have surface hydrology effects in the quarter-mile long reach downslope of the Salmon Lake dam and reservoir and immediately upstream of the Conconully Reservoir. It is likely that groundwater recharge within this reach is dominated by down-valley groundwater flow along the North Fork Salmon Creek, downslope groundwater flow under Salmon Lake, and the groundwater support provided by water surface elevations in Conconully Reservoir.

The feeder canal upgrade would create minor surface hydrology decreases and possible local reductions in soil moisture along the short reach of the North Fork channel below the canal diversion. However, it would not produce any net change in local groundwater recharge. The magnitude and duration of surface hydrology changes would be small compared to groundwater source volumes and recharge rates. In addition, the water diverted from the North Fork Salmon Creek would be conveyed to and stored in adjacent Salmon Lake, which would continue to provide recharge to local groundwater.

3.1.2.4 Alternative 1: Stream Rehabilitation

Stream rehabilitation under Alternative 1 consists of removing the gravel bar at the mouth of Salmon Creek. This action would not affect water quantity within Salmon Creek or elsewhere in the system.

3.1.2.5 Alternative 2: Upgrade Shellrock Pumping Plant

Streamflow

Alternative 2 would provide overwintering flows in the middle and lower reaches of Salmon Creek that have not been provided under historic irrigation operations.

Middle Salmon Creek

Alternative 2 would reduce the unnaturally high summer flows that have occurred in the middle reach under historic irrigation operations and would continue under the No Action Alternative.

The estimated median monthly streamflow in the middle reach of Salmon Creek under Alternative 2 would decrease in July through September, but increase for November through May relative to the No Action Alternative. The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel. Alternative 2 would decrease middle reach streamflow by about 25 cfs in July, August, and September when Shellrock pumping from the Okanogan River reduces the need to convey Salmon Creek water through the middle reach. Alternative 2 would provide overwintering flows for fish survival, increasing the median from nearly zero to 5-10 cfs in the months of November through March. The median streamflow in April would increase from about 15 cfs to approximately 35 cfs, would increase in May by 20 to 30 cfs, and would decrease in August by about 30 cfs. Minor differences (5 to 10 cfs) in the resulting monthly medians depend on which fish passage flow regime is assumed.

The estimated minimum monthly streamflow in the middle reach of Salmon Creek under Alternative 2 would increase about 2 to 6 cfs in the months November through March and 15 to 30 cfs in April, but would decrease by up to 25 cfs in July, August, and September when Shellrock pumping replaces the need to convey Salmon Creek water through the middle reach. Estimated minimum streamflows in April, May, and June are a function of both the instream flow requirements for fish passage in the lower reach and irrigation releases to the OID diversion dam. In May, estimated minimum streamflow in the middle reach would increase about 4 to 20-25 cfs. During June, estimated minimum streamflow in the middle reach would increase about 8 cfs for the steelhead and Chinook fish passage flow regime, but only by a couple cfs for the steelhead only flow regimes.

Lower Salmon Creek, Flow Below Weir

Alternative 2 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations and would not be provided under the No Action Alternative.

Under Alternative 2, the median monthly streamflow below the weir would increase by about 4 to 10 cfs November through March for all three fish passage flow regimes. Stream flow in April would increase from zero to about 15 to 32 cfs, and in May from about 15 to 30-35 cfs, depending on which fish passage flow regime is applied. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, July, and August. The Steelhead and Chinook flow regime would increase flow in the channel by about 10 cfs in July and August, while under all other scenarios, the channel is dry.

The minimum monthly streamflow in lower Salmon Creek below the weir would increase under Alternative 2 by about 2 to 9 cfs during November through March for all fish passage flow regimes. Minimum monthly streamflow would increase in April, May, and June by 7 to 32 cfs, depending on the target fish species flow requirement. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, July, and August. The Steelhead and Chinook flow regime would maintain about 15 cfs more in the channel in June compared to the other fish passage alternatives. It is the only scenario with flow in the lower Salmon Creek channel in July.

Lower Salmon Creek, Flow at Mouth

Alternative 2 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations.

Under Alternative 2, the estimated median monthly stream flow in the lower reach of Salmon Creek at the mouth would increase by about 2 to 9 cfs November through March for all three fish passage flow regimes. Estimated stream flow in April would increase from zero to about 12 to 25 cfs, and in May from about 13 to 23-28 cfs, depending on the target fish species flow requirements. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, July, and August. The Steelhead and Chinook flow regime would increase flow in the channel by about 10 cfs in July and August, while under all other scenarios, the channel is dry.

Under Alternative 2, the estimated minimum monthly stream flow in the lower reach of Salmon Creek at the mouth would increase by about 2 to 8 cfs November through March for all fish passage flow regimes. Estimated minimum monthly stream flow would increase in April, May, and June range from 6 to 25 cfs, depending on the target fish species flow requirement. The greatest variability in flow magnitudes between the three fish passage flow regimes would occur in April, July, and August. The Steelhead and Chinook flow regime would maintain about 10 cfs more in the channel in June compared to the other fish passage regimes, and is the only scenario with flow in the channel in July.

Okanogan River, Shellrock to Salmon Creek

The average monthly percentage of the Okanogan River that would be pumped under Alternative 2 would increase for all fish flow regimes over all water year types (**Table 3-12**). However, the increased percentage would not be of a magnitude or seasonality that adversely affects stream flow in the Okanogan River. The number of months with flow below WAC minimums various water year types would remain identical to the No Action Alternative (**Table 3-12**).

Table 3-12. Percent of Okanogan River Pumped and Number of Months Below WAC Minimum Flows, No Action vs Alternative 2

Water Year Type	No Action Alternative		Alternative 2	
	Percent of Okanogan River Pumped [a]	Number of Months Below WAC Minimum Flows	Percent of Okanogan River Pumped [a,c]	Number of Months Below WAC Minimum Flows[b]
Wet	0.01	0.4	0.33 to 0.34	0.4
Above Normal	0.10	0.3	0.49 to 0.51	0.3
Normal	0.06	1.2	0.64 to 0.65	1.2
Below Normal	0.21	1.4	0.76 to 0.77	1.4
Dry	0.83	6.4	1.44 to 1.19	6.4

[a] In the water model, the percent of flow pumped on a monthly basis from the Okanogan River at Shellrock was simulated for all years on record. The monthly percentages were averaged to determine the mean monthly percentage of flow pumped from the Okanogan River for a given year. The mean monthly percentage of flow pumped in a given year was then ranked by water year type and averaged again to calculate the mean monthly percentage of water pumped in a year for each of the five water year types.

[b] For all years in the water model, simulated Okanogan River streamflow between Shellrock and Salmon Creek was evaluated on a monthly basis to determine if WAC minimum instream flows were met. The number of months that WAC minimum instream flows were not met in a given year were totaled, and then ranked by water year type and averaged to calculate the mean number of months for a certain water year type that WAC standards were not met.

[c] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Table 3-10 summarizes the water rights that exist in this reach of the Okanogan River. If the proposed Project pumps when minimum flows established under the WAC are not met, it could reduce water otherwise available to these water right holders.

Okanogan River, Salmon Creek to Malott

Salmon Creek inflow to the Okanogan River would increase under Alternative 2 for all water year types (**Table 3-13**). The increase would represent a doubling or tripling of Salmon Creek inflow to the Okanogan in wet, above normal and normal water years. For below normal and dry water years the increase would be four to five times that under the No Action Alternative. Water right holders downstream of Salmon Creek could be affected by reduced water availability if water is pumped during times when WAC minimum flows are not met.

Table 3-13. Salmon Creek Inflow to the Okanogan River as a Percentage of Okanogan River Streamflow at Malott, No Action Compared to Alternative 2

Water Year Type	No Action Alternative [a]	Alternative 2 [a,b]
Wet	0.25	0.54 to 0.57
Above Normal	0.21	0.47 to 0.54
Normal	0.19	0.50 to 0.58
Below Normal	0.13	0.45 to 0.56
Dry	0.09	0.52 to 0.72

[a] In the water model, Salmon Creek inflow into the Okanogan River as a percentage of total monthly Okanogan River streamflow measured between Salmon Creek's mouth and Malott was simulated for all years on record. The monthly percentages were averaged to determine Salmon Creek's mean monthly percent contribution of flow to the Okanogan River for a given year. The mean monthly percent contribution of Salmon Creek inflow in a given year was then ranked by water year type and averaged again to calculate the mean monthly percent contribution of Salmon Creek inflow in a year for each of the five water year types.

[b] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Reservoir Levels

Salmon Lake Reservoir

The estimated median monthly Salmon Lake reservoir water surface elevation this alternative is the same or increased by 1 to 3 feet in August through January (**Appendix D-4**). The median lake elevation in February and March would increase or decrease by a foot compared to the No Action Alternative, depending on the fish passage flow regime. In April, median lake elevation would be about 2 feet lower than the No Action Alternative, while in May through July, median lake elevations for all three fish passage flow regimes and the No Action Alternative would be nearly identical. In May, June, and July, median Salmon Lake elevations would be maintained at full active storage capacity (2,318 ft, 10,000 AF). The median lake elevation would be higher and would reduce the seasonal fluctuation of Salmon that have occurred under historic irrigation operations. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The high reservoir elevations would increase surface and groundwater availability along the margins of Salmon Lake reservoir.

The estimated minimum monthly Salmon Lake water surface elevation under this alternative would be lower than the No Action Alternative January through July for all three fish flow regimes. Minimum Salmon Lake elevations would decrease by 2 to 5 feet in January, February, and July and by less than 3 feet August through December. The minimum Salmon Lake elevations in February through June would decrease by 8 to 12 feet, depending on the fish species target flow requirements. The decreased minimum water surface elevations in Salmon Lake (despite increased median lake levels) indicate the increased operational use of Salmon Lake, as facilitated by the upgraded feeder canal.

Conconully Reservoir

The estimated median monthly Conconully Reservoir water surface elevation under Alternative 2 would increase in all months, except May, June, and July, which would remain at maximum active storage level (**Appendix D-4**). The median water surface elevation would increase by about 5 feet in March and August to about 10 feet in September. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The increased median reservoir elevations in late summer through winter would increase surface inundation and groundwater availability along the reservoir margins.

Flood Hazards

Reservoir Margins

The estimated maximum monthly Salmon Lake elevations under Alternative 2 would be the same as the No Action Alternative from April to October of each year. From November through March the maximum monthly lake levels would be reduced up to 1.6 feet, with the lowest elevation occurring in February (**Appendix D-4**). Alternative 2 would represent a slight beneficial impact for reduction of flood hazard from the No Action Alternative.

The estimated maximum monthly Conconully Reservoir elevations under Alternative 2 would be comparable to the No Action Alternative in all months except October (**Appendix D-4**). No change in flood hazard would occur along the margins of Conconully Reservoir.

The estimated maximum monthly Conconully Reservoir spill volume and the 10% exceedence spill volume would decrease under Alternative 2 relative to the No Action Alternative in April, May, and June (**Appendices D-2, D-4**). This would be a minor beneficial reduction of flood hazard. These small volume differences may reflect minor operational charges due to the release of fish flows during spring, but the available storage capacity created in the reservoir would be small enough that the monthly maximum elevation statistics do not change.

Middle Salmon Creek

The estimated maximum monthly streamflow and the 10% exceedence streamflow in the middle reach of Salmon Creek under Alternative 2 would be similar to the No Action Alternative in magnitude and seasonality (**Appendices D-3, D-5**). No adverse or beneficial impacts to flood hazard in the middle reach would occur under Alternative 2.

Lower Salmon Creek

The estimated maximum monthly and 10% exceedance streamflow in the lower reach of Salmon Creek under Alternative 2 would be similar to the No Action Alternative in magnitude and seasonality (**Appendices D-3, D-5**). No adverse or beneficial impacts to flood hazard in the lower reach would occur under Alternative 2.

Flooding/Inundation

Reservoir Margins

Wetland inundation along the Salmon Lake reservoir margins would increase slightly under Alternative 2, since the lake would experience an increase in the median elevation in most months, and the maximum lake level would remain similar to the No Action Alternative (**Appendix D-4**).

Wetland inundation along the Conconully reservoir margins would increase in most months of the year under Alternative 2, since the median lake level would increase to near the maximum active storage elevation (**Appendix D-4**), and the maximum lake level remains similar to the No Action Alternative.

Middle Salmon Creek

Flooding and riparian wetland inundation along the middle reach of Salmon Creek under the Alternative 2 would be similar to the No Action Alternative since the magnitude and frequency of high streamflow volume would be similar (**Appendix D-5**), and the channel capacity would not be modified.

Lower Salmon Creek

Flooding and riparian wetland inundation along lower Salmon Creek under the Alternative 2 would be subject to the same pattern of extreme high flow magnitude and seasonality as under the No Action Alternative (**Appendix D-5**). However, portions of the lower reach that are modified for channel rehabilitation may experience minor increases in overbank flow and inundation of adjacent re-contoured floodplains. These areas of potential benefit would be limited to reaches that have suitable valley width to allow floodplain recontouring.

Groundwater

Okanogan River Valley Aquifer

Groundwater recharge and levels along the Okanogan River Valley aquifer under the Alternative 2 would experience a potential decrease in the vicinity of and down gradient towards the mouth of Salmon Creek, at least during dry years or below normal years, when the percentage of Okanogan River pumped would be approximately one percent or more. These effects are not quantitatively modeled, but since the Frequency with which WAC minimum flows are not met would not increase in duration (**Table 3-12**), it would be unlikely that groundwater recharge would be decreased.

In addition, the potential localized, short-term groundwater decrease would be offset by increased Salmon Creek inflow to the Okanogan River 3.2 miles downstream. Average Shellrock pumping would increase almost 5,000 AF under the Alternative 2 compared to the No Action Alternative (**Appendix D-1**). However, Salmon Creek inflow volume to the Okanogan River would increase about 5,100 AF, even in dry years.

Reservoir Margins

The estimated groundwater levels along the margins of both Conconully Reservoir and Salmon Lake would be relatively constant throughout the year during normal to wet years under the Alternative 2, and would experience less seasonal variability relative to the No Action Alternative. During dry years, groundwater levels would be slightly higher in the fall and early winter months relative to the No Action Alternative in Conconully Reservoir, but slightly lower throughout the rest of the year. During dry years, groundwater levels around Salmon Lake would be depressed throughout the year relative to the No Action Alternative.

Salmon Creek Valley Aquifer

Estimated groundwater levels and recharge along the middle reach of Salmon Creek under the Alternative 2 would likely experience a seasonal shift since median and minimum streamflow would increase in fall, winter, and spring months, but decrease in summer (**Appendix D-5**). The magnitude of flows would be similar although the timing would be shifted, as indicated by the consistent simulated average annual flow. The increase of base flows over much of the year may result in more consistent seasonal groundwater levels.

Groundwater recharge potential in lower Salmon Creek under the Alternative 2 would be increased compared to the No Action Alternative, since median and minimum streamflows increase and the total flow volume released/spilled over the OID weir increases by a few thousand AF per year, in all water year types (**Appendix D-5**).

The groundwater levels and recharge in lower Salmon Creek under the Alternative 2 would be influenced by the channel rehabilitation features, which contain several design elements intended to produce increased recharge within the riparian corridor. Design factors that should increase groundwater inputs include higher wetted area associated with low flow channel, flows that will sufficiently remove fines (which retard permeability), design guidelines that require unsealed banks and greater floodplain water storage and seepage relative to the No Action Alternative.

Duck Lake Aquifer

The estimated Duck Lake maximum pumping rate would increase under the Alternative 2, but the annual average volume pumped from Duck Lake and annual storage retained in Duck Lake to recharge artificial groundwater storage would be maintained at 500 AF (no change from the No Action Alternative) (**Appendix D-1**). The minimum and maximum Duck Lake water surface elevations would be the same under the Alternative 2 and the No Action Alternative, although the season and pattern of pumping may vary. No substantial impacts to Duck Lake Aquifer groundwater levels or recharge would occur under the Alternative 2.

OID Water Availability

Alternative 2, combined with the provision of flows for steelhead and chinook, results in a small critical period shortage that would occur when conditions are similar to the early 1930's drought period. The shortage would be equal to a capacity of about 10 cfs and is modeled to persist for four years, with a peak critical storage deficit of 1678 AF per year in the second year of the drought sequence. This deficit would occur even though pumping from Duck Lake and Shellrock would be maximized when critical storage volumes in Conconully and Salmon Lake reservoirs fell below 15,000 ac-ft. Thus, the model suggests that the significantly greater instream flow demands for maintaining chinook species would impact the OID water system when drought conditions are similar to those experienced in the late 1920's and early 1930's.

3.1.2.6 Alternative 2: Feeder Canal Upgrade

The environmental impacts would be the same as described in **Section 3.1.2.3**.

3.1.2.7 Alternative 2: Stream Rehabilitation

Streamflow

Potential water quantity impacts of the stream rehabilitation may include short-term disruption of flow during construction and long-term changes to flow during operation. Operational stream flow and groundwater impacts are discussed in **Section 3.1.2.5**. Over the operational period, minor beneficial effects to surface hydrology from stream rehabilitation include increased flow depths under low to moderate streamflow magnitudes within the reconfigured fish passage low flow channel.

Construction of the rehabilitated channel in Lower Salmon Creek would occur when the channel is dewatered and when the probability of spill is low. It is expected that channel rehabilitation construction activities within the lower reach of Salmon Creek could readily be scheduled without the need for a temporary bypass or dewatering. It is possible that minor (1-2 cfs) surface flow would be present in the work areas closest to Watercress Springs, or in the vicinity of drainage/treatment outfalls within the City. However, construction requirements would not be likely to create or require complete elimination of small seepage flows.

Flood Hazards

No adverse impact to the existing flood hazard would occur with full stream rehabilitation, since the channel would be designed to pass the base flood (100-year flood) without increasing the area or water surface elevation of the existing regulatory floodplain. Recontouring of channel bed and banks would be designed to alter overbank flow and flood water retention at portions of lower Salmon Creek that have adequate valley width (e.g., upstream of city limits-downstream of Watercress Springs). While some minor flood storage benefit may occur, it would be unlikely to cause a measurable decrease flows in the 100 year water surface elevations.

Flooding/Inundation

Some minor beneficial effects on floodplains and wetland inundation might occur under full stream rehabilitation. The recontouring of channel bed and banks would be designed to increase the frequency of overbank flow and floodwater retention, at portions of lower Salmon Creek that have adequate valley width (e.g., upstream of the City limits-downstream of Watercress Springs). However, it is unlikely that measurable increases in riparian wetland innudation would occur.

Groundwater

Groundwater recharge would not be expected to increase under Stream Rehabilitation alone, since the volume and timing of water released or spilled to lower Salmon Creek would not change under the No Action Alternative. However, it is possible that groundwater recharge might experience slight benefits from the recontouring of channel bed and banks in the portions of lower Salmon Creek that have adequate valley width (e.g., upstream of the City limits-downstream of Watercress Springs). Any recharge benefits would occur only in the same limited number of months and years that experience spill to lower Salmon Creek under the No Action Alternative.

Loss of groundwater to surface flow via interception, extraction, or other means would not be expected to increase under Stream Rehabilitation. The channel bed elevations would not be excavated below the normal groundwater levels, and no new groundwater pumping would occur.

3.1.2.8 Alternative 3: Water Rights Purchase

Streamflow

Alternative 3 would provide overwintering flows in the middle and lower reaches of Salmon Creek that have not been provided under historic irrigation operations and would maintain base flows at the mouth of the creek.

Middle Salmon Creek

Alternative 3 reduces the unnaturally high summer flows in the middle reach that occurred under historic irrigation operations.

The estimated median monthly streamflow in the middle reach of Salmon Creek under Alternative 3 would decrease in July through September, but increase in November through May compared to historic operation. The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel. Alternative 3 would decrease middle reach streamflows by about 25 cfs in July, August and September, when irrigation demand would be reduced compared to the No Action Alternative. Alternative 3 would provide overwintering flows for fish survival that increase the median from near zero to 5-10 cfs in the months of November through March. Variability in the streamflow magnitudes between the three fish flow regimes would be most evident in April and May. The median streamflow in April would increase from about 15 cfs up to approximately 35 cfs, and by about 20 to 22 cfs in May, depending on which fish flow regime is assumed.

The estimated minimum monthly streamflow in the middle reach of Salmon Creek under Alternative 3 would increase about 2 to 6 cfs in the months of November through March and 10 to 30 cfs in April, but decrease about 7 to 10 cfs in months of June through August compared to historic operation. Alternative 3 minimum monthly streamflow in April through August would be a function of both instream demand and needs for OID irrigation. Minimum flows would be highest in April (for the two steelhead only Alternatives), while the minimum required for the steelhead and Chinook salmon during summer would keep the middle reach minimums closer to the No Action than for steelhead only.

Lower Salmon Creek, Flow below Wier

Alternative 3 would re-establish seasonal fish migration flows in lower Salmon Creek that have not occurred under the historic irrigation operations.

The estimated median monthly streamflow in lower Salmon Creek below the weir would increase in all months for the steelhead and Chinook flow regime, and in all months except July and August for the steelhead only regimes compared to historic operation. Median monthly streamflow would increase by 3 to 7 cfs from September through March. Increases in April would range from 15 to 30 cfs (larger for the steelhead only regimes) and would be about 20-25 cfs in May.

Under Alternative 3, the minimum monthly streamflow in lower Salmon Creek below the weir would increase about 3 to 5 cfs October through February for the steelhead only flow regimes, and about 5 to 8 cfs for the steelhead and Chinook regime. Minimum streamflows would be substantially increased March through June (by 10 to 30 cfs, depending on the fish flow regime). Minimums would also be increased from zero to about 10 cfs July through September, for the steelhead and Chinook flow regime.

Lower Salmon Creek, Flow at the Mouth

The estimated median monthly streamflow for the lower reach Salmon Creek at the mouth under Alternative 3 would be increased in all months for the steelhead and Chinook flow regime, and in all months except July and August for the steelhead only flow regimes. The median streamflow would increase 3 to 7 cfs September through March for all fish flow regimes. Increases in April and May would be the largest and most varied. Depending on species requirements, median flow increases in April would vary from about 10 cfs for steelhead and Chinook to about 25 cfs for steelhead without the channel rehabilitation. Increases in May would be about 20 to 22 cfs. Only the steelhead and Chinook regime would provide median flow greater than zero in July and August.

Under Alternative 3, the estimated minimum monthly streamflow in lower Salmon Creek at the mouth would increase about 3 to 5 cfs October through February for the steelhead only regimes and about 5 to 8 cfs for the steelhead and Chinook flow regime compared to historic operation. Minimum streamflows would be substantially increased March through June (by 10 to 30 cfs depending on the fish flow regime). Minimums would also increase from zero to about 10 cfs July through September for the steelhead and Chinook flow regime.

Okanogan River, Shellrock to Salmon Creek

The percentage of Okanogan River that would be pumped under Alternative 3 would increase for all fish flow regimes over all water year types (**Table 3-14**). However, neither the magnitude nor seasonality of increased pumping would adversely affect minimum streamflow in the Okanogan

River. The number of months below WAC minimum flows would be identical to the No Action Alternative (**Table 3-14**).

Table 3-14. Percent of Okanogan River Pumped and Number of Months Below WAC Minimum Flows, No Action vs Alternative 3

	No Action Alternative		Alternative 3	
Water Year Type	Percent of Okanogan River Pumped [a]	Number of Months Below WAC Minimum Flows	Percent of Okanogan River Pumped [a,c]	Number of Months Below WAC Munimum Flows [b]
Wet	0.01	0.4	0.21 to 0.24	0.4
Above Normal	0.10	0.3	0.33 to 0.36	0.3
Normal	0.06	1.2	0.44 to 0.46	1.2
Below Normal	0.21	1.4	0.52 to 0.54	1.4
Dry	0.83	6.4	1.01 to 1.03	6.4

[a] In the water model, the percent of flow pumped on a monthly basis from the Okanogan River at Shellrock was simulated for all years on record. The monthly percentages were averaged to determine the mean monthly percentage of flow pumped from the Okanogan River for a given year. The mean monthly percentage of flow pumped in a given year was then ranked by water year type and averaged again to calculate the mean monthly percentage of water pumped in a year for each of the five water year types.

[b] For all years in the water model, simulated Okanogan River streamflow between Shellrock and Salmon Creek was evaluated on a monthly basis to determine if WAC minimum instream flows were met. The number of months that WAC minimum instream flows were not met in a given year were totaled, and then ranked by water year type and averaged to calculate the mean number of months for a certain water year type that WAC standards were not met.

[c] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Okanogan River, Salmon Creek to Malott

Salmon Creek inflow to the Okanogan River would increase under Alternative 3 for all water year types (**Table 3-15**). The increase would be a doubling or tripling of Salmon Creek inflow to the Okanogan in wet, above normal and normal water years. For below normal and dry water years, the increase would range from four to nine times that under the No Action Alternative.

Table 3-15. Salmon Creek inflow to the Okanogan River as Percentage of Okanogan River Streamflow at Malott, No Action vs Alternative 3

Water Year Type	No Action Alternative [a]	Alternative 3 [a,b]
Wet	0.25	0.57 to 0.62
Above Normal	0.21	0.51 to 0.60
Normal	0.19	0.54 to 0.68
Below Normal	0.13	0.49 to 0.65
Dry	0.09	0.55 to 0.89

[a] In the water model, Salmon Creek inflow into the Okanogan River as a percentage of total monthly Okanogan River streamflow measured between Salmon Creek's mouth and Malott was simulated for all years on record. The monthly percentages were averaged to determine Salmon Creek's mean monthly percent contribution of flow to the Okanogan River for a given year. The mean monthly percent contribution of Salmon Creek inflow in a given year was then ranked by water year type and averaged again to calculate the mean monthly percent contribution of Salmon Creek inflow in a year for each of the five water year types.

[b] Variation by fish flow regime (lowest pumping would be for the steelhead only regimes, higher pumping would be for the steelhead and Chinook flow regime).

Reservoir Levels

Salmon Lake

The estimated median monthly Salmon Lake reservoir water surface elevation under Alternative 3 would increase 1 to 3 feet August through February, and decrease 1 to 3 feet in April compared to the No Action Alternative. In May, June and July, median lake level for the three fish flow regimes and the No Action Alternative would be the same, at full active storage capacity (2,318 ft). Alternative 3 would reduce seasonal fluctuation in Salmon Lake level that has occurred under historic operations. A large volume of water would be consistently in storage, providing water for releases to meet instream flow requirement in the middle and lower reaches of Salmon Creek. The high water surface elevations would increase surface and groundwater availability along the margins of Salmon Lake reservoir.

The estimated minimum monthly Salmon Lake reservoir water surface elevations under Alternative 3 would increase in July through March for the two steelhead flow regimes and decrease in all months for the steelhead and Chinook flow regime compared to historic operation. Alternative 3 would reduce the seasonal variability of minimum reservoir elevations slightly. The steelhead only flow regime would increase minimum Salmon Lake reservoir elevation by 3 to 7 feet in late summer through early winter. The steelhead and Chinook flow regime would decrease minimum reservoir elevation by 2 to 6 feet in all months.

Conconully Reservoir

The estimated median monthly Conconully Reservoir water surface elevation under Alternative 3 would increase in August through April by 5 to 10 feet, such that median reservoir elevation would be near full active storage in most months. Alternative 3 would eliminate the large seasonal fluctuation in median reservoir elevation that has occurred under historic conditions. The estimated median Conconully reservoir elevation would be similar for all three fish flow regimes. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow demands in the middle and lower reaches of Salmon Creek. The reservoir levels would provide more seasonally consistent surface and groundwater accumulations along the margins of Conconully Reservoir.

The estimated minimum monthly Conconully Reservoir water surface elevation under Alternative 3 would increase August through March, and decrease in May and June for the steelhead flow regimes and decrease in all months for the steelhead and Chinook flow regime compared to historic operation. The minimum Conconully Reservoir elevation would increase 5 to 10 feet in fall and winter for the steelhead flow regimes, and drop 1 to 3 feet in May and June. Decreases in minimum reservoir elevation for the steelhead and Chinook flow regime would range from less than a foot in September and October to as much as 7 or 8 feet (April).

Flood Hazards

Reservoir Margins

The estimated maximum monthly Salmon Lake water surface elevations under Alternative 3 would be comparable to the No Action Alternative from March to November of each year. From December to February the maximum monthly lake levels would be reduced up to 1.6 feet, with the lowest elevation occurring during February. Alternative 3 would provide a slight beneficial flood hazard reduction compared to the No Action Alternative. However, the sight increase in available flow storage capacity occurs in months with low probability of flood events and the reservoirs are not authorized for flood storage.

The estimated maximum monthly Conconully Reservoir water surface elevations under Alternative 3 would be comparable to the No Action Alternative in all months except October. The maximum monthly Conconully Reservoir spill volume and 10% exceedence spill would decrease under the Alternative 3 in April, May, and June. This would be a minor beneficial flood hazard reduction. The small volume differences may reflect minor operational changes due to the release of fish flows in spring, but the available storage capacity created in the reservoir would be small, and does not alter the maximum monthly reservoir elevation statistics.

Middle Salmon Creek

The estimated maximum monthly streamflow and 10% exceedence streamflow in the middle reach of Salmon Creek would be similar to the No Action Alternative in magnitude and seasonality. No adverse or beneficial impacts to flood hazards in the middle reach would occur under Alternative 3.

Lower Salmon Creek

The estimated maximum monthly flow and 10% exceedence in lower Salmon Creek under Alternative 3 would be comparable to the No Action Alternative in both magnitude and seasonality. No adverse or beneficial impacts to flood hazards in the lower reach would occur in Alternative 3.

Flooding/Inundation

Reservoir Margins

Wetland inundation along the Salmon Lake reservoir margins would increase slightly under Alternative 3 since the lake would experience increases in median lake level in most months, and maximum elevation would remain similar to the No Action alternative. Under the steelhead only fish flow regimes, minimum Salmon Lake elevations would also increase by a few to several feet.

Wetland inundation along the margin of Conconully Reservoir would increase in most months of the year under Alternative 3 since the median lake level would increase to near the maximum active storage, and maximum lake level remains similar to the No Action Alternative. Under the steelhead only fish flow regimes, minimum Conconully Reservoir levels would also increase several feet in most months.

Middle Salmon Creek

Flooding and wetland inundation along the middle reach Salmon Creek under Alternative 3 would be similar to the No Action Alternative since the magnitude, seasonality, and frequency of high streamflow volumes would be similar and the channel capacity would not be modified.

Lower Salmon Creek

Flooding and riparian wetland inundation along the lower reach of Salmon Creek under Alternative 3 would be driven by the same magnitude, seasonality, and frequency of high streamflow volumes as under the No Action Alternative.

Groundwater

Okanogan River Valley Aquifer

Groundwater recharge and levels along the Okanogan River Valley aquifer under Alternative 3 would experience a small potential decrease in the vicinity of the Shellrock pump station and down gradient towards Salmon Creek. The effects are not quantitatively modeled, but since the frequency with which flows fall below WAC minimums does not increase (**Table 3-14**), it would be unlikely that groundwater recharge would be substantially reduced. The potential local groundwater decreases would be more than offset by increased Salmon Creek inflow to the Okanogan River 3.2 miles downstream of Shellrock. Average pumping from the Okanogan River under the Alternative 3 would increase by from 2,200 AF (steelhead) to 2,700 AF (for steelhead and Chinook) over the No Action Alternative (**Appendix D-1**). Flow at the mouth of Salmon Creek would increase by about 5,100 AF, even in dry years. Therefore, the net impact to the Okanogan River Valley aquifer would be beneficial, providing about 2,400 AF surplus for the steelhead only flow regimes and a little over 800 AF of surplus under the steelhead and Chinook flow regime.

Reservoir Margins

The groundwater levels along the margins of Salmon Lake and Conconully Reservoir would be more consistent seasonally and from year to year under Alternative 3 compared to the No Action Alternative, as median water surface levels, and some minimum lake levels are increased. During normal to wet years, groundwater levels around the reservoirs would experience less seasonal variability. For dry years, Salmon Lake and Conconully Reservoir would experience increased groundwater recharge and levels for the steelhead only fish flow regimes. The minimum lake levels under the steelhead and chinook fish flow regime would not increase substantially at Salmon Lake, and would decrease slightly in some months at Conconully Reservoir. Overall, the impact to groundwater along the reservoir margins would be a substantial benefit, increasing recharge volumes and reducing fluctuations in local groundwater gradients.

Salmon Creek Valley Aquifer

Groundwater levels and recharge along the middle reach of Salmon Creek under Alternative 3 would likely experience a seasonal shift, since median and minimum streamflow would increase in fall, winter, and spring months, but decrease in summer. The magnitude of flow volumes would be similar to the No Action Alternative, as indicated by consistent simulated average annual flow. The increase of base flows, distributing flow throughout more of the year, may result in more consistent groundwater levels.

Groundwater recharge potential in lower Salmon Creek under Alternative 3 would be increased compared to the No Action Alternative, since median and minimum streamflow volumes would increase and the total flow volume released/spilled over the OID weir would increase by a few thousand acre felt per year in all water year types.

Duck Lake Aquifer

The Duck Lake maximum pump rate would be increased, but storage retained for artificial groundwater recharge would not be increased under Alternative 3. The average volume of water pumped from Duck Lake would decrease by about 300 AF (for the steelhead and Chinook flow regime) or almost 550 AF (for the steelhead only flow regime). The minimum and maximum Duck Lake elevations do not change. No adverse impact to the Duck Lake aquifer would occur under Alternative 3, and a small potential benefit may result.

OID Water Availability

Alternative 3 combined with the provision of flows for steelhead and Chinook would result in a small critical period shortage that would occur when conditions are similar to the early 1930's drought period. The shortage is modeled to persist for two years, with a peak critical storage deficit of 674 AF per year in the first year of the drought sequence. This deficit would occur even though pumping from Duck Lake and Shellrock would be maximized when critical storage volumes in Conconully and Salmon Lake reservoirs fell below 15,000 ac-ft. Thus, the model suggests that the significantly greater instream flow demands for maintaining Chinook species would impact the OID water system when drought conditions are similar to those experienced in the late 1920s and early 1930s.

OID Service Area Water Availability

Reduced irrigation in the OID service area could have local effects on the static water level in wells, as groundwater recharge may be locally reduced. Such an effect has been noted in other areas where irrigation has been significantly reduced due to conservation or land retirement (e.g., the Sequim-Dungeness Valley in WRIA 18). Aquifer recharge from applied irrigation (or leaking ditches) is not a natural recharge source, therefore ground water withdrawals from the aquifer that is artificially recharged are not protected from impairment.

3.1.2.9 Alternative 3: Feeder Canal Upgrade

The impacts would be the same as described in **Section 3.1.2.3**.

3.1.2.10 Alternative 3: Stream Rehabilitation

Since there would be no stream rehabilitation associated with this alternative, the impacts would be the same as the No Action Alternative.

3.1.2.11 No Action Alternative

Streamflow Impacts

Upper Salmon Creek

Estimated streamflow in the upper reach of Salmon Creek would remain unregulated under all of the alternatives, similar to the existing and historical conditions (**Figure 3-5**). Natural variability in watershed runoff production would continue to produce differences by water year type as a function of climatic influences. The water system model assumes that the volume and pattern of runoff from the unregulated upper watershed would remain the same under all alternatives.

Middle Salmon Creek

The median and minimum monthly estimated streamflow in the middle reach of Salmon Creek under the No Action Alternative would be similar to the existing and historical conditions (**Appendix D-5**). The graphed exceedence values for the middle reach of 0.5 cfs in the month of April under the No Action Alternative do not accurately represent the true flow in this reach for the month. Because of how the model accounts for estimated seepage in the middle reach and handles the first month of irrigation demand, it indicates a very low streamflow, when in reality there is likely up to approximately 15 cfs in the channel. The No Action Alternative would continue to provide high summer flows in the middle reach, similar to historical irrigation operations (**Figure 3-6**). Simulated median monthly streamflow in the middle reach of Salmon Creek from May through September is slightly greater (3 to 6 cfs) under the No Action Alternative than for historic irrigation operations. Minor differences are primarily due to standardized operation assumptions used to model future operations, versus actual variations in historic operations.

Lower Salmon Creek

The median and minimum monthly estimated streamflow in lower Salmon Creek under the No Action Alternative would be similar to the existing and historical conditions (**Appendix D-5**). Under the No Action Alternative, the median flows in the lower reach would remain near zero and the minimum flow would be zero in most months, as under the historical irrigation operations (**Figure 3-7**). Minor differences are primarily due to standardized operation assumptions used to model future operations, versus actual variation in historic operations.

Okanogan River, Shellrock to Salmon Creek

The estimated percentage of Okanogan River streamflow that would be pumped would increase under the No Action Alternative's simulated standard future operations relative to the District's pumping patterns since the irrigation system was improved in 1987[7]. However, under the No Action Alternative, the frequency with which flows fall below WAC minimum instream flows for the Okanogan River between the Shellrock pump station and Salmon Creek would be identical to existing and historical conditions. The distribution of occurance of flows below WAC instream minimums distribution by water year type under the No Action Alternative would be the same as for the historical irrigation operations (**Table 3-3** and **Appendix D-6**).

Okanogan River, Salmon Creek to Malott

Estimated Salmon Creek inflow will continue to comprise between about one tenth to two tenths of a percent of the Okanogan River flow under the No Action Alternative, similar to existing and historical conditions (**Table 3-16**). Salmon Creek inflow would comprise about two tenths of a percent of Okanogan River monthly streamflow in normal, above normal, and wet water year types, and between 0.09 and 0.13 percent in dry and below normal years under the No Action Alternative.

Table 3-16. Salmon Creek Inflow to the Okanogan River as a Percentage of Okanogan River Streamflow at Malott

Water Year Type	Salmon Creek Inflow to Okanogan River (%)	
	Historical	No Action Alternative
Wet	0.24	0.25
Above Normal	0.20	0.21
Normal	0.19	0.19
Below Normal	0.12	0.13
Dry	0.11	0.09

Reservoir Levels

Salmon Lake Reservoir Levels

The estimated minimum, median, and maximum monthly Salmon Lake water surface elevation under the No Action Alternative would remain similar to the existing and historical condition. The minimum Salmon Lake elevation would be between 2,280 ft and 2,285 ft in January through March, increases to around 2,293 ft in May and June, then decreases in July and August to stabilize at about 2,282 ft for the remainder of the year. The maximum Salmon Lake elevation would be at the active storage maximum of 2,318 ft. Minor differences from existing and historical conditions occur due to the model's assumptions of standardized future operations, versus actual variation in historical operations (See **Appendix D-4**).

[7] This occurs because the most recent 16 years of Shellrock operation are not fully representative of the entire 99-year water record, and the No Action Alternative considers the full 99-year record in modeling the No Action Alternative

Conconully Reservoir Levels

The estimated minimum, median, and maximum monthly Conconully Reservoir water surface elevation under the No Action Alternative would be similar to the existing and historical conditions. The minimum Conconully Reservoir elevation would be about 2,249 ft January through March, increases to 2,264 ft in June, then decreases in July and August to stabilize at about 2,247 ft for the remainder of the year. The median Conconully Reservoir elevation would be about 2,280 ft January through March, increases in April to the active storage maximum of 2,287 ft in May, June, and July, then decreases in August and September to stabilize around 2,275 ft for the remainder of the year. The maximum Conconully Reservoir elevation would be at the active storage maximum of 2,287 ft every month of the year except October, when the lake elevation is one foot lower (**Appendix D-4**). Minor differences from existing and historical conditions occur due to the model's assumptions of standardized future operations, versus actual variation in historical operations.

Flood Hazards

Reservoir Margins

No daily maximum or peak reservoir water surface elevation data exist for either Salmon Lake or Conconully Reservoir. Estimated maximum monthly reservoir elevations (1% exceedence) and the monthly Conconully spill volumes are the best available model output to form a basis for interpreting flood hazards.

The estimated maximum monthly Salmon Lake water surface elevation under the No Action Alternative would be the same as existing and historic operations in both magnitude and seasonality. The maximum monthly Salmon Lake elevation is at the full active storage capacity of 2,318.4 ft every month of the year (**Appendix D-4**). The No Action Alternative does not include facilities or operational changes from existing or historical operations that would be expected to modify flood hazards along the margins of Salmon Lake reservoir.

The estimated maximum monthly Conconully Reservoir water surface elevation under the No Action Alternative would be the same as existing and historic operations in both magnitude and seasonality. The maximum monthly Conconully Reservoir elevation is at full active storage capacity of 2287 ft every month of the year (**Appendix D-4**).

The estimated maximum monthly Conconully Reservoir spill volume under the No Action Alternative is the same as existing and historical operations in both magnitude and seasonality (**Appendix B-2**). Based on existing and historical operations, the maximum monthly unregulated reservoir inflow (**Figure 3-5**) would be essentially the same as the maximum monthly streamflow in the middle reach (**Figure 3-6**) below the dam (600 cfs). According to the Bureau of Reclamation, the OID reservoirs are not authorized for flood storage. Monthly volume similarities upstream and downstream of the dam show that the reservoir do not reduce flood peak volumes, and this remains true under the No Action Alternative as compared historical operations.

The No Action Alternative does not include facilities or operational changes from existing or historical operations that would be expected to modify flood hazards along the margins of Conconully Reservoir, or flood hazards generated by spill from Conconully Reservoir.

Middle Salmon Creek

No instantaneous peak flow data or daily peak streamflow data exist for the middle reach of Salmon Creek. Estimated maximum monthly streamflows (1% exceedence) are the best available model output as a basis for interpreting flood hazards, as they include the effect of Conconully Reservoir spill to the middle reach.

The estimated maximum monthly streamflow for the middle reach Salmon Creek under the No Action Alternative is the same as existing and historical operations in both magnitude and seasonality (**Figure 3-6** and **Appendix D-5**). The No Action Alternative does not include facilities or operational changes from existing or historical operations that would be expected to modify the 100-year flood hazards along the middle reach of Salmon Creek.

Lower Salmon Creek

No instantaneous peak flow data of daily peak streamflow data exist for the lower reach of Salmon Creek. Estimated maximum monthly streamflows (1 % exceedence) are the best available model output as a basis for interpreting flood hazards, as they include the effect of Conconully Reservoir spill and spill across the OID diversion dam.

The estimated maximum monthly streamflow on lower Salmon Creek under the No Action Alternative is similar to the existing and historical condition in seasonality and slightly reduced in magnitude (**Figure 3-7** and **Appendix D-5**). The maximum monthly streamflow on lower Salmon Creek is 450 cfs under the No Action Alternative, about 125 cfs less than the maximum monthly flow for existing and historical operations (**Figure 3-7**). This slight reduction in flow volume may represent a beneficial effect of the assumed standardized operations, improved reservoir inflow-release monitoring and automation to facilitate partial OID diversion of Conconully spill under the No Action Alternative in comparison to historical practices. However, this difference does not indicate that a net beneficial impact results from the No Action Alternative.

It is assumed that no actions would be taken by others under this Alternative that would worsen the 100-year flood flows, floodplain, or floodway. The 100-year flood hazard would be confined within the levee system in the City of Okanogan as it is for the existing condition (**Figure 3-9**).

Flood hazards to property associated with channel instability and bank erosion under the existing and historical operations would continue with the No Action Alternative, although a minor lessening of maximum monthly streamflow could produce a slight decrease.

Flooding/Wetland Inundation

Reservoir Margins

The seasons and frequency of months that Salmon Lake and Conconully Reservoir will be at maximum active storage capacity under the No Action Alternative would be similar to the existing and historical condition. Wetland areas along the reservoir margins would experience inundation depth and frequency similar to the existing and historical condition under the No Action Alternative.

Middle Salmon Creek

Along the middle reach of Salmon Creek, the existing stream channel experiences minor overbank flows that inundate riparian wetlands every several years. Flooding and riparian wetland inundation along the middle reach of Salmon Creek under the No Action Alternative will be similar to the existing and historical condition, since the magnitude seasonality, and frequency of monthly streamflow volumes is similar (**Appendix D-5**), and the channel capacity would not be modified.

Lower Salmon Creek

Along the lower reach of Salmon Creek, particularly downstream of Watercress Springs, existing floodplains and wetlands are hydrologically disconnected from the channel due to historical erosion that has lowered the channel bed relative to the top of the banks. Only very infrequent, extreme high streamflow events are large enough to overtop the banks and inundate riparian areas, and then only for very short duration. Flooding and riparian wetland inundation along the lower reach of Salmon Creek under the No Action Alternative will be similar to the existing and historical condition, since the magnitude seasonality, and frequency of monthly streamflow volumes is similar (**Appendix D-5**) and the channel capacity would not be modified.

Groundwater

Okanogan River Valley Aquifer

Groundwater levels and recharge in the Okanogan River Valley Aquifer under the No Action Alternative would be similar to existing and historical conditions. Monthly streamflow volumes and frequencies in lower Salmon Creek are similar, producing similar seasonal and inter-annual contributions to the Okanogan River Valley Aquifer. Pumping from the Okanogan River would increase slightly, from the standardized operation[8] of Shellrock under the No Action Alternative. However, the changes in pumping due to modeled standardization would likely affect water years that already have higher Okanogan River flows, and experience high groundwater recharge. The magnitude of pumping increase would be very small relative to recharge in those

[8] "Standardized" refers to operations simulated for the full 99-year water record under the rules described for No Action Alternative in Chapter 2 and Appendix 3-D.

years. No measurable effect on groundwater would be expected under the No Action Alternative compared to existing and historical conditions.

Reservoir Margins

Groundwater levels and recharge along the reservoir margins under the No Action Alternative would be similar to existing and historical conditions. Monthly reservoir levels would occur at similar elevations and frequency, indicating comparable long-term groundwater recharge in the vicinity of the reservoirs.

Middle Reach Salmon Creek

Groundwater levels and recharge along the middle reach of Salmon Creek under the No Action Alternative would be similar to existing and historical conditions. Monthly streamflow volumes and frequencies in the middle reach of Salmon Creek are similar, producing similar seasonal and annual groundwater recharge.

Lower Reach Salmon Creek

Groundwater levels and recharge from surface streamflow along lower Salmon Creek under the No Action Alternative would continue to be minimal, as under existing and historical conditions. The volume of water released to lower Salmon Creek through uncontrolled spill at Conconully and the OID diversion dam would not be modified under the No Action Alternative. Monthly streamflow amounts and frequencies would be similar, producing similar seasonal and annual groundwater recharge.

Duck Lake Aquifer

The Duck Lake pumping rates, the volume of Duck Lake water sales, and canal spill under the No Action Alternative would be similar to existing and historical conditions (**Appendix D-7**). Groundwater recharge at Duck Lake under the No Action Alternative would be the same as under existing and historical conditions. Minor differences may occur due to the modeled assumptions of standardized future operations and improved monitoring of canal spill, in comparison to varied historical operations.

3.1.3 MITIGATION MEASURES

The following mitigation measures address potential adverse effects of the Alternatives. In most cases, the nature or magnitude of effect would be similar for each of the alternatives, therefore the mitigation measures are similar. If alternative-specific effects require distinct mitgation, it is identified below.

3.1.3.1 Flood Hazards

Flood hazards under the No Action and all three Alternatives are similar during peak runoff season (May, June). All three water supply Alternatives will result in the median Conconully Reservoir elevation being maintained at or near maximum capacity for most months. The potential for flooding in Salmon Creek below Conconully increases if the reservoir would be at or near capacity and cannot store a large runoff event. However, the reservoirs are not authorized for flood storage. No mitigation measures would be required, however, the following mitigation would be recommended to provide a beneficial improvement from the No Action condition:

- The reservoir management component of the Stream Management Plan could consider incorporating a flood storage rule, however this would require a change in the authorized uses of the reservoirs to include flood storage. Based on the area-capacity curves, a rule that creates a peak flow storage buffer for about 500 cfs could be included without the need to lower reservoir elevations more than about one foot.

3.1.3.2 Groundwater

Okanogan River Valley Aquifer

Alternative 1 increases pumping capacity on the Okanogan River by up to 55[9] cfs. This may create localized, seasonal groundwater drawdown in close proximity to the new pump station. The extent and severity of this potential adverse impact would vary with the local geologic conditions and location of any water supply wells. Because of these uncertainties, the following mitigation would not be required, but is recommended:

- Any drawdown effects on ground water supply at existing wells would be compensated by deepening existing wells and/or by subsidizing the incremental increase in pumping costs.

Salmon Creek Valley Aquifer

While groundwater levels should generally increase within the lower Salmon Creek valley alluvial aquifer, some uncertainty exists about the degree and extent of groundwater increases in lower Salmon Creek after channel rehabilitation.

- A pre and post-construction groundwater monitoring program should be included as part of the Stream Management Plan to evaluate the net effects on groundwater. If monitoring indicates that groundwater recharge and levels are unexpectedly decreased, modifications to instream flow hydrographs through regulation of reservoir releases could be considered for mitigation.

---

[9] Although the new Okanogan River pump station would be sized at 80 cfs, the District currently can pump 25 cfs at Shellrock; the difference (55 cfs) is the potential increase in pumping capacity on the river.

Duck Lake Aquifer

The Stream Management Plan should include groundwater monitoring within the Duck Lake Aquifer to ensure that overall water system operations prevent groundwater impacts.

3.1.4 UNAVOIDABLE ADVERSE IMPACTS

3.1.4.1 Streamflow

The No Action Alternative would continue to provide unnaturally high median and minimum flows in the middle reach, while the lower reach would have zero flow in most months. The frequency and magnitude of spills at Conconully would also remain similar to existing conditions. Under the No Action flow regime, it is expected that channel incision and channel widening will continue to progress upstream through the Watercress Springs area, with negative impacts on water quality, fish passage, and riparian property. Bank stabilization measures and construction of grade control structures would be necessary to prevent further channel degradation.

Alternative 1 would decrease streamflow in the 1.35 miles of Okanogan River from the new pump station to Salmon Creek, and may increase the frequency of WAC minimum in dry years. Although the magnitude of the effect would be small, it would be larger than for the Alternative 2 or Alternative 3. No mitigation would be available without resulting in additional adverse impacts to OID water supply or fish flow regimes.

Alternative 2 would decrease streamflow in the 3.20 miles of Okanogan River from Shellrock to Salmon Creek, but does not increase the frequency of WAC minimum. Although the magnitude of the effect would be small (and would be less than Alternative 1), no mitigation is available without resulting in additional adverse impacts to OID water supply or fish flow regimes.

Alternative 3 would decrease streamflow in the 3.20 miles of Okanogan River from Shellrock to Salmon Creek, but does not increase the frequency of WAC minimum. Although the magnitude of the effect would be smaller than Alternatives 1 and 2, no mitigation would be available without resulting in additional adverse impacts to OID water supply or fish flow regimes.

3.1.4.2 Groundwater

Alternative 1 would increase pumping capacity on the Okanogan River by up to 55 cfs. This may create localized, seasonal groundwater drawdown in close proximity to the new pump station. The extent and severity of this potential adverse impact is uncertain.

Alternative 3 would reduce irrigated farmland by about 30 percent, potentially reducing local recharge to groundwater and affecting nearby wells. However, this effect is uncertain and would likely be attenuated by the modern irrigation systems already in place.

3.1.4.3 OID Water Availability

Under Alternative 2, when instream flows are provided for both steelhead and Chinook, a small critical period shortage occurs in irrigation delivery to OID when drought conditions are similar to those experienced in the early 1930s drought. The shortage is modeled to persist for four years, with a peak critical storage deficit of 1678 AF per year.

Under Alternative 3, when instream flows are provided for both steelhead and Chinook, a small critical period shortage occurs in irrigation delivery to OID when drought conditions are similar to those experienced in the early 1930s drought. The shortage is modeled to persist for two years, with a peak critical storage deficit of 674 AF per year.

3.2 WATER QUALITY

3.2.1 EXISTING CONDITIONS

Salmon Creek and the Okanogan River are classified as Class A (Excellent) waters by the State of Washington Department of Ecology. Characteristic uses for Class A include:

- water supply (domestic, industrial, and agricultural)
- stock watering
- fish and shellfish (including salmonid migration, rearing, spawning, and harvesting)
- wildlife habitat
- recreation (primary contact recreation, sport fishing, boating, and aesthetic enjoyment)
- commerce and navigation.

Water quality standards associated with this classification for Salmon Creek are presented in **Appendix E**. Water quality limitations are described below for Salmon Creek and the Okanogan River.

3.2.1.1 Okanogan River

The Okanogan River is on the State of Washington Department of Ecology 1996 and 1998 Clean Water Act Section 303(d) list for temperature approximately 10 miles downstream from the confluence. DDT has been found in fish tissue in several reaches, and although it is not listed for water in reaches near Salmon Creek based on the 1998 list, it may be listed in reaches near Salmon Creek based on the 2002 list (Mark Peterschmidt, Department of Ecology, personal communication, 2003).

Based on data collected by the State of Washington Department of Ecology and others in the Okanogan River at Malott (**Table 3-17**), Ecology stated that there is a "consistent late summer water temperature criteria violation (annual violations from 1983 through 1993). Fish within the watershed are subject to poor water quality and low flow conditions, as well as critically high water temperatures during summer months" (Ecology, 1995). Data show that other problems include a consistent exceedance of lead and mercury criteria, and sedimentation problems (Ecology, 1995).

Table 3-17. Summary of Okanogan River water quality at the long-term water quality monitoring station at Malott (approximately15 miles downstream from Salmon Creek), based on Washington Department of Ecology data from 1990-2000.

	Flow	Conduc tivity	Fecal Coliform	Ammonia Nitrogen	Nitrate + Nitrate Nitrogen	Dissolved Oxygen	pH	Suspen-ded Solids	Tempe rature	Total Phospho rus	Turbi dity
	(cfs)	(umhos/cm)	(#/100ml)	(mg/L)	(mg/L)	(mg/L)	(pH)	(mg/L)	(deg C)	(mg/L)	(NTU)
Average	3431	217	25	0.01232877	0.0370748	10.80	8.15	22	9.99	0.032	7.4
Minimum	448	86	1	0.01	0.01	7.2	7.1	1	-1.3	0.010	0.7
Maximum	18400	331	150	0.07	0.158	14.7	8.8	405	24.9	0.241	176

Erosion and Sedimentation

Under most flow conditions, the Okanogan River generally has higher suspended sediment and total suspended solids (TSS) concentrations than Salmon Creek. At the Ecology long-term water quality monitoring station at Malott (approximately 15 miles downstream from Salmon Creek), suspended solids ranged from 1 to over 400 mg/L, with the highest values more typically in the 50 to 150 mg/L range from 1990 through 2002 (**Figure 3-13**). The average reading at Malott was 22 mg/L. Turbidity ranged from 0.7 to 176 NTU, averaging 7.4 NTU. The standard for the Okanogan River (Class A freshwaters) is “turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less.” Although the background turbidity has not been calculated, based on the average turbidity or 7.4 NTU, it appears that the standard is exceeded. This may be expected during storm and high flow events. TSS concentrations increase in the spring, showing an annual spike that coincides with high flow.

Water Temperatures

Water temperatures have been collected at the Ecology long-term water quality monitoring station at Malott (**Table 3-17 and Figures 3-14 and 3-15**). For Class A freshwaters, the State standard is “the temperature shall not exceed 18 degrees C (64 degrees F) due to human activities.” However, when natural conditions exceed 18 degrees C (64 degrees F), no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 degrees C. Small incremental temperature increases are also allowed for point and nonpoint sources. It is not known if natural conditions in the Okanogan River exceed 18 degrees C (64 degrees F), or what temperature increases are due to point and nonpoint sources. However, temperatures in the Okanogan River downstream from Salmon Creek (at Malott) do occasionally exceed 20 degrees (68 degrees F) in summer.

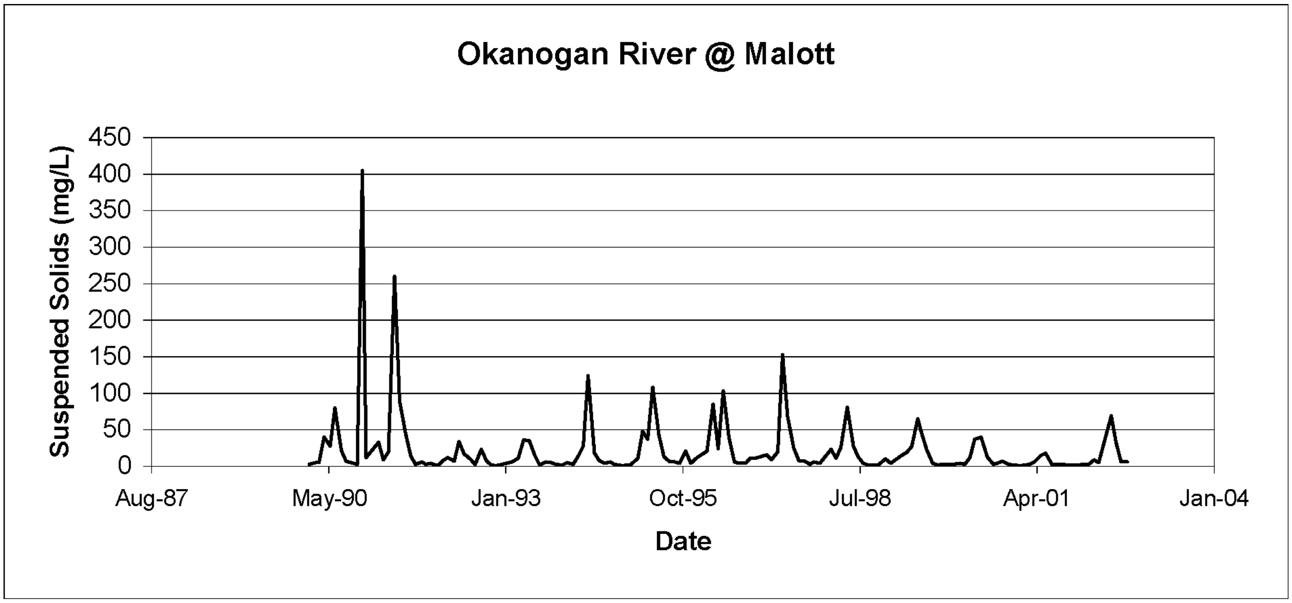

Figure 3-13. Okanogan River Suspended Solid Concentrations at Malott.

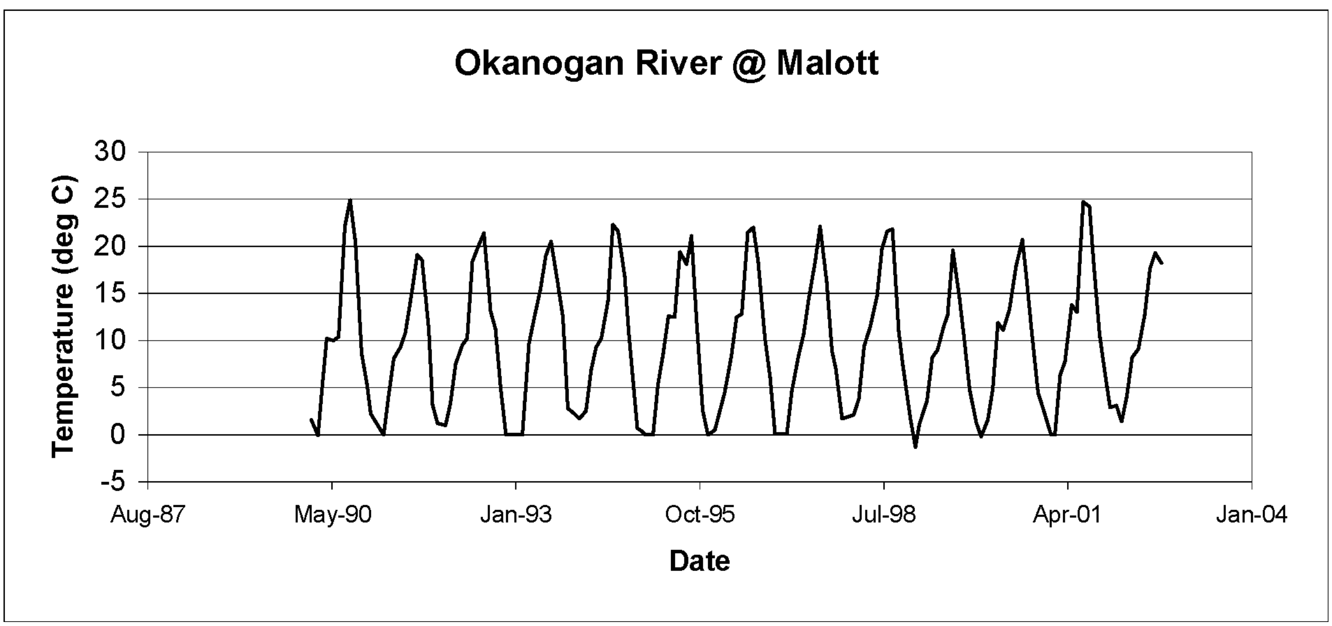

Figure 3-14. Okanogan River Temperatures at Malott.

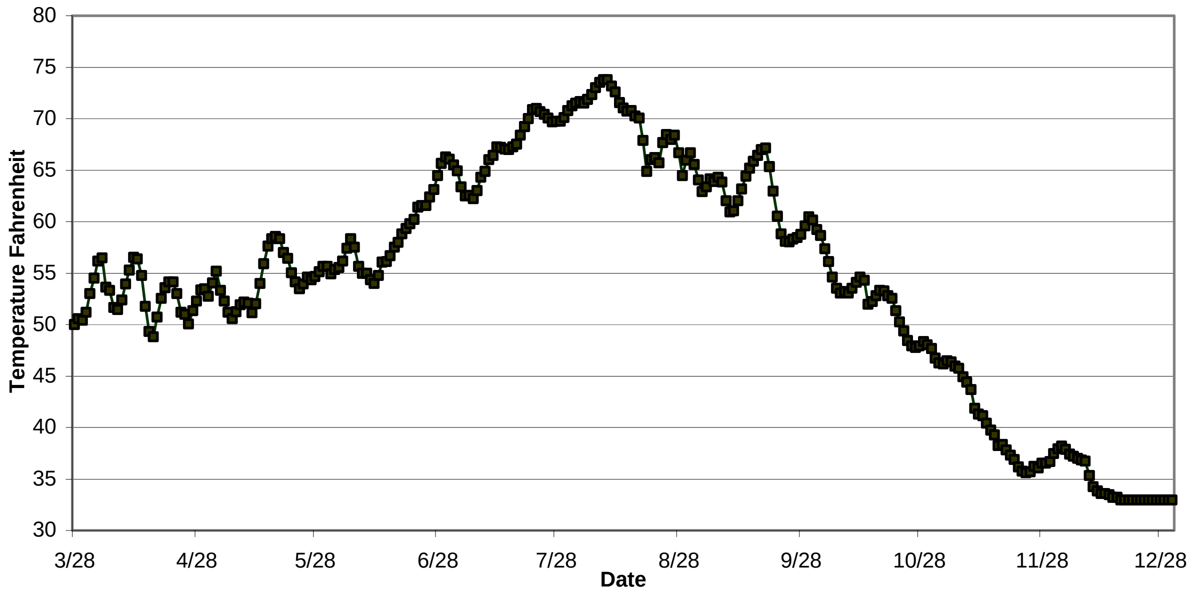

Figure 3-15. Daily Average Okanogan River Water Temperatures (degrees F) during 2000 at Malott, Washington.

3.2.1.2 Salmon Creek

Salmon Creek is on the State of Washington Department of Ecology 1996 and 1998 Clean Water Act Section 303(d) list for instream flow in the lower reach (the condition that the action alternatives would address). The 2002 list has not been finalized, but will probably not include any other analytes (Mark Peterschmidt, Department of Ecology, personal communication, 2003). Some reaches of the Okanogan River are listed for temperature, DO, pH, fecal coliform, and several pesticides. Immediately downstream from the confluence with Salmon Creek the Okanogan River is listed only for fecal coliform.[10] The river is not listed for any analytes immediately upstream from Salmon Creek.

Erosion and Sedimentation

The banks of lower Salmon Creek have significant stability problems and were surveyed and mapped in March 2003 to evaluate stability, erosion, and sedimentation issues. The survey began at Salmon Creek's confluence with the Okanogan River and extended approximately 1.8 miles upstream to the lower section of Watercress Springs, near the OID access road bridge crossing. Results and previous observations show that the lower 1.8 miles of Salmon Creek is generally very unstable with severe erosion, sedimentation and bank degradation or modification

[10] Fecal coliforms are not described in the EIS based on a decision not to include this analyte (impacts were not anticipated).

in multiple locations. These bank conditions can cause significant water quality problems and associated issues for fish and other aquatic life.

Although Salmon Creek generally has lower TSS concentrations than the Okanogan River, it is possible that bank erosion, particularly during storms and when flows are spilled or released from Conconully Reservoir, causes high levels of short-term suspended sediment and TSS concentrations in the creek. However, local observations during high flows have indicated that TSS is suprisingly low compared to the Okanogan River, even during these events. Temperatures can become elevated and DO reduced in some lower reaches due to the lack of riparian vegetation in some areas and the extremely low flows. These problems can contribute to other associated water quality problems, including loadings of total dissolved solids, metals, or nutrients potentially associated with bank materials, changes in pH, or increased algal and other plant growth.

The source material of lower Salmon Creek's valley floor and streambanks is formed from the Pogue-Cashmont-Cashmere association, which is described as a stony fine sandy loam material formed in Pleistocene glacial till and outwash terraces in elevations ranging from 700 to 1,500 feet. The vast majority of lower Salmon Creek's banks have a substrate composed of this unsorted glacial outwash with particle sizes typically dominated by boulder and cobble material, but also including a mixture of sand and gravel that often forms a matrix supporting the coarser material. Some reaches exhibiting prior flooding also contain a thin veneer of fine sand and silt/clay overbank deposits on top of the glacial outwash. Other than locations with the mantle of fine overbank deposits, layering of bank material is non-existent.

Channel incision (i.e., lowering of the bed through degradation) and eroding banks are prevalent throughout lower Salmon Creek, extending about 1.6 miles upstream from the Okanogan River. A knickpoint (i.e., an abrupt break in the longitudinal bed profile) in the channel at Watercress Springs marks the uppermost advance of the incision and bank instability. In general, banks along the lower 1.8 miles of Salmon Creek are at least 6 feet high, with many banks greater than 10 feet high. Most are more than 45 degrees, and many approach or exceed vertical slopes. Approximately 20 percent of the banks have sparse to no vegetation, a condition that is critical for resisting erosion.

The formation of Salmon Creek's banks can be classified into three categories. In the first category are banks that were formed by fluvial downcutting into the unsorted glacial outwash matrix. As a result, these banks have material ranging from fine sand to boulder. The height and steepness of these banks depends on the extent of downcutting. In several reaches where a floodplain used to be connected with the channel, accelerated downcutting has incised the channel and lowered the bed below the former floodplain elevation by about 4 feet. Consequently, banks have been oversteepened beyond the critical point at which gravitational forces are greater than the shear strength of the bank material, resulting in mass failure of material into the creek. High flows that once were released out onto the floodplain are now confined to the incised channel, concentrating fluvial energy and increasing the potential to erode banks. When high flows winnow away the sand and gravel material in the banks, the boulders and cobble lose their support structure and tumble to the bank toe. Much of the coarse material at the base of the bank is likely too coarse to be transported by Salmon Creek flows, so it remains in place and provides protection from further fluvial bank erosion by lower magnitude floods. However, some of this material has been transported downstream to the mouth of the creek under very high flow conditions where it has been deposited in an aggrading bar at the mouth of the creek. In addition, uprooting of vegetation and instability created by the collapse of the coarse material widens the channel and allows mass wasting of finer bank material into the channel for eventual transport downstream.

The second category includes bank types where about 10 percent of the banks are colluvial material (not stream-deposited alluvium) originating from Salmon Creek's valley side slopes. This colluvial material is also unsorted, with a substrate dominated by boulder and cobble, yet containing a larger percentage of loose sand than the banks formed in the valley floor outwash. Colluvial banks are at least 15 feet tall, but can extend for over 100 feet up valley side slopes. These steep and unvegetated banks are typically located on the outside of meander bends and likely contribute a substantial amount of fine sediment to Salmon Creek from sediment entrainment by high flows.

The third bank type is described as fill material, which for the most part is composed of glacial outwash material that has been mechanically pushed up to increase bank heights. Practically all of the banks along the section of channel that runs through the town of Okanogan have been altered to provide flood protection for homes and businesses that have encroached upon the channel. Filled banks are often fortified with concrete rubble or rock gabion in an attempt to reduce active erosion. The height of filled banks often exceeds 10 feet, and many are very steep and show evidence of recent sloughing of fine material into Salmon Creek.

Channel incision and bank erosion has been intensified by long-term alteration of the historic flow regime and riparian land uses. For most of the year, it is typical for all of Salmon Creek downstream of the OID diversion to have practically no flow other than seepage at Watercress Springs. During high runoff years, however, uncontrolled spills at the diversion dam send varying amounts of streamflow into lower Salmon Creek for short periods of time. These extremes in the flow regime of lower Salmon Creek have increased bank instability. Loss of a baseflow has reduced riparian vegetation, which in turn has lessened the ability of banks to resist erosion from the uncontrolled spills. Direct removal of riparian vegetation (primarily in the middle reach) for lumber, firewood, and rangeland improvement, as well as grazing, has further reduced bank stability and increased the amount of fine sediment eroded into the channel.

Water Temperatures

Water temperature data for Salmon Creek are limited to data collected in recent years by the Colville Confederated Tribes, including at the OID diversion dam and at an upper section. Average daily water temperature data for 2001 show values ranging from approximately 4 to 9 degrees C (40 to 48 degrees F) in March and November, to 18 to 19 degrees C (65 to 67 degrees F) in July and August (**Figure 3-16).** Temperatures are generally 1 to more than 10 degrees F higher at the diversion dam than at the upstream location, with the exception of during October and November when they are lower at the dam. Although it is not known if background conditions cause temperatures to exceed the standard of 18 degrees C (64 degrees F) in Salmon Creek, temperatures likely exceed this value in downstream, low-flow areas in summer. Data do not appear to be available in these areas in July or August.

Field water temperatures were also measured at multiple locations along the length of Salmon Creek during a reconnaissance survey on April 15, 2003. Temperatures ranged from 11.5 degrees C (53 degrees F) at the mouth to 6 degrees C (43 degrees F) in the North Fork at the diversion upstream of Conconully Lake. These temperatures were obtained over the course of

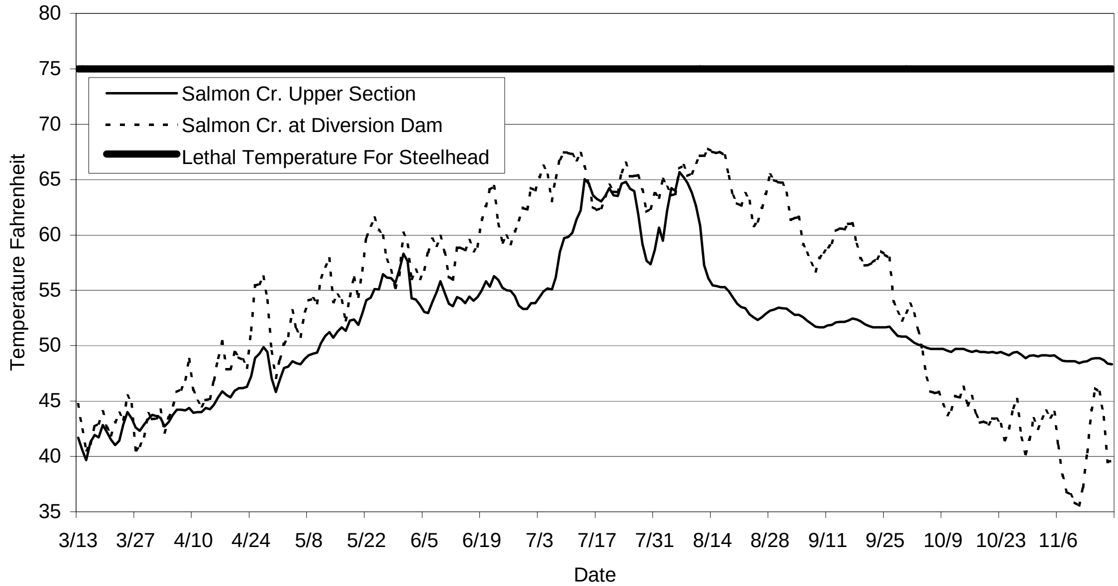

Figure 3-16. Daily Average Salmon Creek Water Temperatures (degrees F) within the Middle Reach during 2001.

the day in an upstream direction. These results indicate water cooler than in the Okanogan River, but with some warmer temperatures in the lower reaches near the mouth under low-flow conditions.

3.2.2 WATER QUALITY IMPACTS

3.2.2.1 Alternative 1: Okanogan River Pump Station and Pipeline

This alternative also would divert water from the Okanogan River by pumping water from the river to the OID main canal for irrigation and allow natural flows and release from the Conconully Reservoir to meet minimum stream flows for fish in Salmon Creek.

Okanogan River

Erosion and Sedimentation

Minor, short-term adverse water quality impacts associated with erosion and sedimentation would occur with this alternative. The pump station would be located up out of the channel and away from the river bank to avoid potential impact with stream meander, erosion, and sedimentation. The floor of the station would be placed above the elevation of the 100-year floodplain. The intake structures in the Okanogan River would be located over a deep hole on the inside bend of the river to minimize impacts and disturbance to the bed during both construction and operation. The bank would be shaped and protected from erosion by use of boulder and timber armoring and/or gabion baskets. Screens for the intake pipes would be placed in a part of the river channel with a relatively stable bed. Mat gabions would be secured under the screens to prevent streambed erosion.

The pipeline from the pump station to the OID main canal would not cross any major surface water features and no obvious stream crossings were observed during field reconnaissance. Only minor adverse erosion and sedimentation impacts associated with construction of the pipeline are expected due to the absence of water.

Mitigation for sediment would be required in the design and operation, because water pumped to the OID main diversion canal and used for agricultural irrigation would be taken from the Okanogan River, which has higher TSS concentrations than the OID's Salmon Creek source. The design includes a water filtration system to remove most solids, a sediment pond, and settling of solids within the canal itself. This design should assure that water with higher TSS from the Okanogan River would not impact irrigation activities. There would be no change in return flows or additional impacts from irrigation water entering either Salmon Creek or the Okanogan River.

Although there would be few adverse impacts from this alternative, short-term erosion and sedimentation impacts during construction of the pump station, intake structures, and the pipeline could occur. Best management practices (BMPs) would be used to reduce impacts of stormwater runoff and control sediment loads generated during construction of these structures. This would include ensuring that sediment generated from construction of the pump station and pipeline do not enter nearby waterways, and that river bank and bed disturbance and erosion during construction of the intakes would be minimized. Typical erosion control practices would include silt fences and diverting and retaining runoff in sediment ponds. The pipeline does not cross any significant waterways and construction BMPs would be used for the pipeline where necessary.

The provision of flows from Salmon Creek would have some small long-term benefits to the Okanogan River downstream from the confluence, when good quality Salmon Creek water (water with lower TSS concentrations) mixes with poorer Okanogan River water.

Water Temperature

Pumping from the Okanogan River could have small-scale long-term impacts on the river by decreasing flows and increasing the magnitudes of some water quality parameters, including increasing temperatures and decreasing DO. However, these impacts are expected to be minor given the small flow to be diverted relative to the flows in the river. Pumping from the Okanogan River will have minor long-term adverse effects on erosion and sedimentation in the river. Based on historical monthly flows in the Okanogan River, monthly distribution of pumping from the Shellrock Station, pumping 5100 AFY from the Okanogan River would divert no more than approximately 1 percent of the river's historical average flow in any given month. Effects would be greatest in August or September, when river flows are low and irrigation requirements are high (assuming the historical monthly distribution of pumping continues). Pumping from the Okanogan River would account for no more than approximately 3 percent of the river's tenth percentile low flow (i.e., 90 percent of the monthly flows for the given month exceed this flow) in August or September, based on the historical flows. Pumping volumes are small enough to cause insignificant changes in water quality, including erosion, sedimentation, TSS, water temperature, and DO, even during historically dry, low-flow years.

No adverse water temperature impacts are expected from construction or operation of the pump station, intakes, or pipeline from the station to the OID main canal.

Salmon Creek

Erosion and Sedimentation

Returning flows to Salmon Creek would have generally long-term positive effects on water quality in the creek. The water would be cooler, but the flow should not be high enough to entrain much sediment. Based on historical data and planned flow releases, Salmon Creek flows would be approximately two to five times the creek's historical monthly flow in August and September. Although it is possible that returning flows to the creek could cause increased erosion and sedimentation problems if the Rehabilitation Alternative is not implemented, the additional flows are expected to be too small to cause any significant problems. Although increased flows in Salmon Creek that would result from this alternative could increase bank erosion and stream sedimentation in the absence of mitigation, flows generally would be low enough that this would not be a problem.

Water Temperature

Returning water to lower Salmon Creek would be have long-term positive effects. Salmon Creek flows are expected to be approximately two to five times higher in August and September. This would decrease water temperatures and increase DO in the creek. It could also provide benefits to the Okanogan River downstream from the confluence. There could be some adverse effects on water temperature and DO in Salmon Creek if bank failure and channel widening continues and the water becomes shallower, with subsequent increases in temperature and DO. These impacts would partly depend on when and how the flows are added.

3.2.2.2 Alternative 1: Feeder Canal Upgrade

Erosion and Sedimentation

There could be minor short-term erosion and sedimentation impacts to surface waters during construction of this component. The canal does not cross any major streams or other surface water features. Construction activities could cause some localized erosion and sedimentation in the vicinity of the canal after construction and in the North Fork Salmon Creek at and immediately downstream from the headworks. Some adverse short-term effects on water quality, particularly suspended sediment and solids, could result. However, use of standard construction BMPs, including silt fences and sediment ponds for stormwater, would reduce these effects.

Water Temperature

There would be no significant water temperature impacts on surface waters from the feeder canal upgrade. The canal does not cross any major streams or other surface water features, and moving the water from an open canal to an enclosed pipeline is not anticipated to cause any detectable change in water temperature in Salmon Lake or the North Fork of Salmon Creek.

3.2.2.3 Alternative 1: Stream Rehabilitation

This component would include removing the gravel bar at the mouth of Salmon Creek to pass both fish and floodwaters.

Erosion and Sedimentation

The primary purpose of this component would be to provide better passage for fish migration. This component would, however, cause short-term erosion and sedimentation at the mouth of Salmon Creek and in the Okanogan River. Part of the creek channel would be altered with large earthmoving equipment, which would cause short-term localized erosion and sedimentation at the mouth of Salmon Creek and in the Okanogan River downstream from the confluence, particularly during higher flow and storm events. Within a few years as the streambanks stabilize, there would be a reduction in erosion and sedimentation. To reduce short-term impacts, construction activities would occur in the late summer or early fall under no-flow conditions and when fish are not migrating. These activities and impacts would require standard mitigation measures used in stream reconstruction programs. Any adverse impacts associated with stream rehabilitation construction would be minor, short-term, and minimized using BMPs.

Water Temperature

This component would have no impact on water temperature in Salmon Creek.

3.2.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

This alternative would include diverting water from the Okanogan River by pumping water from the Okanogan River to the OID main canal for irrigation. This would allow natural flows and release from the Conconully Reservoir to meet minimum stream flows for fish in Salmon Creek during critical periods when water is needed.

This alternative is not expected to have any important adverse impacts on erosion and sedimentation in either the Okanogan River or Salmon Creek. Construction of upstream and downstream wing walls would reduce the amount of sedimentation taken into pump sump. Raising the sill of the intake opening would reduce the amount of bedload sediment entering the intake, again reducing the amount of sediment entering the sump to be pumped through the irrigation delivery system.

Water quality in the Okanogan River downstream of the confluence with Salmon Creek would be improved under this alternative. Cleaner Salmon Creek water would be delivered to the Okanogan River downstream from where the sediment-laden Okanogan River water would be removed. The addition of water to Salmon Creek would generally have positive effects on water quality in the creek by increasing flows.

Although short-term minor impacts could occur during modification of the intake structures, these would be minimized using typical construction BMPs. Work would be accomplished during an irrigation season when plant operations are not needed and the maximum river water surface during construction is elevation 822.0 feet. Modifications to the plant would require that it be dewatered. An earthen cofferdam with a sheetpile cutoff wall would be needed to channel river flows away from the plant during construction. Once the area between the cofferdam and plant is dewatered, the sediment deposits both inside and upstream of the plant would be removed.

The pipeline from the pump station to the OID main canal would not cross any major surface water features and no obvious stream crossings have been identified. Only minor erosion and sedimentation impacts associated with construction of the pipeline are expected due to the absence of water.

Mitigation for sediment would be required in the design and operation, because water pumped to the OID main diversion canal and used for agricultural irrigation would be taken from the Okanogan River, which has higher TSS concentrations than the OID's Salmon Creek source. The design includes a water filtration system to remove most solids, a sediment basin built into a portion of the existing main canal, and settling of solids within the canal itself. Almost two miles of new 30-inch ductile pipeline would be needed to carry sediment-laden Okanogan river water from Shellrock pump station to the main canal where the sediment basin would be located. This design should assure that water with higher TSS from the Okanogan River would not impact irrigation activities. There would be no change in return flows or additional impacts from irrigation water entering either Salmon Creek or the Okanogan River.

Although there would be few adverse impacts from this alternative, short-term erosion and sedimentation impacts during installation of new pumps at the pump station, intake structures, the pipeline, and widening of the main canal for the sediment basin could occur. Best management practices (BMPs) would be used to reduce impacts of stormwater runoff and control sediment loads generated during construction of these structures. This would include ensuring that sediment generated from construction of the pipeline and sediment basin does not enter nearby waterways, and that river bank and bed disturbance and erosion during construction of the intakes would be minimized. Typical erosion control practices would include silt fences and diverting and retaining runoff in sediment ponds. The pipeline does not cross any significant waterways and construction BMPs would be used for the pipeline where necessary.

Impacts would be similar to those described for Alternative 1 but with a lower pumping volume, any effects would be muted as compared to the new pump alternative.

3.2.2.5 Alternative 2: Feeder Canal Upgrade

The water quality impact would be the same as described in **Section 3.2.2.2**.

3.2.2.6 Alternative 2: Stream Rehabilitation

This component includes reconstructing a stable channel and other rehabilitation in the lower reach to pass both fish and floodwaters.

Erosion and Sedimentation

The primary purpose of this component is to provide better passage and habitat for fish migration, however stream rehabilitation measures would reduce erosion and sedimentation in the long term. This component would, however, cause short-term erosion and sedimentation within Salmon Creek and the Okanogan River. Parts of the creek would be diverted and channel banks, bed, and floodplain areas would be altered with large earthmoving equipment. These activities would cause short-term localized erosion and sedimentation in the lower reaches of Salmon Creek and in the Okanogan River downstream from the confluence, particularly during higher flow and storm events. Within a few years as the banks stabilize, there would be a reduction in erosion and sedimentation. Establishment of riparian habitat improvements and natural channel design would reduce loadings of sediment and suspended sediment/solids concentrations during high flow events/storms. To reduce short-term impacts, construction activities would occur in the late summer or early fall dry season. These activities and impacts would require standard mitigation measures used in stream reconstruction programs. Any adverse impacts associated with stream rehabilitation construction would be minor, short-term, and minimized using BMPs.

Any improvements in water quality that occur in Salmon Creek, would contribute to improved water quality in the Okanogan River below its confluence with Salmon Creek.

Water Temperature

This component would contribute towards lowering water temperatures in Salmon Creek. Riparian plantings would provide shade to help cool water temperatures, although it will take several years for riparian vegetation to become established and contribute towards shading so the beneficial effects would not be noticeable for 5-10 years. Modeling studies in the Entiat River Watershed on the eastern slope of the Cascades showed that increasing riparian planting and associated shade by 50 percent had much greater effects on reducing water temperatures than increasing flows by 10 percent. Although this may also be true for Salmon Creek, flows may be increased by significantly higher percentages in the downstream reach as part of the Action Alternatives, resulting in more pronounced temperature reductions. A channel design that increases water depths and velocities and other instream physical habitat features will also help to reduce temperatures and increase DO. These channel changes (and the addition of flow) generally may not decrease water temperatures and increase DO to the extent that riparian planting and associated shade does, but when used in combination these methods all help to improve water quality.

3.2.2.7 Alternative 3: Water Rights Purchase

No new pump infrastructure for pumping is proposed with this alternative. This alternative would not have any adverse affect on the Okanogan River and would have less impact to Salmon Creek than the other water supply alternatives because there is no stream rehabilitation associated with this alternative. There would be a potential beneficial effect of lower water temperatures in the Okanogan River downstream from its confluence with Salmon Creek. No adverse impacts on erosion and sedimentation are anticipated. Irrigation return flows would be reduced proportionally, potentially improving water quality in the waterways. Addition of water to Salmon Creek through water rights purchase would generally have long-term positive effects on water quality in the creek by increasing flows. Although additional and higher flows in the creek could cause increased erosion and sedimentation problems if stream rehabilitation is not implemented, flows generally would be low enough that this would not be a problem.

3.2.2.8 Alternative 3: Feeder Canal Upgrade

The environmental impact would be the same as described in **Section 3.2.2.2**.

3.2.2.9 No Action Alternative

Long-term erosion, sedimentation, and water temperature impacts created by existing conditions could continue and worsen under the No Action Alternative.

Erosion and Sedimentation

Under the No Action Alternative if no preventative measures are taken to control channel incision on Salmon Creek, it is plausible that ultimately the streambanks downstream of the knickpoint in Watercress Springs that are in the early stages of incision and bank erosion would resemble the highly unstable and eroding banks of those farther downstream. The banks would be taller, steeper, have less vegetation, and slough fine material into the channel. Channel incision, and subsequently, bank erosion, would most likely continue to propagate upstream. How much farther upstream and at what rate is not certain. A longitudinal bed profile of Salmon Creek shows a distinct breakpoint and reduction in slope upstream of Watercress Springs (about 2.75 miles upstream of the Okanogan River). The presence of the springs and the break in slope suggest that bedrock underlying the channel may be acting as a grade control on slope at that location. If a natural bedrock grade control does exist there, it may resist channel incision and halt further knickpoint propagation.

For reaches at a more advanced stage of incision (downstream of Watercress Springs), further channel degradation would predominantly come in the form of bank erosion and channel widening rather than additional bed downcutting. The channel bed in lower Salmon Creek is composed predominantly of coarse cobble and boulder, with very little sand and gravel on the surface. As Salmon Creek downcut through the glacial outwash and eventually became incised, fine material available for transport was washed downstream, leaving behind a channel lag deposit composed of material too coarse to be transported by most flood flows. However, some of this material has been transported and deposited at the mouth under very high flow conditions. Although fine material likely exists beneath the surface, it is shielded from fluvial erosion by the coarse lag deposit on the surface. Because the bed material is so coarse and practically immobile at most flows, future channel erosion in already incised sections of channel would continue to come in the form of bank erosion and retreat rather than additional downcutting of the bed. High flows would continue to entrain fine sediment that would cause coarse material to collapse to the bank toe and vegetation to be uprooted. The use of rip-rap and rock gabions to strengthen banks would continue to be necessary in an attempt to limit bank erosion.

Water Temperature

Elevated water temperatures in the Okanogan River, both upstream and downstream from the Salmon Creek confluence would also continue under the No Action Alternative.

Under the No Action Alternative temperatures would continue to be elevated in the lower reach of Salmon Creek when water is present. These elevated temperatures may worsen as the stream continues to degrade. Continued bank erosion may cause additional channel widening, loss of riparian habitat/vegetation and shading, leading to higher temperatures where this occurs. Additional sedimentation and aggradation also may lead to shallower flow depths leading to higher temperatures when water is present.

3.2.3 MITIGATION MEASURES

3.2.3.1 Erosion and Sedimentation

For Alternatives 1 and 2, because water with higher TSS concentrations from the Okanogan River would be pumped to the diversion canal and used for agricultural irrigation, a water filtration system, including a sediment pond, would be installed to remove most solids. Many mitigation measures have been incorporated into the design of the pump houses, intake structures, pipelines, and erosion control devices and are described above. The only other mitigation measures required would primarily consist of standard BMPs during construction activities.

Short–term impacts from construction of the rehabilitation in Salmon Creek would require several mitigation measures. Construction work would only occur when the streambed is dry. Channel banks, bed, and riparian/floodplain areas would be altered with large earthmoving equipment while the stream is dewatered. Mitigation measures would include the following:

- delineating and preparing appropriate work zones, including staging and access areas
- proper siting of equipment, and chemical storage areas away from surface waters
- minimizing slope disturbance from roads
- ensuring that storm water runoff from roads drains to outlets
- physical screening of areas to remain undisturbed
- installing erosion and sediment control measures during site preparation
- using silt fences, straw bales, sediment ponds

- minimizing crossing the stream and use of bridges as much as possible
- avoiding sensitive wetland and riparian areas
- inspecting construction site during or immediately after a rain event
- stockpiling additional erosion and sediment control equipment
- steam-cleaning of vehicles and equipment offsite regularly
- checking vehicles for oil, grease, gas, hydraulic fluid, and anti-freeze leaks and repair, as necessary
- using adequate slopes, bank stabilization, and revegetation methods to minimize erosion

3.2.3.2 Water Temperature

Mitigation measures to minimize any short-term impacts would include those discussed above for erosion and sedimentation. All of these measures can also help to minimize adverse impacts on water temperature.

3.2.4 UNAVOIDABLE ADVERSE IMPACTS

3.2.4.1 Erosion and Sedimentation

There are no unavoidable adverse impacts associated with the action alternatives. There may be unavoidable adverse long-term impacts to water quality associated with the No Action Alternative. These long-term impacts include continued incision and bank instability and erosion in downstream reaches of Salmon Creek, as well as farther upstream (possibly to the knickpoint[11] at Watercress Springs) over time. Lack of action would contribute to increases in TSS, as well as increases in water temperature and decreases in DO. The use of rip-rap and rock gabions to strengthen banks would continue to be necessary in an attempt to limit bank erosion.

3.2.4.2 Water Temperature

There are no unavoidable adverse impacts on water temperature associated with the action alternatives. There could be, however, unavoidable adverse impacts associated with the No Action Alternative. These include potential increases in water temperature in Salmon Creek and the Okanogan River due to activities in the watershed, and alteration of the riparian zone, including floodplain encroachment and removal of vegetation, particularly in Salmon Creek. The small flows and significant bank erosion and sedimentation problems in Salmon Creek are expected to continue to cause channel widening, shallower flows, and higher water temperatures.

[11] A knickpoint is a located at that point along the longitudinal profile of a stream at which slope changes. Typically, the term is used where the change in slope is migrating upstream. The location of a knickpoint may be controlled by bedrock. Significant erosion typically occurs below a knickpoint, as it migrates upstream.

3.3 WETLANDS AND VEGETATION

3.3.1 EXISTING CONDITIONS

The Salmon Creek watershed and the vicinity of its confluence with the Okanogan River are located in the Okanogan Highlands Physiographic Province, as described by Franklin and Dyrness (1973). The watershed exhibits a varied topography, including forested hills, stream corridors with riparian and wetland vegetation; upland valley areas with pastures and orchards, cheatgrass grasslands, native shrublands; and urban development. The following paragraphs describe the location of general vegetation types within the Project area. The vegetation types are described in more detail in the section on Vegetation Communities that follows.

Conconully Reservoir, at the upstream end of the Project, is surrounded by ponderosa pine (*Pinus ponderosa*) forest. Douglas fir forest, with ponderosa pine as a co-dominant, covers the upper reaches of the Salmon Creek watershed below Conconully Reservoir, and is also found above the shrub zone on the southwest side of Salmon Creek. In the lower elevations of the Okanogan watershed in the Project area, ponderosa pine dominates where the annual precipitation is 14 to 16 inches. Douglas-fir (*Pseudotsuga menziesii*) is dominant in areas where the annual precipitation is 16 to 18 inches (NRCS, 1980).

Salmon Creek from Conconully dam to the OID diversion is a perennial stream bordered by a band of riparian vegetation, except where the vegetation has been removed for agricultural purposes. Downstream of the OID diversion, riparian vegetation is patchier in distribution and is completely lacking in some areas, particularly Segment III (See **Figure 2-7**). Between the OID diversion and the bluff above the Okanogan River, vegetation along the proposed pipeline route consists of an intermingling of agricultural uses and sagebrush/grass communities. Before reaching the Okanogan River, the proposed pipeline route crosses an urban area and ends in the riparian belt bordering the river. The riparian vegetation along the Okanogan River at this point consists of black cottonwood and white alder trees.

3.3.1.1 Vegetation Communities

Ponderosa Pine

Ponderosa pine forest (*Pinus ponderosa*) is widely distributed in eastern Washington (Franklin and Dyrness, 1973). This community occupies drier sites than any other forest type except western juniper (*Juniperus occidentalis*). Co-dominant tree species could include western juniper, quaking aspen (*Populus tremuloides*), Douglas-fir, and Oregon oak (*Quercus garryana*). Ponderosa pine forests are usually relatively open. Understory species could include white snowberry (*Symphoricarpos albus*), shiny-leaf spirea (*Spiraea betulifolia* var. *lucida*), interior rose (*Rosa woodsii*), and Nootka rose (*Rosa nutkeana*).

Douglas Fir Forest

Douglas fir forest is dominated by varying combinations of Douglas fir (*Pseudotsuga menziesii*), ponderosa pine, lodgepole pine, and tamarack (*Larix occidentalis*) (Franklin and Dyrness, 1973).

Understory species could include white snowberry, shiny-leaf spirea, interior rose, and Nootka rose, or any of several grasses such as Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Agropyron spicatum*), or needle & thread grass (*Hesperostipa comata*).

Three-tip Sage -- Idaho Fescue

The three-tip sage--Idaho fescue community is a shrub-steppe type consisting of a mosaic of shrubs (mostly three-tip sagebrush) and grasses (Franklin and Dyrness, 1973). Pre-European grasses were primarily bunchgrasses, including Idaho fescue, bluebunch wheatgrass, and Sandberg's bluegrass (*Poa sandbergii*). Native bunchgrasses have mostly been replaced, however, by non-native grasses, particularly cheatgrass. This community occurs within Salmon Creek watershed as far upstream as Conconully Reservoir, where urban and agricultural uses have not altered the landscape.

Big Sagebrush --Bluebunch Wheatgrass

The big sagebrush--bluebunch wheatgrass community is a medium-tall shrubland dominated by big sagebrush, with a grassland understory (Franklin and Dyrness, 1973). Pre-European grasses were primarily bunchgrasses, particularly bluebunch wheatgrass. Native bunchgrasses have mostly been replaced by non-native grasses, particularly cheatgrass. Big sagebrush--bluebunch wheatgrass stands are found along the Okanogan River valley and could occur in the lower reaches of the Salmon Creek watershed where urban and agricultural uses have not altered the landscape.

Steppe and Non-Native Grassland

Steppe communities in eastern Washington include those dominated by bluebunch wheatgrass, Idaho fescue, needle & thread grass, and other native grassland species. However, in disturbed areas and abandoned farmland, the non-native cheatgrass (*Bromus tectorum*) often becomes the permanent vegetation. Grasslands of this type, intergrading with shrub-steppe vegetation, are found along the lower reaches of Salmon Creek where riparian vegetation is absent in Segments III and IV (**Figure 2-7, 2-8)**, as well as along parts of the Okanogan River water exchange pipeline route.

Riparian

Where woody riparian vegetation is present along lower Salmon Creek, it is dominated by willow species (*Salix* spp,) or a mosaic of willow and black cottonwood. Farther upstream, white alder can also be dominant. This community also includes forested wetland areas mapped by the National Wetland Inventory along Salmon Creek (NWI, 2003). At the proposed new pump station location on the Okanogan River, the vegetation consists of black cottonwood and white alder trees. At the existing Shellrock pump station on the Okanogan River, the vegetation consists of willow and white alder.

Freshwater Marsh

The freshwater marsh (Palustrine Emergent Wetland) community may be dominated by a variety of herbaceous species, depending on substrate and water depth. Common plants in shallow standing water conditions include cattail (*Typha latifolia*), several bulrush species (*Scirpus* spp.), and burred (*Sparganium* spp.). In the drier reaches, where the surface may dry out but subsurface is persistently wet, numerous sedges (*Carex* spp.) and rushes (*Juncus* spp.) dominate. Spikerush, (*Eleocharis* spp.) also can be an important component in this seasonal flooded margin. Grasses that are commonly associated with this community include, tufted hair grass (*Deschampsia caespitosa*), bluejoint reedgrass (*Calamagrostis canadensis*), and reed canary grass (*Phalaris arundinacea*). In the Project area, this vegetation is best developed at Watercress Springs and at scattered locations along Salmon Creek.

Agricultural Types

Agricultural areas within the Project vicinity include pastures along Salmon Creek and apple orchards along the pipeline route for the Okanogan River water exchange alternative.

Urban

Vegetation in urban areas consists primarily of landscape species, usually non-natives. Non-landscape species present include non-native invasive species, such as Russian thistle (*Salsola iberica*) and knapweeds (*Centaurea* spp.).

3.3.1.2 Wetland Communities

The National Wetland Inventory (NWI) has mapped a variety of wetland habitats in the Project area. These include the open water areas of Conconully Lake and Conconully Reservoir, freshwater marshes with varying degrees of inundation along Salmon Creek, forested wetlands on Salmon Creek upstream of the OID diversion, and the channels of Salmon Creek and the Okanogan River (NWI, 2003; Cowardin et al., 1979).

3.3.1.3 Special Status Plant Species

Twenty-six special status plant species are reported from the Salmon Creek watershed and vicinity. One species, crenulate moonwort (*Botrychium crenulatum*), is a federal species of concern and a state sensitive species (WDNR2003c). Two species, sparse-leafed sedge (*Carex tenuiflora*) and nagoonberry (*Rubus acaulis*) are state-listed as threatened. Nineteen species are state sensitive species, including tall agoseris (*Agoseris elata*), northern bentgrass (*A. borealis*), crenulate moonwort (*Botrychium crenulatum*), hair-like sedge (*Carex capillaris*), narrow-leafed sedge (*C. eleocharis*), poor sedge, (*C. magellanica* ssp. *irrigua*), Scandinavian sedge (*C. norvegica*), Canadian single-spike sedge (*C. scirpoidea* var. *scirpoidea*), many-headed sedge (*C. sychnocephala*), valley sedge (*C. vallicola*), Snake River cryptantha (*Cryptantha spiculifera*), slender crazyweed (*Oxytropis campestris* var. *gracilis*), Kotzebue's grass-of-parnassus (*Parnassia kotzebuei*), snow cinquefoil (*Potentilla nivea*), glaucous willow (*Salix glauca*), Tweedy's willow (*Salix tweedyi*), nodding saxifrage (*Saxifraga cernua*), pygmy saxifrage (*S.*

rivularis), and blue-eyed grass (*Sisyrinchium septentrionale*). Four species are state review species, including blackened sedge (*Carex atrosquama*), different nerve sedge (*Carex heteroneura*), white-scaled sedge (*Carex xerantica*), and Gray's bluegrass (*Poa arctica* ssp. *arctica*). Phenology and habitat information for these species are provided in **Table 3-18**. Crenulate moonwort and the state-listed species are described in more detail below.

Table 3-18. Special-Status Plant Species Potentially Occurring in the Salmon Creek Project Area.

Common Name Scientific Name	Status[a]	Growth Form	Flowering Period[b]	Potential to Occur
Tall agoseris *Agoseris elata*	WS	Perennial herb	Jun-Aug	Meadows, open woods, and exposed rocky ridge tops on various slope aspects, from low elevations to timberline; in areas with little to no canopy cover. Elevations from (500) 2900 to 7800 feet. Reported from high-elevation locations in or adjacent to the Salmon Creek watershed. May occur in the Project area.
Northern bentgrass *Agrostis borealis*	WS	Perennial herb		Moist, arctic-alpine areas. Reported from a high-elevation location in or adjacent to the Salmon Creek watershed. Unlikely to occur in the Project area.
Crenulate moonwort *Botrychium crenulatum*	FSC, WS	Fern	N/A	Reported from locations in the Douglas fir forests upslope of the ponderosa pine forests adjacent to Conconully Reservoir. May occur in the Project area.
Blackened sedge *Carex atrosquama*	WR2	Perennial herb		Mountain meadows. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Hair-like sedge *Carex capillaris*	WS	Perennial herb	Jun-Aug	Streambanks, wet meadows, wet ledges, and marshy lake shores. Elevation ranges from 2800 to 6500 feet. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Narrow-leafed sedge *Carex eleocharis*	WS	Perennial herb		Reported from the vicinity of Conconully Reservoir. Likely to occur in the Project area.
Different nerve sedge *Carex heteroneura*	WR2	Perennial herb		In the Project vicinity, this species has been reported from several high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Poor sedge *Carex magellanica* Ssp. *Irrigua*	WS	Perennial herb		In the Project vicinity, this species has been reported from 2 high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Scandinavian sedge *Carex norvegica*	WS	Perennial herb	Fruit in Aug	Moist alpine turf or montane grasslands. Elevation 7500- 11516 feet. In the Project vicinity, this species has been reported from high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.

Table 3-18. Special-Status Plant Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name Scientific Name	Status[a]	Growth Form	Flowering Period[b]	Potential to Occur
Canadian single-spike Sedge *Carex scirpoidea* var. *scirpoidea*	WS	Perennial herb	Jun-Aug	Occurs in open, sunny sites, often at the edge of wet meadows, on calcareous substrates. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Many-headed sedge *Carex sychnocephala*	WS	Perennial herb	Jun-Aug	Moist or wet ground adjacent to marshes or along lake shores, sometimes somewhat alkaline. Substrates vary from rather rocky to sandy and silty soils. Elevation ranges from 1000 to 3000 feet. Reported from the vicinity of Conconully Reservoir. Likely to occur in the Project area.
Sparse-leafed sedge *Carex tenuiflora*	WT	Perennial herb	(fl) Jul -Aug (seeds)	Bogs, fens, swamps, wet grassy areas, occasionally in seepage areas in forests. In the Project vicinity, this species has been reported from a single, high-elevation location in or adjacent to the Salmon Creek watershed. May occur in the Project area.
Valley sedge *Carex vallicola*	WS	Perennial herb		In the Project vicinity, this species has been reported from the tributaries of Salmon Creek upstream of Conconully Reservoir. May occur in the Project area.
White-scaled sedge *Carex xerantica*	WR2	Perennial herb	Fruits mature in summer	Grasslands, open slopes, and mountain parks from high plains to subalpine elevations. In the Project vicinity, this species has been reported from the tributaries of Salmon Creek upstream of Conconully Reservoir. May occur in the Project area.
Snake River cryptantha *Cryptantha spiculifera*	WS	Perennial herb	May-Jul	Dry, open, flat or sloping areas in stable or stony soils; where overall cover of vegetation is relatively low. In the Project vicinity, this species has been reported from Pine Creek and the Okanogan valley north of Salmon Creek. May occur in the Project area.
Slender crazyweed *Oxytropis campestris* Var. *gracilis*	WS	Perennial herb	May-Jun	Montane and sub-montane. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Kotzebue's grass-of-parnassus *Parnassia kotzebuei*	WS	Perennial herb		Low arctic, or alpine; in damp depressions such as lakeshores and snow patch areas. In the Project vicinity, this species has been reported from one high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Gray's bluegrass *Poa arctica* ssp. *Arctica*	WR2	Perennial herb		Alpine to subalpine. In the Project vicinity, this species has been reported from high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.

Table 3-18. Special-Status Plant Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name Scientific Name	Status[a]	Growth Form	Flowering Period[b]	Potential to Occur
Snow cinquefoil *Potentilla nivea*	WS	Perennial herb		Arctic-alpine. In the Project vicinity, this species has been reported from high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Nagoonberry *Rubus acaulis*	WT	Perennial herb	mid-Jun-Jul	Montane meadows, and bogs or woods to alpine tundra. Elevation 7000-9000 feet. In the Project vicinity, this species has been reported from a single, high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Glaucous willow *Salix glauca*	WS	Shrub	Jun-Jul	Moist open places to open slopes, mid-montane to above timberline. In the Project vicinity, this species has been reported from a single high-elevation location in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Tweedy's willow *Salix tweedyi*	WS	Shrub	ID Jun-Jul	Streambanks, moist meadows, seeps, and bogs at moderate to fairly high elevations in the mountains. Elevation 5200 to 7200 feet. In the Project vicinity, this species has been reported from high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Nodding saxifrage *Saxifraga cernua*	WS	Perennial herb	Jul-Aug; reproduces via bulblets	Streambanks, moist rocks, and glacial detritus. Circumboreal in alpine zones. In the Project vicinity, this species has been reported from two high-elevation locations in or adjacent to the Salmon Creek watershed. Not likely to occur in the Project area.
Pygmy saxifrage Saxifraga rivularis	WS	Perennial herb	Jul-Aug	Moist locations, in boreal zones. In the Project vicinity, this species has been reported from high-elevation locations in the Salmon Creek watershed. Not likely to occur in the Project area.
Blue-eyed grass *Sisyrinchium septentrionale*	WS	Perennial herb	May-mid-Jul	Occurs primarily in open wet meadows, sometimes in association with perennial streams and sometimes within a mosaic that includes forested wetlands. Elevation 2100 to 6100 feet. Reported from one location near the northeast side of the Salmon Creek watershed. May occur in the Project area.

[a]: Codes are as follows:
FSC federal Species of Concern (an unofficial status)
WE state listed as endangered
WT state listed as threatened
WS Washington sensitive species
WR2 Washington review species - R2 taxa have unresolved taxonomic questions.
Sources: WDNR 2000, WDNR 2003b, Hitchcock and Cronquist 1973, IDFG 2003, McJannet et al. 1997, Newsholme 1992, WYNDD 2002
[b]: Or other cited periods when positive identification is possible.

Crenulate Moonwort

This perennial fern develops a single shoot divided into two morphologically different fertile and sterile fronds, four inches tall or less. Plants emerge in mid- to late spring. Spores are released in summer and early fall. This species is found in moist meadows, creek banks, shrub- or tree-dominated wetlands, springy spots, and wet roadside areas. In the Salmon Creek watershed, crenulate moonwort is reported from the Douglas-fir forest that occupies the slopes above the ponderosa pine forest that surrounds Conconully Reservoir (WDNR, 2003c). This species could potentially occur in the Project area.

Sparse-leafed Sedge

Sparse-leafed sedge (*Carex tenuiflora*) is state-listed as threatened (WDNR 2003b). This sedge is a perennial herb that flowers in July and produces seeds in August. This species is found in bogs, fens, swamps, wet grassy areas, and occasionally in seepage areas in forests (WDNR, 2000). In the Project vicinity, this species has been reported from a single, high-elevation location in or adjacent to the Salmon Creek watershed (WDNR, 2003c). Sparse-leafed sedge could potentially occur in the Project area.

Nagoonberry

Nagoonberry (*Rubus acaulis*) is state-listed as threatened (WDNR, 2003b). This species is a perennial herb that flowers from mid June through July (WYNDD, 2002). Nagoonberry is found in montane meadows, and bogs or woods up to alpine tundra (Hitchcock, 1973). In the Project vicinity, this species has been reported from a single, high-elevation location in or adjacent to the Salmon Creek watershed (WDNR, 2003c). Nagoonberry is not likely to occur in the Project area.

3.3.2 WETLAND AND VEGETATION IMPACTS

3.3.2.1 Alternative 1: Okanogan River Pump Station and Pipeline

Construction of the new pump station would result in the loss of riparian vegetation, primarily white alder and cottonwood, at the proposed site. Implementation of this alternative would result in the return of flow in lower Salmon Creek. The change in flow regime resulting from the implementation of this alternative would provide beneficial conditions in which riparian vegetation typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian vegetation currently exists and would improve conditions for existing riparian vegetation. Because of the relatively small area needed for the station (less than one acre), and the possible enhancement of riparian vegetation on lower Salmon Creek resulting from flow releases under this alternative, the loss at the site is expected to be minor.

Construction of the pipeline would result in temporary loss of upland vegetation, primarily cheatgrass grassland, in Omak and in an abandoned orchard near the main canal. This impact is expected to be minor.

Construction of the water filtration system and sediment pond would result in the permanent loss of upland shrub-steppe vegetation near Diversion 2. This impact is expected to be minor.

Implementation of Alternative 1 would result in minor impacts to vegetation and wetland habitat during construction. This alternative would return flow to the lower portion of Salmon Creek during periods when it is currently dry. The change in flow regime would provide beneficial conditions in which riparian vegetation typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian vegetation currently exists and would improve conditions for existing riparian vegetation.

3.3.2.2 Alternative 1: Feeder Canal Upgrade

Implementation of the feeder canal upgrade would result in temporary disturbance of vegetation along the canal route during removal and upgrade of the existing canal and during installation of the proposed pipeline. The portion of the feeder canal that is removed and replaced by a pipeline would likely be maintained in an early seral stage to permit access for maintenance purposes and to prevent damage to the buried pipeline from tree roots. Neither installation nor maintenance of the pipeline is expected to result in significant impacts to wetland or other vegetation communities in the section of pipeline that would be installed in the existing canal. Direct impacts to sensitive species that occur in wetland or riparian areas could result from this alternative, particularly where work is conducted at the headworks and at the diversion from the North Fork. Elimination of water leakage from the canal may cause areas below the canal fed by the leaks to dry up. Implementation of the mitigation measures provided in **Section 3.3.3** would reduce potential adverse impacts from construction to a low level.

Operation of the upgraded feeder canal would potentially decrease streamflow for the short reach of North Fork Salmon Creek between the OID feeder canal intake and the upstream end of Conconully Reservoir. Operation of the upgraded feeder canal during moderate and high flow events would reduce the potential for overbank flow and inundation of riparian areas within the stream reach between the OID feeder canal intake and the upstream end of Conconully Reservoir. This stream reach is short, and these potential impacts are considered to be minor.

3.3.2.3 Alternative 1: Stream Rehabilitation

Construction would result in temporary impacts to riparian vegetation at the mouth of Salmon Creek. Direct impacts to special status species that occur in wetland or riparian areas could result from this alternative. Implementation of the mitigation measures provided in **Section 3.3.6** would reduce potential adverse construction impacts to a minor level, and these impacts would be off-set by the long-term improvement in riparian conditions.

3.3.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

Construction that would be needed at the Shellrock pump station may impact existing riparian vegetation at the construction site, particularly in the areas where the wing walls will be constructed. This potential adverse impact would be limited to less than one acre and is expected to be minor. Implementation of Alternative 2 would result in the return of flow in lower Salmon Creek. The change in flow regime resulting from the implementation of this alternative would provide beneficial conditions in which riparian vegetation typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian vegetation currently exists and would improve conditions for existing riparian vegetation. Potential adverse impacts would be offset by the possible enhancement in riparian conditions on lower Salmon Creek due to increased flow releases for fish.

Construction of the pipeline would result in temporary loss of upland vegetation near Omak. There are no wetlands inventoried in the location of the pipeline route, however the route passes through two draws that are mapped as wet areas on Okanogan County maps. The location of the pipeline follows an existing unsurfaced road for part of its length through established orchards. Total impact to vegetation is expected to be minor.

Installation of the sediment basin in the main canal to clean sediment from Okanogan River water before it is delivered to irrigation would result in some temporary impact to upland vegetation around the main canal where construction would take place. This impact would be minor due to a small amount of area impacted. See **Section 3.4.2.6** for impacts related to implementing stream rehabilitation in conjunction with this alternative.

3.3.2.5 Alternative 2: Feeder Canal Upgrade

Wetland and vegetation impacts would be the same as described in **Section 3.3.2.2**.

3.3.2.6 Alternative 2: Stream Rehabilitation

Construction may result in temporary impacts to riparian vegetation. This alternative would result in the long-term enhancement of riparian vegetation in much of lower Salmon Creek. Direct impacts to special status species that occur in wetland or riparian areas could result from this alternative. Implementation of the mitigation measures provided in **Section 3.3.3** would reduce potential adverse construction impacts to a minor level, and these impacts would be offset by the long-term improvement in riparian conditions. Portions of the lower reach of Salmon Creek that are modified for channel rehabilitation may experience minor increases in overbank flows and inundation of adjacent, recontoured flood plains. However, these areas would be limited to reaches that have suitable valley width to allow floodplain recontouring. Increased overbank flows may benefit the establishment of riparian and wetland vegetation in this reach.

3.3.2.7 Alternative 3: Water Right Purchase

Implementation of Alternative 3 would result in the return of flow in lower Salmon Creek. The change in flow regime resulting from the implementation of this alternative would provide beneficial conditions in which riparian vegetation typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian vegetation currently exists and would improve conditions for existing riparian vegetation.

3.3.2.8 Alternative 3: Feeder Canal Upgrade

Wetland and vegetation impacts would be the same as described in **Section 3.3.2.2**.

3.3.2.9 Alternative 3: Stream Rehabilitation

There would be no stream rehabilitation or associated impacts with this alternative.

3.3.2.10 No Action Alternative

Under the No Action alternative, stream incision and bank erosion downstream of Watercress Springs is likely to continue. Slightly increased flows from conservation measures, if they occur at all, are unlikely to affect riparian vegetation. Uncontrolled bank erosion would continue to reduce the extent of riparian vegetation along lower Salmon Creek, or result in a change in species composition. Installing bank protection could result in a change in species composition of the riparian vegetation.

3.3.3 MITIGATION MEASURES

3.3.3.1 Wetland Avoidance

A wetland delineation would be conducted prior to construction of the water supply alternatives or the stream rehabilitation component. Wetland boundaries outside the construction footprint would be flagged and fenced off to avoid impacts from construction equipment.

3.3.3.2 Rare Plant Avoidance

Prior to any construction activities with any Project components, special-status plant surveys would be conducted to locate any plant populations within the construction corridors. These surveys would be conducted in the summer when the plants are readily identifiable. Areas within the construction corridor containing special-status plant species, if found, would be fenced off so that construction equipment could avoid impacts to such species to the extent compatible with Project goals.

3.3.3.3 Sediment Control

Sediment and pollution control measures would be implemented during construction activities associated with action alternatives. To ensure no transport of disturbed materials from upland sites into waterways, straw bales and silt fences would be placed downslope from upland grading locations prior to construction. BMPs for stream channel construction, as specified in **Section 3.2.3,** would be implemented during stream rehabilitation to minimize impacts to riparian vegetation.

3.3.3.4 Avoidance of Important Habitats and Habitat Features

Construction would avoid removal of important habitat features such as large trees or other perching areas and nesting habitats, where possible. To minimize impacts to important habitats, construction equipment and staging areas would be located to avoid impacts to wetland buffer areas and large, well-established vegetation, as well as to avoid priority habitats such as wetlands, riparian areas, shrub-steppe, and native grasslands.

3.3.4 UNAVOIDABLE ADVERSE IMPACTS

No unavoidable adverse impacts to wetland or vegetation resources are expected to occur from implementation of any of the alternatives other than the No Action alternative. Continued channel degradation is expected to occur under the No Action alternative, which would result in loss of riparian vegetation.

3.4 WILDLIFE

3.4.1 EXISTING CONDITIONS

The Project vicinity contains nine vegetation communities and their associated wildlife habitats, which support a diversity of wildlife. For a detailed discussion of vegetation communities within the Project area, see **Section 3.3.1**. The nine vegetation communities can be grouped into seven wildlife habitats, including ponderosa pine forest, riparian, freshwater marsh, shrub-steppe (three-tip sage and big sage communities), eastside grassland, agricultural, and urban. Wildlife habitats were classified according to the system in Wildlife-Habitat Relationships in Oregon and Washington (Johnson and O'Neil, 2001; NHI-IBIS, 2003).

3.4.1.1 General Wildlife Species

The following subsections discuss representative amphibians, reptiles, birds, mammals, and game species expected to occur in the Project area. Information regarding wildlife species known or expected to occur in the Project area has been obtained from the Washington GAP program data (WDFW, 1999).

Amphibians

Amphibians expected to occur include Pacific treefrog (*Hyla regilla*), western toad (*Bufo boreas*), and the non-native bullfrog (*Rana catesbeiana*). All species of amphibians require water or cool moist areas for reproduction. Riparian communities support the highest levels of amphibian species richness and diversity in Washington. Streamside pools and low-flow shallows can provide breeding habitat for a variety of species of frogs, toads, and newts. Other species of salamanders and newts would utilize adjacent moist, terrestrial habitats underneath fallen logs and leaf litter.

Reptiles

Reptiles that may be found include western fence lizard (*Sceloporus occidentalis*), northern alligator lizard (*Gerrhonotus coeruleus*), and western skink (*Eumeces skiltonianus*). Snakes likely to occur include the common garter snake (*Thamnophis sirtalis*), western rattlesnake (*Crotalus viridis*), racer (*Coluber constrictor*), and gopher snake (*Pituophis melanoleucus*).

Birds

Birds are the most abundant vertebrates in the Project area. Barn swallows (*Hirundo rustica*), western bluebird (*Sialia mexicana*), western meadowlark (*Sturnella neglecta*), American robin (*Turdus migratorius*), Canada goose (*Branta canadensis*), American kestrel (*Falco sparverius*), and turkey vulture (*Cathartes aura*) are found in non-native grasslands and agricultural lands.

Swainson's thrush (*Catharus ustulatus*), warbling vireo (*Vireo gilvus*), and song sparrow (*Melospiza melodia*) are more abundant in riparian habitats. Great blue heron (*Ardea herodias*.), belted kingfisher (*Ceryle alcyon*), and various species of waterfowl utilize the near shore areas of rivers and creeks for foraging and nesting. Swifts, swallows, and flycatchers can be found foraging over open water habitats.

Coniferous forests, including ponderosa pine and eastside mixed coniferous forests (usually dominated by Douglas fir), provide habitat for many birds and mammals. Spotted towhee (*Pipilo maculatus*) and sparrows would forage in the understory of ponderosa pine forests. Bird species found in ponderosa pine and mixed conifer forests include the hairy woodpecker (*Picoides villosus*), sharp-shinned hawk (*Accipiter striatus*) and brown creeper (*Certhia americana*).

Non-native bird species that occur in the Project area include brown-headed cowbird (*Molthrus ater*), wild turkey (*Meleagris gallopavo*), ring-necked pheasant (*Phasianus colchicus*) and chukar (*Alectoris chukar*).

Mammals

A number of small mammals are common to the Project vicinity. Common bat species include big brown bat (*Eptesicus fuscus*), California myotis (*Myotis californicus*), and hoary bat (*Lasiurus cinereus*). Other small mammals expected to occur include voles (*Microtus* spp.), western harvest mouse (*Reithrodontomys megalotis*), Cascade golden-mantled ground squirrel (*Spermophilus saturatus*), northern pocket gopher (*Thomomys talpoides*), striped skunk (*Mephitis mephitis*), long-tailed weasel (*Mustela frenata*), red squirrel (*Tamiasciurus hudsonicus*), bushy-tailed woodrat (*Neotoma cinerea*), deer mouse (*Peromyscus maniculatus*), and raccoon (*Procyon lotor*). Larger mammals in the Project vicinity include coyote (*Canis latrans*), red fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), and mountain lion (*Felis concolor*).

Game Species

Big game species near Project components could include white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), and black bear (*Ursus americanus*). Other game species include upland game birds, such as blue grouse (*Dendragapus obscurus*), chukar, and wild turkey; waterfowl, such as mallard (*Anas platyrhynchos*), pintail (*Anas acuta*), and Canada goose; and mammals, such as cottontail rabbit (*Sylvilagus nuttallii*).

3.4.1.2 Special Status Wildlife Species

Forty-four special status wildlife species may occur in the Project vicinity (WDFW, 1999). Habitat descriptions and an evaluation of the potential to occur in the Project area are provided in **Table 3-19**. One species, blue grouse, is tracked by the state, but is not protected. Federally-listed species may also have state status, and species with state status may also be federal species of concern. Habitat conditions for federal- and state-listed species are described in more detail below.

Gray Wolf

The gray wolf (*Canis lupus*) is federally listed as threatened and state listed as endangered (WDNR 2003a). This species historically was found in a variety of habitats. In Washington, the gray wolf is currently found only in the northern Cascades, probably in forests. Wolves in the Pacific states feed primarily on ground squirrels, rabbits, and hares, but will also take larger mammals such as deer and elk (Ingles, 1965). Wolves may pass through the uppermost elevations of the Salmon Creek watershed, but are unlikely to occur in the Project area.

Bald Eagle

Western Washington has one of largest concentrations of bald eagles (*Haliaeetus leucocephalus*) (FT, WT) in the contiguous United States. This species is federally and state-listed as threatened (WDNR 2003a). Bald eagles are common breeders along salt and fresh water at lower elevations throughout western Washington (Cassidy, 2003). Bald eagles are uncommon breeders along major rivers and lakes in eastern Washington. Bald eagles are typically found in coniferous forest habitats with large, old growth trees near permanent water sources such as lakes, rivers, or ocean shorelines. They require large bodies of water with abundant fish and adjacent snags or other perches for foraging (Csuti et al., 1997). Bald eagles prey mainly on fish, and occasionally on small mammals or birds, by swooping from a perch or from mid-flight. Nests are found in large, old growth, or dominant trees, especially ponderosa pine with an open branchwork, usually 50 to 200 feet above the ground. Habitat for the bald eagle is present at Conconully Reservoir and along the Okanogan River.

Grizzly Bear

The grizzly bear (*Ursus arctos*) is federally and state-listed as threatened (WDNR 2003a). This bear is an omnivore that once ranged as far south as central California, but is now found in the United States only in Alaska and the northernmost parts of the Cascade Range and the Rocky Mountains. In Washington, the grizzly bear inhabits montane forests (Burke, 2002) and alpine meadows (UMMZ, 2003). Grizzly bears may pass through the uppermost elevations of the Salmon Creek watershed, but are unlikely to occur in the Project area.

Table 3-19. Special-Status Wildlife Species Potentially Occurring in the Salmon Creek Project Area.

Common Name *Scientific Name*	Status[a]	Habitat	Potential To Occur in Project Area
BIRDS			
American avocet *Recurvirostra americana*	Protected	Beaches, flats, shallow lakes, and prairie ponds. Locally common in freshwater ponds & wetlands of the Columbia Basin in central Washington.	May occur at Conconully Reservoir.
Bald eagle *Haliaeetus leucocephalus*	FT, WT	Coasts, rivers, large lakes & also mountains & open country in winter. Locally, western Washington, and uncommon breeders along major rivers & lakes in eastern Washington.	May occur at Conconully Reservoir and on the Okanogan River.
Black tern *Chlidonias niger*	FSC, WM	Fresh marshes, lakes, & coastal waters in migration. Locally, most common east of the Okanogan & Columbia Rivers.	May occur at Conconully Reservoir.
Black-backed woodpecker *Picoides arcticus*	WC	Fir & spruce forests, recent burns. Uncommon permanent residents in Washington's mountains from the Cascade crest east.	May occur at Conconully Reservoir.
Black-crowned night-heron *Nycticorax nycticorax*	WM	Marshes & shores. Roosts in trees. Locally, most common in central & southern Columbia Basin. Winter roosts in northwest Washington, along Columbia River & Tri Cities area.	May occur at Conconully Reservoir, along Salmon Creek, and in the Okanogan River.
Blue grouse *Dendragapus obscurus*	None	Coniferous & mixed mountain forests in summer & in conifer forests at higher elevations in winter. Locally at all elevations throughout most of Washington	May occur at Conconully Reservoir.
Burrowing owl *Speotyto cunicularia*	FSC, WC	Open grassland, prairies, airfields, farmland. Nests in ground burrows. Locally, shrub-steppe zone of eastern Washington, & warmest areas of Columbia Basin in winter.	May occur along lower Salmon Creek and on the pipeline route for the Okanogan River water exchange alternative.
Eared grebe *Podiceps nigricollis*	Protected	Prairie lakes, ponds & also open lakes, salt bays & ocean in winter. Locally, lower elevations up to ponderosa pine zone in eastern Washington, including east of Okanogan River & Columbia Basin.	May occur at Conconully Reservoir.
Flammulated owl *Otus flammeolus*	WC	Open pine, fir forests in mountains. Locally, uncommon breeders east of the Cascades in the ponderosa pine belt May to August.	May occur at Conconully Reservoir.
Lewis` woodpecker *Melanerpes lewis*	WC	Scattered or logged forests, foothills, burns, river groves. Locally, breed in eastern Washington at transition zone between Ponderosa pine & shrub-steppe habitats.	May occur at Conconully Reservoir, and in riparian vegetation along lower Salmon Creek and on the Okanogan River.
Loggerhead shrike *Lanius ludovicianus*	FSC, WC	Semi-open areas with lookout posts (scrub, wire, trees). Locally, eastern Washington spring to early fall, & in winter uncommon in Columbia River bottoms of southeast Washington	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.

Table 3-19. Special-Status Wildlife Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name *Scientific Name*	Status[a]	Habitat	Potential To Occur in Project Area
Merlin *Falco columbarius*	WC	Open woods, cliffs, tundra, adjacent to grassland. Also marshes, open coasts & foothills in migration. Locally, rare breeder in coastal forests of state's outer coast & Puget Sound. Taiga Merlin rare breeder in high-elevation boreal forests of the north Cascades & northeastern Washington, & Prairie Merlins occur in state during migration. Common in major valleys, Puget Sound & coast in winter.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Northern goshawk *Accipiter gentilis*	FSC, WC	Deciduous & coniferous forests, especially in mountains, forest edges. Lowland in winter. Locally, common along eastern slope of Cascades, & less common in the Olympic Mountains & southwestern Washington.	May occur at Conconully Reservoir.
Pied-billed grebe *Podilymbus podiceps*	Protected	Ponds, lakes, marshes, & also salt bays in winter. Locally, lower elevations throughout Washington, except lower slopes of eastern Cascades.	May occur at Conconully Reservoir.
Pileated woodpecker *Dryocopus pileatus*	WC	Conifer, mixed & hardwood forests, woodlots. Locally, uncommon at low to mid-elevations throughout state. More common in western than in eastern Washington.	May occur at Conconully Reservoir.
Prairie falcon *Falco mexicanus*	WM	Mountainous grasslands, open hills, prairie, plains. Locally, uncommon breeders in eastern Washington shrub-steppe zone. Nest in basalt coulees' cliff faces.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Red-necked grebe *Podiceps grisegena*	WM	Lakes, ponds & also salt water in winter. Locally, northeastern Washington, especially lower river valleys. Also coast of Washington & in Puget Sound in winter.	May occur at Conconully Reservoir.
Sage sparrow *Amphispiza belli*	WC	Dry, brushy foothills, chaparral, sage. Also deserts in winter. Locally, common to uncommon breeders in sagebrush of Columbia Basin, & rare in Okanogan Valley.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Sage thrasher *Oreoscoptes montanus*	WC	Brushy slopes, sagebrush, mesas. Also deserts in winter. Locally, common breeders in eastern Washington end of March to mid-August.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Sharp-tailed grouse *Tympanuchus phasianellus*	FSC, WT	Prairie, open thickets, brushy groves, coulees, clearings, open burns in coniferous forests.	May occur along lower Salmon Creek, on the pipeline route for the Okanogan River water exchange alternative, & at Conconully Reservoir.
Vaux`s swift *Chaetura vauxi*	WC	Lakes, rivers, open sky over woodlands. Locally, common breeders spring to fall in forested areas throughout Washington. & also below lower treeline in residential areas of eastern Washington.	May occur anywhere in the Project area.

Table 3-19. Special-Status Wildlife Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name *Scientific Name*	Status[a]	Habitat	Potential To Occur in Project Area
White-headed woodpecker *Picoides albolarvatus*	WC	Mountain pine forests. Locally, uncommon & local in the ponderosa-pine forests of the eastern Cascades, & east of Okanogan River & rare in Blue Mountains.	May occur at Conconully Reservoir.
Mammals			
Big brown bat *Eptesicus fuscus*	Protected	Usually urban & rural areas. Least common in heavily forested regions. Roosts & hibernates in man-made structures (homes, mine caves, storm sewers, etc.).	May occur along lower Salmon Creek, on the pipeline route for the Okanogan River water exchange alternative, & at Conconully Reservoir.
California myotis *Myotis californicus*	Protected	Brushy, dessert or grassy areas & desert-shrub-oak woodland up to ponderosa. Roost in crevices & cracks of canyon walls, & in caves & mineshafts.	May occur along lower Salmon Creek, on the pipeline route for the Okanogan River water exchange alternative, & at Conconully Reservoir.
Fisher *Martes pennanti*	FSC, WE	Prefer continuous conifer & hardwood forests, with high canopy closure & many hollow trees for dens.	May occur at Conconully Reservoir.
Fringed myotis *Myotis thysanodes*	FSC, WM	Mountain woodlands. Night & day roosts, & hibernation in caves, mines, & buildings. Moderate mountain elevations.	May occur at Conconully Reservoir.
Gray wolf *Canis lupus*	FT, WE	North Cascades of Washington. Forested areas, open tundra.	Unlikely to occur in the Project area.
Grizzly bear *Ursus arctos*	FT, WT	Mountainous regions & open areas such as tundra, alpine meadows & coastlines with dense cover. Hibernates in high mountains in winter.	Unlikely to occur in the Project area.
Little brown myotis *Myotis lucifugus*	Protected	In summer, colonies near water bodies in very hot area with temperatures to 131ºF in attic, behind siding or under bridges. Single males also in bark & rock crevices, & groups of males in caves. Hibernate in caves or mines.	May occur at Conconully Reservoir, along Salmon Creek, & along the Okanogan River.
Long-eared myotis *Myotis evotis*	FSC, WM	Roosts in trees, cabins, caves, abandoned mines, & other sheltered areas in coniferous forest regions. 0 to 9600 ft.	May occur anywhere in the Project area.
Long-legged myotis *Myotis volans*	FSC, WM	Montane or subalpine forest, ponderosa pine woodland, pinon juniper woodland, & montane shrub with willow. Roosts in abandoned buildings, ground cracks, crevices, & spaces beneath tree bark, & hibernate in caves & mine tunnels. Most common 6500 to 10000 feet.	May occur at Conconully Reservoir.
Lynx *Lynx canadensis*	FT, WT	Forested areas, swamps.	May occur at Conconully Reservoir.
Pallid bat *Antrozous pallidus*	WM	Rocky, mountainous areas near water & over open grasslands. Day roost warm, horizontal opening. Night roost open, near foliage. Hibernate in buildings, caves, roof cracks.	May occur anywhere in the Project area.

Table 3-19. Special-Status Wildlife Species Potentially Occurring in the Salmon Creek Project Area. (continued)

Common Name *Scientific Name*	Status[a]	Habitat	Potential To Occur in Project Area
Small-footed myotis *Myotis ciliolabrum*	FSC, WM	Rock outcrops on open grasslands, canyons in foothills, or lower mountain woodlands. Day roosts in cracks & crevices in cliffs, beneath tree bark, in mines & caves, & in human dwellings. Night roosts under natural or human-induced structures. Hibernate in caves, mines, & tunnels. Low elevations to 9500 ft.	May occur anywhere in the Project area.
Townsend`s big-eared bat *Plecotus townsendii*	FSC, WC	*From* coniferous forests & woodlands, deciduous riparian woodland, semi-desert & montane shrublands. Roosts include limestone caves, lava tubes, & human-made structures.	May occur anywhere in the Project area.
Western gray squirrel *Sciurus griseus*	FSC, WT	Fairly open oak & pine-oak forests.	Unlikely to occur in the Project area.
White-tailed jack rabbit *Lepus townsendii*	WC, game	Barren, grazed, cultivated lands, grasslands.	May occur along lower Salmon Creek & on the pipeline route for the Okanogan River water exchange alternative.
Wolverine *Gulo gulo*	FSC, WC	Boreal forests, mountains or open plains & brushlands. Rough beds of grass or leaves in caves or rock crevices, in burrows made by other animals, or under a fallen tree, & occasionally construct their nests under the snow.	May occur at Conconully Reservoir.
Yuma myotis *Myotis yumanensis*	FSC, protected	From juniper & riparian woodlands to desert regions near open water. Roost in caves, attics, buildings, mines, underneath bridges, & other similar structures.	May occur along Salmon Creek, on the pipeline route for the Okanogan River water exchange alternative, & on the Okanogan River.
Amphibians			
Columbia spotted frog *Rana luteiventris*	FSC, WC	Still water, & streams & creeks. Breed in flooded margins of wetlands, ponds & lakes. Egg masses in areas with little or no shading from vegetation. Breeding in the Columbia Basin, at elevations near 1800-2000 feet, & the Okanogan Highlands at sites 2000 to above 4500 feet.	May occur in wetlands & ponded areas on Salmon Creek, near Conconully Reservoir, & on the Okanogan River.
Northern leopard frog *Rana pipiens*	FSC, WE	Steppe vegetation zones & lakes, ponds, creeks & rivers. Columbia Basin & Okanogan. 500 to 1500 ft.	May occur in wetlands & ponded areas on Salmon Creek, near Conconully Reservoir, & on the Okanogan River.
Western toad *Bufo boreas*	FSC, WC	Forested, brush or mountain meadow. Breeds in ponds or shallow lake edges with hatchlings & tadpoles in warmest, shallowest water. Toadlets under rocks near ponds or in brush & adults underground, under large debris or in grass & brush. In streams & springs during dry periods. 0 to 7400 ft.	May occur in wetlands & ponded areas on Salmon Creek, near Conconully Reservoir, & on the Okanogan River.

a: Codes are as follows:
FT federally listed as threatened
FSC federal species of concern
WE listed by Washington State as endangered
WT listed by Washington State as threatened
WC candidate species for listing by Washington State
WS Washington State sensitive species
WM Washington State monitored species
Protected This species has no official state listing status, but it is classified by WDFW as protected wildlife.

Sources: WDFW 2002, WNHP 2002, Burt and Grossenheider 1980, Peterson Field Guides; Corkran and Thoms 1996, Franklin and Dyrness 1973, Peterson 1990.

Lynx

The lynx (*Lynx canadensis*) is federally and state-listed as threatened (WDNR, 2003a). This is a boreal species that formerly occurred from the Pacific to the Atlantic coasts, as far south as Oregon and Colorado. The lynx is usually found in dense forest with some openings. The primary food of the lynx in much of its range is the snowshoe hare (*Lepus americanus*), but it also takes birds, other small mammals, and even young deer (Csuti, et al., 1997). Suitable habitat for this species is present in the forests around Conconully Reservoir.

Fisher

The fisher (*Martes pennanti*) is a federal species of concern and is state-listed as threatened (WDNR, 2003a). This species is found primarily in mature, closed-canopy coniferous forests, frequently along riparian corridors (Csuti et al., 1997). In the western United States, the fisher is restricted to the mountains, as far south as the Sierra Nevada in California. The fisher feeds on small mammals, amphibians, reptiles, birds, and eggs. Habitat for this species is present in the forests around Conconully Reservoir.

Northern Leopard Frog

The northern leopard frog (*Rana pipiens*) is a federal species of concern and is state-listed as threatened (WDNR 2003a). This frog is widely distributed from Nevada through the eastern United States. In Washington, this species is found primarily in the central basin and on the Snake River in northeastern Washington. However, it has been reported from the Okanogan River upstream of the confluence with Salmon Creek. The northern leopard frog prefers quiet or slow-moving waters, including marshes, wet meadows, vegetated irrigation canals, ponds and reservoirs (Csuti, et al., 1997). The adults feed on both invertebrates and small vertebrates. Habitat for this species is present in the Project area.

Sharp-Tailed Grouse

The sharp-tailed grouse (*Tympanuchus phasianellus*) is a federal species of concern and is state-listed as threatened (WDNR 2003a). This grouse historically ranged from southern British Columbia, along the eastern slope of the Cascades south to California, and east to Colorado and Utah. This species is found in a variety of habitats, including grasslands, shrublands, and partially cleared forests (Ehrlich et al., 1988). In Washington, this species is currently known only from eight isolated populations in Douglas, Lincoln, and Okanogan Counties (Cassidy, 2003). The areas with the largest subpopulations in Okanogan County are Tunk Valley and Nespelem (Cassidy, 2003). The sharp-tailed grouse feeds on vegetation, including leaves, buds, flowers, and fruits (Ehrlich et al., 1988).

Limited habitat for this species is present in the patches of shrub-steppe/grassland between the Okanogan River and the OID diversion, as well as open margins of the forest in the vicinity of Conconully Reservoir. However, this habitat is interrupted by urban areas and extensive orchards.

Western Gray Squirrel

The western gray squirrel (*Sciurus griseus*) is a federal species of concern and is state-listed as threatened (WDNR 2003a). This squirrel is an arboreal species that is active all year. This species feeds on a variety of seeds and fungi, as well as fruit, green vegetation, and insects. The primary habitat for the western gray squirrel is woodlands of deciduous or broadleaf evergreen trees, dominated by oaks and occasional pines (Csuti et al., 1997). However, this species also occupies riparian forests and mixed coniferous forests. The current range of the western gray squirrel just reaches the western edge of the Salmon Creek watershed (WDFW, 1999), but it is unlikely to occur in the Project area.

3.4.2 WILDLIFE IMPACTS

3.4.2.1 Alternative 1: Okanogan River Pumping Station Facilities

Construction of the new pump station would result in the permanent loss of riparian habitat, primarily white alder and cottonwood, at the proposed site. Because of the relatively small area needed for the station, and the possible enhancement of riparian habitat on lower Salmon Creek that may result from increased flows under this alternative, the loss is expected to be minor.

Construction could result in direct impacts to wildlife species present in the Project area. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce potential impacts to a low level.

Construction of the pipeline would result in temporary loss of upland habitat, primarily cheatgrass grassland. This impact is expected to be less than significant. Implementation of the mitigation measures provided in **Section 3.4.3** would further reduce potential impacts.

Construction of the water filtration system and sediment pond would result in the permanent loss of upland vegetation near Diversion 2. This impact is expected to be minor.

Implementation of the Okanogan River water exchange alternative would result in minor impacts to wildlife and wildlife habitat during construction. This alternative would return flow to the lower portion of Salmon Creek during periods when it is currently dry. The change in flow regime in Salmon Creek associated with the implementation of this action alternative would provide beneficial conditions in which riparian habitat typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian habitat currently exists and would improve conditions for existing riparian habitat.

3.4.2.2 Alternative 1: Feeder Canal Upgrade

Implementation of the feeder canal upgrade would result in temporary disturbance of wildlife habitat along the canal route during removal of the existing canal and installation of the proposed pipeline. The pipeline route would likely be maintained in an early seral stage to permit access for maintenance purposes and to prevent damage to the buried pipeline from tree roots. Because the pipeline would be installed in the location of the existing canal, and because much of the route passes through the settlement of Conconully to the reservoir, neither installation nor maintenance of the pipeline is expected to result in significant impacts to wildlife habitat.

Animals present in the construction zone, or that stray into it, could be killed during construction activities. Animals could also be adversely affected by maintenance activities. Mitigation measures provided in **Section 3.4.3** would reduce these effects to a low level.

3.4.2.3 Alternative 1: Stream Rehabilitation

Construction would result in temporary adverse impacts to riparian habitat at the mouth of Salmon Creek. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce temporary adverse impacts to wildlife habitat.

Channel construction activities would occur in the late summer to early fall, however, direct impacts to wildlife species, including amphibians and riparian-nesting birds, could result. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce potential adverse impacts to a low level.

3.4.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

Relocation of the intake and any other construction at the Shellrock pump station that is required may impact existing riparian vegetation at the construction site. This potential adverse impact would be limited to a small area and is expected to be minor. Potential adverse impacts also would be offset by the improvement in riparian habitat on lower Salmon Creek.

Construction of the pipeline would result in temporary loss of upland habitat, primarily cheatgrass grassland. This impact is expected to be less than significant. Implementation of the mitigation measures provided in **Section 3.4.3** would further reduce potential impacts.

Construction of the sediment basin in the main canal would result in the temporary impact to a small area around the construction site. This impact is expected to be minor.

Upgrading the Shellrock pumping plant would result in minor impacts to wildlife and wildlife habitat during construction. This alternative would return flow to the lower portion of Salmon Creek during periods when it is currently dry. The change in flow regime in Salmon Creek associated with the implementation of this action alternative would provide beneficial conditions in which riparian habitat typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian habitat currently exists and would improve conditions for existing riparian habitat. See **Section 3.4.2.6** for impacts related to implementing stream rehabilitation in conjunction with this alternative.

3.4.2.5 Alternative 2: Feeder Canal Upgrade

The impacts to wildlife would be the same as described in **Section 3.4.2.2**.

3.4.2.6 Alternative 2: Stream Rehabilitation

Portions of the lower reach of Salmon Creek that are modified for channel rehabilitation may experience minor increases in overbank flows and inundation of adjacent, recontoured flood plains. However, these areas would be limited to reaches that have suitable valley width to allow floodplain recontouring. Increased overbank flows would benefit the reestablishment of riparian and wetland vegetation in this reach.

Construction would result in temporary adverse impacts to riparian habitat in the lower reach of Salmon Creek, but would be more than offset by the resulting enhancement of riparian habitat in much of lower Salmon Creek. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce temporary adverse impacts to wildlife habitat.

Channel construction activities would occur in the late summer to early fall, however, direct impacts to wildlife species, including amphibians and riparian-nesting birds, could result. Implementation of the mitigation measures provided in **Section 3.4.3** would reduce potential adverse impacts to a low level.

3.4.2.7 Alternative 3: Water Right Purchase

This alternative would return flow to the lower portion of Salmon Creek during periods when it is currently dry. The change in flow regime in Salmon Creek could provide beneficial conditions in which some riparian habitat typical of Eastern Washington non-perennial streams could reestablish along reaches where no riparian habitat currently exists and would improve conditions for existing riparian habitat. There are no adverse impacts to wildlife or wildlife habitat associated with this alternative.

3.4.2.8 Alternative 3: Feeder Canal Upgrade

The impacts to wildlife would be the same as described in **Section 3.4.2.2**.

3.4.2.9 Alternative 3: Stream Rehabilitation

Since rehabilitation would no be implemented with this alternative, there would be no impacts.

3.4.2.10 No Action Alternative

Under the No Action Alternative, changes from existing conditions are not likely to result in significant effects on terrestrial wildlife. Stream incision and bank erosion are likely to continue to varying degrees along the length of Salmon Creekbut because much of the Lower Salmon Creek corridor has already incurred heavy loss of riparian vegetation, further loss of habitat is unlikely to have an important effect on wildlife. However, lateral and vertical erosion occurring immediately downstream of Watercress Springs is likely to result in further loss of the riparian vegetation currently present in this area. Uncontrolled bank erosion could reduce the extent of riparian vegetation or result in a change in species composition. Installing bank protection in areas with riparian vegetation could result in a change in species composition. Any of these conditions could result in a change in extent and type of riparian habitat available to wildlife species.

3.4.3 MITIGATION MEASURES

In order to reduce potential impacts to wildlife, the following mitigation measures would be implemented.

3.4.3.1 Avoid Disturbing Special Status Wildlife Species

Prior to any construction activities for any component, a qualified biologist would conduct site-specific surveys to evaluate the potential for special status wildlife to occur within the construction corridors. Any areas within the construction corridor that are occupied by special status species would require consultation with the appropriate regulatory agency. Areas could be flagged so that construction equipment could avoid impacts to the species. Sensitive habitats in the Project area, but outside the construction footprints of the stream rehabilitation projects, would also be flagged for avoidance. If construction occurs during the breeding season for special status raptors, a no-disturbance buffer would be established around any active nests found within 0.5 mile of the construction zone. Resource managers would be consulted prior to construction activities. Timing of construction or maintenance operations that may affect important activities (breeding, feeding, etc.) of special status species would be timed to avoid or minimize disturbance.

A biological resource education program for construction crews would be conducted before construction activities begin. The education program would include a brief review of the special-status species and other sensitive resources that could exist in the Project area, locations where they may be encountered, and their legal status and protection under the State and Federal Endangered Species Acts. The education program would include materials describing sensitive resources, resource avoidance, mitigation measures, permit conditions, and possible fines for violations of state or federal environmental laws.

3.4.3.2 Avoid Disturbing Breeding Birds

If vegetation removal during construction occurs during the breeding season for migratory birds, a qualified biologist would conduct surveys to locate any active bird nests within the construction corridors. Areas within the construction corridor containing active nests, if found, would be flagged so that construction equipment can avoid impacts to the nests. If vegetation that must be removed to complete the Project is found to have active nests, removal of that vegetation would be postponed until after the nesting season.

3.4.3.3 Sediment Control

Sediment and pollution control measures would be implemented during construction activities. BMPs for stream channel construction, as specified in **Section 3.2.3,** and measures to avoid transport of upland materials into waterways, as specified in **Section 3.3.3**, would be implemented during construction to minimize impacts to riparian habitat

3.4.3.4 Avoid Important Habitats and Habitat Features

Construction would avoid removal of important habitat and habitat features as specified in **Section 3.3.3**.

3.4.4 UNAVOIDABLE ADVERSE IMPACTS

No unavoidable adverse impacts to wildlife or wildlife habitat are expected to occur from implementation of any of the alternatives other than the No Action alternative. Continued channel degradation is expected to occur under the No Action alternative, which would result in loss of riparian habitat. This loss may be permanent, depending on methods employed to strengthen eroding banks.

3.5 FISHERIES

3.5.1 EXISTING CONDITIONS

3.5.1.1 Overview

Potentially affected waterbodies within the Project area include Salmon Creek and the Okanogan River. The Okanogan River originates in British Columbia, Canada and flows into the Columbia River in Washington State at approximately river mile (RM) 534 (distance upstream from where the Columbia River enters the Pacific Ocean). Salmon Creek enters the Okanogan River at approximately RM 26 (distance upstream from confluence of the Okanogan with the Columbia River). Salmon Creek has a total watershed area of about 167 square miles and is approximately 42 miles long. While Salmon Creek inflows comprise only about 2 percent of the Okanogan average annual flow at Malott, (WDOE, 1995), it has been identified as having perhaps the best potential for improving fish production in relation to other Okanogan River tributaries (Dames & Moore 1999).

The specific area potentially affected in the Okanogan River is from just downstream of the mouth of Salmon Creek (RM 26) to upstream of the existing Shell Rock pump station at RM 29.0 or to the new Okanogan pump station alternative at RM 27.1. The area of interest for the Salmon Creek watershed is divided into three reaches including; 1) the lower reach, extending from the confluence of Salmon Creek and the Okanogan River upstream to the Okanogan Irrigation District (OID) diversion dam (RM 4.3); 2) the middle reach, from the OID diversion dam to the Conconully Reservoir (RM 15.3); and, 3) the upper reach, which includes both reservoirs (Conconully Reservoir and Salmon Lake) as well as the north, south, and west forks of Salmon Creek. Fisheries resources and habitat conditions are discussed for each waterbody and reach of Salmon Creek below.

3.5.1.2 Okanogan River

Fisheries Resources

Anadromous[12] runs of summer chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*0. nerka*), and smaller runs of steelhead trout (*O. mykiss*) are found in the Okanogan River and tributaries, including its Canadian reaches. Other resident (non-migratory) salmonids in this system include mountain whitefish (*Prosopium willamsoni*), rainbow trout (*0. mykiss*), westslope cutthroat trout (*0. clarki clarki*), kokanee (*O. nerka)*, and possibly bull trout (*Salvelinus confluentus*). Important native resident and non-salmonid species in the Okanogan watershed include mountain whitefish (*Prosopium willamsoni*), pygmy whitefish (*Prosopium coulteri)*, lake chub (*Couesius plumbeusI),* peamouth chub (*Mylocheilus caurinusI*), northern pikeminnow (*Ptychocheilus oregonensis*), longnose dace (*Rhinichthys cataractae*), leopard dace (*Rhinichthys falcatus*), largescale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), bridgelip sucker (*Catostomus columbianus*), chiselmouth (*Acropheilus alutaceus*), prickly sculpin (*Cottus asper*), slimy sculpin (*Cottus cognatus*), torrent sculpin (*Cottus rhotheus*),and Pacific lamprey (*Lampetra tridentatus*), an anadromous species. Eastern brook trout (*Salvelinus fontinalis*) is an exotic (non-native) salmonid introduced to the area. Some of these species are federally listed as threatened or endangered or are considered state sensitive species due to depressed population levels in the region, as described by species below.

Various exotic warm water species have been introduced into the Okanogan watershed (OWC, 2000). These include largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomelui*), white crappie (*Pomoxis annularis*), bluegill (*Lepomis macrocherus*), yellow perch (*Perca flavescens*), pumpkinseed sunfish (*Lepomis gibbosus*), black bullhead (*Ictalurus melas*), brook trout (*Salvelinus frontinalis*), lake whitefish (*Coregonus clupeaformis*), carp (*Cypinus carpio),* brown bullhead (*American nebulosis*), black crappie (*Pomoxis nigromaculatus*), tench (*Tinca tinca*), and walleye (*Stizosledion vitreum*). Warm water resident fish supply the majority of the total basin biomass for fish and many are contributors to predation on juvenile salmonids in the reservoirs and tailraces associated with mid-Columbia dams (OWC, 2000).

Summer chinook

Summer chinook are referred to as “ocean-type” because they out-migrate as sub-yearlings and spend little time in their natal streams and rivers (Mathews and Waples, 1991; Waples et al., 1991; Myers et al., 1998). Following spawning in late September through early November (peaking in mid October), eggs are incubated. Emergence of the newly hatched fish (fry) occurs between January and April. Juveniles leave the Okanogan River from one to four months after emergence. These fish have an extended residence period in fresh water through a protracted downstream migration. Sub-yearlings rear in the mid-Columbia impoundments for various periods of time during their outmigration (Peven and Duree, 1997). After 4 to 5 years in the ocean, summer chinook salmon migrate back to the Okanogan River from July through late September to spawn.

[12] Anadromous fish migrate to ocean as part of their life cycle.

The spatial distribution of spawners in the watershed is fairly discontinuous. Summer chinook spawn in limited areas in the Okanogan River in the 61 miles between Zosel Dam (RM 78 and creates Lake Osoyoos) and the town of Malott (RM 17.0). The Similkameen River is the largest tributary to the Okanogan River and enters at RM 74. On the Similkameen River, summer chinook spawn in the nine-mile reach from Enloe Dam (RM 9) downstream to Driscoll Island (just upstream of the confluence with the Okanogan River). In general, the run strength of summer chinook salmon was low in the 1970s and 1980s (Chapman et al. 1994a), with runs of 532 in 1977 and 617 in 1985 (WDOE, 1995). Summer chinook run sizes have increased overall during the past decade, averaging 12,618 per year through Wells Dam between 1994 and 2003. Run sizes were 44,503 in 2003 and 62,595 in 2002.

Spring chinook

Spring chinook salmon in the Okanogan are referred to as “stream-type” salmon because they have a longer freshwater residency than the Okanogan River summer chinook salmon. Okanogan spring chinook spend a year or more in fresh water. They typically enter mid and upper Columbia River tributaries from late April through July and hold in pools until onset of spawning (Chapman et al., 1995). Spawning generally occurs from late July through September and eggs typically hatch in late winter. Fry emerge from the gravel in April or May (Peven, 1992). Out-migration also occurs in April and May. Because spring chinook spend more time in fresh water, out-migrants (smolts) are much larger than their ocean-type (subyearling) counterparts.

Spring chinook salmon are considered extirpated from the Okanogan River drainage (**Table 3-20**). Historical records indicate that they occurred in at least three systems including Salmon Creek (Craig and Suomela, 1941), tributaries upstream of Lake Osoyoos (Chapman et al., 1995), and possibly Omak Creek (Fulton, 1968). There were probably several life history strategies that historically existed in the Similkameen River watershed prior to construction of Enloe Dam in 1920, although there is no clear evidence that chinook salmon passed the natural falls on the lower Similkameen River.

Steelhead Trout

Steelhead trout are the anadromous form of rainbow trout. Hatchery and wild-run summer steelhead trout return to the Okanogan River in October. Steelhead stage (stop migrating and remain in one general area) in locations with favorable habitat conditions until mid-March or April. In April, they begin ascending tributaries and then typically spawn in mid-April. After spawning, many adults out-migrate and, unlike other anadromous species, can return in following years to spawn again. Incubation of eggs normally occurs from April through September and juveniles typically outmigrate during the last part of April and first part of May (summary in Dames & Moore, 1999).

Few wild steelhead currently use the Okanogan River. Although records concerning steelhead abundance in the Okanogan watershed are not complete, Mullan et. al. (1992) estimate that few steelhead historically used the Okanogan River. Evidence suggests that steelhead used Salmon Creek and possibly other tributaries in the Okanogan Basin (Chapman et al. 1994b). During the spring of 2002, CCT fisheries biologists caught summer steelhead in the Okanogan River, holding near the mouth of Salmon Creek (Fisher, per. comm. June 26, 2002). These steelhead are likely returning to Salmon Creek as a result of a reestablishment program. The Washington Department of Fish and Wildlife in coordination with the Colville Confederated Tribes (CCT) have released approximately 10,000 to 15,000 steelhead smolts downstream of the OID diversion dam on Salmon Creek in recent years. The Washington Water Trust leases water from the OID. Flows are provided long enough to imprint the smolts to Salmon Creek and then increased to flush smolts to the Okanogan River. The returning adults are possibly attracted to ground water sources from the watershed when insufficient flows preclude migration into Salmon Creek (Fisher, pers. comm. 2003).

Table 3-20. Special-Status Fish Species Potentially Occurring in the Salmon Creek Project Area. (Source: WDFW 2003).

Common Name *Scientific Name*	ESA Status		Potential to Occur in Project Area
	Federal	Washington	
Bull trout (Columbia Basin) *Salvelinus confluentus*	Threatened	State Candidate	May occur in the Okanogan Basin but are believed to be extirpated downstream of Enloe and Zosel dams. Historically may have been present in Salmon Creek, although interbreeding with eastern brook trout may have eliminated this species from the watershed.
Chinook salmon, spring run (Upper Columbia) *Oncorhynchus tshawytscha*	Endangered	State Candidate	Spring chinook salmon are considered extirpated from the Okanogan River, including Salmon Creek. This race typically uses larger streams and smaller rivers for spawning.
Steelhead (Upper Columbia) *Oncorhynchus mykiss*	Endangered	State Candidate	Steelhead use the Okanogan River. They spawn and rear in tributaries. Steelhead use Salmon Creek when access (water) is available. They have recently been released in the Salmon Creek drainage.
Westslope cutthroat *Oncorhynchus clarki lewisi*	Species of Concern	None	The status of westslope cutthroat trout in the Okanogan is unknown. It is speculated that these trout are not native to the Okanogan River watershed; those currently present in Toats Coulee, and Salmon Creek may have been planted.
Pacific lamprey *Lampetra tridentata*	Species of Concern	None	Recently constructed Pacific lamprey redds (11) were observed in April 2003 in the Similkameen River, a major tributary of the Okanogan River, upstream of Salmon Creek near Oroville, WA. (Ward, 2003).

Note: The lake chub (*Couesius plumbeus*), leopard dace (*Rhinichthys falcatus*), mountain whitefish (*Catostomus platyrhynchus*) and Umatilla dace (*Rhinichthys umatilla*) are all listed as state candidate species, and the pygmy whitefish (*Prosopium coulteri*) is listed as a state sensitive species. All of these species have the potential to occur in the upper Columbia sub-basin and within the Okanogan watershed. However, there are no current documented occurrences in the Okanogan River or in Salmon Creek and they are not thought to be present in the area of the Project (per. comm. Barlett, WDFW August 6, 2003).

Rainbow Trout

Rainbow trout are the resident form of steelhead trout. Rainbow trout spawn and rear in tributaries and do not appear to utilize the Okanogan River to any significant degree. Rainbow trout are basically spring spawners. They spawn in smaller tributaries or inlet/outlet streams of lakes from March to August but mainly from mid-April to late June (Lindsey et al., 1959; Hartman, 1969). Eggs usually hatch in approximately four to seven weeks and with emergence from mid-June to mid-August. Fry of lake-resident spawners move to the lake environment almost immediately and the stream-resident spawners remain in the streams after emergence (Scott and Crossman, 1973).

Sockeye Salmon

Sockeye salmon exhibit three general historical life history strategies in the Okanogan River basin. This includes anadromous sockeye salmon, which spawn in fresh water and grow to adults in the ocean. A few of the anadromous sockeye salmon remain in fresh water to complete their life cycle for one or more generations (residual sockeye salmon). All generations of resident kokanee salmon (fresh water form of sockeye salmon) complete lifecycles in fresh water (Chapman et al., 1995b).

Washington Department of Fisheries reported that Okanogan sockeye salmon spawn in the Okanogan River in and upstream of Lake Osoyoos. They begin migrating up the Columbia River in late-June and peak in early July (WDF et al., 1993). Chapman et al. (1995b) reported sockeye salmon migrating later with a peak migration at Rock Island Dam (RM 453), on the Columbia River the third week in July. Migration may be impeded by as much as three weeks in some years by high water temperatures during mid-summer in the Okanogan River (Major and Mighell, 1966; Mullan, 1986; Swan et al., 1994; Alexander et al., 1998; and Chapman et al., 1995). Sockeye salmon congregate at the confluence of the Okanogan River and Columbia River when water temperatures exceed about 21^{o}C to 22^{o}C and only migrate up the Okanogan River when temperatures fall below this level (Major and Mighell, 1966; Allen and Meekin, 1980; Alexander et al., 1998; and Chapman et al., 1995b). Spawning occurs upstream of Lake Osoyoos in tributaries under high flow years but predominantly in the mainstem Okanogan River or in the lake. Spawning occurs during late September through October (Swan et al., 1994; WDF et al., 1993; and Chapman et al., 1995b). Fry emerge and migrate downstream to Lake Osoyoos, which has been ranked as one of the most productive of all sockeye salmon rearing lakes in the Columbia River Basin. Data from Chapman et al. (1995b) indicate that currently sockeye salmon smolts leave Lake Osoyoos in mid-to late May and migrate past Rock Island Dam in May (Peven, 1987).

According to WDFW and Western Washington Treaty Indian Tribes (1993), a healthy stock of sockeye salmon continues to use the Okanogan basin for spawning and rearing. The Okanogan Sockeye salmon are not listed under ESA, but the run strength of anadromous sockeye salmon in the Okanogan River is highly variable. Population is limited by reduced rearing habitat in the north basin of Lake Osoyoos. Spawning populations ranged from about 20,000 to 35,000 fish in 1993. The 1986-1995 average run size was 28,460 fish. Recent escapement has ranged from a low of 1,662 in 1994 to a high of 127,857 in 1966 as measured at Wells Dam (Hansen 1993).

Kokanee Salmon

Kokanee salmon are the freshwater form of sockeye salmon that rears most of its life in a standing water body and then moves up a tributary to spawn. Maturing adults stage in early August and migration occurs in early September with spawning activity in September and October. Fry emerge from January through May and move immediately to a lake environment (Scott and Crossman 1973, ENTRIX and Golder 2003, and Fisher pers. comm. 2003). Kokanee are not likely to use the Okanogan River in the area of the Project. They do inhabit the upper reaches of Salmon Creek. These fish inhabit Conconully Reservoir, spawning along its shorelines and tributaries, including the North and West forks of Salmon Creek.

Pacific Lamprey

The spawning run of returning adult Pacific lamprey enter freshwater from April to June and completes migration into streams in September. Adults overwinter in freshwater streams, then move upstream to headwaters to spawn from April to October of the following year (Scott and Crossman, 1973). Spawning habitat consists of gravel with a mix of pebble and sand in the tail areas of pools and riffles (Kan, 1975). After spawning, the adults die within 3 to 36 days. The larvae (called ammocoetes) burrow into the substrate and filter-feed on diatoms, detritus, and algae. They remain in the substrate for 5 to 7 years before metamorphosis into juveniles and migration to the ocean. This transformation occurs between July and October and the morphological and physiological changes allow the lamprey to survive in saltwater environments. After entering the ocean, the lampreys become parasitic to soft-scaled fish. It is estimated that Pacific lamprey remain in this environment for 20 to 40 months before returning to freshwater to spawn (Kan, 1975).

Historical distribution of Pacific lamprey in the Columbia River Basin followed that of salmon (Simpson and Wallace, 1978). Lamprey numbers have decreased significantly as the number of dams and the amount of development have increased within the Columbia River Basin; they are a federally listed species of concern. Little is know about the Pacific lamprey population in the Okanogan River or Salmon Creek, although lamprey likely do not use Salmon Creek due to passage constraints. Recently constructed Pacific lamprey redds (11) were observed in April 2003 in the Similkameen River, a major tributary of the Okanogan River, upstream of Salmon Creek near Oroville, WA. (Ward, 2003). Lamprey counts at Rocky Reach Dam on the Columbia River near Wenatchee, declined from 17,200 in 1969 to less than 200 in 1976 (Mullan et al., 1986).

Bull Trout

Bull trout have both anadromous and migratory resident populations. It is unlikely that the anadromous form is found in the Project area. The resident form of bull trout uses headwater areas that are typically in pristine environments. Spawning begins in late August, peaking in September and October. After spawning, adult bull trout overwinter in mainstem rivers and lakes. Newly-hatched fish emerge from the gravel the following spring and normally migrate to mainstem or lakes as two-year-olds. These fish may not mature until they are seven to eight year olds, and rarely reach sizes greater than 14 inches in length (WDFW, 2003).

The status of bull trout in the Okanogan watershed is unknown but they are believed to be extirpated downstream of Enloe Dam located at RM 8.8 on the Similkameen River and Zosel Dam at RM 78 on the Okanogan River (USFWS, 1998). Bull trout in the Columbia River basin were listed as endangered under the ESA in 1999. The Okanogan River is not suitable habitat for bull trout due to the requirement of cold, clean waters with clean gravel/cobble substrate for successful spawning and rearing (ENTRIX and Golder, 2003). Bull trout are documented to have used only Salmon Creek and Loup Loup Creek in the Okanogan Basin. Bull trout were reported in creel census records from the 1940s and 1950s in the north fork of Salmon Creek (K.

Williams, pers. comm. to Nancy Wells, ENTRIX Technical Assessment Group and Golder, 2003). They are not expected to be present in the Okanogan River in the Project area and are discussed below for Salmon Creek.

Westslope Cutthroat Trout

Adult cutthroat trout spawn in spring and early summer. Eggs usually hatch in six to seven weeks and alevins remain in the gravel for another one to two weeks. Emergence can take place through August, when some fry move into the lake environment. Cutthroat are a federally listed species of concern. The status of cutthroat trout in the Okanogan watershed is unknown. Cutthroat trout are not expected to use the Okanogan River in the area of the Project. Cutthroat trout may occur in Salmon Creek as described below and have been observed in the North Fork.

Habitat Conditions

Presently, habitat conditions in the mainstem of the Okanogan River are marginal for salmonids due to high water temperatures, poor quality spawning habitat, and poor water quality (Washington State Department of Ecology, 1996. In general, salmonids probably use the Okanogan River in the area for migration and some staging at the mouth of Salmon Creek. Spawning and rearing habitat for coldwater salmonids appears to be extremely limited, if not completely absent. However, salmonids that tend to spend limited time (short life history phases) in the mainstem Okanogan and Similkameen Rivers have had some success. This life strategy is particularly important to avoid extreme conditions in the summer when temperatures are the highest and flows are lowest. The more successful native species using the Okanogan River mainstem include summer chinook salmon (which hatch and emigrate early in the spring), steelhead, and mountain whitefish (Mullan et al., 1992). Warm water, low velocities and heavy sedimentation in the mainstem limit use by salmonids.

Okanogan River water temperatures often exceed lethal tolerance levels for salmonids in the mid- to late summer. These high temperatures are a result of natural conditions (low gradient and solar radiation on the upstream lakes), but are exacerbated by low summer flows caused by dam operations and irrigation. High water temperatures in late summer and fall form a thermal limitation or barrier that effectively excludes juvenile salmon from rearing in most of the basin, except during the first few weeks after emergence. High water temperatures in the lower Okanogan River also create a thermal barrier for anadromous salmonid passage, sockeye in particular. Sockeye salmon have been observed using the mouths of creeks as thermal refuges during return migrations along the reach of the Okanogan, near the confluence of Salmon Creek (Fisher per. comm., 2003). Water temperatures pose the most difficult problem for increasing the survival of most ocean-type and stream-type salmonids in the basin. Chapman et al. (1994a) plotted water temperature in the Okanogan River at Oroville and Tonasket, showing that mean midsummer daily temperatures were frequently well over 70°F in 1986 and 1987. Hansen (1993) plotted mean daily temperatures near Zosel Dam at 70°F or higher for at least 50 days in 1992, and higher than 77°F for periods of up to 10 days. Hansen (1993) speculated that the alteration of flow regimes by upstream structures have possibly changed retention times in Lake Osoyoos that exacerbate the problem. Adult passage through lower Okanogan River (downstream of Lake Osoyoos) may be blocked in certain years by a thermal barrier during late July and early August (Pratt et al., 1991).

Physical migration barriers, including the extraction of water from tributaries, are an important constraint to anadromous fish production in the Okanogan River watershed. Historical irrigation systems likely caused problems for migrating salmon. The main irrigation canals on the floodplains of Okanogan River were constructed parallel to the river channel and intercepted most tributary streams (Wissmar, et. al, 1994). Anadromous fish barriers on Omak Creek, Salmon Creek and the Similkameen River have restricted access to a considerable amount of tributary spawning and rearing habitat for the migrating fish in the basin. Recently, improvements in passage conditions have been evaluated for these tributaries and have actually been implemented on Omak Creek. A fish ladder has recently been constructed at the OID diversion dam on Salmon Creek.

Local conditions near the confluence of Salmon Creek do not differ greatly from the Okanogan River as a whole. The area of the Okanogan River from the mouth of Salmon Creek, upstream to the alternative pumping station locations is likely used exclusively for migration and some staging, especially in the warm summer months. Observations indicate sockeye salmon use the mouths of tributaries to the Okanogan River as thermal refuge during return migrations. Water temperatures throughout this localized reach create significant concerns to salmonid health.

3.5.1.3 Salmon Creek, Reservoirs and Tributaries

<u>Fisheries Resources</u>

Salmon Creek

Historically, the fisheries in the Salmon Creek watershed included anadromous chinook salmon, coho salmon, chum salmon, and steelhead (Mullen et al., 1994; cited in Fisher et al., 1997). Resident species included rainbow trout, westslope cutthroat trout, and bull trout (Mongillo, 1993). Both steelhead trout and spring chinook salmon runs utilized a large part of the Salmon Creek watershed, including both the west and south forks of Salmon Creek. Salmon Creek provided a large portion of the good spawning habitat for steelhead trout and spring chinook salmon in the entire Okanogan basin (USFWS, 1949). Prior to diversions for irrigation, Salmon Creek had a significant fishery, with runs of considerable size, and provided important subsistence, cultural, and economic value to native peoples, especially the nearby Okanogan Indian Tribe. Early European settlers also harvested fish for consumption. It is reported that anadromous fish ascended to the upper basin streams as late as 1908, when a fish ladder was built at the BOR diversion weir. Shortly after that (1910), Conconully Dam was completed and, in most seasons, any water not delivered to irrigation was used to fill the reservoir. This resulted in the lower reach being completely dry for extended periods of time and largely resulted in the extirpation of anadromous fish from Salmon Creek (USFWS, 1949).

Presently, fish stocks found within Salmon Creek are primarily resident rainbow trout and brook trout. The lack of streamflow below the diversion dam (lower reach) during spring and summer has precluded fish from inhabiting this lower area and has largely prevented migration of adult anadromous fish into Salmon Creek from the Okanogan River. The lower reach has been dewatered, to some degree, since the irrigation diversion began extracting water over 90 years ago (1910). During high water events, there is sufficient water available for adult fish migration. It has been hypothesized that, during these infrequent flood events that typically occur during the spring and correspond to migration times, steelhead trout and possibly chinook salmon could utilize this reach as a migration corridor. Some kokanee salmon are present in this reach from fish that have spilled over the reservoir during flood events. Steelhead trout and chinook salmon can use the middle and upper reaches of Salmon Creek if access is provided (Mullin et. al., 1994; cited in Fisher et al., 1997). In an effort to restore steelhead populations, the Washington Department of Fish and Wildlife has implemented a stocking program in coordination with the Colville Confederated Tribes. Approximately 10,000 to 15,000 steelhead smolts are stocked downstream of the OID diversion dam and water is leased from the OID to provide flows to flush the smolts to the Okanogan River (Fisher et al. 1997, C. Fisher, pers. comm., 2003).

Although spring chinook salmon and steelhead trout do not currently complete their life cycles in Salmon Creek, examination of existing literature reviews and personal communications with biologists familiar with Salmon Creek and nearby populations provide an estimate of likely timing for important life stages of these anadromous fish (Fisher, pers. comm. 2003; ENTRIX and Golder, 2003; Dames and Moore, 1999; Fisher et al., 1997). For steelhead trout, upstream migration and spawning takes place beginning the latter part of March and can continue through the end of May. Eggs incubate from April through July, with outmigration for smolts occurring April through late May the following year. For example, if an adult spawns in spring of 2003, the smolts produced would typically outmigrate in spring of 2005. Spring chinook migrate upstream and spawn from May through August, with incubation of eggs continuing through February. Smolts outmigrate in April through May the following year. Spring chinook migrate upstream and spawn from May through August, with incubation of eggs continuing through February. Smolts outmigrate in April through May.

Reservoirs and Tributaries

Currently, fish species that are known to use the reservoirs and upper tributaries of Salmon Creek include rainbow trout, kokanee salmon, largemouth bass, eastern brook trout, goldfish, and west slope cutthroat trout. Bull trout, a federally listed species (**Table 3-20**), may also occur. All of these species have naturally reproducing populations, although rainbow trout are supplemented by hatchery stocks in the reservoirs. The upper watershed does continue to support a local fishery. Kokanee salmon, resident rainbow trout, and eastern brook trout naturally reproduce in or upstream of the reservoirs. These fish spawn in the north and west folks of Salmon Creek, which enter the reservoirs, or along the reservoir shorelines.

Both Salmon Lake and Conconully Reservoir are managed as hatchery production rainbow trout fisheries (Fisher et al., 1997). The reservoirs are stocked with about 75,000 fry (90 fish per pound) and 25,000 fingerling (15 fish per pound). However, low lake levels in recent years have required an additional stocking of 10,000 catchable-sized trout (2.5 fish per pound). This stocking is needed to offset the lower productivity in the reservoirs due to a decreased water volume. Fishing pressure has been estimated at 60,000 angler days on Salmon Lake and approximately 35,000 angler days for Conconully Reservoir (letter from Barlett, WDFW, June 27, 2002).

Kokanee salmon have been established as a self-sustaining population in the reservoirs since 1990. Spawning appears to occur on beaches within the reservoir (letter from Barlett, WDFW, June 27, 2002) and likely includes the mouths of the upper tributaries. During the fall, kokanee salmon would use the diversion channel between Conconully Reservoir and Salmon Lake as a migration/spawning corridor. This channel is often dewatered in the fall, limiting both fish migrations and available spawning habitat (Fisher et al., 1997). In the recent past when the channel has been dry, the Washington Department of Fish and Wildlife has collected kokanee to artificially spawn and rear fry in a hatchery. These fry are subsequently used to augment natural reproduction within the watershed (Ken Williams, WDFW, per. comm. as cited in Fisher et al., 1997).

Largemouth bass were introduced to the reservoirs around 1990 (Ken Williams, WDFW, pers. comm. as cited in Fisher et al., 1997). Goldfish, which can weigh several pounds each, were introduced into Salmon Lake, and may now occur in Conconully Reservoir. Currently, there is a sustainable population of largemouth bass in both Salmon Lake and Conconully Reservoir. The more frequent and severe water fluctuations in Conconully Reservoir during spawning and incubation periods decrease bass production compared to Salmon Lake (Fisher et al. 1997). In Salmon Lake, the rocky shoreline and fluctuating water levels have mitigated impacts from these introduced species. In general, the largemouth bass in Conconully Reservoir have impacted the resident trout through competition and predation (letter from Barlett, WDFW, June 27, 2002).

Bull trout may still be present in the Salmon Creek drainage and they are a federally listed endangered species (**Table 3-20**). Historical records indicate bull trout were present in the North Fork Salmon Creek (Chelan PUD, 1998), although interbreeding with eastern brook trout (*Salvelinus fontinalis*), which were first introduced in 1951, may have eliminated this species from the watershed (Fisher et al., 1997). If bull trout are in the Salmon Creek watershed, they would be in the upper watershed, upstream of and potentially using Conconully Reservoir (Fisher et al., 1997). Like bull trout, westslope cutthroat trout distribution and abundance is not known. However, westslope cutthroat were collected during sampling in the North Fork Salmon Creek in 1996 (C. Fisher pers. comm. 2003).

Habitat Conditions

Lower Reach of Salmon Creek

The portion of Salmon Creek extending from the Okanogan Irrigation District's (OID) diversion dam to the confluence with the Okanogan River is approximately 4.3 miles in length. Geomorphic and hydrologic conditions within this reach are currently inadequate for fish passage, spawning or rearing. The lower reach of Salmon Creek has been dewatered under normal irrigation operation, except during spring runoff events that result in uncontrolled spill at the reservoirs and diversion dam.

Historical land uses on uplands, combined with yearly dewatering of the channel, have altered vegetation and sediment production. These changes have created a direct and permanent manipulation of the stream channel, stream banks, and riparian vegetation. The result is an adverse affect on the channel geometry and permeability, streambank stability, and riparian area, which has greatly decreased the habitat quality of lower Salmon Creek. In general, the channel cannot maintain surface water flow due to the course bed materials and subsequent lowering of the water table. Riparian vegetation that would help maintain stability and provide shade to the stream has been eliminated in large areas. The stream channel and banks have therefore become unstable, resulting in further deterioration of the stream during flood events. In addition, at the mouth of Salmon Creek, a large delta has formed from the transport of large sediment in the lower reach. The delta extends into the Okanogan River and is approximately 8 feet higher than the base water level of the Okanogan River. Even when flows exist, this alluvial fan impedes fish passage.

Middle Reach of Salmon Creek

The middle reach is approximately 11 miles in length and extends from the OID diversion dam (RM 4.3) to Conconully Dam (RM 15.3). NRCS (1999) conducted the most extensive survey of stream morphology and associated habitat conditions. Related studies generally support the results of the NRCS surveys (Fisher and Fedderson 1998, Hansen 1995, USFS 1997). Construction and operation of Conconully Reservoir has altered the shape of the natural hydrograph in this reach but NRCS found that the nature and magnitude of these alterations are not likely detrimental to salmonid use in this reach. Both Conconully Reservoir and Salmon Lake are operated as irrigation storage reservoirs. While in most years storage occurs during the anticipated period of peak runoff, the reservoirs fill and spill during normal and above normal snowpack years.

In general, riparian vegetation and floodplain function varies from good to poor depending upon location within the reach. Within the four miles below Conconully Dam, the stream corridor is narrow and steep and largely inaccessible. This section of the middle reach does not support extensive agriculture or grazing in the stream corridor and the general condition of the riparian vegetation and floodplain function is quite good. Between the former town of Ruby (RM 10.3) and the OID diversion dam, a distance of approximately six miles, the stream corridor is extensively used for livestock pasture, or hay, wheat, and barley fields. In some locations the stream appears to have been moved from its natural watercourse. The general condition of the riparian vegetation and degree of floodplain development has a negative effect on streambank stability, sediment and nutrient loading. The general condition of riparian vegetation is poor in some areas and likely has some negative influence on stream temperature, allochthonous input (i.e., leaves), benthic production and cover. However, observation of this reach suggests that more than half of this 11-mile stream reach has good riparian shade and good potential for allochthonous input (ENTRIX and Golder, 2003).

Reservoirs and Upper Tributaries (North, South and West Forks of Salmon Creek)

The Upper Salmon Creek watershed consists of the north fork, west fork, and south fork and drains the approximate 119-square-mile upper Salmon Creek watershed. The South Fork Salmon Creek flows into the West Fork about one mile southwest of Conconully at RM 1.3 of the West Fork. The West Fork and North Fork both flow into Conconully Reservoir. Water is diverted from the North Fork through a feeder canal that flows into Salmon Lake. Conconully Reservoir has 450 surface acres with a maximum depth of 50 feet. Salmon Lake has a maximum depth of 110 feet and 313 surface acres. Conconully Reservoir is subject to greater variations because of irrigation operations and limitations imposed by the current condition of the North Fork Feeder Canal to Salmon Lake (restricting the flexibility of water delivery from Salmon Lake to Conconully Reservoir).

Fish habitat within the upper watershed has been altered by past management activities, including dredge and placer mining, timber harvest, livestock grazing, and road construction. Stream surveys have concluded that a lack of large woody debris (LWD), with a subsequent deficiency in the number of pools, and embedded substrate exists in the South Fork. Stream surveys suggest that past logging along riparian corridors is the basis for this lack of LWD. In addition, past mining in the North Fork has resulted in the streambed being dominated by large-size substrate, which leads to marginal spawning habitat for small salmonids (Fisher et al., 1997).

The North Fork feeder canal transports water from about RM 0.5 on the North Fork to Salmon Lake. During field reconnaissance in April 2003, it was estimated that about 7 cfs was being diverted from a total flow of about 16 cfs above the diversion (approximately 40 percent of the total flow). The canal is approximately 0.7 miles in length and is constructed of concrete. Most of the bottom of the canal is exposed concrete with few areas of sandy to small gravel substrate. The upper portion (less than 50 feet) of the North Fork feeder canal may provide some minimal habitat for salmonid rearing, although field surveys (April 2003) indicate that the substrate appears to be too small for spawning and no evidence of reproductive behavior was observed (neither redds nor fish).

3.5.2 Fisheries Impacts

Impacts are analyzed for operation and construction of the action alternatives. Impacts are described for the Okanogan River, and the lower reach, middle reach, and upper reach (including reservoirs and North Fork feeder canal) of Salmon Creek. Impact analysis relies on the water quantity (**Section 3.1**) and water quality (**Section 3.2**) analyses. This section addresses stream flow impacts on fish habitat and related production, focusing on the reaches of Salmon Creek. The stream reaches were modeled to simulate streamflows and reservoir levels using the water models described in Section 3.1 and **Appendix C.** **Appendix D** provides the model output and a statistical analysis of the output and summary graphs of the model output.

As described in **Section 3.1**, the No Action Alternative is very similar to existing and historical conditions, in respect to hydrology, especially on a watershed-scale. Therefore, the No Action alternative uses historical stream flow averages. Streamflow life stage requirements for anadromous fish were used to develop simulated streamflows for the Action and No Action Alternatives.

To estimate impacts of fish habitat and potential production related to water supply alternatives, the instream flow scenarios were overlaid on the species and life stage requirements described above (**Section 3.5.1**). For the middle and lower reaches of Salmon Creek, minimum flow requirements were estimated that would provide adequate protection of the species and life stages in each season. To distinguish these from legal minimum flows (which are not established for Salmon Creek), these are termed “minimum flows for fish” in this section. These estimates of minimum flows for fish are not considered optimum, but would likely maintain anadromous life stages in Salmon Creek and protect populations over generations. Flows below the estimated minimum flows for fish could affect survival. **Table 3-21** provides a summary of steelhead trout and chinook salmon use in Salmon Creek by lifestage and the estimated minimum flows for fish by reach for protection. The time period of use by the steelhead and chinook salmon life stages are shown as gray bars across the months of the year. Corresponding to each species life stages is the estimated monthly minimum flows for fish for each reach in Salmon Creek, and for Lower

Salmon Creek rehabilitation. Impacts were determined by comparing these survival requirements to the amount of water delivered to each reach, as simulated in the streamflow model for each alternative (where applicable).

Extensive work has been done to estimate the potential for salmonid returns to the Okanogan River system as a result of the proposed restoration of this portion of Salmon Creek. **Appendix H** contains a letter from CCT responding to a review of the project by the NWPPC Independent Science Review Panel (CCT, April, 2002). The letter documents production estimates ranging from 6 to 804 steelhead and approximately 121 to 184 chinook.

Changes in reservoir levels (Conconully Reservoir and Salmon Lake) also could affect fish. Reservoir levels also were modeled (see **Section 3.1** and its associated appendices). The timing and magnitude of changes in reservoir levels provide a basis for estimating impacts to the impoundments and feeder streams.

Minimum flow requirements are established for the Okanogan River by the Washington Department of Ecology by rule for protection of aquatic resources. Placed into the Washington Administrative Code (WAC), these regulatory minimum flows represent a "water right for the river" and constrain only junior water rights (those water rights granted later in time than the date the regulatory minimum instream flows were established); they do not affect senior water rights existing at the time minimum flows were promulgated. Regulatory minimum flows are intended to "provide for preservation of wildlife, fish, scenic, aesthetic and other environmental values, and navigational values" (RCW 90.54.020). Changes in the number of of the WAC minimum flow level (flow levels lower than required) as compared to the historical record are used to estimate the impact.

In conjunction with stream rehabilitation and water supply, steelhead trout and chinook salmon could be reintroduced in the future. Natural run pacific lamprey may also utilize spawning and rearing habitat in Salmon Creek following rehabilitation and/or improved flows. Because these are ESA-listed species, their return to the creek with improved flows or access could conflict with some present and future land and water use practices.

The broodstock selected for chinook salmon would likely be "early returning" spring type. It is thus expected that the progeny would also be "early returning." Return migration and spawning could be timed to avoid the potential thermal barrier to fish passage that develops in the warmer summer months (CCT, March 2002). A likely candidate, at least initially, for stocking is the Carson stock spring chinook salmon. This stock has been approved in both Omak Creek and the Okanogan River and is currently being used in both systems (CCT, March 2002). This stock is not federally protected, making stocking, handling, and management less complicated. The source and use of this spring Chinook salmon stock and the development of a monitoring and evaluation plan may be developed based on the outcomes of the NEPA process (CCT, March 2002). Steelhead trout that are presently used for planting in Salmon Creek are a listed stock. The use of listed steelhead trout may change in the future, but no decision has been made. Any final decision would be contingent upon consultation with, and approval by, NOAA Fisheries. The potential for use of early returning broodstock is described in **Appendix H**, as part of the CCT response to the NWPCC Independent Science Review Panel review.

Table 3-21. Estimated fish use and minimum instream flows by month for species life stage requirements, by stream reach and stream rehabilitation alternative for Salmon Creek.

Species and Life Stage[3]	Stream Reach and Alternative	Month Monthly minimum flow value or range in cubic feet per second[3](acre-feet/month))											
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Summer Steelhead	Middle reach[1]	4(246)	4(222)	4(246)	15(891)	15(921)	15(891)	10(614)	10(614)	10(594)	4(246)	4(238)	4(246)
	Lower reach – with stream rehabilitation[2]			15(356)	15(891)	5-25 (812)							
	Lower reach – without stream rehabilitation[2]			15-25 (495)	20-25 (1,337)	5-25 (812)							
Rearing/Overwintering		1/1-3/31									10/1-12/31		
Spawning/Migration					3/20-5/14								
Incubation					4/1-9/31								
Adult Outmigration					4/1-5/25								
Smolt Outmigration					4/1-5/25								
Rearing[4]								7/1-9/1					
Spring Chinook	Middle reach[1]	7(430)	7(388)	7(430)	7(416)	20 (1,228)	20 (1,188)	20 (1,228)	20 (1,228)	7(416)	7(430)	7(416)	7(430)
	Lower reach – with stream rehabilitation[2]					20 (1,228)	20 (1,188)	20(594)					
Rearing/Overwintering		1/1-4/30											
Spawning/Migration						5/1-8/31							
Incubation		1/1-2/28				5/1-12/31							
Smolt Outmigration					4/1-5/31								
Rearing/Overwintering							6/1-12/31						
Chinook and Steelhead	Middle reach[1]	7(430)	7(388)	7(430)	15(891)	20 (1,228)	20 (1,188)	20 (1,228)	20 (1,228)	10(594)	7(430)	7(416)	7(430)
	Lower reach – with stream rehabilitation[2]			15(356)	15(891)	20-25 (1,287)	20 (1,188)	20(594)					

1. -Minimum flow requirements change on 1st of each month.
   -Middle reach recommended instream flows are independent of stream rehabilitation in the lower reach.
2. -Minimum flow requirements change on various dates within month, as some life stages require additional flows for only part of the month (see Appendix 3.1-F for details).
3. -Estimated from existing literature and personal communication with biologists familiar with Salmon Creek and nearby systems (Dames and Moore 1999, ENTRIX, Inc. and Golder 2003, C. Fisher personal comm. 2003).
   -Dark bars show the time period of important use by a species and life stage.
4. -Although rearing takes place all year, the period shown here is related to additional water needs for rearing during this time period.

3.5.2.1 Alternative 1: Okanogan River Pump Station

Okanogan River

Construction

Construction of Alternative 1 would have minor impacts on the Okanogan River bottom at the location where the pump would be located. The sand bar and deep hole in this location are not expected to change in any important ways. Using preventive measures, and perhaps some maintenance, little to no stream meander, erosion, or sedimentation is expected to occur. To prevent erosion near the intake pipes, mat gabions would be placed in a part of the river channel with a relatively stable bottom. Pilings driven into the streambed in front of the screens would prevent damage from floating debris. As debris accumulates on the pilings, flow can be redirected toward the bank. Periodic removal of debris would be required to prevent erosion. Placement of the gabions and pilings would disturb and eliminate the aquatic habitat in the footprint of these structures. It could also provide additional habitat for warm water predators of out-migrating salmon. To minimize or avoid potential erosion and sedimentation resulting from the pump station construction, it would be located away from the riverbank and above the elevation of the 100-year floodplain. Additionally, the bank would be protected from erosion using methods such as boulder and timber armoring or rock gabions (URS, 2002). Pipeline construction would utilize Best Management Practices (BMPs) to minimize erosion and to control runoff. The pipeline would not cross any streams or other surface water bodies influent to the Okanogan River.

Construction activities associated with this alternative would have some negative impacts on fish by causing short-term and localized sedimentation and erosion. BMPs would be used to minimize these impacts.

Screens for the intake pipes would be activated wedge-wire drums, selected using NOAA Fisheries screen criteria for protection of anadromous fish. This screen type was the preferred alternative considered because of its reliability, low maintenance costs, low initial capital costs, and its proven effectiveness in screening adult and juvenile anadromous fish without harm (URS, 2002). The possible negative impacts to fish are potential entrainment or impingement, although these impacts are expected to be minimal, assuming the fish screens are properly maintained.

Operation

Alternative 1 could decrease flows in the Okanogan River by up to 55 cfs. The percentage of Okanogan River flows that would be pumped under Alternative 1 increases for all fish flow regimes over all water year types (**Section 3.1**). However the increased percentage pumped would not be of a magnitude or at a time that would adversely affect streamflow in the Okanogan River in wet, above normal, normal or below normal water years. In these years there would be no change in the frequency with which in stream flows fall below of WAC regulatory minimums as compared to the No Action Alternative (**Section 3.1**). During dry water years pumping from the Okanogan River would slightly increase the frequency with which flows fall below WAC minimums (by approximately three more days of WAC exceedence per year). As with

Alternative 2, impacts to fish would be minor, given the relatively small percentage of the total flow in the Okanogan withdrawn.

Water flow in the river downstream from its confluence with Salmon Creek would be supplemented with cooler, higher quality water flowing from Salmon Creek. The Salmon Creek water would reduce local water temperatures and improve localized water quality in the river. Salmon Creek inflow to the river would increase under this Alternative for all water year types (**Section 3.1**). The increase represents a doubling or tripling of Salmon Creek inflow to the Okanogan in wet and normal water years. For below normal and dry water years the increase is four to five times that of the No Action Alternative. This would have a beneficial impact for salmonid fisheries in the Okanogan River downstream of the confluence with Salmon Creek. This direct and positive impact would create a small thermal refuge, with increased benefits provided during dry water years when conditions in the Okanogan are more severe.

The potential thermal benefit was investigated in some detail in 2000 by the Colville Tribe (CCT, 2002):

> *The proposed pump station, at least conceptually, is intended to deliver "warm" water from the Okanogan River to orchards and farmland within the irrigation district while allowing "cool" water (peak-66.3^{o}F [2000], CCT, unpublished data) historically diverted from Salmon Creek to flow downstream. In addition, this would also address Washington Department of Ecology's (WDOE's) 303d listing of inadequate flows in lower Salmon Creek. The cool water, which has been diverted historically for irrigation, would flow through the lowermost 4.3-mile reach of Salmon Creek to the Okanogan River, providing benefit to both adult and juvenile salmonids. In addition, this "cool" water discharge from Salmon Creek would likely create a thermal refuge in the Okanogan River, and likely be utilized by migrating sockeye salmon. Based upon radio-telemetry tagging studies conducted by Douglas County PUD, sockeye have held in cool water refugia created by tributaries, such as Aneas Creek (~ 4 cfs, 64 ^{o}F, CCT, unpublished data), during migration through the Okanogan River. The thermal refugia may also be used by juvenile salmonids. For instance, Belchik (1997) reported extensive use of thermal refugia at tributary mouths in the Klamath River.*

Negative impacts of water flowing from Salmon Creek into the Okanogan may occur. When water is flowing through lower Salmon Creek, more frequent sedimentation could lead to continued short-term increases in TSS and suspended solid concentrations in the Okanogan River at, and downstream of, the confluence with the creek. These potential impacts are expected to have minor impacts, if any, on fish in the Okanogan River because they would be short-term and localized at the confluence with the creek, and therefore avoidable for fish in the Okanogan.

A thermal barrier potentially could exist between the pump station and the mouth of Salmon Creek. The barrier could delay or impede migrating salmonids (i.e. Sockeye, Summer Chinook), particularly during low flow conditions.

Lower Salmon Creek

Alternative 1 would reestablish seasonal fish migration flows in lower Salmon Creek that do not occur under the historic irrigation operations and that would not be provided under the No Action Alternative. This alternative would reestablish winter base flow in the lower reach (proportionally greater in the upstream section that was dewatered under the historic irrigation operations and would continue to be dewatered under the No Action Alternative. The median monthly streamflow on lower Salmon Creek below the weir (upstream area) under this action alternative would increase for all months, except July and August in normal or drier years. This Alternative also reestablishes seasonal fish migration flows in lower Salmon Creek (at the mouth) that do not occur under historic irrigation operations.

Alternative 1 is best represented in **Table 3-22** by the *steelhead trout without channel rehabilitation* option. The option of partial rehabilitation, such as removal of the gravel bar, was not modeled. In the table, the greatest difference between estimated minimum flow needs for fish and simulated flow delivery would be during April. The deficit in April would be about five cfs, which could be important but is likely an artifact of the way in which the water model handles flows during this month. When compared to minimum flow estimates, the difference between simulated flow in dry versus normal years would be relatively minor. It appears that this alternative could provide flow volumes close to the minimum flow estimates for all options during dry years, indicating a potential stability in habitat during all water year types.

Increased water supply without stream rehabilitation could result in minimal increased stream bank erosion and overall habitat degradation below the OID diversion. The removal of the bar at the mouth of Salmon Creek and increased flows associated with this alternative would provide improved passage for steelhead trout to the middle reach of Salmon Creek, where spawning gravels and overall better habitat conditions would permit successful spawning and juvenile survival of some fish. However, the poor condition of the lower reaches of Salmon Creek may remain inadequate for spring chinook passage and survival. Chinook salmon would likely remain extirpated from Salmon Creek. Only with channel rehabilitation efforts in lower Salmon Creek, in combination with passage flows, would conditions be adequate for chinook salmon survival.

Without stream channel rehabilitation, steelhead survivability through generations would be uncertain. April is the most important month for steelhead trout adult migration, yet this month could have the greatest deficit of water (again, this appears to be an artifact of modeling). It is important to note that during dry years, the water delivered would be similar to an average year in terms of meeting minimum flow needs estimated for steelhead trout. This consistent amount of water, even during low flow years, would increase the potential for long term sustainable populations of steelhead trout.

Overall, this alternative would have long-term beneficial impacts to Salmon Creek fish populations. Direct benefits include water volumes sufficient to provide passage for anadromous fish. Without full channel rehabilitation, steelhead would still benefit from increased flows, and careful water management (i.e., in the amount and timing of water needed for different species/life stage flow needs – see Resource Management Plan) could increase the possibility of a sustainable population over generations. The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region (WDFW and WWTT 1997, ESA 1997, UCSRB 2003).

Table 3-22. Build new 80 cfs pumping station. Comparison of average monthly flows at 10%, 50% and 90% exceedence and average monthly flows estimated by the water model to meet minimum flow estimates for fish species and life stages. Shaded bars indicate when minimum flows for fish would not be met.

Fish Species and Channel Rehabilitation Options	Percent Exceedence[1]												
MIDDLE REACH		**Month**											
Middle Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Steelhead/chinook with channel rehabilitation		7	7	7	15	20	20	20	20	10	7	7	7
Steelhead without channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Middle Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	4	4	6	14	15	15	8	7	10	4	4	4
	50%	8	10	8	15	86	92	26	10	10	4	9	9
	10%	14	15	16	85	285	234	73	28	18	17	20	15
Steelhead/chinook with channel rehabilitation	90%	7	7	7	15	21	19	18	18	8	7	7	7
	50%	7	9	7	15	75	92	27	19	9	7	7	7
	10%	15	16	13	72	285	234	73	28	17	16	20	15
Steelhead without channel rehabilitation	90%	4	4	8	22	15	15	4	8	10	4	4	4
	50%	8	10	9	23	81	91	26	11	10	4	9	9
	10%	14	15	16	84	285	234	73	28	18	17	20	15
LOWER REACH		**Month**											
Lower Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation[3]				6	15	5-25							
(monthly flow average of minimum flow estimate)[4]						(13)							
Steelhead/chinook with channel rehabilitation[3]				6	15	20-25	20	10					
(monthly flow average of minimum flow estimate)[4]						(21)							
Steelhead without channel rehabilitation[3]				15-25	20-25	5-25							
(monthly flow average of minimum flow estimate)[4]				(8)	(23)	(13)							
Lower Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	3	3	5	12	12	12	2	1	8	3	3	3
	50%	7	8	6	12	43	40	8	6	8	3	7	7
	10%	11	12	13	63	202	150	17	8	8	9	15	12
Steelhead/chinook with channel rehabilitation	90%	6	6	5	12	17	16	8	0	1	6	5	5
	50%	6	7	5	12	33	40	8	3	5	6	5	5
	10%	12	13	10	53	202	150	18	8	8	8	15	12
Steelhead without channel rehabilitation	90%	3	3	6	18	12	12	0	0	8	3	3	3
	50%	7	8	7	18	39	40	4	2	8	3	7	7
	10%	11	12	13	63	202	150	18	8	8	9	15	12

1. From Appendix 3.1-F.
2. From Table 3.5-2.
3. A flow range is given when minimum flow estimates change during that month. Minimum flows can change to simulate variation of discharge that would be found under natural conditions. Pulses of water with different flow are also provided to "stimulate" migration.
4. This is the average flow for a month if minimum flow is provided. Some months only require a minimum flow for part of the month, therefore the average monthly flow can be less then a minimum flow. This is provided for comparison to monthly averages presented as exceedence flows.

Middle Salmon Creek

Alternative 1 would reduce the unnaturally high summer flows that occurred in the middle reach under historic irrigation operations. This action alternative would reestablish winter base flows that are not provided under historic irrigation operations. The median monthly streamflow in the middle reach of Salmon Creek under Alternative 1 would decrease in July through September, but would increase for the months from November through May (**Appendix D-5**). Middle reach streamflows would decrease by about 25 cfs in July, August, and September, when Okanogan River pumping replaces the need to convey Salmon Creek water through the middle reach, which would be more typical of summer flows experienced by fish. Winter base flows for fish survival would increase the median from nearly zero to 5 to 10 cfs in the months of November through

March. Variability in streamflow magnitudes between the three passage flow regimes should be most evident in April, May, and August, but would be similar for all other months. The median streamflow in April increases from about zero to 15 to 25 cfs, would increase in May by 30 to 40 cfs, and would decrease in August by 30 to 40 cfs, depending on which fish passage flow regime is applied.

Table 3-22 illustrates that Alternative 1 would meet minimum flow estimates for nearly all species and rehabilitation options except for the 90 percent exceedence level in the middle reach. The deficits are only 1-2 cfs in June through September for chinook and steelhead trout combined, 1-3 cfs in April, July and August for steelhead with channel rehabilitation, and up to 6 cfs in July and August for steelhead without rehabilitation. At the 50 percent exceedence level, there is a one cfs deficit during August and September for the steelhead trout/chinook salmon combination. This time period mostly affects incubation and rearing for both species and the end of the chinook salmon migration. The effects of this small deficit could be limited with refined water management (ie. amount and timing of water needed for different species/life stage flow needs – see Resource Management Plan, 3.5.3.3).

This alternative would provide long-term benefits to both species and under all options in the middle reach. Direct benefits include water volumes sufficient to provide anadromous passage for adults and smolts, spawning, incubation of eggs, emergence, rearing, and overwintering habitat. Resident fish (rainbow trout and brook trout) would also benefit through increased habitat availability and suitability, although competition with anadromous fish would occur. Indirect benefits to aquatic habitat would result from flow stabilization. The provision of anadromous fish access to and enhancement of productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region.

Upper Salmon Creek

No changes to the upper reaches of Salmon Creek streamflow would occur under this action alternative. The unregulated inflow is assumed to remain the same for the tributaries entering the Project reservoirs.

This action alternative would keep the median lake elevation higher and would reduce the seasonal fluctuation of Salmon Lake that occurs under irrigation operations. A large volume of water would consistently be available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The minimum monthly Conconully Reservoir water surface elevation under Alternative 3 would increase from August through March and would decrease in May and June for the steelhead flow regimes and decreased in all months for the steelhead and chinook flow regime (**Appendix D**).

Non-native fish populations (such as largemouth bass) may increase due to stabilized and increased water levels in the project reservoirs and may decrease resident salmonids i.e. kokanee and rainbow trout. Lower water temperatures (especially during the summer months), increased habitat availability, and the increase in inlet stream areas would be likely to increase native fish survivability and productivity. Resident species, including kokanee salmon and rainbow trout would likely benefit, though increased predation may lead to no net change in the rainbow population. Long-term beneficial impacts would likely occur to reservoir resident fisheries and additional opportunities would likely be provided through changes in fisheries management. An indirect benefit may be the opportunity to change management strategies in the upper reach given more stability and flexibility in reservoir operations.

3.5.2.2 Alternative 1: Feeder Canal Upgrade

Okanogan River

This component would have minor impacts on the Okanogan River. It would increase flexibility of water management and perhaps decrease the amount of water pumped from the Okanogan River.

Lower and Middle Salmon Creek

This component would have minor beneficial impacts on fish in the middle or lower reaches of Salmon Creek. It would permit greater control of water levels in Salmon Lake and, therefore, better regulation of water releases into the Conconully Reservoir via a diversion channel. Better control of storage in the reservoirs (and thus better regulation of water available for irrigation and for release into Salmon Creek), would enhance this alternative by providing more water and better results for the current stocking of steelhead trout on the middle reach. It might also provide more water during upstream (adult steelhead trout) and downstream (adult and smolt steelhead trout) migration. More flexibility in water supply operation could have indirect and beneficial impacts to both resident and anadromous fish in the middle reach of Salmon Creek by providing water during important migration periods.

There would be no adverse impacts to fish associated with rehabilitation of the feeder canal since it would be dewatered during construction. Impacts would be limited to those associated with any instream modifications to the headworks.

Upper Salmon Creek

Construction Impacts

Some localized fish impacts may result from construction during feeder canal upgrade activities. Impacts would occur at and immediately downstream of the headworks, in the canal itself and in the immediate vicinity of the outflow of North Fork Salmon Creek into Conconully Reservoir. Short-term adverse impacts may include loading of suspended sediment and solids. Long-term effects may include the degradation of habitat at the present canal entrance in the North Fork of Salmon Creek. The field reconnaissance survey indicated that this habitat is not of high quality and would mostly be limited to a small area that could be used by rearing resident fish. A new pipeline replacing the canal would directly eliminate the area of habitat within the footprint of the new structure. In the section near Salmon Lake where the pipeline leaves the current alignment, there would be minimal to no impact because the present canal does not provide important aquatic habitat. Short-term water quality impacts could be minimized through implementation of construction BMPs and timing of construction activities.

Operation Impacts

Operation of the upgraded feeder canal could decrease streamflow for approximately 0.5 mile of North Fork Salmon Creek between Conconully Reservoir and the OID feeder canal intake. No operational schedule for the feeder canal has been established. Operation of the upgraded feeder canal diversion would likely be focused on moderate to high runoff events in North Fork Salmon Creek, primarily in May and June of normal, above normal and wet years. However, operation of the feeder canal pipeline may occur in other months, and in other water year types. If operated at maximum capacity, the pipeline could decrease peak streamflow in this short reach by as much as 60 cfs during moderate to high runoff events compared to existing and historical operations. The upgraded feeder canal would decrease streamflow in this reach of North Fork Salmon Creek to the legal minimum flow (1.33 cfs) more frequently than under the existing and historical operations. This would likely occur during moderate to low flows such as those observed during field reconnaissance in April 2003 when flows were estimated below 20 cfs. Impacts to fisheries would include reduction in instream habitat in this short reach during the diversion period. The greatest impact would likely be at the mouths of the inlet stream used for migration and spawning. The decreased flow would likely affect both spring (rainbow trout) and fall (kokanee salmon) spawners. This would probably not be important considering the current conditions of low flow in the relatively small area impacted (in relation to the North Fork Salmon Creek in total). Timing of low flows would be the same as current conditions, but the overall flow would likely be lower.

Upgrading the canal would permit greater water supply to, and therefore greater storage in, Salmon Lake. It would allow increased flexibility in water management of Salmon Lake and Conconully Reservoir. Salmon Lake and Conconully Reservoir are stocked to provide rainbow trout fisheries. Low water levels in recent years have required increased stocking to offset the low productivity resulting from lower reservoir levels. Greater control over water flow into Salmon Lake via the feeder canal could permit greater management of water levels and, thus, management of available fish habitat. This alternative would maintain water levels at a greater elevation and maintain them for a longer period without as much fluctuation when compared to present conditions. Somewhat lower water temperatures would likely result, and more fish habitat would be present for salmonids. This would likely decrease habitat for warm water species as compared to present conditions. Because largemouth bass spawn on reservoir and lake margins, reduced water level fluctuations are likely to increase their reproductive success. Cooler water could decrease algae and other aquatic plant growth and would likely increase in dissolved oxygen.

Desirable resident fish likely to experience greater survivability and productivity include kokanee salmon and rainbow trout. However, improved largemouth bass reproductive success may lead to increased predation on goldfish, kokanee, and rainbow trout, all of which use similar habitat. With greater habitat availability, kokanee and rainbow trout populations are not expected to be reduced by the potentially increased predation, and may even increase in biomass. If more fish are produced through natural spawning and survival, rainbow trout fry and fingerling stocking requirements may decrease, and stocking of catchable-sized fish during extreme low reservoir years may be eliminated. Over time, as stocking decreases and rainbow trout become self-sustaining (as kokanee salmon currently are), genetic variation and therefore fish survivability would increase. Better regulation of water flowing through the diversion channel between Conconully Reservoir and Salmon Lake may also limit ongoing habitat dewatering during the fall, creating a direct positive impact for resident fisheries.

North, West and South Forks of Salmon Creek

Kokanee and resident rainbow trout naturally reproduce in the reservoirs, spawning in the North and West Forks of Salmon Creek. Limited spawning may occur in the upper portion of the existing feeder canal, though no records of this occurrence were found. Channeling all the diverted water into a pipe would eliminate any spawning in the feeder canal. Decreased flows below the diversion in North Fork Salmon Creek could also impact spawning in the North Fork.

3.5.2.3 Alternative 1: Stream Rehabilitation

The focus of stream channel rehabilitation in this alternative is removal of the alluvial fan at the mouth of Salmon Creek in order to provide for anadromous fish migration.

Okanogan River

Construction-related sedimentation would lead to a short-term increase in TSS and suspended concentrations in the Okanogan River near the mouth of Salmon Creek and immediately downstream. The removal of the large substrate bar at the confluence would have the potential to affect the Okanogan River. Since this work could be done when there is little or no flow in the lower reach of Salmon Creek and low flow in the Okanogan River, construction BMPs would minimize the impact. There would be increased, but short-term, sedimentation during the period when flows were again returned to the lower reach channel. Impacts to fisheries resources would be minimal and short-term.

Salmon Creek

Construction

There would be very little to no water present in the lower reach of Salmon Creek during construction. It is possible that minor (1 to 2 cfs) surface flow may be present in the work areas in the vicinity of drainage/treatment outfalls within the City. Stream rehabilitation construction would result in a release of sediment when water is returned to the lower reach, with short-term increases in total suspended solids (TSS) and suspended concentrations. Construction of the rehabilitated channel at the mouth of Salmon Creek would likely take several weeks.

Operation

Removing the bar at the mouth of Salmon Creek would provide access to migrating fish with less water than is required under current conditions. This would increase access to the middle reach of Salmon Creek for anadromous fish.

At this time, no changes to current steelhead stocking practices are planned in association with Salmon Creek rehabilitation, although removing the migratory barrier at the mouth of the creek would likely have a positive impact on this program. As steelhead and/or chinook salmon return, rainbow trout, brook trout, and salmon productivity could decrease in the middle reach. If resources become limited, larger steelhead trout or chinook salmon could out-compete smaller trout salmon, also preying on juveniles. The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region.

There would be no direct impacts within the middle reach of Salmon Creek as a result of implementing this component, only the indirect benefits associated with improving access through the lower reach of Salmon Creek.

3.5.2.4 Alternative 2: Upgrade Shellrock Pumping Plant

Okanogan River

Construction

Construction impacts to Okanogan River fisheries resources would be limited to construction during alteration of the intake structure. The new wing walls and raised sill would require the intake structure to be dry. River flow would be diverted to minimize impacts to fish from construction work. There would be a temporary increase in suspended sediments in the area of construction and downstream. The construction area would be dewatered to the extent practical to minimize the amount of water impacted. Direct disturbance of some aquatic habitat would occur, but this is expected to be short-term and minor. Intake screens would be modified to meet state and federal requirements, avoiding impacts from impingement or entrainment.

Operation

Increased pumping at Shellrock could result in increased impacts over current conditions. However, these impacts are likely to be minor. The frequency with which flows fall below WAC minimums in various water year types remains identical to the No Action Alternative (**Section 3.1**). There would not be large changes to water quality or quantity in the Okanogan River and therefore, impacts to fish habitat and production would be minimal. The percentage of the Okanogan River that would be pumped under this alternative would increase for all fish flow regimes over all water year types (**Section 3.1**). Potential direct impacts are related to reduction of flow, impingement (fish driven against the inlet screen by high velocity intake flows), and entrainment (fish drawn into the water being pumped from the river) at the inlet structure. Indirect impacts are related to degradation of water quality in the area between the Shellrock pump station and the mouth of Salmon Creek. Through planning and proper maintenance of pump station operation, impacts are likely to be minor in this area and would be seasonal in nature.

Although Salmon Creek inflow would contribute a small percentage of the Okanogan River Flow for this alternative (**Section 3.1**), the contribution would increase as compared to the No Action Alternative. Long-term beneficial impacts to fish in the Okanogan are expected to result from water flowing from Salmon Creek into the Okanogan. In 2000, high water temperatures peaked at 74°F in the Okanogan River at Malott (downstream of the Salmon Creek mouth), while temperatures in the Middle Reach of Salmon Creek peaked at 66.3°F (CCT unpublished data in CCT, March 2002). Therefore, a modest volume of water in the Okanogan River near the confluence of Salmon Creek would be cooled (and suspended sediments would be diluted as well) when water is released into lower Salmon Creek. This could have long-term beneficial impacts to anadromous fish that could use the area as a small thermal refuge during migration.

Flow releases to the lower reach would be timed to optimize passage in Salmon Creek and therefore, the small thermal refuge benefit could locally benefit steelhead trout and chinook salmon jiuveniles in the Okanogan River. Temperatures in the Okanogan River are generally highest in July, August, and September. While the waters flowing from Salmon Creek would be beneficial to the Okanogan River at any time, water would not be released into lower Salmon Creek during these warmest summer months. Therefore the timing of upstream migration and outmigration for some species would not coincide with flows in lower Salmon Creek. For example, there appears to be a thermal barrier that blocks adult sockeye salmon migration in the Okanogan River in certain years during late July and early August. Okanogan River spring flow augmentation from Salmon Creek would not likely benefit this sockeye salmon migration.

Lower Salmon Creek

There would be no construction impacts as a result of the upgrade to Shellrock Pump Station in any reach of Salmon Creek.

Alternative 2 would re-establish seasonal fish migration flows in lower Salmon Creek that do not occur under the historic irrigation operations and that would not be provided under the No Action Alternative. Alternative 2 could reestablish some winter base flow in the upstream area of the lower reach, which was decreased under the historic irrigation operations and which would continue to be dewatered under the No Action Alternative. Under Alternative 2, the median monthly streamflow below the OID diversion weir (upstream portion of the lower reach) increases by about 4 to 10 cfs from November through March for all three fish passage flow regimes (**Appendix D-5**). Stream flow in April would increase from zero to about 15 to 32 cfs, and in May from about 15 to 30 to 35 cfs, depending on which fish passage flow regime is applied. The greatest variability in flow magnitudes between the fish passage flow regimes is found in April, July, and August.

Table 3-23 provides a summary of minimum flow requirements for fish passage provided by Alternative 2. The period of concern for the lower reach focuses on anadromous fish migration periods, which occur from May through July. Comparison of estimated minimum flows to the simulated streamflows for this alternative (represented in the table by *steelhead with rehabilitation* or *steelhead/chinook with rehabilitation*) indicates that there would be sufficient water to provide passage for steelhead trout and chinook salmon with rehabilitation during wet water years (10 percent exceedence). Steelhead trout minimum flow estimate options are met or exceeded for all water year types (10 percent, 50 percent, and 90 percent exceedence). There would be an average monthly deficit of water for the steelhead trout/chinook salmon combination during March, April and July under an average water year (50 percent exceedence) or any drier years. The average monthly shortage ranges from one to four cfs. These shortages are relatively minor and could be managed through a refined water supply management plan(see

Resource Management Plan, 3.5.3.3) and flows may be sufficient to serve fish needs when examined more closely.

Overall, this alternative would have long-term beneficial impacts to Salmon Creek fish populations in the lower and the middle reaches. Direct benefits include water volumes sufficient to provide passage for anadromous fish and improved habitat suitability in some areas. Indirect benefits would include water quality improvements such as decreased temperatures, decreased dissolved/suspended sediment, improved gravel quality with less embedded fine substrate, and more complex and productive habitat such as pools created from large wood pieces in the stream. These benefits are an indirect result of riparian enhancement, channel and bank stabilization, and flow stabilization. Resident species would benefit from increased survival and production (probably restricted to the upstream portion of the lower reach), offset by increased competition from anadromous species. Anadromous species (both steelhead trout and chinook salmon) would greatly benefit with channel rehabilitation incorporated with Alternative 2. This could result in a sustained, naturally reproducing population of both species. The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region.

Middle Salmon Creek

Alternative 2 reduces the unnaturally high summer flows that have occurred in the middle reach under historic irrigation operations and reestablishes winter base flows that are not provided under historic irrigation operations. Under this action alternative, flows in the middle reach decrease in July through September (when Shellrock pumping from the Okanogan River reduces the need to convey Salmon Creek water through the middle reach), but increase for November through May (**Appendix D-5**).

Table 3-23 provides the comparison of estimated minimum flows for fish species and lifestages as compared to simulated flows expected to occur in the middle reach with this alternative. The flows provided for this alternative meet or exceed all of the minimum flow requirements for all species and life stages of concern.

This alternative would have long-term beneficial impacts to Salmon Creek fish populations. Direct benefits include water volumes sufficient to provide anadromous passage for adults and smolts, spawning, incubation of eggs, emergence, rearing, and overwintering habitat. Currently resident fish populations are limited by overwintering flows, so the provision of such flows will enhance their survival. Resident fish (rainbow trout and brook trout) would also benefit through increased habitat availability and suitability, although competition with anadromous fish would increase. Indirect benefits to aquatic habitat include water quality improvements such as decreased temperatures, decreased dissolved/suspended sediment, improved gravel quality with less embedded fine substrate, and more complex and productive habitat such as pools created from large wood pieces in the stream. These benefits are an indirect result of riparian enhancement, channel and bank stabilization, and flow stabilization. Anadromous species, especially steelhead trout, would greatly benefit since passage is provided in the lower reach resulting in access to the good habitat in the middle reach.

Table 3-23. Upgrade Shellrock pump station. Comparison of average monthly flows at 10%, 50% and 90% exceedence and average monthly flows estimated by the water model to meet minimum flow estimates for fish species and life stages. Shaded bars indicate which minimum flow requirements would not be met.

Fish Species and Channel Rehabilitation Options	Percent Exceedence[1]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MIDDLE REACH		**Month**											
Middle Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Steelhead/chinook with channel rehabilitation		7	7	7	15	20	20	20	20	10	7	7	7
Steelhead without channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Middle Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	4	4	11	28	26	16	13	12	11	4	4	4
	50%	**6**	**8**	**11**	**28**	**75**	**88**	**22**	**18**	**11**	**5**	**5**	**4**
	10%	14	15	16	79	285	231	71	27	17	15	17	14
Steelhead/chinook with channel rehabilitation	90%	7	7	7	15	21	23	21	20	11	7	7	7
	50%	**7**	**7**	**7**	**15**	**72**	**88**	**26**	**21**	**11**	**8**	**7**	**7**
	10%	15	15	13	74	283	230	71	27	17	15	17	14
Steelhead without channel rehabilitation	90%	4	4	12	32	20	16	12	11	11	4	4	4
	50%	**6**	**8**	**12**	**32**	**67**	**88**	**22**	**18**	**11**	**5**	**5**	**4**
	10%	14	15	16	79	283	230	71	27	17	15	17	14
LOWER REACH		**Month**											
Lower Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation[3] (monthly flow average of minimum flow estimate[4])				6	15	5-25 (13)							
Steelhead/chinook with channel rehabilitation[3] (monthly flow average of minimum flow estimate[4])				6	15	20-25 (21)	20	10					
Steelhead without channel rehabilitation[3] (monthly flow average of minimum flow estimate[4])				15-25 (8)	20-25 (23)	5-25 (13)							
Lower Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	3	3	8	22	19	7	0	0	2	0	3	3
	50%	**5**	**6**	**8**	**22**	**28**	**34**	**0**	**0**	**5**	**1**	**3**	**3**
	10%	11	12	12	55	194	147	17	2	8	6	14	11
Steelhead/chinook with channel rehabilitation	90%	6	6	5	12	17	16	8	2	4	3	5	5
	50%	**6**	**6**	**5**	**12**	**27**	**36**	**9**	**7**	**6**	**4**	**5**	**5**
	10%	12	12	10	50	194	148	19	13	8	7	13	11
Steelhead without channel rehabilitation	90%	3	3	9	25	15	7	0	0	2	0	3	3
	50%	**5**	**6**	**9**	**25**	**23**	**34**	**0**	**0**	**5**	**1**	**3**	**3**
	10%	11	12	13	56	194	146	17	2	8	6	14	11

1. From Appendix 3.1-F.
2. From Table 3.5-2.
3. A flow range is given when minimum flow estimates change during that month. Minimum flows can change to simulate variation of discharge that would be found under natural conditions. Pulses of water with different flow are also provided to "stimulate" migration.
4. This is the average flow for a month if minimum flow is provided. Some months only require a minimum flow for part of the month, therefore the average monthly flow can be less then a minimum flow. This is provided for comparison to monthly averages presented as exceedence flows.

Upper Salmon Creek

No changes to the upper reach Salmon Creek streamflow (tributaries to the reservoirs) would occur under the Shellrock Pump Station Upgrade Alternative. The unregulated inflow is assumed to remain the same for the No Action and all Alternatives (**Appendix B-3**).

This action alternative would keep the median Salmon Lake elevation higher and would reduce the seasonal fluctuation of the lake as compared to historic irrigation operations. A large volume of water is consistently available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The higher reservoir elevations would increase surface and groundwater availability along the margins of Salmon Lake reservoir. The median monthly Conconully Reservoir water surface elevation under Alternative 2 is increased in all months, except May, June, and July, which already operate at maximum active storage capacity.

As a result of stabilizing and increasing water levels during the summer and fall in the Project reservoirs, there could be a positive effect on fish habitat and salmonid production. Lower water temperatures (especially during the summer months), and the increase in inlet stream areas would be likely to increase native fish survivability and productivity. Resident species, including kokanee salmon and rainbow trout would be likely to benefit. However, non-native fish populations (such as largemouth bass) may also increase due to stabilized and increased water levels in the project rservoirs and prey on resident salmonids i.e. kokanee and rainbow trout. Long-term beneficial impacts would be likely to occur to reservoir resident fisheries and additional opportunities would likely be provided through changes in fisheries management.

3.5.2.5 Alternative 2: Feeder Canal Upgrade

Impacts would be the same as described in **Section 3.5.2.2**.

3.5.2.6 Alternative 2: Stream Rehabilitation

The focus of stream channel rehabilitation is reconstructing a stable stream channel in the lower 4.3 miles (lower reach) that would provide for anadromous fish migration and passage of flood flows while maintaining channel stability, reducing erosion and sedimentation, and reducing the risk of property loss. This component would modify the lower flow channel shape and size and decrease the minimum streamflow required for adequate fish passage. This will reduce the total volume of water needed for fish passage and/or allow greater flow management flexibility.

Okanogan River

Construction

Construction-related sedimentation would lead to a short-term increase in TSS and suspended concentrations in the Okanogan River near the mouth of Salmon Creek and immediately downstream. The construction activities in the lower two miles of the lower reach, especially the removal of the large substrate bar at the confluence, would have the greatest potential to affect the Okanogan River. Since this work could be done when there is little or no flow in the lower reach of Salmon Creek and low flow in the Okanogan River, construction BMPs would minimize the impact. There would be increased, but short-term, sedimentation during the period when flows were again returned to the lower reach channel. Potential water quantity and water quality impacts of stream rehabilitation on the Okanogan would be negligible. Impacts to fisheries resources would be minimal and short-term.

Operation

Full channel rehabilitation of Salmon Creek would be expected to have long-term beneficial impacts to the Okanogan River fish habitat, primarily related to the increased quantity and quality of water discharged at the mouth of Salmon Creek. Stabilization of the bed and banks of lower Salmon Creek would reduce erosion and thus sediment entering the Okanogan River. Rehabilitation would also include revegetation of areas disturbed by construction, including streambanks. The combination of channel rehabilitation, revegetation efforts, and increased streamflow would be expected to produce net benefits to water quality discharged from Salmon Creek to the Okanogan River. Specific benefits from termperature reduction due to channel shading by riparian vegetation would likely be limited in area and take several years to be achieved.

Lower Salmon Creek

Construction

There would be very little to no water present in the lower reach of Salmon Creek during construction. It is possible that minor (1 to 2 cfs) surface flow may be present in the work areas closest to Watercress Springs, or in the vicinity of drainage/treatment outfalls within the City. Stream rehabilitation construction would result in a release of sediment when water is returned to the lower reach, with short-term increases in total suspended solids (TSS) and suspended concentrations.

Operation

The stabilized channel in the lower reach of Salmon Creek would reduce channel erosion, increase stream shade, lower surface water temperatures, and provide a low flow channel that is adequate to provide migration of fish with much less water than is required under current conditions. This would increase the quality and quantity of habitat within the lower creek and provide better access to the middle reach of Salmon Creek for anadromous fish. Channel rehabilitation would include revegetation of stream banks in Salmon Creek, but the areal extent of riparian vegetation, degree of overhanging/shading, and the number of years needed to achieve shading are uncertain. Therefore, decreased stream temperature in Salmon Creek due to riparian revegetation is considered a minor benefit compared to the greater benefits from increased volumes of cool water from the watershed and storage sources. Increased quantity and quality of water would benefit fisheries habitat. Channel rehabilitation would be expected to have long term beneficial impacts to the lower reach of Salmon Creek. Direct beneficial impacts would include creation of wetted area (habitat), especially in the lower two miles where, with appropriate flows, migration would be made possible for anadromous fish species. Also, both resident and anadromous species would directly benefit from overall improvement and availability of habitat in both the middle and lower reaches through increased habitat diversity. Indirect benefits would largely consist of improved water quality resulting from restored riparian areas. In turn, this would lead to decreased water temperature, increased large woody debris recruitment, and long term reduction of sediment.

At this time, no changes to current steelhead stocking practices are planned in association with Salmon Creek rehabilitation, although channel rehabilitation would likely have a positive impact on this program. It is expected that with any of the Action Alternatives, current stocking practices would continue with approximately the same number (10 to 15 thousand annually) of summer steelhead being stocked in Salmon Creek. Following return migration, and at the time of spawning, redd surveys would be conducted. Based on habitat availability, stocking numbers would be increased as needed, to maximize habitat use (Fisher pers. comm., 2003). The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region.

There would be no direct impacts within the middle reach of Salmon Creek as a result of implementing this component, only the indirect benefits associated with improving the lower reach of Salmon Creek.

Upper Salmon Creek

The Channel Rehabilitation Alternative is not expected to affect the reservoirs or tributaries.

3.5.2.7 Alternative 3: Water Rights Purchase

Under this alternative, no infrastructure components are involved. Therefore no construction impacts are expected and the only change from existing conditions would be operations.

Okanogan River

The percentage of Okanogan River water that would be pumped under Alternative 3 would increase for all fish flow regimes over all water year types (**Section 3.1**). However, the increased percentage pumped would not be of a magnitude that would adversely affect minimum streamflow in the Okanogan River. The number of months with WAC minimum flow would be identical to the No Action Alternative.

Salmon Creek inflow to the Okanogan River would increase under this action alternative for all water year types (**Section 3.1**). The increase would represent a doubling or tripling of Salmon Creek inflow to the Okanogan in wet, above normal and normal water years. For below normal and dry water years the increase would range from four to nine times that under the No Action Alternative. As discussed in the other Action Alternatives, a long-term beneficial impact would be the provision of better salmonid habitat, especially a small thermal refuge to fish migrating in the Okanogan River. The water flowing from Salmon Creek would directly improve water quality at and immediately downstream of the confluence with the Okanogan.

Lower Salmon Creek

Alternative 3 would reestablish seasonal fish migration flows in lower Salmon Creek that did not occur under the historic irrigation operations. The median monthly streamflow in lower Salmon Creek below the diversion dam would increase in all months for the steelhead trout and chinook salmon flow regime, and would increase in all months except July and August for the steelhead-only regimes (see **Appendix D**). Under this action alternative, the median monthly streamflow for the lower reach of Salmon Creek (measured at the mouth) would increase in all months for the steelhead trout and chinook salmon flow regime, and would increase in all months except July and August for the steelhead-only flow regimes (see **Appendix D**).

Table 3-24 illustrates that, with this alternative, represented in the table by *steelhead without rehabilitation*, all estimated minimum flow needs for steelhead trout would be met or exceeded during all water years, including dry years, when compared to simulated flows. Steelhead trout would receive migration flows that would result in successful passage for this species. It can be inferred from the flows for the *steelhead trout/chinook salmon option with channel rehabilitation* option that Alternative 3 would be unable to pass Chinook salmon and would be below the estimated minimum flows needed for steelhead in March and April during normal water years. Even with rehabilitation, during March there would be a one cfs deficit and during April there would be a 3 cfs deficit. These deficits are based on model outputs and conservative estimates of the amount of water needed to provide adequate passage and overwintering flows. The deficits for chinook salmon without rehabilitation would likely be even greater.

Overall, this alternative would have long-term beneficial impacts to Salmon Creek fish populations in the lower reach. Direct benefits include water volumes sufficient to provide passage for steelhead and improved habitat suitability in some areas. Indirect benefits would include water quality improvements such as decreased temperatures, as an indirect result of flow stabilization. Resident species would benefit from increased survival and production (probably restricted to the upstream portion of the lower reach), offset by increased competition from anadromous species. Anadromous species (both steelhead trout and chinook salmon) would greatly benefit if channel rehabilitation were incorporated. This could result in a naturally reproducing population of both species. The proposal in Alternative 3 to not include channel rehabilitation would still benefit steelhead and may sustain a population over generations. Chinook salmon would not likely receive long-term benefit from this alternative without channel rehabilitation, in terms of a naturally reproducing and sustainable population. The provision of anadromous fish access to productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region (WDFW and WWTT 1997, ESA 1997, UCSRB 2003).

Middle Salmon Creek

Alternative 3 reduces the unnaturally high summer flows in the middle reach that occur under historic irrigation. This action alternative would reestablish winter base flows that are not provided under historic irrigation (see Appendices).

This action alternative would meet or exceed all estimated minimum flows for all species under all options. Steelhead trout would experience beneficial impacts associated with provision of flows to Salmon Creek under this alternative. Direct benefits include water volumes sufficient to provide anadromous passage for adults and smolts, spawning, incubation of eggs, emergence, rearing, and overwintering habitat. Resident fish (rainbowand brook trout) would also benefit through increased habitat availability and suitability, although there may be competition with anadromous fish. Indirect benefits to aquatic habitat would result from flow stabilization. Steelhead trout would benefit since passage would be provided in the lower reach resulting in access to the good habitat in the middle reach. The provision of anadromous fish access to and enhancement of productive and sustainable habitat is consistent with state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region (WDFW and WWTT 1997, ESA 1997, UCSRB 2003).

Table 3-24. Purchase water rights. Comparison of average monthly flows at 10%, 50% and 90% exceedence and average monthly flows estimated by the water model to meet minimum flow estimates for fish species and life stages. Shaded bars indicate which minimum flow requirements would not be met.

Fish Species and Channel Rehabilitation Options	Percent Exceedence[1]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MIDDLE REACH		**Month**											
Middle Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Steelhead/chinook with channel rehabilitation		7	7	7	15	20	20	20	20	10	7	7	7
Steelhead without channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Middle Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	4	4	11	27	26	15	11	10	10	4	4	4
	50%	**7**	**8**	**11**	**28**	**78**	**89**	**24**	**16**	**10**	**4**	**4**	**7**
	10%	14	15	16	76	284	233	73	29	18	16	18	14
Steelhead/chinook with channel rehabilitation	90%	7	7	7	15	21	21	21	21	11	8	7	7
	50%	**7**	**7**	**7**	**15**	**71**	**88**	**24**	**22**	**12**	**8**	**7**	**7**
	10%	15	15	13	74	282	230	71	27	17	15	17	14
Steelhead without channel rehabilitation	90%	4	4	12	32	20	15	11	10	10	4	4	4
	50%	**7**	**8**	**12**	**32**	**74**	**89**	**24**	**16**	**10**	**4**	**4**	**7**
	10%	14	15	16	76	282	233	73	29	18	16	18	14
LOWER REACH		**Month**											
Lower Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation[3]				6	15	5-25							
(monthly flow average of minimum flow estimate)[4]						(13)							
Steelhead/chinook with channel rehabilitation[3]				6	15	20-25	20	10					
(monthly flow average of minimum flow estimate)[4]						(21)							
Steelhead without channel rehabilitation[3]				15-25	20-25	5-25							
(monthly flow average of minimum flow estimate)[4]				(8)	(23)	(13)							
Lower Reach Simulated Flows (cfs)[1]													
Steelhead with channel rehabilitation	90%	3	3	8	22	19	7	0	0	2	1	3	3
	50%	**5**	**6**	**8**	**22**	**40**	**48**	**0**	**0**	**5**	**2**	**3**	**5**
	10%	11	12	13	59	206	160	30	2	8	9	14	11
Steelhead/chinook with channel rehabilitation	90%	6	6	5	12	17	16	11	10	8	4	5	5
	50%	**6**	**6**	**5**	**12**	**35**	**46**	**13**	**12**	**8**	**5**	**5**	**5**
	10%	12	12	10	53	202	159	32	16	8	8	13	11
Steelhead without channel rehabilitation	90%	3	3	9	25	15	7	0	0	2	1	3	3
	50%	**5**	**6**	**9**	**25**	**36**	**48**	**0**	**0**	**5**	**2**	**3**	**5**
	10%	11	12	13	59	205	160	30	2	8	9	14	11

1. From Appendix 3.1-F.
2. From Table 3.5-2.
3. A flow range is given when minimum flow estimates change during that month. Minimum flows can change to simulate variation of discharge that would be found under natural conditions. Pulses of water with different flow are also provided to "stimulate" migration.
4. This is the average flow for a month if minimum flow is provided. Some months only require a minimum flow for part of the month, therefore the average monthly flow can be less then a minimum flow. This is provided for comparison to monthly averages presented as exceedence flows.

Upper Salmon Creek

No changes to the upper reach Salmon Creek streamflow would occur under Alternative 3. The unregulated inflow is assumed to remain the same for the No Action and all Alternatives (**Appendix B-3**).

This action alternative would keep the median lake elevation higher and would reduce the seasonal fluctuation of Salmon Lake that occurs under historic irrigation operations. A large volume of water would consistently be available in storage, providing water for releases to meet instream flow requirements in the middle and lower reaches of Salmon Creek. The median monthly Conconully Reservoir water surface elevation under Alternative 3 would increase in August through April by 5 to 10 feet, such that median reservoir elevation would be near full active storage in most months (see **Appendix D**). The median Conconully Reservoir elevation would be similar for all three fish flow regimes. A large volume of water would be consistently available in storage, providing water for releases to meet instream flow demands in the middle and lower reaches of Salmon Creek. The reservoir levels would provide more seasonally consistent surface and groundwater accumulations along the margins of Conconully Reservoir.

As a result of stabilizing and increasing water levels during the summer and fall in the Project reservoirs, there would be a potential positive effect on fish habitat. Lower water temperatures (especially during the summer months), and the increase in inlet stream areas would be likely to increase native fish survivability and productivity. Resident species, including kokanee salmon and rainbow trout would be likely to benefit though non-native fish populations (such as largemouth bass) may also increase due to stabilized and increased water levels in the project rservoirs and may prey on resident salmonids. Long-term beneficial impacts would be likely to occur to reservoir resident fisheries and additional opportunities would likely be provided through changes in fisheries management.

3.5.2.8 Alternative 3: Feeder Canal Upgrade

Impacts would be the same as described in **Section 3.5.2.2**.

3.5.2.9 Alternative 3: Stream Channel Rehabilitation

There would be no impacts expected since no rehabilitation is proposed as part of this alternative.

3.5.2.10 No Action Alternative

<u>Okanogan River</u>

Pumping at the Shellrock pump station would continue to affect flow in the Okanogan River.. WAC minimum instream flow violations for the Okanogan River between Shellrock and Salmon Creek would remain identical to existing and historical conditions. This would not result in any major change to water quality or quantity in the area and therefore would not create any new impacts to existing fish habitat or production. Salmon Creek inflow would continue to comprise from one to three percent of the Okanogan River flow under this alternative, which is similar to existing and historical conditions (**Section 3.1**).

With the No Action Alternative, there would be continued sedimentation that leads to a short-term increase in total suspended sediment (TSS) concentrations in the Okanogan River at and downstream of the confluence with Salmon Creek. This would typically occur in the spring. Loading of total dissolved solids, metals and other nutrients, and changes in pH would also occur from Salmon Creek flood and storm flows entering the river, resulting in short-term, localized impacts on fish health and habitat. The alluvial bar formed by sediments at the mouth would continue to act as a barrier to fish migration in most years.

Flow of cooler Salmon Creek water into the Okanogan River would continue to be intermittent, unreliable, and restricted. No reliable thermal refuge for Okanogan River anadromous fish would exist at or near the mouth of Salmon Creek.

Lower Salmon Creek

The median monthly streamflow in lower Salmon Creek under the No Action Alternative would be similar to the existing and historical conditions and would remain near zero in most months (**Appendix B-2**).

Table 3-25. Alternative 4 - No Action. Comparison of average monthly flows at 10%, 50% and 90% exceedence and average monthly flows estimated by the water model to meet minimum flow estimates for fish species and life stages. Shaded bars indicate which minimum flow requirements are not met.

Fish Species and Channel Rehabilitation Options	Percent Exceedence[1]												
MIDDLE REACH		**Month**											
Middle Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Steelhead/chinook with channel rehabilitation		7	7	7	15	20	20	20	20	10	7	7	7
Steelhead without channel rehabilitation		4	4	4	15	15	15	10	10	10	4	4	4
Middle Reach Simulated Flows (cfs)[1]													
No Action	90%	2	2	2	0	9	19	30	32	19	4	2	2
Alternative	**50%**	**2**	**2**	**2**	**0**	**47**	**88**	**53**	**53**	**41**	**5**	**2**	**2**
	10%	2	6	11	56	286	235	73	62	48	6	2	2
LOWER REACH		**Month**											
Lower Reach Minimum Flow Estimates (cfs)[2]		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Steelhead with channel rehabilitation[3] (monthly flow average of minimum flow estimate)[4]				6	15	5-25 (13)							
Steelhead/chinook with channel rehabilitation[3] (monthly flow average of minimum flow estimate)[4]				6	15	20-25 (21)	20	10					
Steelhead without channel rehabilitation[3] (monthly flow average of minimum flow estimate)[4]				15-25 (8)	20-25 (23)	5-25 (13)							
Lower Reach Simulated Flows (cfs)[1]													
No Action	90%	1	1	1	0	0	0	0	0	0	0	1	1
Alternative	**50%**	**1**	**1**	**1**	**0**	**12**	**36**	**0**	**0**	**0**	**0**	**1**	**1**
	10%	1	5	9	41	202	151	17	0	0	0	1	1

Flows not met for either the steelhead or the steelhead/chinook option (dark shading)
Flows met for the steelhead option but not met for steelhead/chinook option (light shading)

1. From Appendix 3.1-F.
2. From Table 3.5-2.
3. A flow range is given when minimum flow estimates change during that month. Minimum flows can change to simulate variation of discharge that would be found under natural conditions. Pulses of water with different flow are also provided to "stimulate" migration.
4. This is the average flow for a month if minimum flow is provided. Some months only require a minimum flow for part of the month, therefore the average monthly flow can be less then a minimum flow. This is provided for comparison to monthly averages presented as exceedence flows.

Table 3-25 provides a comparison of monthly flows at 10, 50, and 90 percent exceedence (from the simulated streamflows) and the corresponding flows needed to meet the minimum instream flow for fish species. The lower reach is considered only for migration life stages (**Table 3-21**).

In the lower reach, estimates of minimum flows for fish are provided as a range in some months (**Table 3-25**). The range is provided where minimum flows for fish change during the month due to "ramping up and down" (variation) of flows or providing "pulses" of water. These changes in flow are provided to simulate natural conditions, such as freshets, or to stimulate the fish to migrate. Also, some minimum flows for fish are not timed to start at the beginning or end of the month. For example, **Table 3-21** shows that minimum flow for steelhead trout spawning migration starts on March 20. Since the exceedence flow output (produced by the streamflow model) is provided as monthly averages (and not as partial months), the estimated minimum flows for fish were treated comparably and are shown as monthly averages. Monthly flow averages are provided in parenthesis below the estimated minimum flows for fish in **Table 3-21**. These monthly average minimum flows for fish are necessary only in the lower reach where minimum flows for fish fluctuate or do not begin at the first or end of a month.

By comparing the minimum flows for fish to the simulated flows for the No Action Alternative (**Table 3-25**), an estimate of impact to fish migration is possible. The 50 percent exceedence flows represent an average flow scenario for the creek. Passage would be unsuccessful throughout the migration period for steelhead at this flow. The only period in which a steelhead/chinook combination could migrate successfully in an average year would be June. High flow years (10 percent exceedence flows) may be able to provide passage for both species, though the combined passage and habitat requirements of chinook salmon would likely remain unmet with no channel rehabilitation.

The lack of water in the creek below the OID diversion would continue to eliminate approximately 4.3 miles of potential/historic fish migration corridor under most conditions. This would continue to have a long term impact on the survival of naturally producing populations of steelhead trout and chinook salmon and on exclusion of resident species. Without provision of passage from the Okanogan to the middle reach of Salmon Creek, anadromous species would largely remain extirpated from Salmon Creek, except for release programs for steelhead and small water releases that could allow limited migration. Stream bank erosion and degradation would continue to occur particularly during storms and other high flow events. This would continue the associated degradation of water quality and quantity. Deposition of large substrate (i.e. boulders) and the removal of gravel and fine sediment during flood events would continue throughout the reach (especially at the mouth of Salmon Creek) making migration more difficult.

Middle Salmon Creek

The median monthly streamflow and minimum monthly streamflow in the middle reach of Salmon Creek under the No Action Alternative would be similar to the existing and historical conditions (**Appendices B and D**). The No Action Alternative would continue to provide high summer flows in the middle reach, similar to historical irrigation operations (Figure 3-6). Due to irrigation water releases, during normal years middle reach flows are two to five times higher than would be required by fish during the months of May through September. As described above, this water is diverted at the downstream end of the middle reach and is not released to the lower reach unless there is spill over the diversion weir.

In a normal water year (50 percent exceedence), estimated minimum flow needs are not met for steelhead trout or chinook salmon from November through April. Chinook salmon minimum flows would not be met in October. The deficit of water during these months affects overwintering and rearing potential for both chinook salmon and steelhead trout. The largest deficit would occur in the latter part of March and April when steelhead adults are migrating upstream and downstream, spawning, and smolts are outmigrating. Chinook salmon would be impacted during the first half of smolt outmigration (April).

In general, the No Action Alternative represents a “reverse hydrograph” (proportional streamflow amounts are opposite from normal quantities expected under natural conditions) in the middle reach of Salmon Creek when compared to natural conditions. During the spring months, such as April, smolts would be outmigrating and adult steelhead would be migrating upstream and spawning during this high flow period. During the spring, reservoir filling prevents normal streamflow amounts from entering the middle reach Salmon Creek. As summer progresses and normal stream flow typically would decrease, the need for irrigation water increases leading to unusually high flows in the middle reach during late summer and early fall. During the rearing and overwintering periods (winter), reservoir filling again reduces flows from what would occur under a normal hydrograph. The resident fish populations would continue to be affected in the same manner as current conditions. Impacts of current conditions on resident fish have not been documented but are considered negative, especially during low flow periods such as overwintering.

Currently, in the middle reach of Salmon Creek, anadromous fish cannot achieve a sustainable and naturally reproducing population under the No Action alternative. Resident fish populations are likely to be impacted negatively by inadequate flows during winter and early spring. This alternative results in long term negative impact to both anadromous and resident fish habitat and populations.

The continued exclusion of anadromous fish from the Salmon Creek drainage is contrary to state, federal, and tribal goals to reestablish and eventually provide harvestable populations in the region (WDFW and WWTT. 1997, UCSRB 2003).

Upper Salmon Creek

Streamflow in the upper reach of Salmon Creek would remain unregulated under the No Action Alternative, similar to the existing and historical conditions (**Figure 3-5**). Natural variability in watershed runoff production would continue to produce differences by water year type as a function of climatic influences, as well as vegetation removal and forest fires in the upper watershed. Fish production in the upper tributaries would remain unchanged.

The median, minimum, and maximum monthly water surface elevations for both Salmon Lake and Conconully reservoirs are similar to the existing and historical condition under the No Action Alternative. Impacts to the reservoir fisheries would result from continuation of low water surface levels in late summer fall, particularly during dry years. The water level of Salmon Lake would be at its lowest in September, then would slowly rise in April and drop back down from July to September (**Appendix D**). With no upgrade to the North Fork feeder canal or supplementation of irrigation flows, the ability to manage lake levels would remain impaired.

As a result of seasonally low water levels in the Project reservoirs, there would be a direct negative effect on fish habitat and resulting lower production. Higher water temperatures (especially during the summer months), and dewatering of inlet stream areas could continue to decrease in native fish survivability and productivity. Continued rainbow trout stocking efforts, including catchable sizes would likely be required to support a sport fishery in some years. Other resident species, including kokanee salmon and rainbow trout that utilize habitat in the reservoirs and inlet stream areas would continue to have lower survivability and productivity. Additionally, with limited water stored in Salmon Lake, the channel between the two reservoirs would continue to be frequently dewatered during the fall. This would further decrease kokanee salmon survival and productivity, as this spawning area would be limited in availability and success.

3.5.3 Mitigation Measures

To reduce potential impacts to fisheries, the following mitigation measures would be implemented. See **Table 3-26** for a summary of mitigation actions.

Table 3-26. Summary of recommended mitigation measures for construction and operation impacts.

	Project Alternative Involved				
Mitigation Action	No Action	Feeder Canal Upgrade	Stream Rehabilitation	Upgrade Shellrock Pumping Plant	New 80 cfs Capacity Pump Station
CONSTRUCTION MITIGATION					
Have emergency spill containment kits available to contain and remove accidentally spilled fuels, hydraulic fluids, etc. immediately.		X	X	X	X
All equipment refueling and fuel storage would not occur within 100 ft. of any surface water. All equipment refueling and fuel storage would not occur within 100 ft. of any surface water.		X	X	X	X
Disposal of waste materials and washing of equipment would not occur within 100 ft. of any watercourse, ravine, drainage ditch, etc.		X	X	X	X
A spill prevention , control and countermeasures plan (SPCC) would be developed prior to the start of construction.		X	X	X	X
Construction of steep, straight roads, which could result in concentration of runoff and channelization, would be avoided.		X	X	X	X
Access roads and pipelines would be sited to avoid water bodies and riparian areas. When in close proximity, sedimentation control structures would be put in place prior to beginning work.		X	X	X	X
All construction access roads, staging areas, and any other disturbed upland or riparian vegetated area would be revegetated following construction.		X	X	X	X
Pump intake devices would be located in areas of river where disturbance to the streambed and stream bank are minimized. They would also be located on mat gabions to help prevent disturbance.				X	X
To the greatest extent possible, construction activities would be timed around periods of lowest fish use and instream flows.		X	X	X	X
Operation Mitigation					
A water filtration system would be constructed to mitigate for water being used from the Okanogan River with a high total suspended solid concentration.				X	X
Pilings would be driven into the streambed in front of fish screens to prevent damage by floating debris, maintaining functionality of fish screens.		X	X	X	X
Pump intake structures would be located in locations where they would have the least impact when in operation.				X	X
The Okanogan Irrigation District Comprehensive Water Conservation Program would be implemented to conserve water and prevent excess irrigation runoff.	X	X	X	X	X

Table 3-26. Summary of recommended mitigation measures for construction and operation impacts. (continued)

	Project Alternative Involved				
Mitigation Action	No Action	Feeder Canal Upgrade	Stream Rehabilitation	Upgrade Shellrock Pumping Plant	New 80 cfs Capacity Pump Station
Pump intake and diversion canal fish screens would be designed in accordance with NOAA Fisheries specifications and utilized to prevent fish from entering pumping structures or irrigation canals and to prevent injury.		X	X	X	X
Pump station would be located away from the riverbank and above the elevation of the 100-year floodplain.					X
Streambanks along Project structures would be protected from erosion using methods such as boulder and timber armoring or rock gabions.		X		X	X
Work with landowners adjacent to the mainstem Okanogan River and Salmon Creek and their tributaries in order to minimize impacts of land use on fisheries resources.	X	X	X	X	X
Resource Management Plan (RMP)					
The RMP would provide a framework encompassing and identifying implementation elements and responsibilities ranging from the construction contractor and environmental permit compliance monitoring to water supply system oversight and short- and long-term monitoring programs.	X	X	X	X	X
The *Streamflow and Reservoir Operation Plan* would provide for monitoring streamflows and reservoir water levels and operation, as well as the associated impacts on Project goals.	X	X	X	X	X
The *Stream Channel and Riparian Management Plan* would provide for monitoring impacts associated with streamflow and provide actions to be taken as mitigation.	X	X	X	X	X
The *Fisheries Management Plan* would establish management criteria for each target species.	X	X	X	X	X
The *Monitoring and Adaptive Management Plan* would provide for ongoing adjustments to management plans as necessary.	X	X	X	X	X

3.5.3.1 Construction

Various construction activities are associated with the Action Alternatives. All construction activities have the potential to disturb fisheries resources in the Project area, though impacts can be avoided or minimized. To avoid or minimize these impacts, construction Best Management Practices (BMPs) would be utilized. During any period of construction, all impacts would be regularly monitored and BMPs would be put in place or altered to address these impacts.

To protect water quality, various preventive measures would be taken. All equipment refueling and fuel storage would occur in locations at least 100 feet from any surface water. Disposal of waste materials and washing of equipment would also occur at least 100 feet from any surface water, as well as from any watercourse, ravine, drainage ditch, or other feature where water may potentially flow. Prior to beginning construction, work zones would be delineated and prepared, including staging and access areas, in locations that would minimize disturbance. Additionally, to deal with any chemical spill, emergency spill containment kits would be available on-site to immediately contain and remove accidentally spilled fuels or any other potentially hazardous materials. A spill prevention, control, and countermeasures (SPCC) plan would also be developed prior to any construction activities.

To avoid stream bank erosion and sedimentation, construction of steep, straight roads for construction that could result in concentration of runoff and channelization, would be avoided. Access roads to build the pipeline would also be situated to avoid water bodies and riparian areas. Clearing of vegetation would be minimized. When in close proximity to water bodies, sedimentation control structures would be placed prior to beginning work. Structures include straw bales along stream banks and sediment ponds in runoff areas to catch excess water and sediment loads, riprap, boulder and timber armoring to strengthen banks and limit bank erosion, and silt fences and rock gabions to prevent rocks and other debris from falling into water bodies.

All construction access roads, staging areas and any other disturbed upland or riparian vegetated area would be revegetated following construction. This is important to control stream-bank erosion and sedimentation.

If either Alternatives 1 or 2 are chosen, a water filtration system, including a sediment pond, would be constructed to mitigate for water being used with higher total suspended solid concentrations. New pump intakes for these options would be designed and constructed to minimize disturbance and impact to the streambed during construction and also operation.

To further minimize impacts on fish, construction activities would be timed to avoid periods of fish use and instream flows. Stream rehabilitation in lower Salmon Creek would occur at times when when the channel is dry and no fish are present. Likewise, work on the Salmon Lake Feeder Canal, the diversion in North Fork Salmon Creek, and the Okanogan River would take place when flows are at their lowest and fish use is at a minimum.

3.5.3.2 Operational Mitigation

Many of the above actions, such as bank stabilizing and sediment retention structures, and revegetation of disturbed areas would continue to be utilized during post-construction activities, if required. Inspection and maintenance of these measures would be done on a regular basis.

For Alternatives 1 or 2, fish screens based on NOAA Fisheries specifications would be placed on the water intake pipes to minimize fish entrapment and injury. Currently the Shellrock pump has screens, however they do not meet NOAA Fisheries criteria with respect to sweeping velocity, and there are concerns over high approach velocities at low river flows. The existing fish screen at the OID diversion in Salmon Creek meets NOAA criteria but is currently only minimally successful. A fish ladder has been recently constructed at the OID diversion that is adequate to pass fish. There is an existing issue with lack of flows to operate either the fish bypass or the fish ladder. This is a flow related problem and not a screen design problem. Fish can be trapped when the bypass is shut down so fish are not bypassed to the “dry” stream below the diversion dam. Under those alternatives that provide streamflow below the diversion, this problem would be alleviated. These issues can be adequately resolved after fish passage through the lower reach is reliably available during the migration periods. All fish screens would be inspected and maintained on a regular basis.

Collaboration with landowners in the Project vicinity, in particular on land adjacent to Salmon Creek and its tributaries, would be critical and would take place to minimize or improve land use impacts. Coordination with landowners and management of land use activities would be ongoing with mitigation actions implemented and altered as needed.

3.5.3.3 Resource Management Plan

The successful operation and subsequent management of the Project would require construction, operation, and performance standards and monitoring. A Resource Management Plan (RMP) would be developed and implemented to provide a framework encompassing and identifying implementation elements and responsibilities ranging from the construction contractor and environmental permit compliance monitoring to water supply system oversight and short- and long-term monitoring programs. Adaptive management principles would be incorporated into the RMP to ensure improvement over time. The RMP would likely include the following:

- Streamflow and reservoir operations
- Stream channel and riparian maintenance
- Fisheries management
- Agricultural interface
- Agency coordination
- Monitoring and adaptive management

Of particular importance to fish impact mitigation are the streamflow and reservoir operations, stream channel and riparian management, and fisheries management. As described in the impact section, several of the minimum flow estimates for different species and life stages would not be met by the action alternatives. This may be in part an artifact of modeling. It is likely that those flows that would be within a few cfs of meeting minimum flow estimates, could be refined to minimize impact to the population as a whole and to increase the possibility of a long-term sustainable population. There are other opportunities to enhance fisheries populations in the Project area related to increased supply and flexibility of using high quality Salmon Creek water.

The RMP would maximize the potential to meet the goals of both resident and anadromous fisheries enhancement through identification of streamflow and reservoir operations. This would include the following objectives.

Refine the knowledge of minimum flow requirements for all species and life stages, especially after stream rehabilitation.

- Refine water supply and release scenarios to fulfill specific needs of each species and life stage –specific needs.

- Attenuate peak streamflows that otherwise would damage newly constructed channel sections or streambank stabilization treatments.
- Maintain base streamflow sufficient to sustain multiyear (albeit temporary) irrigation of riparian vegetation.
- Reserve storage for OID in case of pump station malfunction.
- Maintain and possibly enhance existing reservoir fisheries.

The RMP would provide guidance for implementation of stream channel projects and riparian management actions and the degree to which adequately funded and well-focused actions could be taken to mitigate for undesirable high or low streamflow conditions. A monitoring program would be developed, which would annually assess the stability of instream and streambank treatments, groundwater and surface water interactions, signs of channel instability and bank failure, indicators of channel degradation or aggradation, and the vitality or rate of recovery of riparian plantings or enclosure areas. It would also set forth site-specific monitoring protocols to watch problem areas and determine rates of change, as well as corrective actions to take to avoid problems of major significance.

The RMP would address fisheries management and establish management criteria for each target species. Important components would be likely to include habitat-related production (i.e., egg-to-fry survival, smolt to adult returns, or passage success), habitat availability and suitability, natural production, interspecies competition, hatchery outplants, condition of rearing fish (i.e., food availability), and (eventually) management of the Salmon Creek system with respect to stream flows, reservoir operations, and harvest.

The RMP would include a monitoring and adaptive management plan to provide a basis for ongoing adjustment of management plans by using each step in a management program to gather information and reflect upon how the natural system is behaving under the management regime.

3.5.4 UNAVOIDABLE ADVERSE IMPACTS

Under the No Action Alternative, habitat degradation would continue (as described in **Sections 3.1 and 3.2**). These continuing adverse impacts would further limit habitat and water quality for fish in Salmon Creek and the Okanogan River, making attempts to recover listed and extirpated species more costly and difficult. There are no unavoidable adverse impacts to fisheries from the Action Alternatives.