CHAPTER 3.0 AFFECTED ENVIRONMENT

3.1 Project Area Description

The affected environment for the Lake Roosevelt Incremental Storage Releases Project includes Lake Roosevelt and its shoreline, the Columbia River downstream of Grand Coulee Dam, and the Odessa Subarea (Figure 3-1). Water routed to the Odessa Subarea would flow through the existing conveyance system consisting of Banks Lake, the Main Canal, Billy Clapp Lake, and the East Low Canal. These areas were described in the Programmatic EIS (Ecology, 2007). Additional information is provided in this chapter as needed to help clarify potential impacts. Sections 3.2 through 3.14 provide more detailed information about specific aspects of the project area.

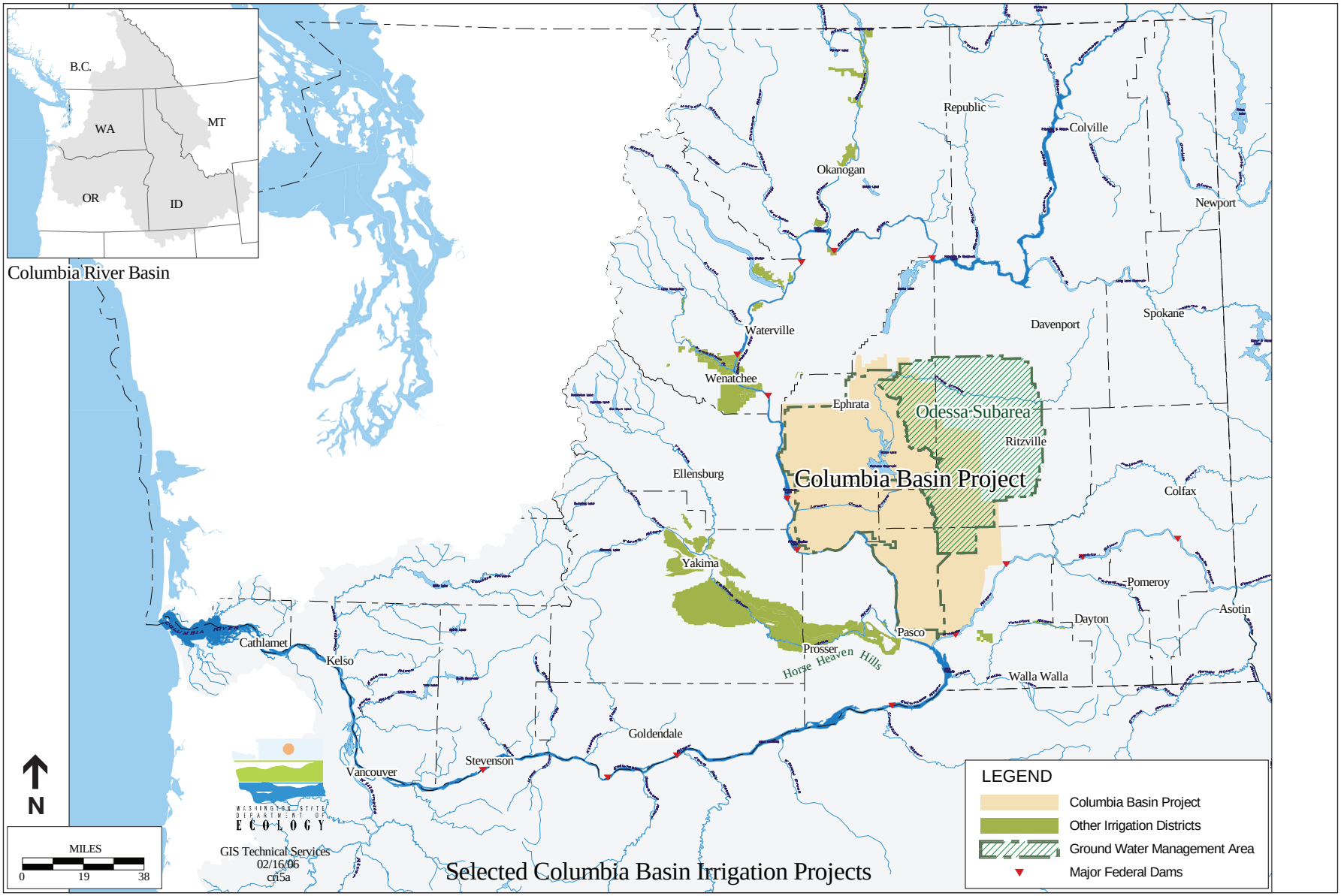
3.2 Earth

3.2.1 Lake Roosevelt

The upper Columbia River has an extensive history of landsliding, both prior to and after completion of Grand Coulee Dam. During the initial filling of Lake Roosevelt (full pool elevation attained in 1942), 245 known landslides occurred along the shoreline of Lake Roosevelt (Hansen, 1987). Between 1943 and 1952, an additional 255 known landslides occurred along the shoreline of Lake Roosevelt (Hansen, 1987). As a result of these frequent landslides, some of which resulted in damage to property and infrastructure, Reclamation commissioned an intensive geologic study to determine areas of the Lake Roosevelt shoreline that are likely to be impacted by landslides. Field work for this study occurred between 1948 and 1955, and is summarized in Jones et al. (1961).

The Jones et al. (1961) study consisted of an in-depth analysis of landslides that occurred between 1948 and 1955 and earlier, and included descriptions of landslide type, geology, and the conditions at the time of landsliding. The Jones et al. (1961) study concluded that the majority of the landslides that occurred along the Lake Roosevelt shoreline and downstream are of the slump-earthflow type, which consists of a slump at the head area, transitioning to an earthflow at the toe. The Jones et al. (1961) study considered multiple variables that contributed to the landslides, including:

- Fluctuations of the Lake Roosevelt water level;
- River flow for areas downstream of Grand Coulee Dam (discussed in Section 3.2.2.1);
- Barometric pressure;
- Maximum and minimum air temperatures;
- Precipitation;
- Earth tides (sub-meter motion of the earth caused by moon and sun gravitation); and
- Earthquakes.



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SOURCE: Washington State Department of Ecology, 2006.

Figure 3-1
Project Area
Washington

The study concluded that there was a strong correlation between the number of landslides and Lake Roosevelt's water level, with the majority of landslides occurring during the initial filling of Lake Roosevelt, and during major drawdowns (Jones et al., 1961). The Jones study noted that out of approximately 500 known landslides that occurred between 1941 and 1953, 245 (49 percent) occurred during the initial filling, 30 (6 percent) occurred during a 30-foot drawdown in 1944, and 120 (24 percent) occurred during 65-foot drawdowns in 1952 and 1953 (Jones et al., 1961). A secondary correlation was also found with air temperature, with several landslides occurring shortly before or after freezing weather (Jones et al., 1961).

The Jones et al. (1961) study also found that many of the larger landslides occurred in areas where landsliding had occurred prior to the construction of Grand Coulee Dam, and were therefore predisposed to landslide formation. Some of the landslides that had occurred before the construction of Grand Coulee Dam were quite large. In 1894, 1906, and 1929, large landslides temporarily blocked the Columbia River for up to one hour.

Landslides have continued to occur since the completion of the Jones et al. (1961) study, but generally less frequently. Notable periods of landslide activity include the period from 1969 to 1975 (Schuster, 1979) and 1978 (Hansen, 1987). These high landslide-activity periods generally corresponded to major drawdowns. Natural climatic events also have triggered more recent landslides, such as the 1978 Hughes Slide which was most likely caused by rapid snowmelt (Schuster, 1979).

The concern for landslides is identified as minor for lake levels above 1,260 feet, moderate for lake levels between 1,240 and 1,260 feet, and major for lake levels below 1,240 feet (Reidel, 1997). To reduce the frequency and number of landslides, Reclamation has adopted operating procedures to attempt to keep lake drawdown rates at less than 1.5 feet per day or less than 3 feet over 2 days (Reidel, 1997). Reclamation annually inspects the shoreline of Lake Roosevelt to evaluate changes resulting from landslides and erosion, and summarizes the results of these inspections in annual reports.

Shallow embayment areas of the lake include Kettle Falls River, Colville River, Marcus Flats, Hall Creek Bay, Nez Perce Creek, Wilmont Creek, Nine Mile Bay, Spokane River, Hawk Creek Arm, Swawilla Bay, Welch Creek, Jump Canyon, San Poil Arm, Crescent Bay, and Porcupine Bay. The figures in the Map Folio at the end of this document show the elevation contours of the land within each embayment area.

As tributary rivers and streams enter Lake Roosevelt, their water velocities are reduced, resulting in deposition of sediment. The specific location of these alluvial deposits is dependent on the level of Lake Roosevelt. During periods with high lake levels, alluvium is deposited further up the valleys than during drawdown periods.

3.2.2 Columbia River Downstream

The Columbia River downstream of Grand Coulee Dam is an area of ancient and historical landsliding. Landslides downstream of Grand Coulee Dam generally occur as reactivations of ancient landslides, resulting both from natural conditions and operation

of the Grand Coulee Dam. These landslides generally correspond to unusually high or low water levels (Hansen, 1987). In 1948 and 1952, high precipitation and seasonal runoff reactivated several of these landslides (Hansen, 1987). The 1948 Seatons and Koontville Landslides involved reactivations of ancient landslides downstream of the dam and damaged communities built on the landslides (Jones et al., 1961). Movement on these landslides occurred over several years and generally corresponded to low stages of the Columbia River (Jones et al., 1961). The Jones et al. (1961) study also identified several ancient landslides further downstream from the dam, which were not active at the time of the study.

In 1978, landslides occurred along the 6-mile river reach downstream from the dam, reportedly as a result of a 13-foot drop in the mean tailrace elevation caused by failure of one of the units in the Third Powerplant (Hansen, 1987). This 6-mile reach encompassed several communities downstream of the dam. To stabilize the river bank downstream of the Grand Coulee Dam, Reclamation took the following actions (Hansen, 1987):

- Reshaped and rearmored a previously placed embankment;
- Constructed drainage features to reduce pore pressure fluctuations; and
- Installed automated instruments and real-time alarms to monitor the downstream area identified as unstable.

3.2.3 Odessa Subarea and Banks Lake

3.2.3.1 Odessa Subarea

The earth resources in the Odessa Subarea were previously discussed in the Programmatic EIS (Ecology, 2007).

3.2.3.2 Banks Lake

Erosion occurs along the shorelines of Banks Lake due to land use activities, large boat wakes and wind (Reclamation, 2004). Areas identified in Reclamation (2004) where erosion is occurring include the west shore of the Steamboat Rock peninsula; north and south of the Million Dollar Mile North Boat Launch; south of the Million Dollar Mile South Boat Launch; Barker Flat; and Electric City Community Park (Coulee Playland).

3.3 Climate

The Programmatic EIS (Ecology, 2007) described the climate of the Columbia River Basin and briefly summarized findings of climate change modeling for the region. This section provides additional information on predicted climate changes for the Columbia River Basin. Climate models can simulate global to continental scale temperature trends and such information has been shown to be reliable for projecting regional trends. However, smaller scale climate projections are not reliable; therefore, this section discusses climate change on a regional scale.

3.3.1 Background on Global Climate Change

Climate change science has been studied and documented by the Intergovernmental Panel on Climate Change (IPCC) since the late 1980s. The IPCC was created by the World Meteorological Organization and the United Nations Environment Programme. The IPCC is mandated to:

> …assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature produced worldwide relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation.

The global mean surface temperature has increased more during the last few decades of the 20th century than the prior four centuries (National Academy Science, 2006). Global temperature projections forecast continued increases during the 21st century (IPCC, 2001). Climate change has the potential to affect temperature regimes and precipitation events that in turn influence stream runoff rates, the seasonality of runoff, water temperatures, and reservoir operations.

In 2007, the IPCC released the Fourth Assessment Report (*Climate Change 2007*) presenting information based on assessments by the three IPCC Working Groups. The report provides current climate change data and an explanation of the data. The report also presents statements and uncertainties about trends, human influences, and projections for severe weather events.

Climate change science studies the statistically significant variation in either the mean state of the climate or in its variability over an extended period of time, often several decades. The IPCC defines climate variability as variations in the mean state (and other statistics) of the climate on all temporal and spatial scales other than individual weather events. Variability may be caused by natural or anthropogenic factors operating internally or externally. Climate change is any change in climate over time, whether due to variability or a result of human activity (CCTS, 2006).

3.3.1.1 Climate and Snowpack in the Pacific Northwest

Climate data indicate that temperatures in the Pacific Northwest generally increased between 1916 and 1997 (Mote et al., 2003). The warming that occurred in the region increased faster than the global average (CCTS, 2006). Pacific Northwest climate models also project a warming rate for the first half of the 21st century that is significantly higher than warming recorded during the 20th century (Snover et al., 2005).

Analysis of Pacific Northwest snowpack data from 1950 to the present shows a reduction in spring snowpack. Below elevations of approximately 6,000 feet mean sea level (msl), reduced snow water equivalent (SWE) measurements were observed as temperature and the amount of precipitation increased (Mote et al., 2003). A recent study indicates that spring snow melt could occur as much as two months earlier in the Pacific Northwest (Rauscher et al., in press; Purdue University, 2008).

In the Pacific Northwest, snow provides a significant proportion of inflow to lower elevation reservoirs during spring and summer. A warmer regional climate would result in increased temperatures that reduce winter snowpack (with precipitation being equal). This would increase the volume of runoff during the winter, and result in earlier spring peak flows and reduced warm season runoff (Hamlet et al., 2007).

3.3.1.2 Columbia River Basin

Data indicate increased winter runoff volumes associated with increased Columbia River Basin temperatures (Hamlet and Lettenmaier, 1999). Warmer winter temperatures would result in more precipitation falling as rain rather than snow. A reduced winter snowpack would result in less snowmelt during the summer and lower dry season runoff volumes in the region.

Change in seasonal water regimes may have significant implications for water resource management. Greater runoff volumes and stream flows during winter months, and corresponding lower volumes and flows during the summer months, result in the potential for lower reservoir levels earlier in the season. A reduction in reservoir storage may cause increased competition for water during non-winter months.

3.3.2 Climate Projections

There is consensus among the climate models that future warming is likely to occur in the Pacific Northwest region; however, the models are not as consistent regarding increases in mean annual precipitation. A survey of climate model projections for the Pacific Northwest region indicates more projections suggest wetter rather than drier conditions (Reclamation and Ecology, 2008). For the Yakima River Basin Water Storage Feasibility Study, Reclamation sampled the World Climate Research Programme's Coupled Model Intercomparison Project—Phase 3 multi-model dataset. The survey indicates consensus that warming is projected to occur throughout the upper Columbia River Basin, with approximately 75 percent of the studies projecting wetter conditions in the basin. A major uncertainty of precipitation projections is how changes in large-scale weather patterns may interact with local features. For example, the interaction between the Northwest's Pacific storm tracks and the effect of the Cascade Mountains on local weather patterns is not fully represented in the climate change projections (Reclamation and Ecology, 2008).

The uncertainty of the precipitation projections complicates projecting runoff for the Columbia River Basin since runoff is dependent on both temperature and precipitation. Studies have shown that decreased runoff during spring and summer could be offset by an increase in precipitation during these seasons (Hamlet and Lettenmaier, 1999). The inability to reliably project regional precipitation trends affects the ability to accurately determine how climate change may quantitatively affect water resources and their management. Therefore, the discussion in this Supplemental EIS of potential climate change impacts on Columbia River Basin water resources is qualitative rather than quantitative.

3.3.3 Potential Climate Change Impacts on Runoff and Surface Water Supplies

Climate change has the potential to significantly alter the timing of runoff contributing to the Columbia River and its reservoir system. Warming without increases in precipitation during winter would result in a seasonal shift in runoff, with higher flows during winter and decreased volumes during summer. Studies of the Pacific Northwest spring snowpack since the mid 20th century indicate regional increases in temperature leading to declines in snowpack and runoff (Mote, 2003). Other studies have confirmed these hydrologic conditions associated with higher temperatures: a reduced spring snowpack in the mountains and earlier spring snowmelt runoff, coupled with increases in winter flow and decreases in summer flow (Mote et al., 2005).

According to some climate projections, a portion of the decrease in runoff associated with regional warming could be offset with increases in precipitation (Hamlet and Lettenmaier, 1999). This would reduce the impact on dry season water supplies; however, reservoir management and operation would still need to contend with changes in the timing and quantity of winter runoff.

Reductions in summer flows could have a significant impact on summer hydropower production and water available for irrigation. Without proper reservoir management and operation, conflicts could arise between municipal and industrial parties interested in energy and water demand, parties interested in irrigation allocations, and parties interested in maintaining stream flows for fish habitat (Callahan et al., 1999; Miles et al., 2000).

3.4 Surface Water

3.4.1 Water Quantity

3.4.1.1 Lake Roosevelt

A description of surface water resources of Lake Roosevelt is contained in the Programmatic EIS (Ecology, 2007). Additional information on Lake Roosevelt operations is provided in Section 1.4.

3.4.1.2 Columbia River Downstream

A description of surface water resources of the Columbia River downstream of Lake Roosevelt is contained in the Programmatic EIS (Ecology, 2007).

3.4.1.3 Odessa Subarea and Banks Lake

Odessa Subarea

Surface water bodies in the Odessa Subarea include Crab Creek, Rocky Coulee, Weber Coulee, Lind Coulee, Esquatzel Coulee and several smaller coulees and streams. Most streams in the Odessa Subarea are intermittent, but the portion of Crab Creek that flows

through the Odessa Subarea is perennial. The streams convey runoff from precipitation and in some cases intercept seepage flow from irrigation. Runoff from Crab Creek, Rocky Coulee, Weber Coulee and Lind Coulee flows into Moses Lake or the Potholes Reservoir, supplying water for the South Columbia Basin Irrigation District. South of Lind Coulee, some flow from the Odessa Subarea is captured by irrigation drains and canals.

Banks Lake

Banks Lake is a man-made reservoir used to regulate irrigation water prior to entering the Columbia Basin Project canal system. Water is pumped into Banks Lake from Lake Roosevelt via the 1.6-mile-long Feeder Canal using six pumps and six pump-generators (65,000 horsepower each) located at the Grand Coulee pump-generating plant. Banks Lake supplies water to the Main Canal from March to October of each year as required for irrigation. The average annual quantity of water supplied to the Main Canal from Banks Lake for irrigation is 2.4 million acre-feet while the peak monthly supply of water averages 434,000 acre-feet in July (Montgomery Water Group, 2003).

Banks Lake was formed in Upper Grand Coulee by two dams, the North Dam located near Grand Coulee Dam and Dry Falls Dam at Coulee City. The lake is 27 miles long, has a surface area of 28,000 acres (42 square miles), and has a total storage capacity of 1,275,000 acre-feet. About 60 percent of the total storage capacity, or 715,000 acre-feet, is active storage above the minimum outlet elevation. The reservoir's full pool elevation is 1,570 feet. Under current operating conditions, the reservoir is drawn down to a minimum elevation of 1,565 feet in August and refilled by September 22 to elevation 1,570 feet. The total amount of water passing through Banks Lake each year to the Main Canal is equivalent to a little over twice the total storage capacity of the lake.

Periodically Banks Lake is drawn down by over 20 feet during the winter to allow maintenance of the pumping plant, Feeder Canal, and Main Canal headworks, and to control Eurasian watermilfoil, a noxious weed.

Banks Lake acts as an equalizing reservoir, making it unnecessary to regulate pumping of water from Lake Roosevelt to meet the fluctuating daily irrigation demands and also allowing irrigation pumping to occur during off-peak hours when water and electrical demand at Grand Coulee Dam are low. Banks Lake is also used to store water for hydroelectric power generation at the Grand Coulee pump-generating plant. Of the 12 pumps at the plant, six are reversible pump-turbines that can be used for power generation during times of peak demand or for reserve firm capacity.

3.4.2 Water Quality

3.4.2.1 Lake Roosevelt

Water quality data for Lake Roosevelt and the Columbia River below Grand Coulee Dam are available from several sources:

- The Lake Roosevelt Fisheries Evaluation Program (LRFEP) for the STI has sampled water quality parameters from sites on Lake Roosevelt and the Spokane Arm for the past 19 years (1989 to 2007). LRFEP annual reports contain information regarding sampling efforts for total dissolved gas (TDG), water temperature, dissolved oxygen, total dissolved solids (TDS) and turbidity in Lake Roosevelt and the Spokane Arm.
- Water temperature is monitored by the Corps of Engineers at the forebay of Grand Coulee Dam (Reclamation, 2008a). In addition, water temperature and TDG are monitored by the Corps of Engineers on the Columbia River downstream of Grand Coulee Dam (Reclamation, 2008a). Water quality data were reviewed in relation to representative water years, with 1997 representing a wet year, 2002 an average year, 2003 a dry year, and 2001 a drought year.

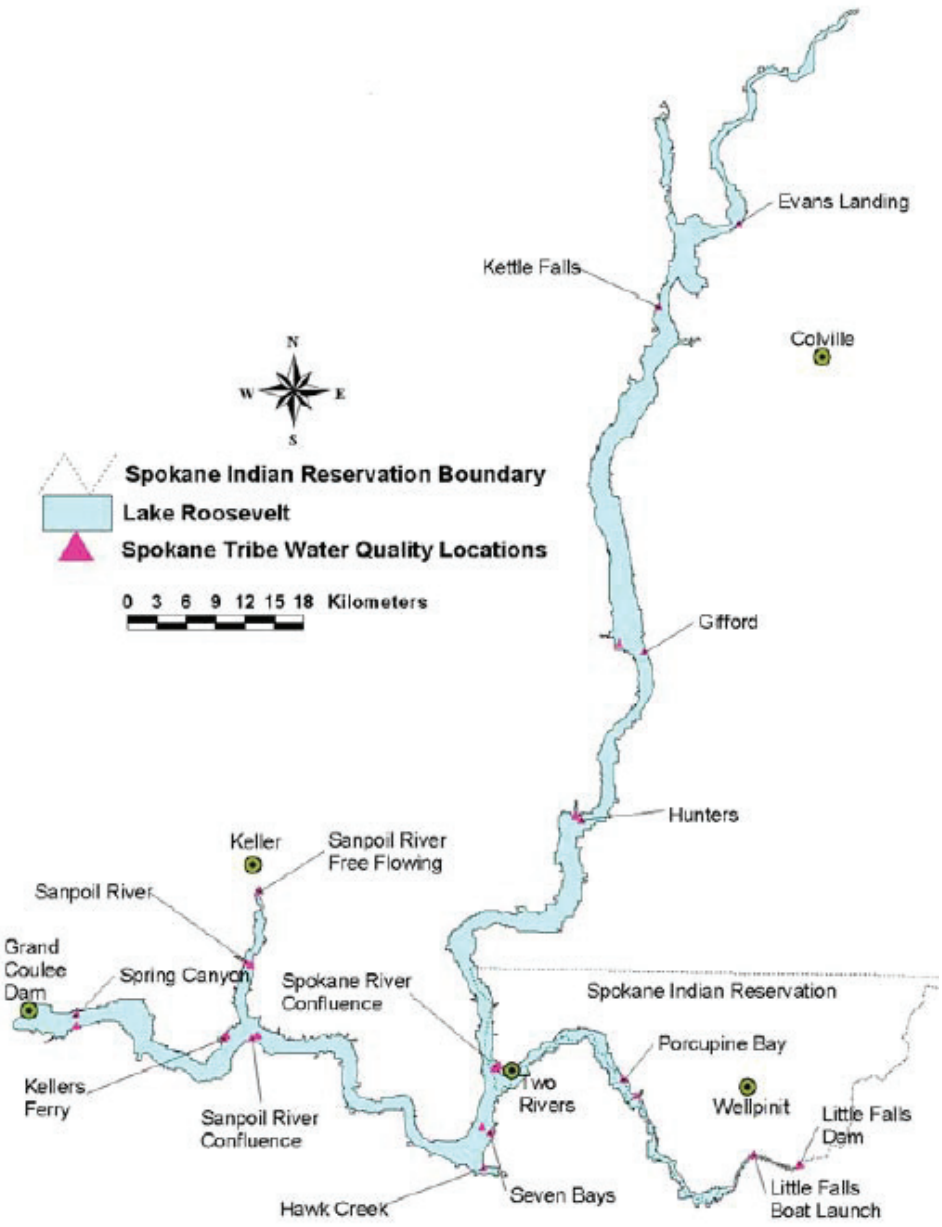
Sampling Efforts

Parameters

From 2002 to 2005, the LRFEP sampled TDG, water temperature, dissolved oxygen, turbidity, and TDS from pelagic zones using a Hydrolab Surveyor 4®. The LRFEP annual reports for sampling efforts in 2006 and 2007 are not yet available. Measurements for TDG were also obtained from fixed monitoring stations (U.S./Canada border and Grand Coulee Dam forebay) on Lake Roosevelt operated by Reclamation (Scofield et al., 2005; Lee et al., 2004; Pavlik-Kunkel et al., 2003; and Fields et al., 2002). Additional samples were also analyzed for turbidity between 2003 and 2005.

Sample Locations and Methods

In 2002, LRFEP sampling on Lake Roosevelt and the Spokane Arm began with 17 different sampling locations during the first month of January (Figure 3-2). However, after January, sampling was reduced to six sampling stations that were located in Gifford, Seven Bays, Keller Ferry, Spring Canyon, Porcupine Bay, and the Little Falls Dam. During the 2003, 2004, and 2005 sample years, the five historic index locations (Gifford, Seven Bays, Keller Ferry, Spring Canyon and Porcupine Bay) plus four locations near Little Falls Dam were sampled by the LRFEP (Table 3-1).



Note: Figure modified from Field, et. al, (2002)

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Figure 3-2
Water Quality Sampling Locations

Table 3-1 LRFEP Sampling Dates for Each Year

2005	*2004*	*2003*	*2002*
1. Jan 24 – 26	1. Jan 13 – 15	1. Jan 13 - 16	1. Jan. 15-17, & 22
2. Apr 5 & 7	2. May 10 – 11, & 14	2. May 12 - 13	2. May 13-15
3. May 16 – 18	3. Jun 14 – 16	3. Jun 10 - 12	3. Jun. 12-14
4. Jun 22 – 24	4. Jul 12 – 14	4. Jul 14 - 16	4. Jul. 15-16, & 23
5. Jul 21 – 25	5. Aug 9 – 10, & 12	5. Aug 20 - 22	5. Aug. 12-14
6. Aug 16 – 18	6. Sep 13 – 15	6. Sep 22 - 24	6. Sep. 16 & 18
7. Sep 12 – 15	7. Oct 11 – 13	7. Oct 13 - 15	7. Oct. 14-16
8. Oct 17 – 18, & 20	--	--	--

LRFEP collected Hydrolab® data at each location from the surface to a depth of 108 feet at 10-foot intervals. Additional measurements were taken from 131 feet to 295 feet at 33-foot intervals at Keller Ferry and Spring Canyon to characterize the profundal zones[1] of the lower reservoir (Scofield et al., 2005; Lee et al., 2004; Pavlik-Kunkel et al., 2003; and Fields et al. 2002).

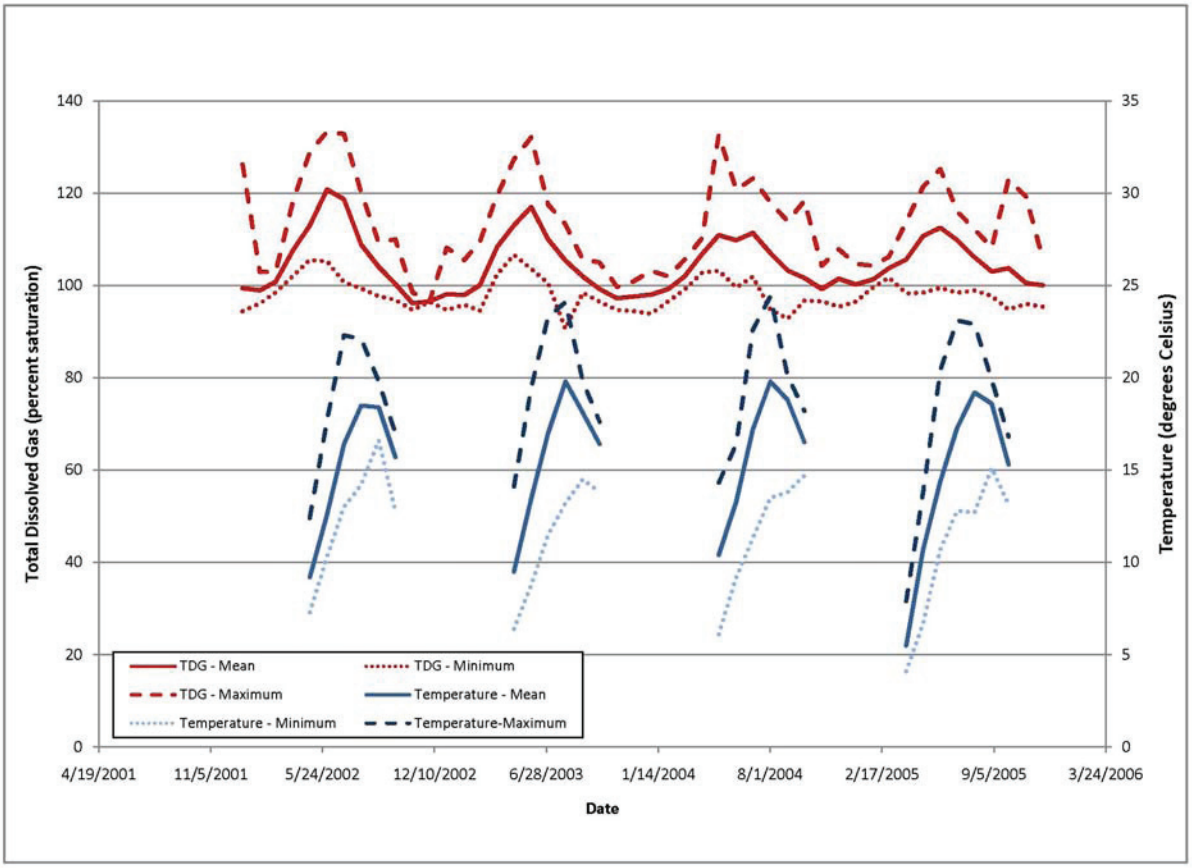
Results

Summaries of LRFEP 2002-2005 sample results (as reported by the STI) for TDG, temperature, dissolved oxygen, turbidity, and total dissolved solids are presented in Tables 1 to 5 in Appendix C, and summarized below.

Total Dissolved Gas

Annual mean TDG saturation within Lake Roosevelt was highest at Keller Ferry at 109.4 percent in 2005 and lowest at Spring Canyon at 104.2 percent in 2004 (Table 1 in Appendix C). Between 2002 and 2005, peak TDG reached as high as 132.6 percent. TDG tended to be highest in the summer months with peaks in June, and lowest in the winter months (Figure 3-3).

[1] The profundal zone is a deep zone of a water body, which is located below the range of effective light penetration.



Note. This figure is based on the monthly TDG and temperature data from Tables 1 and 2 in Appendix 3-A.

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Figure 3-3

Total Dissolved Gas and Temperature at Lake Roosevelt Sampling Stations

Temperature

Based on the data presented in the LRFEP, Lake Roosevelt exhibits thermal stratification during the summer as follows:

- Keller Ferry: Maximum sample depth of 100 meters. August stratification only: 73.4 to 57.2 degrees F (23 to 14 degrees C). Isothermal: 62.6 to 68 degrees F (17 to 20 degrees C) in September and October.
- Spring Canyon: Maximum sample depth of 100 meters. August stratification only: 75.2 to 57.2 degrees F (24 to 14 degrees C). Isothermal: 62.6 to 66.2 degrees F (17 to 19 degrees C) in September and October.
- Porcupine Bay: Maximum sample depth of 35 meters. Stratified in June, July and August: 73.4 to 53.6 degrees F (23 to 12 degrees C). Isothermal: 60.8 to 68 degrees F (16 to 20 degrees C) in September and October.

Mean monthly temperatures across all sampling locations for 2002 to 2005 (as reported by the STI) ranged as follows (Figure 3-3):

- June: 54.7 to 57.9 degrees F (12.6 to 14.4 degrees C)
- July: 61.5 to 63.1 degrees F (17.3 to 16.4 degrees C)
- August: 65.3 to 67.64 degrees F (18.5 to 19.8 degrees C)
- September: 64.6 to 65.8 degrees F (18.1 to 18.8 degrees C)
- October: 59.5 to 61.7 degrees F (15.3 to 16.5 degrees C)

Dissolved Oxygen

Based on the data presented in the LRFEP, thermal stratification of Lake Roosevelt during the summer caused stratification in dissolved oxygen levels. Dissolved oxygen concentrations remained greater than 5 mg/L at most of the sites monitored (Table 3 in Appendix C). However, the hypolimnion (near the bottom) of Lake Roosevelt in Porcupine Bay had anoxic (less than 0.5 mg/L of dissolved oxygen) conditions in 2004 and 2005, and Keller Ferry had dissolved oxygen concentrations of less than 2 mg/L in 2003.

Turbidity

In general turbidity was very low (Table 4 in Appendix C). There were five maximum concentrations above 10 nephelometric turbidity units (NTU). Mean turbidity was less than 3 NTU for all months and all locations.

Total Dissolved Solids (TDS)

Annual mean TDS concentrations at mainstem sites ranged from 74 to 83 mg/L (Table 5 in Appendix C). The annual mean TDS concentrations for Spokane Arm sites were slightly larger (71 to 120 mg/L). TDS concentrations tended to be highest in September and October and lowest in May through July.

3.4.2.2 Columbia River Downstream

Temperature and TDG are monitored by the Corps of Engineers on the Columbia River downstream of Grand Coulee Dam and reported on Reclamation's Hydromet website (Reclamation, 2008a). Variations in daily average water temperature and computed TDG saturation at the monitoring site were analyzed with respect to representative years with 1997 representing a wet year, 2002 an average year, 2003 a dry year, and 2001 a drought year.

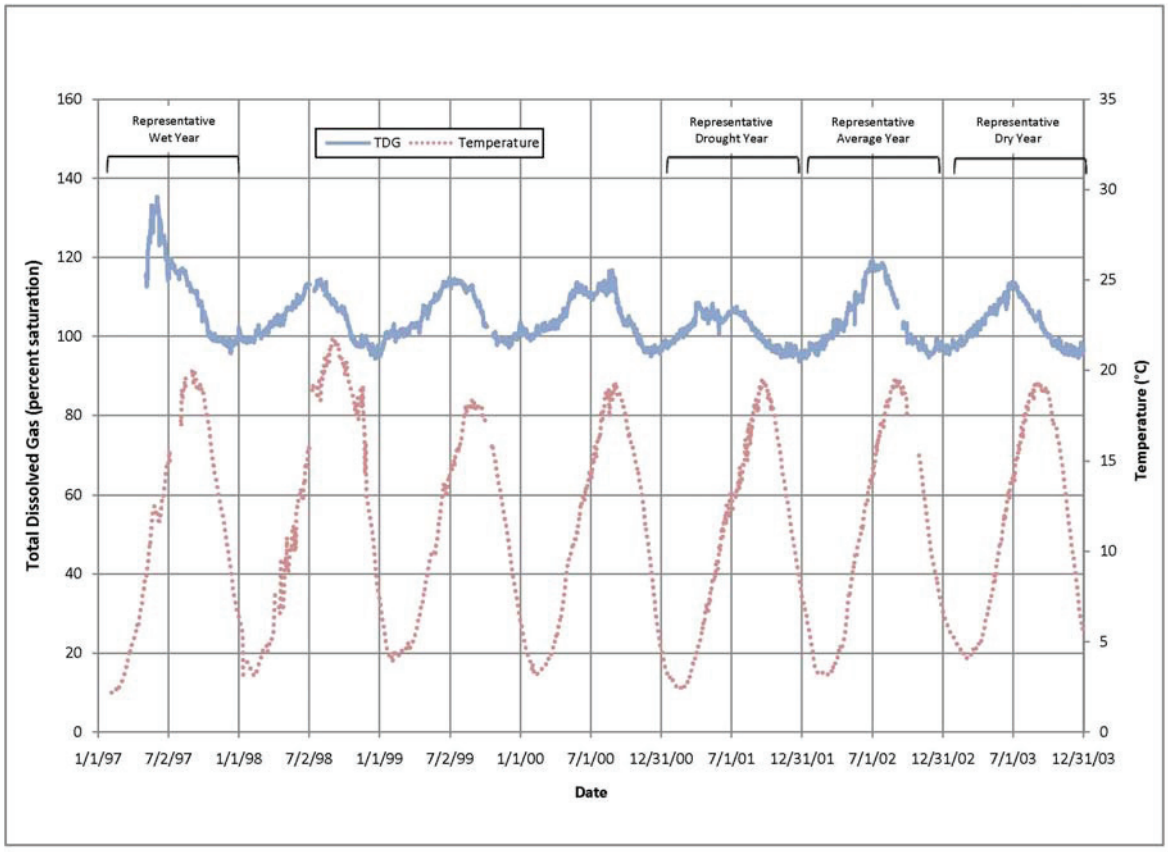
Total Dissolved Gas (TDG)

TDG data are displayed in Figure 3-4. In general, the maximum TDG was monitored in July and August and minimum TDG was recorded in the winter months. For the average year (2002) TDG concentrations ranged from 94.5 percent to 119 percent saturation. The 1997 wet year shows a higher and earlier peak TDG concentration than any other year. The 2001 drought year has the smallest range of TDG concentrations ranging from 93.6 to 108.6 percent saturation.

Temperature

Water temperature downstream of Lake Roosevelt generally ranges from 37.4 degrees F (3 degrees C) in winter to about 68 degrees F (20 degrees C) in summer (Figure 3-4).

Water is released from Lake Roosevelt through power plant intakes and spillways. The Left and Right Power Plant intakes are located at an elevation of 1,041 feet msl and the Third Power Plant is located at an elevation of 1,130 feet msl. The river outlet intakes are located at elevations of 1,136.7 and 1,036.7 feet msl and the spillway release gates can be set at variable elevations between 1,260 and 1,288 feet msl (Reclamation, 2000). Temperature profiles at the Grand Coulee Dam forebay indicate that thermal stratification occurs in the late summer months (Reclamation, 2000). The forebay's water temperature was greater than 64.4 degrees F (18 degrees C) down to an elevation of almost 1,000 feet msl during the summer of 1998. Water temperatures in the summer of 1999 had a greater range, with temperatures greater than 64.4 degrees F (18 degrees C) occurring above 1,210 feet msl, but 60.8 to 64.4 degrees F (16 to 18 degrees C) between 990 and 1,210 feet msl (Reclamation, 2000).



Note. The graph shows how TDG and temperature change throughout the year. Representative water years are also identified.

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Figure 3-4

Temperature and Total Dissolved Gas (TDG) from 1997 to 2003 on the Columbia River Downstream of Grand Coulee Dam

3.4.2.3 Odessa Subarea and Banks Lake

Odessa Subarea

Water quality in the Odessa Subarea was previously discussed in the Programmatic EIS (Ecology, 2007).

Banks Lake

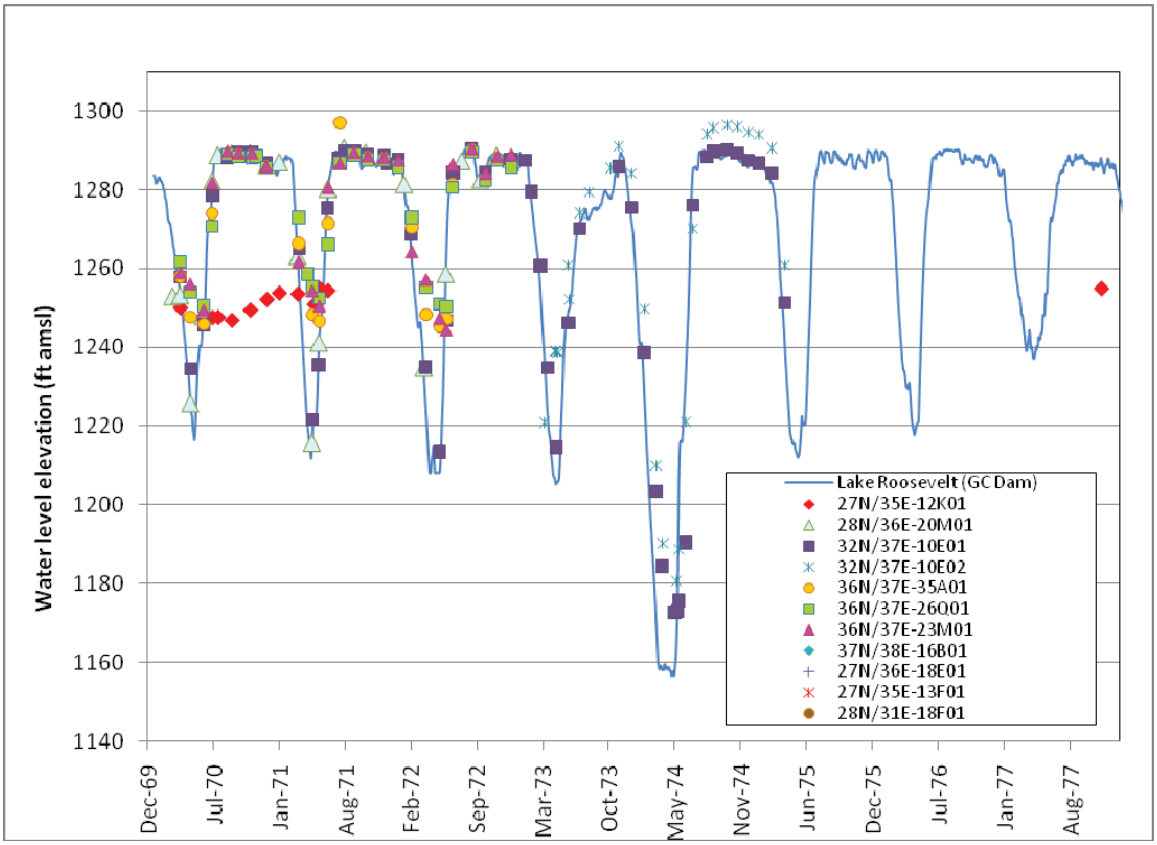
Banks Lake stratifies slightly in the summer; however, mixing of cooler water pumped from Lake Roosevelt limits stratification in the northern part of the lake (Reclamation, 2004). As reported in Reclamation (2004), phosphorus levels range from 10 to 20 mg/L, and surface temperature of the lake ranges from 75.2 to 82.4 degrees F (24 to 28 degrees C). Banks Lake was on the 2004 303(d) list for 2,3,7,8-TCDD and Total PCBs in tissue (Ecology, 2004).

3.5 Ground Water

3.5.1 Lake Roosevelt

Ground water level elevations were compared with Lake Roosevelt water level elevations to evaluate ground water conditions around the Lake Roosevelt area. Historic reservoir surface water level elevations for Lake Roosevelt were obtained from Reclamation's online database (Reclamation, 2008a). Ground water level elevations for U.S Geological Survey (USGS) wells located within approximately 1 mile of Lake Roosevelt were obtained from the USGS online database (USGS, 2008). Wells with more than one ground water level elevation were compared to the water level elevations for Lake Roosevelt. General observed trends from this analysis are as follows:

- Ground water level elevations for most wells located within 1 mile of Lake Roosevelt appear to be in hydraulic connection with Lake Roosevelt. Exceptions to this trend are deep wells (greater than 600 feet below ground surface) and wells that are completed above the level of Lake Roosevelt (greater than 1,290 feet msl) (Figure 3-5). Ground water levels are generally higher or equal to the Lake Roosevelt water level elevation (Figure 3-6). Therefore, ground water generally flows toward Lake Roosevelt.
- Ground water level elevations decrease in response to the lowering of the Lake Roosevelt surface water elevation. Ground water continues to flow toward Lake Roosevelt during drawdown and recovers quickly during refilling of the reservoir.



Note. The line traces the water level elevation of Lake Roosevelt at Grand Coulee Dam.
The points on the graph reflect groundwater elevations at different wells within 1 mile of Lake Roosevelt.
The wells are identified based on the USGS name.

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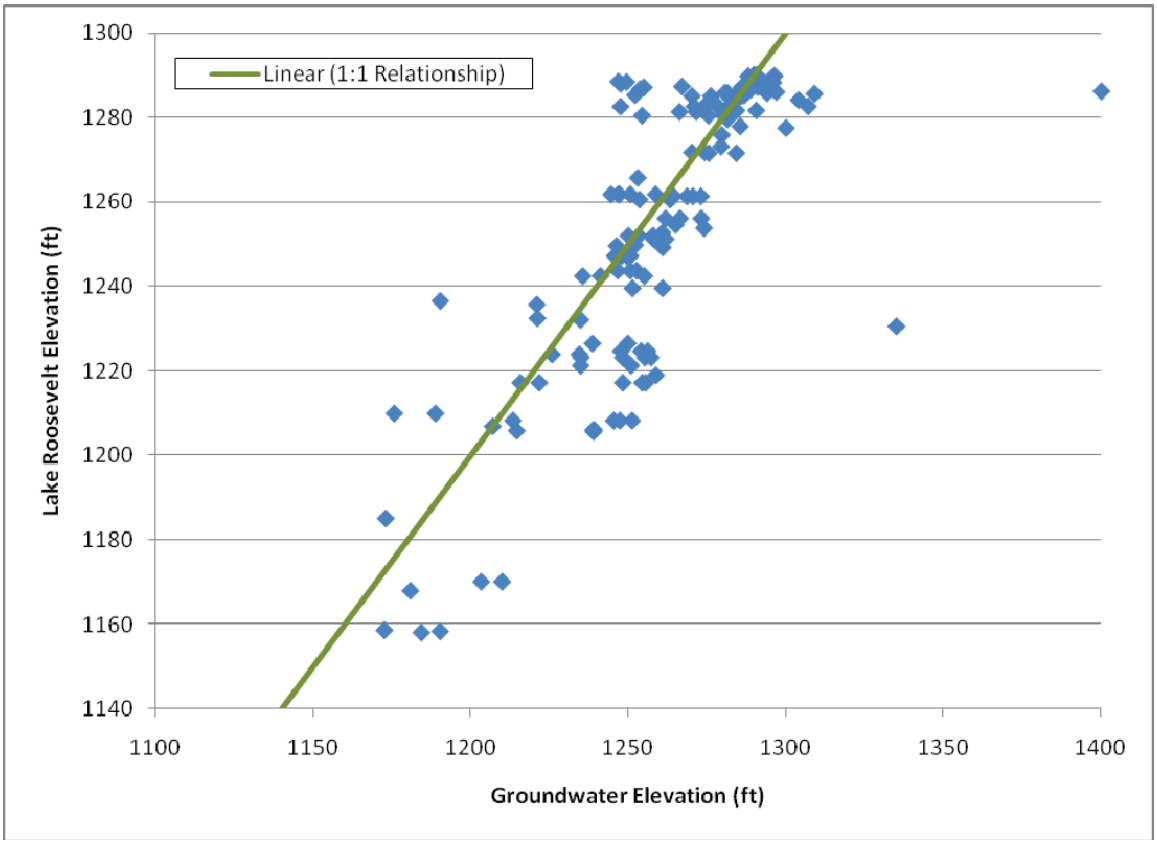
Figure 3-5
Lake Roosevelt and Groundwater Fluctuations 1970-1977



Note. This graph shows the groundwater level elevation and corresponding Lake Roosevelt elevation at the same time for a sub-set of wells located within one mile of Lake Roosevelt. The linear (1:1 Relationship) line shows when the groundwater elevation at a well is equal to the water level elevation of Lake Roosevelt. Groundwater levels are higher than the Lake Roosevelt water level elevation for points below the linear (1:1 Relationship) line. Groundwater levels are lower than the Lake Roosevelt water level elevation for points above the linear (1:1 Relationship) line.

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Figure 3-6

Lake Roosevelt Level Versus Groundwater Level 1970-1985

3.5.2 Columbia River Downstream

Ground water resources were previously discussed in the Programmatic EIS (Ecology, 2007).

3.5.3 Odessa Subarea and Banks Lake

3.5.3.1 Odessa Subarea

Ground water quantity and quality in the Odessa Subarea were previously discussed in the Programmatic EIS (Ecology, 2007).

3.5.3.2 Banks Lake

The Wanapum unit is the upper aquifer beneath Banks Lake. Ground water from the Columbia River moves south/southwesterly (in the direction of Banks Lake) through the Wanapum aquifer (Reclamation, 2004). A confining unit located below the Wanapum aquifer separates it from the deeper Grande Ronde aquifer. Horizontal ground water movement in the Grande Ronde aquifer is also south/southwesterly from the Columbia River (Reclamation, 2004). Ground water in the Banks Lake area generally has less than 450 mg/L total dissolved solids, average nitrate concentrations of 1.9 mg/L and low concentrations of pesticides (Steinkampf, 1989; Cook, 1996; Reclamation, 2004).

3.6 Legal Considerations

Legal considerations associated with the Lake Roosevelt Incremental Storage Release Project were described in the Programmatic EIS (Ecology, 2007). This section provides additional information on relevant legal issues.

3.6.1 Water Rights

The Government-to-Government Agreement in Principle between the State of Washington and the CCT (discussed in Section 1.3.1.2 of the Programmatic EIS) has evolved into Water Resource Management Agreements between the state, the CCT, and the STI. The agreements authorize annual payments in exchange for the tribes' agreement to support incremental storage releases of up to 132,500 acre-feet per year from Lake Roosevelt. "The payments will be used to mitigate the damage on fish and wildlife, cultural resources, and recreational activities resulting from the release of water from Lake Roosevelt, and for economic development investments to benefit the local economy. The funding is not for purchase of water or water rights from the tribes" (Office of Governor Christine Gregoire, 2005). The agreements also do not affect either tribe's future water right claims. The tribes' water rights to Lake Roosevelt are not quantified and to do so would take many years. These agreements facilitate the immediate need for more water in the Columbia Basin.

3.6.2 Endangered Species Act Biological Opinion

Reclamation's Columbia Basin Project, which includes Grand Coulee Dam and Lake Roosevelt, is part of the Federal Columbia River Power System (FCRPS). Operation of the FCRPS has been embroiled in legal challenges since the 1990s. The issue has been the application of the Endangered Species Act to management of the FCRPS. A total of 13 anadromous salmonid species have been listed as threatened or endangered under the ESA between 1991 and 2005 (NOAA Fisheries, 2008). The seven listed species from the interior Columbia Basin are Snake River fall Chinook salmon, Snake River sockeye salmon, Upper Columbia River steelhead, Middle Columbia River steelhead, Snake River spring/summer Chinook salmon, Snake River steelhead, and Upper Columbia River spring Chinook salmon.

Whenever a federal action may adversely affect listed species, the ESA requires that the "action agencies" consult with a consulting agency that evaluates the effects of the proposed action on the listed species. The evaluation is contained in a biological opinion. For operation of the FCRPS, the action agencies are the Corps of Engineers, Bonneville Power Administration (BPA), and Reclamation. The consulting agency is the National Marine Fisheries Service (NOAA Fisheries).

As discussed in Section 3.6.1.6 of the Programmatic EIS (Ecology, 2007), in October 2005, Judge Redden of the U.S. District Court in Oregon remanded the 2004 Biological Opinion to NOAA to make a jeopardy determination for operation of the FCRPS that complies with ESA requirements. On appeal of the 2004 Biological Opinion both Judge Redden and the Ninth Circuit Court of Appeals held that the jeopardy standard requires NOAA Fisheries to consider two things: (1) whether the species will survive, and (2) how the proposed action will affect the species' prospects for recovery (NOAA Fisheries, 2007).

On remand, a Policy Working Group including a representative from each of the sovereign entities (federal, state and tribal) provided input to the Action Agencies on development of a Biological Assessment and proposed reasonable and prudent alternatives (RPA). The group focused on "narrowing our areas of disagreement and clarifying policy issues" (Graves, 2007). Other parties to the litigation were involved in technical working groups.

In August 2007, the FRCPS Action Agencies released a Biological Assessment for the Effects of the FCRPS and Mainsteam Effects of Other Tributary Actions and Reclamation released a Biological Assessment on the operations and maintenance of its projects in the Snake River Basin above Brownlee Reservoir. The Action Agencies that operate the FCRPS had already concluded that operation of the hydropower projects would jeopardize listed species unless further mitigation was provided. The FCRPS Biological Assessment included a proposed RPA to address impacts to ESA-listed species. The RPAs contain "73 detailed sets of additional mitigation actions that are required to avoid jeopardy and adverse modification of critical habitat" (NOAA Fisheries, 2007).

On October 31, 2007, the Draft FCRPS Biological Opinion and the Upper Snake River Biological Opinion were released. The Biological Opinions analyze the Biological Assessments, including the proposed RPA (Graves, 2007). On May 5, 2008, NOAA Fisheries issued the 2008 Biological Opinion (NOAA Fisheries, 2008).

Reasonable and Prudent Alternative Action 4 in the 2008 Biological Opinion addresses Storage Project Operations, including those at Lake Roosevelt. Operations specific to Grand Coulee Dam include drafting the reservoir to support salmon flow objectives during July and August with a variable draft limit of 1,278 to 1,280 feet by August 31 based on the water supply forecast. Currently, the lower draft of 1,278 feet is to be limited to those years when the April to August runoff volume is less than 92 million acre-feet (approximately 50 percent of the years of record)[2] (Graves, 2007). This element of RPA Action 4 is subject to future evaluation and modeling (NOAA Fisheries, 2007 and 2008).

Reasonable and Prudent Alternative Action 14 is for Dry Water Year Operations. A "Dry Water Year" is defined as "the lowest 20th percentile years based on the Northwest River Forecast Center's averages for their statistical period of record (currently 1971-2000) using the May final Water Supply Forecast for the April to August period as measured at The Dalles Dam" (Graves, 2007). Two of the specific elements within Action 14 call for the Action Agencies to convene a technical workshop to scope and investigate alternative strategies for dry water years, and to consider annual and future long-term agreements between the U.S. and Canada (NOAA Fisheries, 2008).

Several Northwest tribes recently entered into new agreements with the Action Agencies that resolve the tribes' objections to the Biological Opinion. On March 25, 2008, the CCT agreed to a Draft Memorandum of Agreement (MOA) with the Action Agencies in which the Action Agencies agree to provide long-term commitments for funding and implementation activities to support the recovery of listed species in the Columbia River. The parties agree that the MOA is intended to resolve issues associated with tribal claims related to the effects of construction and operation of the FCRPS and Reclamation's Upper Snake River projects on fish and wildlife resources of the Columbia River Basin (CCT et al., 2008). A second draft agreement was entered into between the Confederated Tribes of the Umatilla Indian Reservation, The Confederated Tribes of the Warm Springs Reservation of Oregon, and The Confederated Tribes and Bands of the Yakama Nation (3 Treaty Tribes, 2008). Both agreements are for a term of 10 years.

The Draft MOA with the CCT states that nothing in the agreement is intended to "concede, quantify, settle or diminish any aspects of the Tribes' water or fishing rights" (CCT et al., 2008). The agreement is intended to build upon the Action Agencies' proposed RPA for the FCRPS/Upper Snake River projects (CCT et al., 2008). Section A.1.e of the Draft MOA, entitled Flow Actions, specifically addresses operations of Lake Roosevelt. These flow actions are included in Appendix D. The agreements were signed

[2] A study will be conducted that looks at draft to elevation 1,278 feet msl in only the driest 20 percent of water years.

by all parties on May 2, 2008 and are now referred to as The Columbia Basin Fish Accords.

3.6.3 Columbia River Treaty

As discussed in Section 3.6.1.5 of the Programmatic EIS, International-Interstate Issues, the Columbia River Treaty was signed by the U.S. in 1961 and ratified by Canada in 1964. The Treaty may be terminated by either party in 2024 with 10 years notice. The Treaty may also be renegotiated under the same terms. It is anticipated that the Treaty will be renegotiated with notice to be given in 2014.

The Treaty was designed to provide more flood control after the 1948 flood showed that Grand Coulee Dam alone was not adequate (Showman, 2003). Three large dams built in British Columbia pursuant to the Treaty help prevent flooding and also firm up the U.S. power generation year-round. The U.S. and Canada split the benefits from the power: 50 percent for the U.S. ("downstream power") and 50 percent for Canada (the "Canadian Entitlement") (Showman, 2003). At the time of the Treaty, Canada did not need its share of the power and sold it to a consortium for 30 years. In 2003, British Columbia started getting its share of the firm power back. BPA must now make sure the Canadian Entitlement is generated and delivered to the border (Showman, 2003).

The Treaty terms have been augmented by agreements to address flows for Columbia River salmon, sturgeon, whitefish, and rainbow trout (Osborn, 2007). The Treaty has been implemented on a day-by-day basis by BC Hydro for Canada and BPA and the Corps of Engineers for the U.S. One dispute arose in 1993 and 1994, which Canada elevated to the national level. When nothing was resolved at that level, the operations managers in Canada and the U.S. quickly negotiated a resolution (Showman, 2003).

As the time approaches for either party to give notice for renegotiation of the Treaty, issues are being identified that may arise in any future negotiations. There are general concerns that some in Canada want changes in the management of Canadian dams, which could impact water supply and/or timing of supply to U.S. reservoirs (Osborn, 2007). Some Canadians do not like the system being run to preserve fish because the Chief Joseph Dam and Grand Coulee Dam were built without fish passage and destroyed the salmon runs into Canada (Showman, 2003). Others note that with more pressure on water supply and the impacts of global warming, water disputes are expected between Canadian Provinces as well as internationally (Pynn, 2007). Of note, one provision in the 2004 MOU between the state of Washington, Reclamation, and the three Columbia Basin Irrigation Districts, is an agreement to seek water from existing Canadian storage facilities (see Section 1.3.1.1 of the Programmatic EIS).

3.7 Fish

Resident and anadromous fish and their habitats in the project area were described in the Programmatic EIS (Ecology, 2007). Additional information specific to fish and habitat conditions in Lake Roosevelt, the Columbia River downstream of Grand Coulee Dam, Banks Lake, and the Odessa Subarea is described below.

3.7.1 Lake Roosevelt

Construction of the Grand Coulee Dam ending in 1941 eliminated migratory forms of anadromous fish species from Lake Roosevelt and all upstream areas. A fishery survey in 1963 found native fish such as peamouth, northern pikeminnow, suckers, shiners, kokanee, and rainbow trout dominated the fish community (Earnest et al., 1966; Scholz et al., 1986). A variety of non-native fish had also been introduced, including carp, yellow perch, smallmouth bass, pumpkinseed, lake whitefish, brook trout, walleye, and bullheads. By 1973, yellow perch and walleye comprised 32 percent of the catch, suggesting a shift in dominance in the fish community to walleye (Harper et al., 1981; Scholz et al., 1986).

At full pool, Grand Coulee Dam inundated 151 miles of habitat in the Columbia River mainstem from the dam to the Canadian border, 28 miles of the lower Spokane River, 12 miles of the Sanpoil River, and 15 miles of the Kettle River. The shallow, free-flowing river system was converted to a deep reservoir. The impoundment likely selected against the native westslope cutthroat trout, rainbow trout, bull trout, and mountain whitefish that were adapted to a fluvial environment. Unfavorable conditions for existing fish populations in the reservoir, combined with fish entrainment past the dam, resulted in declining native fish populations. Resident fish species were further impacted through lost productivity (i.e., absence of marine derived nutrients from anadromous fish) and habitat degradation related to land use practices (e.g., agriculture, grazing, logging, and municipal development).

The U.S. Fish and Wildlife Service (USFWS) conducted a comprehensive limnology and fisheries study on Lake Roosevelt between 1980 and 1982 (Beckman et al., 1985). They determined the Lake Roosevelt recreational fishery consisted primarily of walleye with a limited rainbow trout fishery in the lower reaches of the reservoir.

Walleye were illegally stocked into Lake Roosevelt in the 1950s. They are opportunistic feeders and have been known to feed on other fish including yellow perch, rainbow trout and kokanee in the reservoir. Between 1980 and 1982, walleye harvest ranged between 128,000 and 108,000 fish per year (Beckman et al., 1985). A decline in yellow perch abundance initiated a concern that the walleye fishery could collapse. Additionally, the average size of walleye harvested by anglers decreased from 18.5 inches in 1973 to 14.1 inches from 1980 to 1983 (Beckman et al., 1985). A collapse in the fish population could shift the age and size structure of the spawning population to the point where it may not be able to replace itself (WDFW, 1994). In 1995, walleye spawning areas in the Spokane Arm, below Little Falls Dam, Sanpoil River, and Kettle River were closed to fishing between April and May. The bag limit was reduced to eight fish. A minimum recreational harvest size of 16 inches was established to allow all walleye to reproduce at least once before harvest.

Nearly 7.5 million kokanee were stocked in Lake Roosevelt from 1942 to 1945 (Scholz et al., 1985). A report by the Bureau of Commercial Fisheries indicated that “sizeable kokanee populations were present in the lake” (Snyder, 1967, as cited in: Stober et al., 1977, and Scholz et al., 1985). Snyder (1967) indicated reservoir conditions were

favorable for kokanee in the mid-1960s. Following construction of Grand Coulee Dam's third powerhouse in 1968, fisheries and fishery managers began working with a new set of operational dynamics. Scholz et al. (1985) suggested the third powerhouse increased fish entrainment through the dam.

Historically, rainbow trout inhabited tributaries of the reservoir. However, the rainbow trout fishery was noted as "mediocre" by Earnest et al. (1966). Before the mid-1980s, little historical data were documented for rainbow trout in Lake Roosevelt. In the early 1980s, migrating adult rainbow trout averaging 16.2 inches were captured in the Sanpoil River (Beak Consultants, 1980; Scholz et al., 1985). A population of approximately 9,113 rainbow trout existed in Blue Creek, a tributary to the Spokane River (Scholz et al., 1985).

It was clear that reservoir operations negatively affected salmonid fish reproduction and limited juvenile rearing habitat. Nevertheless, a large food base of zooplankton existed that was capable of supporting a substantial number of adult rainbow trout and kokanee salmon. Continued research in the early 1980s determined artificial production was a viable alternative to restore and enhance kokanee salmon and rainbow trout in Lake Roosevelt (Scholz et al., 1986).

In the Northwest Power Planning Council's (NPPC) 1987 Columbia River Basin Fish and Wildlife Program (NPPC, 1987), the Council recommended that the Bonneville Power Administration (BPA) support construction of two kokanee salmon hatcheries to enhance the Lake Roosevelt fishery. Rainbow trout production objectives were added before completion of the hatcheries. To accomplish this goal, the Lake Roosevelt Fishery Enhancement Program (LRFEP) was formed. The LRFEP is a cooperative effort between the STI, , CCT, Washington Department of Fish and Wildlife (WDFW), Eastern Washington University, the Lake Roosevelt Development Association (now known as the Lake Roosevelt Voluntary Net Pen Program), and the National Park Service. The purpose of the LRFEP is to develop a collaborative multi-agency artificial production program as a mitigation measure to restore and enhance kokanee salmon and rainbow trout populations in Lake Roosevelt. Since 1987, annual funding from BPA's Columbia Basin Fish and Wildlife Program (CBFWP) has been instrumental in developing a robust, harvestable fishery in Lake Roosevelt.

From 1988 to 1998, the principal sport fishery on Lake Roosevelt shifted from walleye to rainbow trout and kokanee salmon (Underwood et al., 1997; Tilson and Scholz, 1997). The angler use, harvest rates for rainbow and kokanee and the economic value of the fishery has increased substantially during the latest 10-year period. The investigations on the lake also suggest the hatchery and net pen programs have enhanced the Lake Roosevelt fishery while not negatively impacting native stocks within the lake (Lake Roosevelt Forum, 2008b). Fishermen praise the volunteer net pen program and the hatchery efforts since an extremely high percentage of the rainbows and kokanee caught during the lake fishing derbies are of hatchery origin (Lee, 2002). Hatchery and other programs supported by BPA's CBFWP are described below.

3.7.1.1 Artificial Propagation Facilities

Artificial propagation facilities in the region are an important management component to supplement subsistence and recreational fisheries, to offer short-term opportunities for population recovery and to provide species and genetic conservation. Three primary kokanee salmon and rainbow trout artificial propagation facilities in the area, including WDFW's Sherman Creek and Ford Hatcheries as well as the Spokane Tribal Hatchery, are utilized to partially mitigate for the loss of anadromous fish habitat in northeastern Washington (Figure 3-7). The purpose of these hatcheries is to reestablish fish populations in the upper Columbia River Basin following construction of the Grand Coulee Dam in 1941. When funding and stocks are available, the WDFW Colville Hatchery and Colville Confederated Tribal Hatchery also contribute additional fish to Lake Roosevelt.

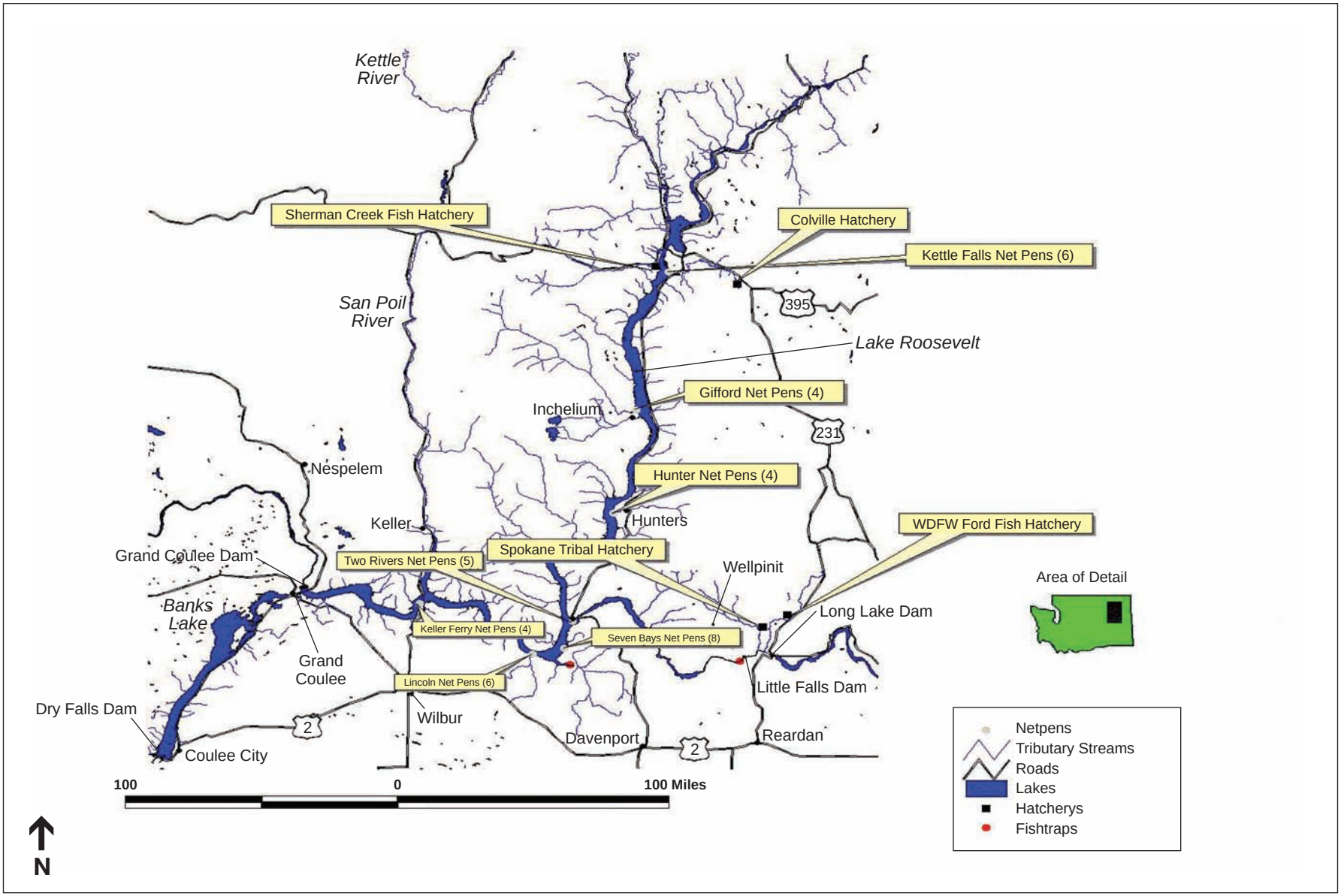

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Figure 3-7
Hatcheries

The Ford Trout Hatchery is located at the eastern edge of the STI Reservation, on the upper unit of the Chamokane Valley Aquifer system. The Sherman Creek Hatchery is located at a northern tributary in Lake Roosevelt near Kettle Falls, Washington. The Spokane Tribal Hatchery is located at Galbraith Springs on the STI Reservation. The operation of these facilities, in conjunction with the Lake Roosevelt Volunteer Net Pen Program, complement each other in the annual rearing and release goal of 1,000,000 yearling, 700,000 fingerling, and 700,000 kokanee salmon fry as well as 500,000 yearling rainbow trout. A current policy for the regional hatchery program includes the increased use of native kokanee salmon, where available, for propagation into the upper Columbia River Basin waters.

The annual production goals and objectives for the Sherman Creek, Ford, and Spokane Tribal Hatchery are developed from the interagency Lake Roosevelt Hatchery Coordination Team (LRHCT) consisting of the WDFW, STI and the CCT. The coordination team was formed in 1988 and is independently advised, through the LRFEP, BPA, Eastern Washington University, Fishery Science Center, and the Lake Roosevelt Net Pen Coordinator. Details of the artificial propagation facilities are included in Appendix E.

3.7.2 Columbia River Downstream

Water flow from Grand Coulee Dam discharges into Lake Rufus Wood, the reservoir impounded behind Chief Joseph Dam. Since no upstream passage facilities exist, Chief Joseph Dam currently represents the most upstream extent of anadromous fish production in the Columbia River basin.

Lake Rufus Woods

The habitat conditions found in Lake Rufus Woods are largely controlled by the operation of Grand Coulee and Chief Joseph Dams. Lake Rufus Woods Dam has very little storage capacity and functions as a re-regulating reservoir passing the water released from Grand Coulee Dam either by spilling or power generation. This creates highly variable water levels in the lake. Grand Coulee Dam operations (power production and spill) contribute to dissolved gas saturation that has been recorded to 138 percent in Lake Rufus Woods (Corps, 2000). The Lake Rufus Woods fish assemblage is likely influenced by downstream migrating fish entrained through Grand Coulee Dam from Lake Roosevelt.

Fisheries projects on the reservoir are partial substitution for lost anadromous fish caused by construction of Chief Joseph Dam. As part of the Columbia River Fish and Wildlife Mitigation Program basinwide effort, the CCT coordinates the BPA's Chief Joseph Kokanee Enhancement Project. A component of this effort includes evaluating the status of the natural production kokanee in streams tributary to Lake Rufus Woods and examining entrainment through Grand Coulee Dam. Historical information alludes to wild kokanee production in the Nespelem River, the largest tributary to Lake Rufus Woods (LeCaire, 2000). The genetic makeup of these native fish and their contribution to

the lake and river fisheries are unknown. Similarly, the level of influence of hatchery releases on wild fish stocks is unknown.

The goal of the Chief Joseph Kokanee Enhancement Project is to protect and enhance the natural production of kokanee stocks above Chief Joseph and Grand Coulee dams to provide successful subsistence and recreational fisheries and potentially provide a broodstock source for artificial production in Lake Roosevelt. Critical ongoing activities include:

- Monitoring emigrating kokanee stocks into Lake Rufus Woods from upriver areas;
- Determining the genetic structure of all in-basin (upriver) stock using micro-satellite DNA analysis;
- Examining methods of reducing entrainment using strobe light technology and hydroacoustic monitoring.

Data collected by the Enhancement Project supplements fishery data collected by other BPA-funded projects in the region. The Enhancement Project is addressing methods of reducing or eliminating entrainment; assessing genetic introgression between hatchery and wild-origin stock; and evaluating adult spawner escapement in tributaries to Lake Roosevelt and Lake Rufus Woods. Updated results of these efforts will be available in the near future.

Similar to Lake Roosevelt, Lake Rufus Woods supports resident fisheries primarily for rainbow trout, and kokanee salmon. Major fisheries occurring in Lake Rufus Woods are described by species below.

Rainbow Trout

The popular rainbow trout fishery in Lake Rufus Woods consists mainly of fish originating from the Spokane Tribal Hatchery and Trout Lodge. Spokane Tribal Hatchery fish collected in Lake Rufus Woods are likely fish released from Lake Roosevelt net pens that have moved downstream past Grand Coulee Dam. The Trout Lodge stock is a triploid steelhead stock that is planted by the Colville Tribe in Lake Rufus Woods to supplement subsistence and recreational opportunities (Truscott, 2000). Trout Lodge stock also is known to escape from the Columbia River Fish Farms net pens in Lake Rufus Woods and enter the fishery.

Kokanee

An adfluvial population of kokanee salmon maintains a sustainable wild population in the reservoir by successfully spawning in the Nespelem River below the barrier falls at River Mile 1.5 (LeCaire, 1999; LeCaire, 2000). The primary kokanee hatchery stock in the area is released in Lake Roosevelt. Since 1995, adult kokanee returns have been monitored annually in the lower Nespelem River with adult returns ranging from 6 to 389 in 1997 and 1999, respectively. Upstream migration into the Nespelem River begins as early as mid-July and spawning occurs between August and November (LeCaire, 1999). The behavior of juvenile fish is unknown. Redd capping attempts to assess fry production have been unsuccessful due to unusually high flows during the spring months

(LeCaire, 1999). Juvenile fish are hypothesized to migrate to the reservoir shortly after emergence in the spring (LeCaire, 2000).

Mainstem Columbia River Further Downstream

Five Mid-Columbia PUD dams with linking reservoirs are located further downstream of Lake Rufus Woods. Wells, Rocky Reach, Rock Island, Wanapum, and Priest Rapids Dams are located upstream of the only free-flowing stretch of the Columbia River remaining at Hanford Reach. Anadromous fish species dominate the species composition in these areas. The anadromous fish resource assemblages for the Mid-Columbia region were presented in the Programmatic EIS (Ecology, 2007) and will not be further discussed here.

Since kokanee salmon and rainbow trout comprised 89 percent of experimental gillnetting efforts in the Grand Coulee Dam forebay, it is assumed a large number of fish immigrating to Lake Rufus Woods are kokanee and rainbow trout (LeCaire, 1999). Data suggest some fish passing Grand Coulee Dam may continue to entrain downstream, although estimates of total fish migrating downstream do not exist (LeCaire, 2000).

3.7.3 Odessa Subarea and Banks Lake

3.7.3.1 Odessa Subarea

There is no additional fish or fish habitat information for the Odessa Subarea presented in the SEIS. Refer to the Programmatic EIS (Ecology, 2007) for a discussion of the existing conditions of fish and fish habitat features in the Odessa Subarea.

3.7.3.2 Banks Lake

Banks Lake covers 27,000 acres with a 91-mile shoreline. The water source for Banks Lake is pumping from Lake Roosevelt. Since the storage capacity of Banks Lake is a little over 1 million acre-feet, the reservoir's water volume is completely flushed out about 2.5 times during the irrigation season for an average water retention time of 146 days (Lewis et al., 2002). Water withdrawal for the Columbia Basin Project causes the elevation of Banks Lake to vary during the irrigation season between late March and late October, annually. Normally, small water level fluctuations occur, but a maximum drawdown of 45 feet is possible. The lake is regularly drawn down as much as 25 feet for maintenance of reservoir facilities. Banks Lake reaches its maximum elevation (1,570 feet msl) in September or October, and remains in full pool status through the winter. Irrigation demand, rainfall, runoff, and power demand contribute to changes in water surface elevations (Stober et al., 1974). Reclamation pumps additional water into Banks Lake over Labor Day weekend each year when power costs are low. The additional water raises the lake level above 1,565 feet msl in early September.

Nearshore aquatic plants (macrophytes) serve as critical spawning and nursery habitat for many of Banks Lake fish species. Most aquatic plants in the Banks Lake littoral zone occur in a band from water surface elevation 1,569 feet to 1,566 feet msl (Reclamation, 2004). The number of days that the littoral zone is currently exposed during lake level drawdown below elevation 1,566 feet msl ranges from approximately 6 to 36 days (Reclamation, 2004).

There are 22 fish species in Banks Lake of which 11 are actively pursued by anglers. The reservoir supports a variety of non-game, warmwater and cold water game fish species most notably walleye, bass, trout, and kokanee salmon.

Kokanee salmon are known to naturally spawn in the lake during October and November, with peak spawning around the first week of November. Generally, Banks Lake is operated favorably with respect to the kokanee life cycle and the lake supports an ongoing population of natural spawners. As discussed below, populations of kokanee are supplemented with annual fish plants. However, the kokanee population may be more dependent on lake shore spawning than hatchery supplementation to perpetuate the population and fishery (Washington Department of Game, 1986). In the early 1970s, kokanee were the mainstay of the fishery in Banks Lake. Unfortunately kokanee are also the most sensitive fish species in the lake to environmental manipulations (Washington Department of Game, 1982) and their numbers have widely fluctuated over the years.

Planting of hatchery rainbow trout fingerlings has resulted in a successful non-seasonal boat and bank fishery. This species is a prized gamefish in Banks Lake. Operation of the reservoir influences rainbow trout far less than kokanee. Lakeshore spawning of rainbow trout is not significant and annual hatchery fingerling plants must be made to sustain a viable fishery (Washington Department of Game, 1986).

Warmwater game fish initially held the spotlight in Banks Lake; however, these populations have declined and stabilized. Today, yellow perch, bass, and walleye remain a popular fish species with anglers on Banks Lake. The average size of yellow perch has decreased slightly over time, yet this species provides an excellent year-round fishery (Washington Department of Game, 1986). Largemouth bass are a target fishery for Banks Lake anglers today. This species, though widespread throughout the lake, is somewhat confined to specific areas of preferred habitat. Current lake management focuses on mixed-species recreational fisheries.

A cooperative rainbow trout rearing project between WDFW, an Electric City sportsmen's group, and Coulee City Chamber of Commerce has been conducted to improve trout fishing. Other major fisheries projects on the lake, including hatchery releases of game fish and fishery surveys, are partial substitution for lost anadromous fish caused by construction of Grand Coulee Dam. These topics are described below for Banks Lake.

Artificial Propagation

Species stocked in Banks Lake since 1959 include kokanee, rainbow trout, cutthroat trout, coho salmon, and walleye. Since 1990, stocking has concentrated on rainbow trout, kokanee, and walleye. Rainbow trout have been stocked every year since 1990 at an average of over 188,000 fish annually. Average kokanee stocking between 1990 and 1999, was more than 915,000 fish annually. Walleye were stocked in 1992, and 1995 through 1998 at an average of 125,000 fish annually.

Current management calls for stocking Banks Lake with one million kokanee annually as part of the Columbia River Fish and Wildlife Mitigation Program. The goal for kokanee salmon at the Ford Hatchery includes the incubation, hatching, and rearing of 700,000 kokanee fry released into Banks Lake in spring, and another 700,000 kokanee fingerlings planted into Banks Lake in the fall (Lewis, 2003).

Historical and Current Fishery

The Banks Lake fishery has undergone many changes, both favorable as well as adverse since its construction in 1951. Soon after the formation of Banks Lake, a noted year-round kokanee fishery developed when these fish entrained to Bank's Lake from Lake Roosevelt.

Large numbers of kokanee are entrained downstream of Banks Lake despite a barrier net at the outlet (Stober et al., 1976). As reported in the Programmatic EIS, kokanee are caught in the unstocked Billy Clapp Lake, downstream from Banks Lake (Ecology, 2007). The University of Washington Fisheries Research Institute conducted a creel census of Billy Clapp Lake in 1978 and found the catch to consist almost entirely of kokanee salmon (Stober et al,. 1979). More recent WDFW surveys continue to report kokanee in the creel at Billy Clapp Lake, and since 1997, few anglers reported an improvement in the kokanee fishery (USFWS, 2002).

Although the Ford and the Spokane Tribal Hatcheries continued to release kokanee annually into Banks Lake, creel studies to quantify the Banks Lake fishery were lacking between the early 1980s and the 1990s. Information from anglers indicated a continued reduction and general disappearance of kokanee from the creel in Banks Lake. The kokanee currently stocked have been somewhat fewer but considerably larger than those stocked during the 1950s and 1960s. Despite stocking 600,000 to 1.2 million kokanee annually since 1989, the kokanee fishery failed to rebound during the 1990s (WDFW, 1996).

In September 2001, the Bonneville Power Administration (BPA) allocated funds to WDFW through the Ford Hatchery Renovation Project to conduct a 10-year creel study on Banks Lake. The objective of the study was to evaluate the Banks Lake fishery, and to determine if hatchery stocked kokanee and rainbow trout were being targeted and harvested by anglers. First year results of this effort indicate:

- Kokanee harvest in 2001 and 2002 from Banks Lake was near zero; however, 2,064 rainbow trout, 3,453 smallmouth bass, 6,768 walleye, and 2,300 yellow perch were harvested from Banks Lake during this period.
- Banks Lake was primarily a rainbow trout/yellow perch fishery in the winter and spring and a smallmouth bass/walleye fishery in the spring, summer, and fall.

As noted, a limited number of kokanee were harvested during the study. Local fishermen and guides have indicated there are a few anglers who target and catch kokanee from boats. However, creel clerks did not encounter these individuals (Baldwin et al., 2003). It is possible the 2001 netting survey sampled a strong year class of age 3 or 4 kokanee and that subsequent year class survival was poor. Several more years of creel data, in conjunction with data from the Banks Lake Fishery Enhancement Project, will be required to quantify the future abundance and harvest of kokanee in Banks Lake.

The study determined that smallmouth bass and lake whitefish dominated the nearshore species composition in May. However, yellow perch replaced lake whitefish as the second most common species to smallmouth bass in July. On a pelagic basis, lake whitefish dominated the offshore catch during May and July. The May hydroacoustic survey revealed highest densities of fish in the upper one-third of the water column in the mid- to northern sections of the reservoir near Steamboat Rock.

3.8 Wildlife and Plants

The Programmatic EIS (Ecology, 2007) contains a broad discussion of wildlife and plants in the Columbia River Basin. Specific information regarding federal and state listed species has been presented in the Programmatic EIS and will not be further discussed herein. Additional information specific to wildlife, habitat conditions, and plants in Lake Roosevelt, the Columbia River downstream of Grand Coulee Dam, Banks Lake and the Odessa Subarea is described below.

3.8.1 Lake Roosevelt

Lake Roosevelt is surrounded by multiple vegetation communities including mixed conifer forests, shrub-steppe, riparian wetlands, open water, and mixed agriculture and pasture grasslands. These communities provide abundant and diverse habitats for wildlife species. Due to the annual and rapid fluctuation of water levels within the reservoir, there are limited aquatic bed and wetland communities.

3.8.1.1 Plant Communities and Habitats

Vegetation along the 150-mile-long lakeshore gradually transitions from conifer forests in the north to semiarid grassland and sagebrush communities in the south. Conifer forests north of Kettle Falls are dominated by second-growth ponderosa pine, Douglas-fir, and western larch. Dry, rocky areas within the forest are dominated by shrub thickets of elderberry, snowberry, deer brush, chokecherry, Oregon grape, and buck brush. South of Kettle Falls, riparian areas characterized by alder, willow, hazelnut and black cottonwood are present next to ponderosa pine and Douglas-fir dominated forests. Shrub

areas are dominated by wild rose, serviceberry and Douglas hawthorn with scattered forb species of hairy goldaster, phlox, and nodding onion.

Cliff and bluff, shrub-steppe, and riparian priority habitats are most prevalent in the southern portion of the lake and on its eastern side (WDFW, 2008). The southern end of the lake also contains areas of disturbed shrub-steppe and irrigated agricultural lands.

The National Wetland Inventory (NWI) maps wetlands in the lake area that are primarily associated with its tributaries, including the Kettle, Sanpoil, and Spokane Rivers (USFWS, 1987). Wetland priority habitats mapped by WDFW are extensive around the northern portion of the lake where fewer disturbances have occurred. Due to the fluctuating water levels, there are few perennial wetlands along the shoreline of Lake Roosevelt. The two largest wetlands are at the mouths of the Kettle and Colville Rivers (NPS, 2000). Intermittent wetlands that flood seasonally are more common along the shoreline.

Littoral and Riparian Zones

Lake Roosevelt has more than 600 miles of shoreline. The shore ranges from 100 to 300 feet wide when the reservoir is full, and in locations, it is wider when water levels are lower. The littoral zone of the lake is generally the interface between dry land and open water. It extends from the shore to a depth where the light is barely sufficient for rooted aquatic plants to grow (Goldman and Horne, 1994). This zone supports aquatic plants, such as bulrushes, sedges, reeds and cattail, which provide food and cover for waterfowl, mammals, and amphibians. Submersed aquatic plants include water starwort, waterweed, common watermilfoil, common hornwort, pondweeds, and pygmy weed.

Also present along the shoreline is riparian vegetation, including cottonwood trees and willow. Cottonwood trees can provide important roosting and perching sites for bald eagle and other raptors.

There is little available information for emergent and riparian vegetation distribution and quality for the Lake Roosevelt shoreline. The northern portion of the lake is flanked by conifer forests that are relatively undisturbed with the exception of developed areas. Transportation corridors, including roads and a railway, extend parallel to the shoreline for much of its length. Land use activities such as agriculture, dispersed recreation and roads are present throughout the central and southern portions of the lake, contributing to a lack of riparian vegetation.

Invasive and Noxious Species

Noxious weeds are a problem in the Lake Roosevelt area despite control efforts by NPS. The most common problem terrestrial plants are thistle (Canadian, star, and Russian), diffuse and spotted knapweed, Dalmatian toadflax, cheatgrass, common mullein, wormwood, leafy spurge, houndstongue, rush skeletonweed, goat weed, and baby’s breath (NPS, 2000).

Both Eurasian watermilfoil and yellow flag iris are invasive aquatic species that have been noted in Lake Roosevelt. Eurasian watermilfoil is a submersed perennial plant that can thrive in a variety of aquatic environments. This species can develop into a land based form when water levels recede slowly and gradually strand the plant. It requires high light and grows best on fine-textured, inorganic sediments and is typically most abundant in 1 to 4 meter-deep waters (Smith and Barko, 1990). Because of its high photosynthetic rate and rapid ability to grow new shoots, Eurasian watermilfoil can easily form thick canopies that shade out native aquatic vegetation. As vegetative spread is considered the primary means for this plant's reproduction, recreational activities such as boating, which disturb water and separate plants into fragments, have a high likelihood of spreading existing infestations. Infestation of this noxious weed is heaviest in shallow water areas where sunlight is plentiful. In average or above average water years, Lake Roosevelt is dropped to 1,280 feet msl in mid-August to provide ample water flow for salmon. In low water years, the lake is dropped an additional 2 feet in mid-August, to 1,278 feet. Residents and recreationalists in the lower Spokane Arm of Lake Roosevelt have noted a much higher incidence of Eurasian watermilfoil growth in shallow and sunny areas when the lake level is dropped to 1,278 feet msl (Lake Roosevelt Forum, 2006a).

Yellow flag iris is most commonly found in temperate wetlands and along the margins of lakes and rivers. It can grow in up to 10 inches of inundation, although very shallow water or muddy areas are preferred habitat. Yellow flag iris grows well in nutrient-rich soils and prefers partial shade to full sun exposure. Rhizomatic spread causes dense stands of yellow flag iris to form, creating monocultures and excluding native wetland vegetation. A scattered stand was found along a stretch of Lake Roosevelt between Long Lake Dam and Porcupine Bay, causing Lincoln County to add yellow flag iris to its noxious weed list in 2007.

Winter drawdowns for flood control can help contain aquatic invasives by exposing beach areas. In some cases, the control of invasive plants, including Eurasian watermilfoil, has been the driver behind operation regimes at various reservoirs across the country. Reducing lake and reservoir elevation to allow dessication of shallow water habitats has proven an effective control of invasive plant communities (Cooke, 1980; Cooke et al., 1986). Where shallow water habitats are extensive throughout a reservoir, an extended period of drawdown during freezing temperatures is the only practical means of control (Smith and Barko, 1990).

Reservoir Drawdown

The biological compositions of habitats within the littoral zone of Lake Roosevelt have been developed over a period of nearly 70 years since the construction of the Grand Coulee Dam in 1939-1941. Significant water level fluctuations have occurred during most years of reservoir operation. The aquatic plant communities and riparian vegetation in Lake Roosevelt have been influenced by spring and early summer drawdown. In years when spring runoff is high, reservoir levels are drawn down more than 80 feet to accommodate the anticipated inflows.

The reservoir levels determine the extent of littoral habitat and the fluctuations determine the function of the littoral habitat. Emergent and floating-leaved plants seldom grow in water exceeding 10 feet deep, so deep lakes also have limited emergent communities. Vegetation growth in the littoral zone is also affected by water clarity (light availability), nutrient richness, water chemistry, and substrate.

Above the littoral zone, many species of riparian vegetation, especially cottonwood, have specific soil moisture requirements needed for germination and seedling survival. These requirements typically involve early spring high water levels that recede just prior to fall, providing a moist seedbed (Bradley and Smith, 1986). The normal operating conditions of the reservoir include low water levels during spring and high levels in fall (Figure 1-1), the opposite water regime needed for cottonwood growth.

A study of Lake Roosevelt's biological resources in 1993 found that the littoral zone of the lake has limited production of emergent and aquatic bed vegetation due to reservoir fluctuation. Voeller (1993) observed little aquatic plant community growth and low benthic macroinvertebrate assemblages due to the lack of stable littoral habitats. For an approximately three-month period, the lake drawdown separates the riparian habitats from the reservoir by an expanse of barren land.

3.8.1.2 Wildlife Species

Vegetation communities in the Lake Roosevelt area support abundant wildlife, including an estimated 75 species of mammals, 200 species of birds, 10 species of amphibians and 15 species of reptiles (NPS, 2000). Systematic surveys of wildlife have not been conducted in the area, but Priority Habitats and Species (PHS) data (WDFW, 2008) note the presence of elk, deer, and bird species, as discussed in the following sections.

Much of the upland area surrounding Lake Roosevelt is occupied by herds of Rocky Mountain elk, mule deer, and white tailed deer (WDFW, 2008). Hunting is permitted within the National Recreation Area during established seasons as regulated by WDFW. Other mammal species that are likely to occur in habitats along the lake are black bear, mountain lion, beaver, river otter, bobcat, coyote, mink, badger, skunk and red fox. A grizzly bear was observed near the northern portion of the lake in 1983 (WDFW, 2008). Small mammals include marmot, ground squirrels, chipmunks, deer mice, and house mice (NPS, 2000).

Upland habitats near Lake Roosevelt support several species considered priority species by WDFW. These species, though not abundant in the area, include bald eagle, golden eagle, osprey, northern goshawk, Merriam's wild turkey, Rio Grande wild turkey, blue grouse, Lewis woodpecker, and white headed woodpecker (WDFW, 2008). Some areas along the shoreline are identified by WDFW as providing roosting and breeding habitats, including several communal bald eagle roosts found in proximity to the lake. WDFW has identified areas that support high concentrations of waterfowl in Lake Roosevelt including large numbers of migrating or wintering ducks and geese. Waterfowl species present during the winter months include mallard, northern pintail, cinnamon teal, redhead, canvasback, lesser scaup and Canada geese. Areas of emergent vegetation not

impacted by rapid reservoir fluctuations are important for nesting for species such as red-winged and yellow-headed blackbird, marsh wren, grebe, bittern, Canada geese, and muskrat.

WDFW has noted single occurrences of California floater, western toad, and Pacific western Townsend's big eared bat, which are all priority species (WDFW, 2008). Other priority reptiles and amphibians that have been documented in the area include sagebrush lizard, short-horned lizard, western rattlesnake, bull snake (also known as gopher snake), western terrestrial garter snake, and salamander species. Bullfrog, a nonnative species that is considered invasive, is also present where suitable emergent habitats or shallow open water habitat exists.

Reservoir Drawdown

The rapid annual fluctuation of water levels due to reservoir operations limits the establishment of shoreline vegetation and the amount of suitable habitat for nesting waterfowl and breeding amphibians along the edge of Lake Roosevelt. However, in some areas, the 20- to 25-foot drawdown between early April and mid-May affects wildlife species through the loss of floating vegetation and draining of side channels (USFWS, 1982). Where suitable habitats exist, a loss of nests, eggs, and young occurs each year.

In some embayment areas, such as Marcus Flats and Kettle River (Figures 17 and 18 in the Map Folio at the end of this document), reservoir drawdown can result in increased benthic invertebrate prey for shorebirds and waterfowl as additional mudflat areas are exposed. The current drawdown schedule provides some exposed areas during spring migration. Mihuc et al. (1997) studied various habitats within an irrigation reservoir in southern Idaho for shorebird predation on benthic macroinvertebrate populations. They observed significant predation by shorebirds on a medium size class of chironomid (midge) larvae in an area that had higher sediment slope and slower water receedence than other areas. These conditions resulted in a higher concentration of shorebirds on a smaller area of newly exposed sediment.

Sprandel et al. (2002) observed changes in bird usage of Lake Talquin, a reservoir managed for recreation and hydroelectric power, following drawdown, with increased use by some species and decreased use by others. As would be expected, waterfowl and cormorant were more abundant during the months when the reservoir remained at full pool elevation. Fish-eaters such as wading bird species, bald eagles and gulls were more abundant during the drawdown due to the availability of trapped fish and increased exposed areas for gull foraging. Increased shorebird usage may also occur, but is dependent on substrate composition of the exposed areas (soft sediment versus hard clam shell-lined). Early spring drawdowns can provide habitat for migrating shorebirds, depending on the reservoir latitude and timing of drawdown. A drawdown resulting in a littoral zone composed of shallow water that is interspersed with mudflats is considered ideal for shorebirds (Fredrickson and Taylor, 1982). Columbia River Downstream

The mainstem of the Columbia River consists of a series of dams linked by reservoirs with the exception of the only free-flowing stretch remaining at Hanford Reach. The Programmatic EIS (Ecology, 2007) broadly characterized plants and vegetation communities in the Columbia River Basin. Specific information regarding priority habitats and species identified by WDFW and from other existing information for the Columbia River is described in the following sections.

3.8.1.3 Lake Rufus Woods

Once released from the Grand Coulee Dam, water flows through Lake Rufus Woods to the north and west through arid habitats and along the CCT Reservation. Pothole springs and lakes are present south of the lake and the CCT Reservation comprises the northern border. Wetland habitats along the shoreline provide foraging and breeding habitat for waterfowl concentrations and Canada geese. However, highly variable water levels due to the operating regimes of Chief Joseph Dam and Grand Coulee Dam have influenced establishment of wetland vegetation. Cliff and bluff habitat is extensive along this 50-mile stretch. Bald and golden eagles are present, and have nesting territories throughout the area.

LeCaire (2000) notes that winter surveys for both mule and white-tailed deer indicated that populations are declining on the CCT Reservation side of Lake Rufus Woods. Conversely, mule deer populations are stable in the area south of the lake since implementation of the three-point harvest restriction rule throughout the State of Washington. During winters with heavy snow accumulation on the plateau, mule deer move down to lands adjacent to the reservoir and may move further downriver and outside of the subbasin, thus accounting for the surveyed decline. However, other reasons behind the decline are likely. LeCaire (2000) concludes that additional research and monitoring are needed to determine mule deer population trends and limiting factors before determining strategies to reverse negative population trends.

Mule and white-tailed deer are culturally significant: They contribute subsistence to CCT members and are an important big game species. Elk and moose populations are also present and increasing in the Lake Rufus Woods area (LeCaire, 2000). However, similar to the mule deer, some proportion of the increase could be attributable to animal/herd movement from adjacent subbasins.

South of Bridgeport, the central portion of the Columbia River flows through arid habitats, including disturbed shrub-steppe and irrigated agricultural fields. Documentation of priority species by WDFW includes several bald eagle communal roosts, nesting records of prairie falcon, Swainson’s hawk, loggerhead shrike, and long-billed curlew (WDFW, 2008). Waterfowl concentrations occupy the area, and woodhouse toad and sagebrush lizard have been documented in the area, both of which are priority species.

3.8.1.4 Hanford Reach

The Hanford Reach of the Columbia River supports remnant habitat for aquatic organisms that were widespread before the remainder of the Columbia River system was converted to reservoirs (USFWS, 2006). In addition, dune, instream, riparian, and urban natural open space priority habitats are located along the shoreline (WDFW, 2008). WDFW notes occurrences of breeding Swainson's hawk, burrowing owl, long-billed curlew, and Canada geese in this area. The Reach's riverine habitat provides large trees and abundant cover for wildlife, comprising the most intact and valuable riparian habitat along the Columbia River. Wading birds, wintering waterfowl, double-crested cormorants, American white pelicans, gulls and terns use the islands within the Reach. The islands are vegetated by willow, poplar, Russian olive and mulberry (USFWS, 2006). Surveys have identified several rare plant associations along the shoreline and islands of the Reach. The bluffs and rock outcrops provide perching, nesting and escape habitat for prairie falcons, red-tailed hawks and multiple swallow species.

Similar to riparian and emergent habitats in Lake Roosevelt, shoreline areas along the Hanford Reach are affected by fluctuating water levels due to operation schedules at Priest Rapids Dam. As a result of daily fluctuations in discharges from Priest Rapids Dam, the depth and width of the river varies significantly over a short time. Width of the river varies from approximately 1,000 feet to 3,300 feet along the Hanford Reach (USFWS, 2006). The width also varies temporally as the flow rate changes, which causes repeated wetting and drying of an area along the shoreline.

Multiple priority species occurrences have been recorded by WDFW, including mule deer, Rocky Mountain elk, Rocky Mountain bighorn sheep, black-tailed jackrabbit, and Ord's kangaroo rat. Golden eagle, prairie falcon, peregrine falcon, Swainson's hawk, common loon, and chukar have also been observed multiple times. Racer, striped whipsnake, night snake, and sagebrush lizard are reptiles that have been documented in the vicinity of the river (WDFW, 2008).

3.8.2 Odessa Subarea and Banks Lake

3.8.2.1 Odessa Subarea

The Odessa Subarea comprises a large area within Adams and Grant Counties with a small portion in Franklin County. The subarea mainly supports arid lands that have been converted to irrigated agricultural land.

Some areas of intact and disturbed shrub-steppe are present. WDFW notes shrub-steppe, wetland, and riparian priority habitats throughout the northern portion of the Odessa Subarea. Priority species documented in this area include ferruginous hawk, sage sparrow, sharp-tailed grouse, Washington ground squirrel, and white-tailed jackrabbit. All of these species are state or federally listed or are candidate species due to low abundance.

Extensive wetland habitat containing waterfowl concentrations is present in northwestern portion of the Odessa Subarea. Mule deer and ring-necked pheasant habitat is common. American white pelican and tundra swan have been documented occur in the north-central portion, while swan, prairie falcon, loggerhead shrike, sage thrasher, and tiger salamander have been recorded in the northeastern portion. Washington ground squirrel, a state and federal candidate species, have been documented in the western and southern portions of the subarea.

3.8.2.2 Banks Lake

Banks Lake is an artificial impoundment that stores and subsequently supplies irrigation water. As discussed in Section 3.7.3.2, water elevations in the lake vary during irrigation season (March to October) and this impedes the development of extensive wetland and riparian vegetation. However, water levels fluctuate only 3 to 5 feet annually and the lake does provide areas of aquatic plants between 1,569 feet and 1,566 feet msl (Reclamation, 2004). Shallow, low-gradient shorelines are present in bays and along shorelines throughout the lake. The ability to tolerate periodic drawdown and drying determines which aquatic species survive (Reclamation, 2004). There are over 20 islands in the lake, including Steamboat Rock, a granite outcrop in the northern portion of the lake, which contain undisturbed vegetation communities. Shrub-steppe priority habitats are present to the southeast and rural natural open space is relatively common. The lake supports several concentrations of waterfowl (WDFW, 2008).

Records of priority species include greater sage grouse, which have been documented west of the lake, and sandhill cranes that are also known to inhabit the land west of the lake. Mule deer occur in the lake vicinity, especially to the northwest and northeast. Chukar, a priority game species, have been documented southwest of the lake. Several bald eagle communal roosts exist around the lake.

Multiple occurrences of golden eagle, prairie falcon, peregrine falcon, Swainson's hawk, and loggerhead shrike have been recorded near Banks Lake. American white pelican, long-billed curlew, black-crowned night heron, common loon, and western grebe have also been reported. A gull colony is located within the lake boundaries, and Canada geese frequent the area (WDFW, 2008).

3.9 Cultural Resources

3.9.1 Lake Roosevelt

Cultural resources in the Lake Roosevelt area were described in Section 3.10.4.1 of the Programmatic EIS (Ecology, 2007).

3.9.2 Columbia River Downstream

Cultural resources in the Columbia River downstream area were described in Section 3.10.2 of the Programmatic EIS (Ecology, 2007).

Archaeological sites on islands in the Columbia River were not specifically discussed in the Programmatic EIS, but incorporated into the general overview of cultural resources in the project area. Land that is now considered an island, in many cases, would not have been an island prior to inundation in the 20th century. Many island sites are included in the counts of Historic Properties on Project Lands in Table 3-26 of the Programmatic EIS (Ecology, 2007).

3.9.3 Odessa Subarea and Banks Lake

Cultural resources in the Banks Lake area were included in the region described in Section 3.10.2 of the Programmatic EIS (Ecology, 2007). In addition, evaluation of cultural resources within the Odessa Subarea was conducted by Reclamation as part of an evaluation of the water delivery alternatives possible in the Odessa Subarea. Research was conducted to identify previously recorded cultural resources and previous cultural investigations in the 2,000-square-mile study area; no fieldwork was undertaken. Previous cultural resource investigations were found to have been conducted in less than 1 percent of the study area; only six prehistoric and nine historic sites have been previously recorded (Ives, 2007). Additionally, a preliminary TCP (Traditional Cultural Property) study was conducted for the Odessa Subarea (Shannon, 2007).

3.10 Environmental Health

Specific environmental health issues were not discussed in the Programmatic EIS. Therefore, information specific to hazardous and toxic materials and public health and safety in Lake Roosevelt, the Columbia River downstream of the Grand Coulee Dam, Bank's Lake, and the Odessa Subarea is described below.

3.10.1 Lake Roosevelt

3.10.1.1 Hazardous and Toxic Materials

Located 10 river miles upstream of the U.S.-Canadian border, Teck Cominco has been in operation as a smelting facility since 1896. As stated in the US Environmental Protection Agency 2007 Contaminated Sediments Technical Advisory Group (CSTAG) Recommendations for the Upper Columbia River Memo:

> This facility either produces or has historically produced lead, zinc, cadmium, silver, gold, bismuth, antimony, indium, germanium, arsenic, mercury, sulfuric acid, liquid sulfur dioxide, ammonia, ammonium sulfate, and phosphate fertilizers. The smelter complex has discharged liquid effluent and water-granulated fumed slag into the Columbia River, including a number of accidental spills and releases to the river (CSTAG, 2007).

In 2004, the EPA began a Remedial Investigation and Feasibility Study (RI/FS) of contaminants in the upper Columbia River above Grand Coulee Dam. Sediment sampling conducted as Phase I of the Draft RI/FS highlighted the following metals and organic compounds as preliminary Constituents of Interest:

- Metals: antimony, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, uranium, and zinc
- Organics:
  - Pesticides: 2,4-DDE, 2,4-DDT 4,4-DDD, 4,4-DDE, 4,4-DDT, and aldrin
  - Polychlorinated Biphenyls: Aroclor 1016 and Aroclor 1260
  - Dioxins and furans: 2,3,7,8 TCDD toxicity equivalent (TEQ) and 14 congeners, as listed in Table 4-1
  - Polycyclic Aromatic Hydrocarbons: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene (CH2M Hill, 2006).

Screening levels for Constituents of Interest were defined both by human health (EPA Standards, STI Human Health Values, CCT Human Health Values) and ecological values (Probable Effects Concentrations (PECs) and Threshold Effects Concentrations (TECs)).

While Teck Cominco has been identified as a primary source of discharge and pollution into the upper Columbia River, other potential sources of pollution were also identified, including: mining and milling operations, smelting, pulp and paper operations, sewage treatment plants, other industrial activities, and municipal and agricultural runoff.

Metal Contamination

Coarse-grained water-granulated fumed slag was the primary source of metal contamination (antimony, arsenic, chromium, copper, iron, lead, manganese, zinc, and lesser constituents). The following accumulation areas were noted in the 2006 CH2M Hill report:

- Side-bank beach and point bar areas in the upriver reaches (e.g., Black Sand Beach at RM 742; large point bar deposit at RM 738) deposited during high river flow events;
- Dispersed accumulations to an unknown depth within the interstices of the coarse, cobbly sediments in the main river channel upstream of approximately RM 729 (Onion Creek);
- Localized accumulations within the original pre-reservoir river channel downstream from approximately RM 729 to approximately RM 710 (near the entrance to Marcus Flats); and
- Within Marcus Flats, accumulations concentrated in the original pre-reservoir river channel.

Downstream accumulations of water-granulated fumed slag were not identified, but are possible based on historical quantities discharged into the Columbia River. Downstream sources are most likely related to effluent discharges, fine-grained water-granulated fumed slag, or weathering of more coarse-grained slag particles. Sediments downstream of Marcus Flats at an elevation below 1,255 feet have greater concentrations of metals than those above 1,255 feet due to washing of fine particulates and transport of contaminants from higher elevations (CH2M Hill, 2006).

Organic Compound Contamination

Concentrations of organic compounds within the upper Columbia River are generally low; however, where present, these compounds are typically above human health standards. No patterns of organic compound movement or areas of accumulation were identified (CH2M Hill, 2006).

Beach Screening

In June 2006, the EPA published a draft report outlining the general results of sediment sampling at recreational beaches along Lake Roosevelt. Screening was conducted based on limited recreational use. Samples revealed that 12 of the 15 sites sampled were below detection limits for all contaminants tested, and were designated as safe for use. Three sites (Black Sand, Northport, and Dalles) had arsenic and/or lead concentrations slightly above screening levels; these beaches were designated as safe for seasonal recreation (EPA, 2006a).

Risk Assessment

The EPA is conducting a human health risk assessment and Teck Cominco is conducting an ecological risk assessment regarding upper Columbia River contamination. These assessments have not yet been completed and results will not be available for this Supplemental EIS.

3.10.1.2 Public Health and Safety

Sanitation

Sanitation issues (e.g., human waste left on beaches) have been noted along Lake Roosevelt. The problems occur mainly in dispersed areas and other shoreline areas where restroom facilities are not provided. Bacteria in human waste present potential health risks for beach users.

Fish Advisory

The Washington State Department of Health (DOH) currently has an updated fish advisory in effect for walleye due to high mercury levels. DOH recommends that "women who might become pregnant, are pregnant, nursing, and young children should not eat more than 2 meals per month of walleye caught from Lake Roosevelt" (DOH, 2008). Also recommendations are in place to eat no more than four meals per month of burbot or sucker.

Fish Consumption Survey

A fish consumption survey conducted in 1994 and 1995 by the STI and the DOH examined fish catch and consumption for anglers at Lake Roosevelt. Anglers consumed an average of 42 fish meals per year; furthermore, 75 percent of those surveyed ate 48 or fewer fish meals per year (DOH, 1997). Rainbow trout were the primary fish caught and

consumed (86 percent), followed by walleye (66 percent), kokanee (40 percent), and bass (28 percent) (DOH, 1997).

The majority of anglers surveyed were Caucasian males, with only 2.4 percent of the population surveyed being Native American (DOH, 1997). This survey notes that "only a limited portion of the Spokane Tribe of Indians and the Colville Indian Nation use the lake as a fisheries resource." However, due to the small percentage of Native Americans questioned, fish consumption for these groups is not adequately represented (DOH, 1997).

Although specific studies for the CCT and STI have not been conducted, fish consumption surveys were completed in 1992 for the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes along the Columbia River. Rates of fish consumption for these tribes were approximately nine times higher than the national consumption rate for adults surveyed. Rates of fish consumption for the tribes were approximately three times higher than the national consumption rate for children (Columbia River Inter-Tribal Fish Commission, 1994).

Fish Tissue Sampling Studies

According to a fish sampling study conducted during the summer of 1994 by the USGS and the Spokane Walleye Club, average mercury concentrations in walleye from Lake Roosevelt were 0.3 parts per million (ppm), below the national average of 0.52 ppm (Erwin and Munn, 1997). Furthermore, mercury levels in Lake Roosevelt fish were below the 1.0 ppm limit set by the Food and Drug Administration (FDA) (Erwin and Munn, 1997).

A fish sampling study was also conducted in 2005 as part of the Phase I RI/FS Report for the upper Columbia River (CH2M Hill, 2007). The study included sampling walleye, rainbow trout, lake whitefish, largescale sucker, and burbot tissues for metals and toxic compounds. Comparison Values (CVs), which were based on published risk based data, were used to identify broad trends and patterns in contaminant data. This process provided an initial evaluation of fish tissue analytical data.

Metals that most often exceeded their CV included: total mercury, arsenic, selenium, chromium, copper, zinc, aluminum, lead, and cadmium. PCB and dioxin/furan (s, 3, 7, 8-Tetrachlorodibenzofuran [TCDF]) compounds also exceeded the CV for most fish species and sample types. General results from the study found that contaminant concentrations were similar across species for aluminum, barium, cadmium, chromium, copper, iron, selenium, uranium, and zinc. Results suggested that contaminant levels appear to be unchanged or declining in some cases, especially with declining mercury levels in walleye and rainbow trout and declining 2,3,7,8-TCDF in lake whitefish. A more detailed discussion of sampling results, general trends, and statistical analyses is presented in Appendix H. (CH2M Hill, 2007)

Results from the 2007 sampling analysis were used to update the fish advisory for Lake Roosevelt.

3.10.1.3 Mosquitoes

Mosquitoes are a concern due to risk of transmission of mosquito-borne pathogens such as West Nile Virus. Summer and early fall are the most common times for human infections with West Nile Virus (Campbell et al., 2002 in Reclamation, 2004). Shallow, stagnant waters with dense, emergent vegetation are prime mosquito breeding habitat; conversely, "wind-swept shorelines lacking vegetation and pools containing fish and other mosquito larvivores are not conducive to mosquito production" (Pratt and Moore, 1993 in Reclamation, 2004).

3.10.2 Columbia River Downstream

Sediment sampling discussed in the 2006 upper Columbia River Report did not continue below Grand Coulee Dam. Although specific data were not readily available, some transport of contaminants from Lake Roosevelt is likely present downstream in the Columbia River.

Specific data for areas directly downstream of Grand Coulee Dam were not readily available. Larger-scale studies of the entire Columbia River have noted contaminants (a variety of organic compounds and heavy metals) in fish tissues (EPA, 2002).

3.10.3 Odessa Subarea and Banks Lake

3.10.3.1 Hazardous and Toxic Materials

Sediment sampling discussed in the 2006 upper Columbia River Report did not continue below Grand Coulee Dam. However, sediment samples were analyzed for mercury concentrations at Banks Lake as part of an Ecology study reviewing statewide mercury levels in fish tissues. Sediment samples from Banks Lake were found to have some of the lowest mercury concentrations (12 parts per billion [µg/kg] dry weight) compared to other state lakes. Sediment samples were well below the Threshold Effects Level (TEL) of 170 µg/kg dry weight. TEL is defined as the level below which adverse effects rarely occur in bioassays and benthic communities (Ecology, 2003).

3.10.3.2 Public Health and Safety

Largemouth bass tissues sampled as part of the 2003 Ecology study were found to have a mean mercury concentration of 114 µg/kg. Two of the 10 fish sampled had mercury levels above the DOH criteria of 150 µg/kg wet weight; however, all fish sampled in Banks Lake were below the EPA 2001 Revised Fish Tissue Residual Criterion of 300 µg/kg wet weight. When compared to other Washington state lakes in the study, Banks Lake was found to have significantly lower mercury concentrations in fish (Ecology, 2003).

3.11 Recreation and Scenic Resources

3.11.1 Lake Roosevelt

The Programmatic EIS (Ecology, 2007) contains general information on recreation and scenic resources in the Columbia River Basin. The following section provides additional information on recreation facilities and uses in the Lake Roosevelt area to support the evaluation of impacts associated with releases from Lake Roosevelt in more detail. The discussion is based on readily available information from the National Park Service (NPS), the CCT, and the STI.

3.11.1.1 Recreation Activities and Use Levels

Lake Roosevelt provides recreation opportunities for 1.2 to 1.5 million visitors annually. Most visitors come from Washington and the immediate region, including Canada (NPS, 2000). The lake is popular because of its size, surrounding scenery, the quality of its water, and the fact that it is one of the few large lakes in the region that has an extensive amount of shoreline and adjacent lands that are publicly owned and available for public use.

Visitor use at Lake Roosevelt is unevenly distributed throughout the year, with peak activity and visitation occurring from June through September, which accounts for nearly 75 percent of visitor use. In general, visitor use dramatically increases in June, peaks in August, and falls off dramatically in September. The latest NPS visitation data (2007) show visitation at a high of 357,742 in August and a low of 23,265 in January (Table 3-2).

Table 3-2. Lake Roosevelt National Recreation Area Visitation[1] (2007)

Month	*Visitors*
January	23,265
February	25,392
March	48,244
April	61,028
May	106,819
June	191,062
July	335,533
August	357,742
September	149,654
October	83,062
November	41,064
December	27,573
2007 Total	1,450,438

Source: NPS Public Use Statistics Office (2008a)

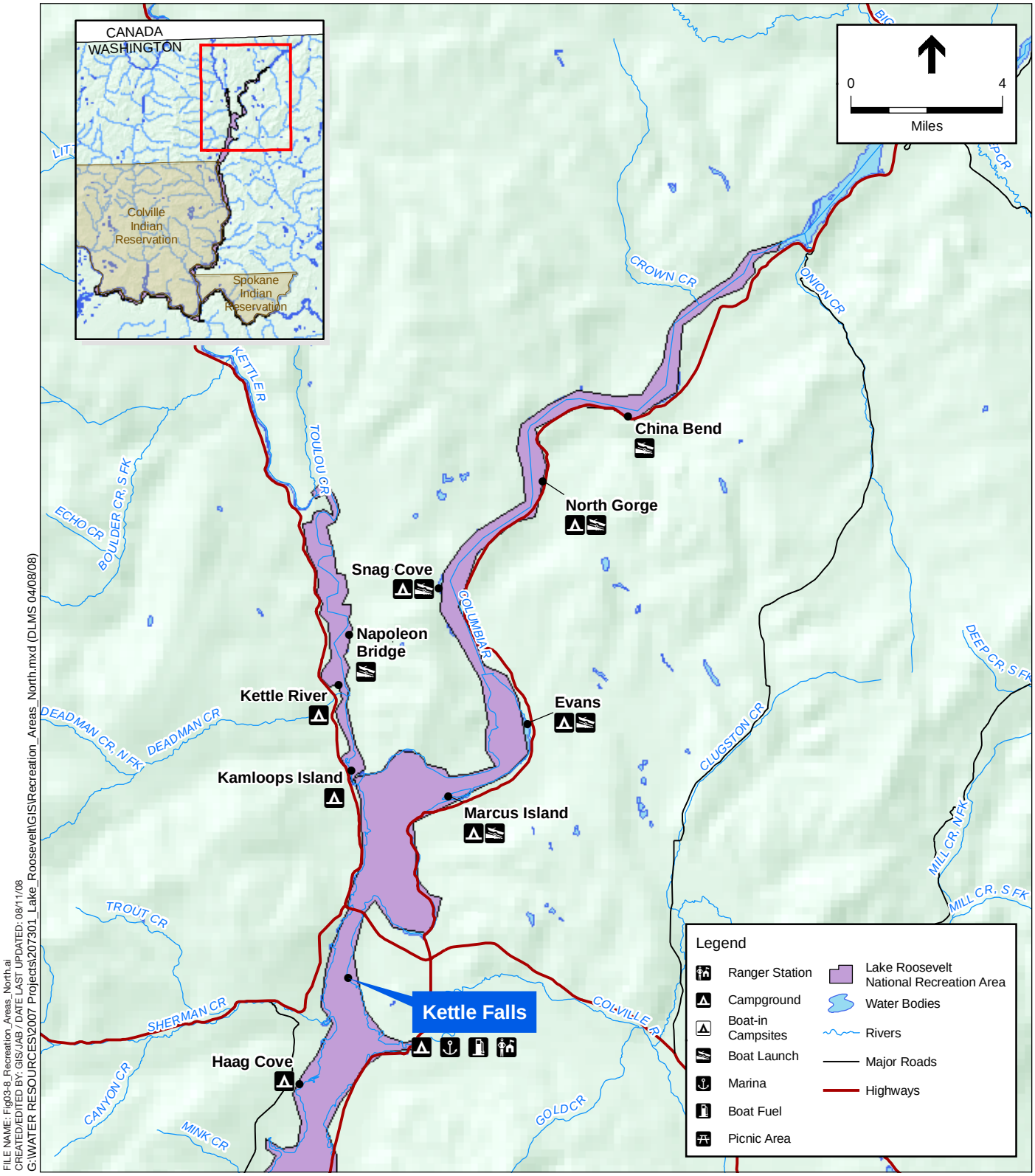
[1] Recreation visits are the entries of persons, for any part of a day, onto lands or waters administered by the NPS for recreation purposes.

A visitor use study was conducted by the NPS in 1996. Survey results indicated that most visitor respondents were from the state of Washington (74 percent). About 13 percent of the respondents were from Canada, and an additional 5 percent of the respondents were from other Pacific Northwest areas. About 7 percent of the respondents were from other parts of the United States. About 46 percent of the respondents were repeat visitors. The most popular activities with visitor survey respondents were camping in a developed campground (16 percent), swimming (15 percent), motor boating (11 percent), and fishing (10 percent) (NPS, 2000).

3.11.1.2 Recreation Facilities

Recreation areas at Lake Roosevelt are managed by the NPS, the CCT, and the STI (Figures 3-8, 3-9, 3-10, and 3-11). The recreation areas managed by these entities serve a wide range of developed day and overnight recreation sites and facilities, and are located throughout the reservoir (Table 3-3).

The NPS manages the Lake Roosevelt National Recreation Area (LRNRA), which has 26 public campgrounds and boat-in-only campgrounds, 11 designated swimming beaches, and three concessionaire-operated marinas at Kettle Falls, Keller Ferry, and Seven Bays that provide moorage, boat rental, fuel supplies, sanitary facilities, and other miscellaneous services. The CCT operates 1 developed boat ramp (AA Campground), 7 developed campgrounds, and several primitive camping areas on reservation lands (see Figures 3-9, 3-10, and 3-11) (Palmer, pers. comm., 2008). The CCT also operates concessions on the lake through its Roosevelt Recreation Enterprises. The STI operates 1 developed boat ramp (Two Rivers), 2 primitive boat ramps, 11 developed campgrounds, and several primitive camping areas (see Figure 3-10).



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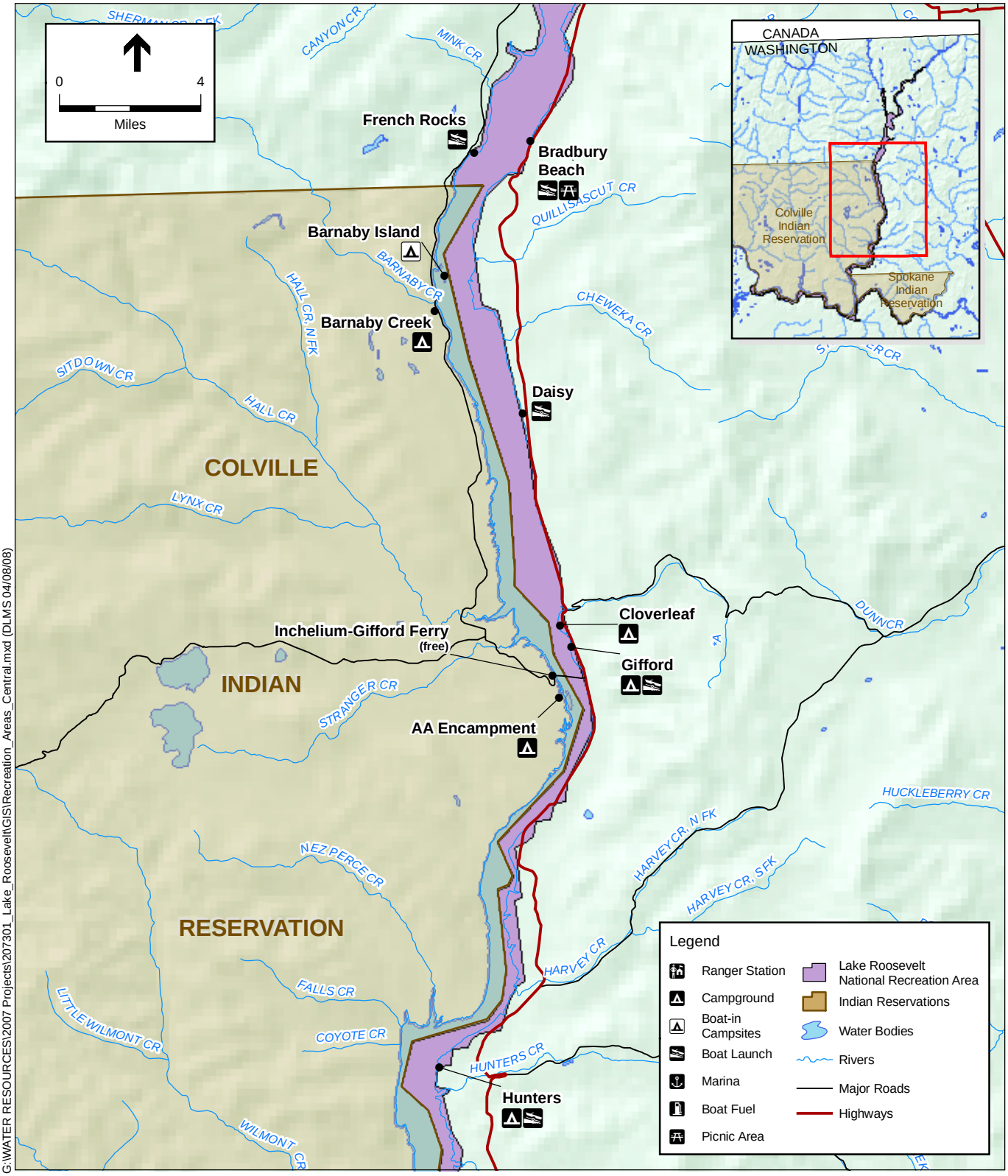
SOURCE: ESA Adolfson, 2008;
WSDOT, 2005 (roads), 1996 (NRAs), 1994 (reservations);
Ecology, 1998 (streams); WA DNR, 1997 (hillshade)

Figure 3-8
Recreation Areas
Northern Lake Roosevelt



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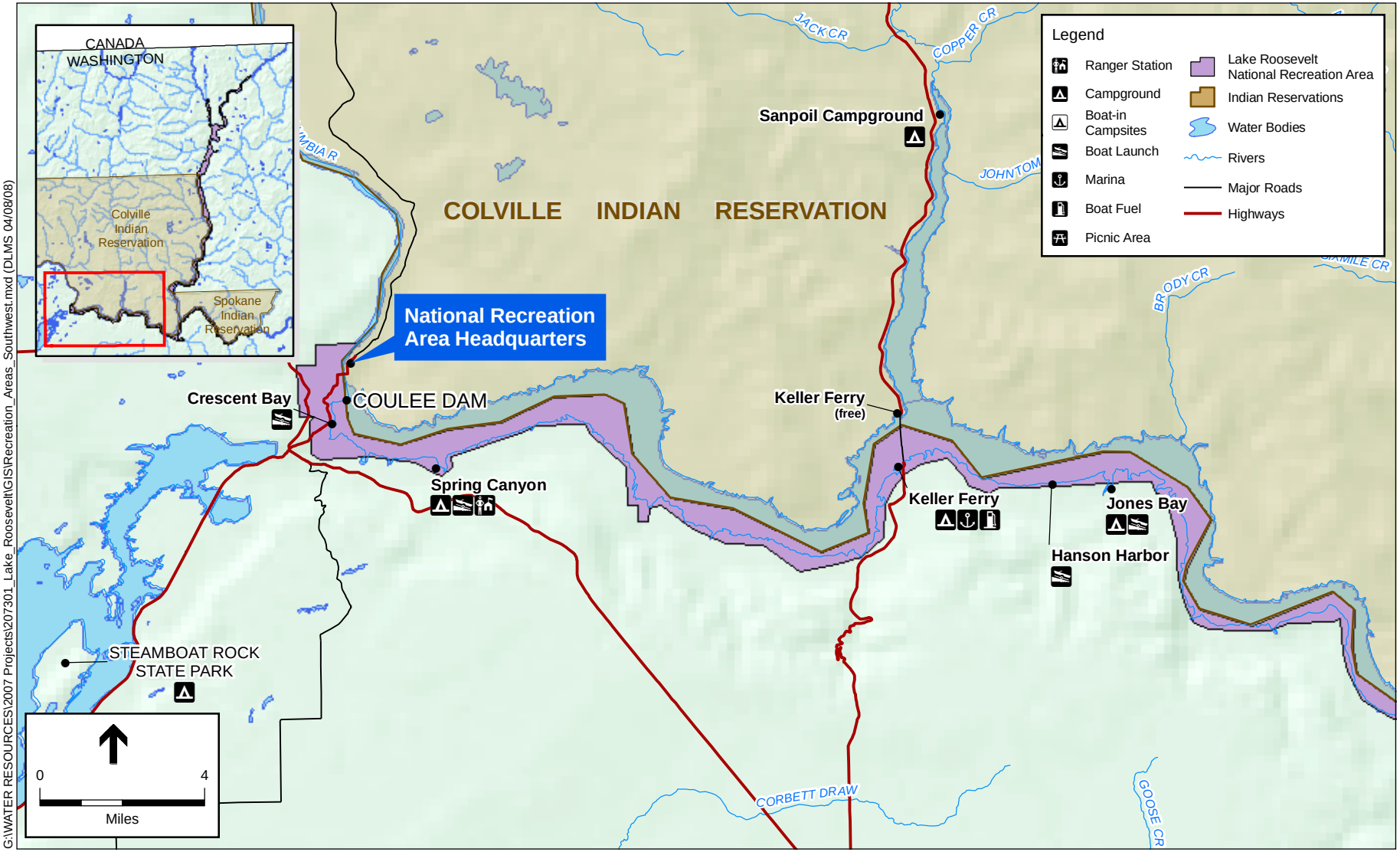
SOURCE: ESA Adolfson, 2008;
WSDOT, 2005 (roads), 1996 (NRAs), 1994 (reservations);
Ecology, 1998 (streams); WA DNR, 1997 (hillshade)

Figure 3-9
Recreation Areas
Central Lake Roosevelt



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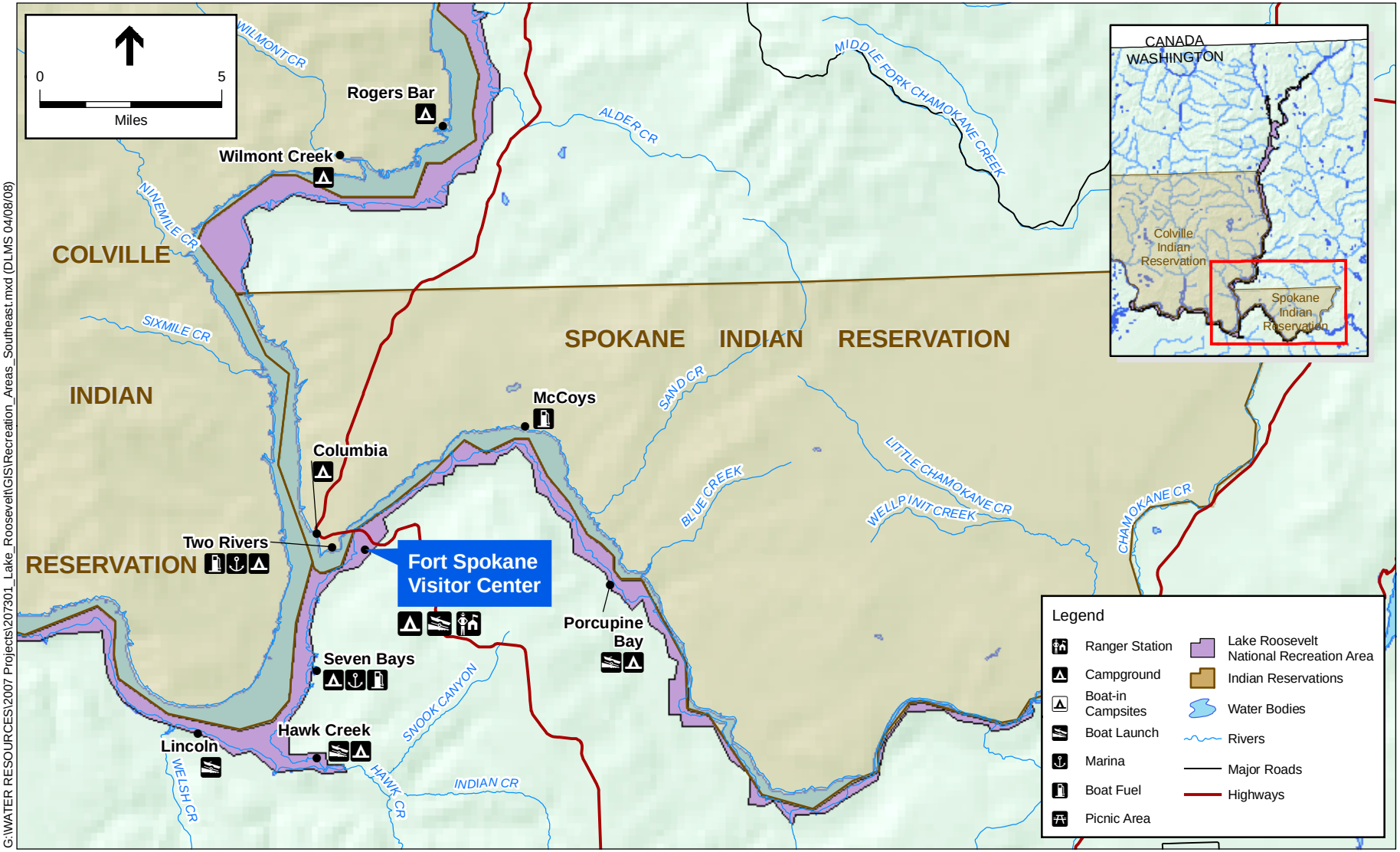
SOURCE: ESA Adolfson, 2008;
WSDOT, 2005 (roads), 1996 (NRAs), 1994 (reservations);
Ecology, 1998 (streams); WA DNR, 1997 (hillshade)

Figure 3-10
Recreation Areas
Southwest Lake Roosevelt



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SOURCE: ESA Adolfson, 2008;
WSDOT, 2005 (roads), 1996 (NRAs), 1994 (reservations);
Ecology, 1998 (streams); WA DNR, 1997 (hillshade)

Figure 3-11
Recreation Areas
Southeast Lake Roosevelt

Table 3-3 Developed Recreation Areas on Lake Roosevelt

Developed Area	*Minimum Boat Launch Elevation*[1]	*Campgrounds*	*Marina*	*Developed Swimming Area*
National Park Service – Lower Lake				
Crescent Bay	1,265	no	no	no
Spring Canyon	1,222[2]	yes	no	yes
Keller Ferry (Marina)	1,229[2]	yes	yes	yes
Hanson Harbor	1,253	no	no	no
Jones Bay	1,268	yes	no	no
Lincoln Mill	1,245[2]	no	no	no
Hawk Creek	1,281	yes	no	no
Sevens Bay Marina	1,227[2]	no	yes	no
National Park Service – Spokane River Arm				
Fort Spokane	1,247[2]	yes	no	yes
Porcupine Bay	1,243	yes	no	yes
National Park Service – Upper Lake				
Hunters	1,232[2]	yes	no	yes
Gifford	1,249[2]	yes	no	no
Cloverleaf	no boat launch	yes	no	yes
Daisy	1,265[2]	no	no	no
French Rocks	1,265	no	no	no
Bradbury Beach	1,251[2]	no	no	yes
Haag Cove	no boat launch	yes	no	no

Developed Area	*Minimum Boat Launch Elevation*[1]	*Campgrounds*	*Marina*	*Developed Swimming Area*
Kettle Falls (Marina)	1,234[2]	yes	yes	yes
Marcus Island	1,281	yes	no	yes
Kamloops	no boat launch	yes	no	no
Kettle River	no boat launch	yes	no	no
Napoleon Bridge	1,280	no	no	no
Evans	1,280	yes	no	yes
Snag Cove	1,277	yes	no	no
North Gorge	1,280	yes	no	no
China Bend	1,280	no	no	no
Colville Indian Reservation				
Reynold's Resort	no boat launch	yes	no	no
Rogers Bar	no boat launch	yes	no	no
Wilmont Creek	no boat launch	yes	no	no
Barnaby Island	no boat launch	yes	no	no
Barnaby Creek	no boat launch	yes	no	no
Inchelium Ferry (AA Camp)	1,270	yes	no	no
Keller Park	no boat launch	yes	no	no
Spokane Indian Reservation				
Blackberry Cove	no boat launch	no	no	no
McGuires Place	no boat launch	yes	no	no
Balcomb's Landing	no boat launch	yes	no	no

Developed Area	*Minimum Boat Launch Elevation*[1]	*Campgrounds*	*Marina*	*Developed Swimming Area*
Upper Columbia	no boat launch	yes	no	no
Lower Columbia	no boat launch	yes	no	no
Abraham Cove	no boat launch	no	no	no
Two Rivers (Marina)	1,280	yes	yes	no
Cornelius	no boat launch	yes	no	no
Hidden Beach	no boat launch	yes	no	no
Chief 3 Mountain	no boat launch	yes	no	no
Raccoon Cove	no boat launch	no	no	no
Maggie Shoup	no boat launch	yes	no	no
No Name	no boat launch	yes	no	no
Sand Creek	no boat launch	yes	no	no
McCoys (Marina)	no boat launch	no	no	no

Source: NPS (2008b)
[1] Minimum operating elevation for developed boat launches
[2] Winter boat launch (accessible at low lake levels)

Visitation statistics for August 2007 indicate the highest boat launch use by visitation is at Fort Spokane (1,456), Porcupine Bay (1,381), Hunters (1,289), Kettle Falls (1,239), Keller Kerry (1,237), and Lincoln Mill (1,120) (NPS, 2008c). The Kettle Falls camping area in the North District accounted for more than 21 percent of the total LRNRA visitation. In the South District, visitor use is more evenly spread among several sites.

While much of the recreation use on Lake Roosevelt is concentrated at developed recreation sites, a large amount of dispersed use occurs in undeveloped areas along the lake shoreline. The most popular dispersed camping areas in the LRNRA occur in the southern portion of the lake (Dashiell, pers. comm., 2008). Because of their remote locations, management of dispersed camping areas is an ongoing challenge. Trash and human waste are the biggest management issues associated with these areas. Camping along the shoreline outside of developed areas will continue to be allowed as long as it can be managed to keep resource impacts at acceptable levels. The LRNRA General

Management Plan (2000) acknowledged that a process to assess damage and manage dispersed sites along the shoreline may be required (NPS, 2000).

The results of the 1996 NPS visitor survey indicated visitors were concerned with crowding that happens on weekends at popular facilities such as Porcupine Bay and Keller Ferry. Their primary areas of concern were a lack of camping spaces and crowding of boat ramps.

3.11.1.3 Reservoir Drawdown

The lake is characterized by seasonal fluctuations in the lake level as described in the Programmatic EIS. This affects boat launches and other waterfront facilities because they must be designed to be operable under variable water level conditions. In response to low lake levels rendering certain boat ramps inoperable, the NPS extended some ramps in the year 2000 to be operable under current lake management. These included the Snag Cove, Jones Bay, and China Bend ramps. Following these extensions, and under normal non-drought conditions, the lake level is generally high enough to meet the needs of all ramps in the LRNRA. Under drought conditions when lake levels reach 1,278 feet, six of the 22 boat ramps within the LRNRA are inoperable during two of the highest use months on the reservoir. This is approximately one-third of the ramps. Ramps that continue to be susceptible to low lake levels in the high visitor use season include Hawk Creek, Marcus Island, Evans, Napoleon Bridge, and North Gorge. According to NPS, launching is reported to shift to other ramps when these become inoperable (Dashiell, pers. comm., 2008).

The STI closes their developed boat launch at Two Rivers when lake levels render it inoperable. During wet and average years, this generally occurs from January through mid-June and again for a few days in August during average years. During drought years, the launch is closed for approximately two weeks in August. In general, if lake levels are too low, visitors are allowed to use primitive launches at their own risk as no extensions are provided. Many visitors cross the bridge to use launches at Fort Spokane when the Two Rivers launch is closed (Kieffer, pers. comm., 2008).

The minimum operating elevations of the designated swimming areas vary by site topography. The NPS is able to move swimming markers to adjust to lower lake levels, but does not adjust swimming platforms. Two of the swimming areas (Marcus Island and Kettle Falls) may not have water when lake levels are low (NPS, 2008d). During spring drawdowns, the concessionaire must relocate houseboats to deeper water. Rental boat docks are not available at some locations for up to six weeks during this time.

3.11.2 Columbia River Downstream

As described in the Programmatic EIS (Ecology, 2007), the Columbia River downstream areas include a variety of recreation and scenic resources. Recreation areas include parks, monuments and historic areas, wildlife refuges, wilderness areas, forest, and range areas. Recreation activities in the downstream areas include fishing, hunting, bird watching, boating, swimming, and other water-oriented activities.

3.11.3 Odessa Subarea and Banks Lake

3.11.3.1 Odessa Subarea

The Odessa Subarea comprises a large area within Adams and Grant Counties with a small portion in Franklin County. The subarea mainly supports arid lands that have been converted to irrigated agricultural land. As described in the Programmatic EIS, many of the municipalities that could receive water through this Proposal own and operate local parks used for a variety of recreational purposes.

3.11.3.2 Banks Lake

Banks Lake is a popular recreational area due to its diverse recreational opportunities and scenic natural features. Activities on the reservoir include fishing, swimming, boating, water skiing, and wind surfing. The highest concentration of boating activity occurs in the Devil's Punch Bowl, Osborn Bay, Kruk's Bay/Airport Bay, and Jones Bay areas. Scenic natural features of the area include basalt outcroppings and coulee walls rising on the east and west sides of the reservoir.

There are 19 developed recreation areas on the lake. These include developed recreation sites and facilities, generally concentrated at the south and northeast ends of the reservoir. While much of the recreation use is concentrated at developed recreation sites, either managed directly by the state (e.g., Steamboat Rock State Park), under lease from the state (e.g., Sunbanks Resort, Coulee Playland), or under lease from Reclamation (e.g., Coulee City Community Park), a significant amount of dispersed use occurs in undeveloped areas along the lake's shoreline.

At full pool (1,570 feet), the reservoir covers 27,000 acres and inundates 91 miles of shoreline. Water withdrawal from the Columbia Basin Project causes the elevation of the lake to vary during the irrigation season between late March and late October, annually. These fluctuations overlap the high-use recreation season on the lake of mid-May through September. Under current operating conditions the reservoir is drawn down to a minimum elevation of 1,565 feet in August and refilled by late September. The lake is characterized by shallow, low-gradient shorelines; therefore, shore facilities can be affected by even small fluctuations in lake level.

WDFW is responsible for the operation and maintenance of six boat ramps. The Washington State Parks and Recreation Commission (WSPRC) is responsible for three boat ramps. Operation and maintenance for the other boat ramps located on the reservoir (Sunbanks Resort, Coulee Playland, and Coulee City Community Park) are the responsibly of the respective lessee or concessionaire. During drawdowns, certain boat ramps may be more difficult to use or may become inoperable: Dry Falls, Million Dollar Mile North and South, Barker Flat, and Osborn Bay Southeast boat ramps. Launching is reported to increase at the Steamboat Rock Rest Area and Boat Launch during low reservoir elevation periods.

Swimming is ranked as the second most common activity on Banks Lake. Periodically, low water elevations in the swimming areas are also a concern.

3.12 Socioeconomics

The Programmatic EIS (Ecology, 2007) identified the goods and services derived from the river and related resources, and the potential socioeconomic consequences of management decisions affecting those resources. The following text augments that discussion.

3.12.1 Lake Roosevelt

The Lake Roosevelt area is predominantly used for purposes of the Lake Roosevelt National Recreation Area (LRNRA) and the STI and CCT Reservations. The National Park Service manages the LRNRA primarily for boating, camping, and fishing activities. The two tribes partake in these activities and conduct business activities that rely on the associated recreational uses.

The local economy with direct links to Lake Roosevelt includes the STI and CCT Reservations, and the adjacent portions of Ferry, Stevens, Lincoln, Grant, Douglas, and Okanogan Counties. Table 3-4 shows that, in 2006, the six counties had a total population of 183,220 (U.S. Census Bureau 2008a,b,c). All counties but Grant County have been experiencing a slower population growth, have a higher concentration of persons 65 years and older, and have a higher concentration of American Indian and Alaska Native persons than the state as a whole.

The 2000 Census reported the CCT and STI Reservation populations as 7,587 and 2,004, respectively (U.S. Census Bureau 2008a, b). As described in the Programmatic EIS, the tribes generally manage areas near Lake Roosevelt for natural-resource oriented purposes.

3.12.2 Columbia River Downstream

The near downstream region of the Columbia River is contained by Okanogan County to the north and Douglas County to the south. Banks Lake is within Grant County. The city of Odessa and surrounding agricultural lands are within Lincoln County. These counties are demographically similar to the other counties surrounding Lake Roosevelt. Lincoln County and Douglas County have particularly high shares of land in agriculture relative to the other counties and the state of Washington as a whole (Table 3-4).

3.12.3 Odessa Subarea and Banks Lake

Banks Lake is within Grant County. The city of Odessa and surrounding agricultural lands are within Lincoln County. These counties are demographically similar to the other counties surrounding Lake Roosevelt. Lincoln County has a particularly high share of land in agriculture relative to the other counties, besides Douglas County, and the state of Washington as a whole (Table 3-4).

Table 3-4 Demographic Statistics for Counties and Reservations Surrounding Lake Roosevelt

	Ferry County	*Grant County*	*Lincoln County*	*Okanogan County*	*Stevens County*	*Douglas County*	*Colville Reservation*	*Spokane Reservation*	*Washington State*
Population, 2006 estimate	7,560	82,612	10,376	40,040	42,632	35,772	7,587[a]	2,004[a]	6,395,798
Population, change, April 1, 2000 to July 1, 2006	4.1%	10.6%	1.9%	1.2%	6.4%	9.7%	NA	NA	8.5%
White persons, 2006	78.5%	94.8%	94.9%	85.3%	90.9%	95.4%	32.6% [a]	18.5% [a]	84.8%
American Indian and Alaska Native persons, 2006	17.5%	1.4%	2.0%	11.0%	5.5%	1.4%	59.7% [a]	76.5% [a]	1.6%
Bachelor's degree or higher, persons age 25+, 2000	13.5%	13.7%	18.8%	15.9%	15.3%	16.2%	8.4% [a]	4.9% [a]	27.7%
Per capita money income, 1999	$15,019	$15,037	$17,888	$14,900	$15,895	$17,148	$12,185	$10,151	$22,973
Persons below poverty, 2004	17.80%	16.20%	11.80%	18.80%	15.10%	12.1%	26.8% [a]	28.7% [a]	11.60%
Persons per square mile, 2000	3.3	27.9	4.4	7.5	16.2	17.9	5.7	8.4	88.6
Land area, 2000 (sq. miles)	2,204	2,681	2,311	5,268	2,478	1,821	1032	238	66,544
Land area in farms (percent), 2002	56.7%	62.6%	83.4%	36.8%	33.3%	75.4%	NA	NA	36.0%

[a] Reservation population data only available to 2000.
Sources: U.S. Census Bureau 2008a,b,c; U.S. Department of Agriculture 2008.

3.13 Public Services and Utilities

Public services and utilities were described in the Programmatic EIS (Ecology, 2007). Additional information is provided here on hydroelectric power generation facilities.

3.13.1 Lake Roosevelt

There are 12 hydroelectric facilities on the mainstem of the Columbia River including Grand Coulee Dam and the Grand Coulee pump-storage facility. For the facilities downstream of Lake Roosevelt, the dams operate primarily as run-of-river hydroelectric facilities which generate power according to the flow in the Columbia River. There is limited regulating capacity in the reservoirs upstream of each of the dams. Table 3-5 lists each hydroelectric facility, its current installed capacity and the estimated annual production in kilowatt-hours.

Table 3-5 Hydroelectric Facilities on the Columbia River

Hydroelectric Facility	*Owner*	*Instantaneous Generating Capacity (Peak MW[1])*	*Estimated Annual Generation (aMW[2])*
Grand Coulee	Reclamation	6,326	2,500
Grand Coulee Pump-Storage	Reclamation	300	Included in Grand Coulee number
Chief Joseph	U.S. Army Corps of Engineers	2,535	1,300
Wells	Douglas PUD	774	470
Rocky Reach	Chelan PUD	866	700
Rock Island	Chelan PUD	624	290
Wanapum	Grant PUD	1,038	585
Priest Rapids	Grant PUD	855	550
McNary	U.S. Army Corps of Engineers	1,127	640
John Day	U.S. Army Corps of Engineers	2,484	1075
The Dalles	U.S. Army Corps of Engineers	2,074	800
Bonneville Dam	U.S. Army Corps of Engineers	1,047	580

Sources: Watson (2008), Chelan PUD (2008), Grant PUD (2008), Douglas PUD (2008), Department of Energy (2008a,b)
[1]MW = Megawatts
[2]aMW = annual megawatts. Calculated by dividing the total number of megawatt-hours generated by the number of hours in a year. 8,760 Megawatt-hours.

3.13.2 Columbia River Downstream

The Columbia River downstream hydroelectric facilities are described in Table 3-5.

3.13.3 Odessa Subarea and Banks Lake

In addition to the mainstem Columbia River dams, Banks Lake acts as a pump-storage facility. Water is pumped into Banks Lake and stored, and then released back to Lake Roosevelt to generate power from the elevation difference between the two lakes.

Two hydroelectric plants exist between Banks Lake and the Odessa Subarea. The plants are the Summer Falls and Main Canal Headworks hydroelectric facilities operated by the Grand Coulee Project Hydroelectric Authority. Those projects recover energy from water flowing from Banks Lake to the Main Canal. The Summer Falls project is 92 MW and generates 39aMW. The Main Canal project is 26 MW and generates 10.8aMW.

3.14 Transportation

The Programmatic EIS (Ecology, 2007) contains information on surface transportation modes serving the Columbia River Basin. Surface transportation modes described included highways, railroads, and waterborne transportation. The following section provides additional information on waterborne transportation on Lake Roosevelt to support the evaluation of impacts associated with releases from Lake Roosevelt in more detail.

3.14.1 Lake Roosevelt

The CCT operates the Inchelium-Gifford Ferry, a small capacity car ferry on the upper lake, connecting Inchelium on the west shore to State Route 25 on the east shore (see Figure 3-8). The Inchelium-Gifford Ferry becomes inoperable when Lake Roosevelt elevation falls below 1,228 feet, requiring passengers to drive approximately 30 miles north to the bridge at Kettle Falls or take a longer route to the south. This occurs during drought years only (4 percent of the time).

Washington State Ferries operates the Keller Ferry, a 12-car capacity ferry from Ferry County and the CCT Reservation on the north bank of Lake Roosevelt to Lincoln County on the south bank, near the lake's confluence with the Sanpoil River (see Figure 3-9). Approximately 60,000 vehicles travel on the ferry each year. During normal lake elevation of 1,290 feet above sea level to approximately 1,248 feet, ferry service is "on-demand" in order to avoid unnecessary empty runs. The ferry crew can observe both landings and remain at the north or south landing until a vehicle appears needing to cross in either direction. Occasionally, perhaps every two or three years, when lake elevations drop below 1,248 feet, the north landing is moved a short distance up the Sanpoil River, extending the normal 10-minute crossing to about 20 minutes. At this location, the ferry can operate normally with lake levels as low as 1,208 feet. With some special provisions in the ferry operations, it can be operated on a limited basis with levels as low as 1,180 feet (Washington State Ferries, 2008). The primary east-west land transportation route serving Lake Roosevelt is U.S. 2, which connects Spokane, Davenport, and Coulee City to points west. State Route 20, which

extends from U.S. 395 at Colville to U.S. 97 through Republic to Tonasket, is the primary east-west route for the northern portion of the National Recreation Area. Major south-north routes are U.S. 97, connecting Ellensburg, Wenatchee, Okanogan, and crossing the Canadian border north of Oroville; State Route 17, connecting Moses Lake to Okanogan; and U.S. 395, connecting Spokane to Colville and crossing into Canada.

3.14.2 Columbia River Downstream

Water transportation on the Columbia River downstream areas is described in Section 3.11.3 of the Programmatic EIS (Ecology, 2007).

3.14.3 Odessa Subarea and Banks Lake

As described in Section 3.11.4 of the Programmatic EIS, transportation in the areas that would receive additional water supplies is primarily land-based road and rail.