PORT TOWNSEND SPECIAL USE PERMIT

BIOLOGICAL ASSESSMENT

5/23/2005

1.0 INTRODUCTION

Section 7 of the Endangered Species Act (ESA) of 1973 (as amended), directs federal departments and agencies to ensure that actions authorized, funded, and/or conducted by them are not likely to jeopardize the continued existence of any federally proposed or listed species, or result in destruction or adverse modification of critical habitat for such species. In addition, federal agencies must consult with the National Oceanic and Atmospheric Administration (NOAA) Fisheries on all activities, or proposed activities, authorized, funded or undertaken by the agency that may adversely affect Essential Fish Habitat (EFH), as designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) of 1996.

The City of Port Townsend is seeking re-issuance of three USDA Forest Service Special Use Permits for continued operation of municipal water supply facilities. This Biological Assessment (BA) evaluates the effects on ESA-listed Hood Canal Summer Chum Salmon and Puget Sound Chinook Salmon and their proposed critical habitat resulting from the re-issuance of these Special Use Permits. This BA also describes potential effects to Essential Fish Habitat as required under MSA.

Other ESA-listed species including the marbled murrelet (*Brachyrampus marmoratus*) and its critical habitat, the northern spotted owl (*Strix occidentalis occidentalis*) and its critical habitat, the bald eagle (*Haliaeetus leucocephalus*), and the bull trout (*Salvelinus confluentus)* will be addressed in a separate programmatic biological assessment to be submitted to the US Fish and Wildlife Service for consultation

This BA was originally prepared by MWH Consulting under contract with the City of Port Townsend. The BA has been revised by the USDA Forest Service to more fully describe potential impacts to Hood Canal Summer Chum and its proposed critical habitat.

1.1 Description of the Proposed Action

The Forest Service proposes to reissue three Special Use Permits for the occupancy and use of Federal land by the City of Port Townsend. These parcels of land contain improvements for the purpose of operating and maintaining the municipal water supply for the City of Port Townsend. No substantial changes to the occupancy and use of the land and facilities are proposed during the proposed 20-year term of the permits. A complete description of each Special Use Permit is provided in Section 1.3.

The project area is located on the east slope of the Olympic Mountains immediately west of the community of Quilcene, in Jefferson County, Washington.

1.2 Description of the Existing Project Facilities, Operations, Maintenance, and Hydrology

1.2.1 Project Facilities

The City of Port Townsend maintains water diversion facilities at River Mile (RM) 9.4 of the Big Quilcene River and RM 7.2 of the Little Quilcene River for the purpose of providing residential, municipal, and industrial customers with a reliable, cost effective, and uninterrupted supply of water. Both diversions are well above potential summer chum habitat.

The Big Quilcene River diversion facilities consist of a timber crib dam approximately 10 feet high and 51 feet wide. The elevation of the Big Quilcene diversion facility is approximately 1,023 feet. Water is diverted from the river through a screen and gate intake structure into a steel pipeline for transmission to the City's water supply distribution facilities. The City has a water right for the continuous diversion of 30 cubic feet per second (cfs) from the Big Quilcene River per Washington Department of Ecology. There is no minimium instream flow requirement associated with the water right.

The Little Quilcene River diversion facilities consist of a stream bypass and concrete diversion and intake structure on an outside bend of the river. The elevation of the Little Quilcene diversion facility is approximately 1,048 feet. A small concrete weir spans the river and directs a portion of the flow to the intake structure. The concrete weir is notched to allow fish passage upstream and downstream. River water is diverted through a screen and gate intake structure into a steel pipeline for transmission to the City's water supply distribution facilities. The City has a water right for the diversion of up to 9.56 cfs, with a minimum instream flow requirement of 6 cfs per Washington Department of Ecology.

The water transmission pipeline is engineered as a gravity operated system and does not require pumping to deliver water to storage reservoirs and system users. Water diverted from the Little Quilcene River enters a 20-inch diameter pipeline for transmission to Lords Lake. Water diverted from the Big Quilcene River enters a 36-inch diameter steel pipeline that turns into a 30-inch diameter pipe after approximately 0.5 miles, for transmission to City Lake, although it may be used to fill Lords Lake.

Lords Lake is located approximately 1.5 miles from the Little Quilcene diversion and is the primary storage facility for the City water supply system. The elevation of Lords Lake is approximately 920 feet. The storage capacity of Lords Lake is 500 million gallons, and provides approximately a 30-day storage supply for the City and Paper Mill. Lords Lake is filled directly by the Little Quilcene River diversion.

City Lake reservoir is located along the pipeline approximately 20 miles from the Big Quilcene diversion. City Lake has a capacity of 120 million gallons, and functions as an equalizing storage reservoir to meet the short-term fluctuations in water demand. City Lake also serves as a settling basin for the water supply system. The elevation of City Lake is approximately 610 feet.

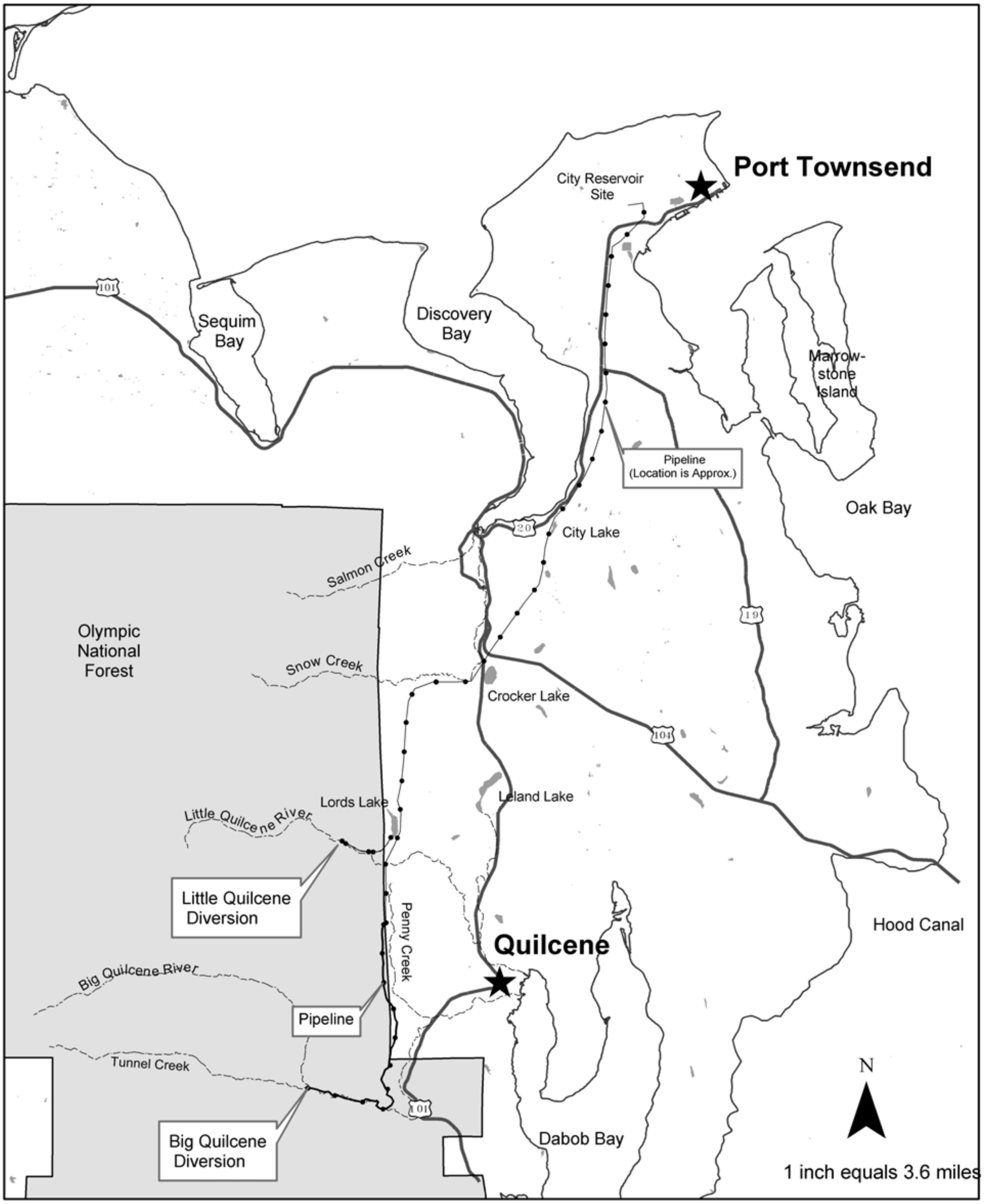
Figure 1 shows the Port Townsend water supply system and the Olympic National Forest boundary. Lords Lake and City Lake storage reservoirs are not located on federal lands. The facilities that are located on federal land and under the jurisdiction of the Forest Service Special Use Permits include:

1. The Big Quilcene River diversion facilities and approximately six miles of 10-foot-wide right-of-way for the water transmission pipeline.

2. The Little Quilcene River diversion facilities and approximately 0.4 miles of 50-foot-wide right-of-way for the water transmission pipeline.

3. Caretaker residence and maintenance buildings adjacent to the Big Quilcene River diversion facilities.

Figure 1. Port Townsend Water Supply Vicinity Map



1.2.2 Project Operations

Big Quilcene River Diversion

The Big Quilcene River diversion is the primary water source for the City. During periods of high stream turbidity, or when flows within the river are limited, water is supplied to the City from storage in Lords Lake. The City's water right on the Big Quilcene River allows for a maximum continuous diversion of 30 cfs. There is no minimum instream flow requirement as a condition of this water right, although since 1994, the City has maintained a policy of providing a minimum instream flow below their diversion (when available) for instream fish habitat and water supply to the Quilcene National Fish Hatchery (QNFH). Before 1994 the City and Mill worked cooperatively with the QNFH, a junior water rights holder, to ensure they had sufficient water for operations. This is estimated to have been between 20-25 cfs. In 1994 the City and Mill, as part of the Dungeness-Quilcene Water Resources Management Planning process, agreed to leave 24 cfs instream. In 1997 the minimum agreed instream flow was revised to 27 cfs. Under normal operating conditions at the diversion facility, three storm doors and the shutoff gates remain open, and the bypass gate is used to regulate water levels and flows. Diversion flow rates are monitored with a flow meter within the pipeline a short distance below the diversion. The amount of flow remaining in the Big Quilcene River is monitored at a USGS gaging station immediately below the diversion facility. Operation of the Big Quilcene diversion will typically fall under three types of conditions, as follows:

1. Instream flows at or below 27 cfs: No withdrawals are made following the City and Mill's voluntary instream flow policy.

2. Flows between 27 cfs and approximately 57 cfs: The intake gate is opened and adjusted to divert flow while maintaining the voluntary 27 cfs instream flow.

3. Flows greater than approximately 57 cfs: The intake gate is opened and adjusted to divert needed flows. The intake gate may be closed if turbidity levels become too high. The bypass gate may be opened to flush debris and sediments.

Little Quilcene River Diversion

The Little Quilcene River diversion is used to supply water to the Lords Lake reservoir, except during turbid river conditions or low flows. The City's water right on the Little Quilcene River allows for the continuous diversion of up to 9.56 cfs, provided that a minimum of 6 cfs is maintained instream. Stream flows and Lords Lake reservoir levels determine the operation of the Little Quilcene diversion. A U.S. Geological Survey (USGS) staff gage is located approximately 100 feet below the diversion gatehouse. Using the current USGS rating table, the gage height can be translated to cfs to determine whether the instream flow requirement below the diversion is being met. A flow meter is monitored in the pipeline immediately below the diversion to ensure that the maximum diversion amount is not exceeded. Operation of the Little Quilcene diversion will typically fall under three types of conditions, as follows:

1. Instream flows at or below 6 cfs: No withdrawals are permitted. Both the intake and bypass gates are closed.

2. Flows between 6 cfs and approximately 17 cfs: The bypass gate remains closed. The intake gate is opened and adjusted to divert flow while ensuring a minimum 6 cfs instream flow.

3. Flows greater than 17 cfs: The intake gate and bypass gates are opened adjusted for necessary water withdrawls. The intake gate may be closed if turbidity levels become too high. The bypass gate can be opened to flush debris and sediments.

Lords Lake Reservoir

Lords Lake reservoir is located approximately 1.5 miles from the Little Quilcene diversion and is not located on Forest Service land. Lords Lake is generally filled from the Little Quilcene diversion through a pipeline. The reservoir has a storage capacity of 500 million gallons, approximately a 30-day supply.

Under normal operations Lords Lake reservoir is maintained at full pool. Draw down usually occurs during periods of low water availability from the Big Quilcene River or high turbidity events in the Big Quilcene River. Reservoir maintenance or inspections are usually coordinated with seasonal drawdowns. Overflow from the reservoir is diverted back into the Little Quilcene via Howe Creek by a chute-type spillway located at the north dam.

1.2.3 Project Maintenance

The project facilities are maintained by the Port Townsend Paper Company through a contractual agreement with the City of Port Townsend. The Paper Company employees perform all operation and maintenance on the transmission pipeline, diversion facilities, and reservoirs. Three full-time employees of the Paper Company maintain and monitor the operation and condition of the system, providing coverage seven days a week. The City of Port Townsend Department of Public Works operates and maintains the water treatment facilities and infrastructure for the distribution of water within the City. Responsibilities for maintenance and operation of the project facilities are detailed in the Operations and Maintenance Manual for the Olympic Gravity Water Supply System (Port Townsend Paper Company 2002).

1.2.4 Project Hydrology

The diversion of water from the Big Quilcene and Little Quilcene Rivers by the City of Port Townsend has modified the natural hydrology of these rivers below the points of diversion. Diversions for the municipal water supply began in 1928 from the Big Quilcene River and in 1956 from the Little Quilcene River. The U.S. Geological Survey (USGS) has collected stream-gauging data for both rivers on a limited basis. The data were gathered in 1926-27, 1951-52, 1971-72, and 1994 to the present on the Big Quilcene River, and 1926-27 and 1951-57 on the Little Quilcene River. The City of Port Townsend has kept records of diverted flows from both rivers since 1992, instream flows since 1993 on the Big Quilcene River, and instream flows since 1994 on the Little Quilcene River. Records have also been kept of water levels over the diversion dams from 1934-1994. The water levels over the Big Quilcene River diversion have been used to estimate historical flows due to limited USGS gauging (Anvil Corporation 1989, USDA Forest Service 1994).

During a typical year the average annual diversion from the Big Quilcene River is approximately 17.3 to 18.4 cfs, and for the Little Quilcene River is approximately 2.2 to 3.5 cfs. An average daily diversion is approximately 23 cfs and 2 cfs for the Big Quilcene and Little Quilcene Rivers, respectively. Daily diversions range from 0 cfs to 30 cfs for the Big Quilcene River and 0 cfs to 9.56 cfs for the Little Quilcene River depending on streamflow conditions and the city's need for water.

The City has water rights of 30 cfs on the Big Quilcene River and 9.56 cfs on the Little Quilcene River for a total potential supply of approximately 25.6 mgd (million gallons per day) (1 cfs = 646,317 gallons per day). The hydraulic capacity of the transmission pipeline between the Big Quilcene diversion and City Lake is approximately 20 mgd. The hydraulic capacity of the transmission pipeline downstream of City Lake is approximately 25 mgd (CH2M Hill 1998). Water availability at the City's diversion facilities fluctuates on a seasonal and diurnal basis depending on long-term climatic and short-term weather conditions. The City of Port Townsend water use for 1999 was equivalent to an annual average diversion of approximately 1.41 cfs; the Paper Mill used approximately 22.5 cfs.

There are three primary factors that influence the timing and amount of water diverted from the Big Quilcene and Little Quilcene Rivers that affect the planning, management, and operational decisions of the water supply system. The first is an instream flow requirement of 6 cfs on the Little Quilcene River as a condition of the water right. The second factor is the limitation on diversion during high turbidity events in either river above the point of diversion. The third factor is a City and Mill policy to provide a minimum of 27 cfs instream below the Big Quilcene diversion (when naturally available) to provide for the aquatic ecosystem and water supply to the QNFH. These diversion restrictions, the City's water use requirements, and knowledge of seasonal weather patterns form the planning, management, and operational constraints under which decisions are made regarding the use of water from diverted flow, or from storage reservoirs.

Hydrological analysis has been conducted to model the natural (undiverted) flows for both the Big Quilcene and Little Quilcene Rivers (Orsborn and Orsborn 2002); data on this analysis is presented in Section 1.3.3. Low natural stream flow conditions often place restrictions on the amount of water the City can divert from the Big Quilcene and Little Quilcene Rivers during the months of August, September, and October. During these periods the City must rely on the use of water from storage reservoirs. High turbidity events can occur in the fall, winter, and spring months when there is high rainfall amounts within short time periods or significant snowmelt runoff. The diversion of water is halted during these turbidity events.

Low stream flows during the late summer can lead to water shortages for the City as stream diversions are severely restricted or eliminated and reservoir levels are depleted. When this occurs conservation measures are implemented by the Port Townsend Paper Company and within the City to reduce the demand for water on a short-term basis to approximately 16-20 cfs.

1.2.5 Water Conservation Measures

The City of Port Townsend's Big Quilcene River municipal diversion has been operating since 1928. For many years it was necessary to maintain a constant 30 cfs flowing through the pipeline for City use and the Mill's chemical pulping and paper making processes. Before the mid 1950's the storage in City Lake was only able to provide approximately 6 days of supply. Available storage capacity was insufficient to allow for extended reductions or shut downs of the Big Quilcene River diversion. After construction of the Little Quilcene River diversion and Lords Lake Reservoir (500,000,000 gallons) in the mid 1950s it became possible to utilize stored water in place of the Big Quilcene River diversion for up to 25 days.

The City and Mill have worked cooperatively with the Quilcene National Fish Hatchery to ensure sufficient flows for hatchery operations for many years, despite having a senior water right. In 1994 during discussions with the Jefferson County Water Resources Council, the City and Mill volunteered to leave a minimum of 24 cfs instream below the diversion. The voluntary minimum instream flow was revisited in 1997 in discussions with the USFWS, WDFW, Tribes, County and other interested parties and revised upwards to 27 cfs. This was based on water necessary for hatchery operations and observations of fish passage and spawning in the lower river by the WDFWS and USFWS.

Over time the Port Townsend Paper Company has completed several projects and implemented actions to reduce water consumption and improve Big Quilcene River streamflows during low flow periods. The Mill has upgraded its equipment and improved operating processes so that it uses less water today than it did 20 years ago, while paper production has increased 50 percent. Average water use to produce a ton of paper has declined by 41percent between 1996 and 2003.

During low flow periods, conservation measures implemented by the mill reduce water consumption by another 8 percent. Operating under the current conservation program results in over $150,000 in added costs each year to the mill and requires the mill to operate at an increased level of risk for equipment failure, increased maintenance issues, and decreased product quality.

Specific steps the mill has taken to conserve water include:

- Moving the annual maintenance shutdown to October when streamflows are generally lowest and Lords Lake draw down is typically greatest.
- Shutting down the Hydro-turbine power generation when drawing from Lords Lake during low stream flows. This reduces water usage but eliminates the generation of 375 KW per hour of electricity and results in a revenue loss of approximately $9,000 per month.
- For the past two years the Mill has rented and operated evaporating cooling towers to reclaim water. This costs approximately $60,000 per year.
- In 2002 there was a partial curtailment of mill production in order to maintain the voluntary instream flow after Lords Lake Reservoir was emptied. The mill was preparing to shut down all production if necessary. This shutdown cost the mill $330,000.
- The mill is installing new equipment this year to reclaim and reuse vacuum pump seal water.
- Variable frequency drives were installed in 2003 on two pumping systems to eliminate makeup water chests from overflowing to the sewer.

The 1998 Water System Plan evaluated the capacity of the surface water system to meet current and future needs of the City and Port Townsend Paper Company. When the Water System Plan was drafted it was estimated City water use would rise from an average daily demand of 1.41 mgd in 1994 to 5.11 mgd in 2024 and maximum daily demand would increase from 2.54 mgd to 9.3 mgd during the same period. There was a predicted shortfall of 3.4 mgd if the Mill continued to use 13.5 mgd. The projected City water demand would have also exceeded the maximum 5 mgd allotted to the City by the current water system contract with the Mill. Paper Company staff identified possible changes to mill operations and equipment that would potentially reduce water usage. As described above, some changes were implemented, while others were dropped as being impractical (#10 power boiler flushing) or not compatible with current mill operating strategies (chemical pulp mill shutdown).

Conservation is an important element of the City's water system plan. Through a combination of water conservation practices the City has reduced its average daily demand of water from 1.4 mgd in 1991 to 0.9 mgd in 1999, even though the City's population increased from 7,400 to 8,800 over the same period. This correlates to an average per capita consumption of 113 gallons per day compared to the average Washington daily per capita residential and commercial consumption of 164 gallons.

Specific water conservation steps the City has taken since 1993 include:

- Leak detection program for the City water distribution system.
- Installation of meters for all service customers.
- Increased water and wastewater utility rates to encourage conservation.
- Installation of source water meters.
- Allocated an employee as conservation program manager on a quarter-time basis.
- Distribution of conservation kits and information to all residential customers.
- Public education and outreach through speakers and newsletters.
- Installed xeriscaping at City parks and facilities.
- Adopted a Water Shortage Response Plan to more closely manage and reduce City and Mill water use during low-flow periods.
- Coordinated monitoring and conservation efforts with a number of agencies and organizations including WSU Cooperative Extension, USFWS, WDFW, Jefferson County, PUD, Wild Olympic Salmon, USFS, Port Townsend Paper Company, and Point No Point Treaty Council Tribes.

1.3 Description of the Project Area and the Action Area

The project area for the proposed action is the area encompassing the Special Use Permits. This includes the immediate vicinity of the water diversion facilities on the Big Quilcene and Little Quilcene Rivers, and the pipeline right of way on land administered by the U.S. Forest Service, as listed below for each Special Use Permit. Figure 2 shows the project area location for each of the three Special Use Permits.

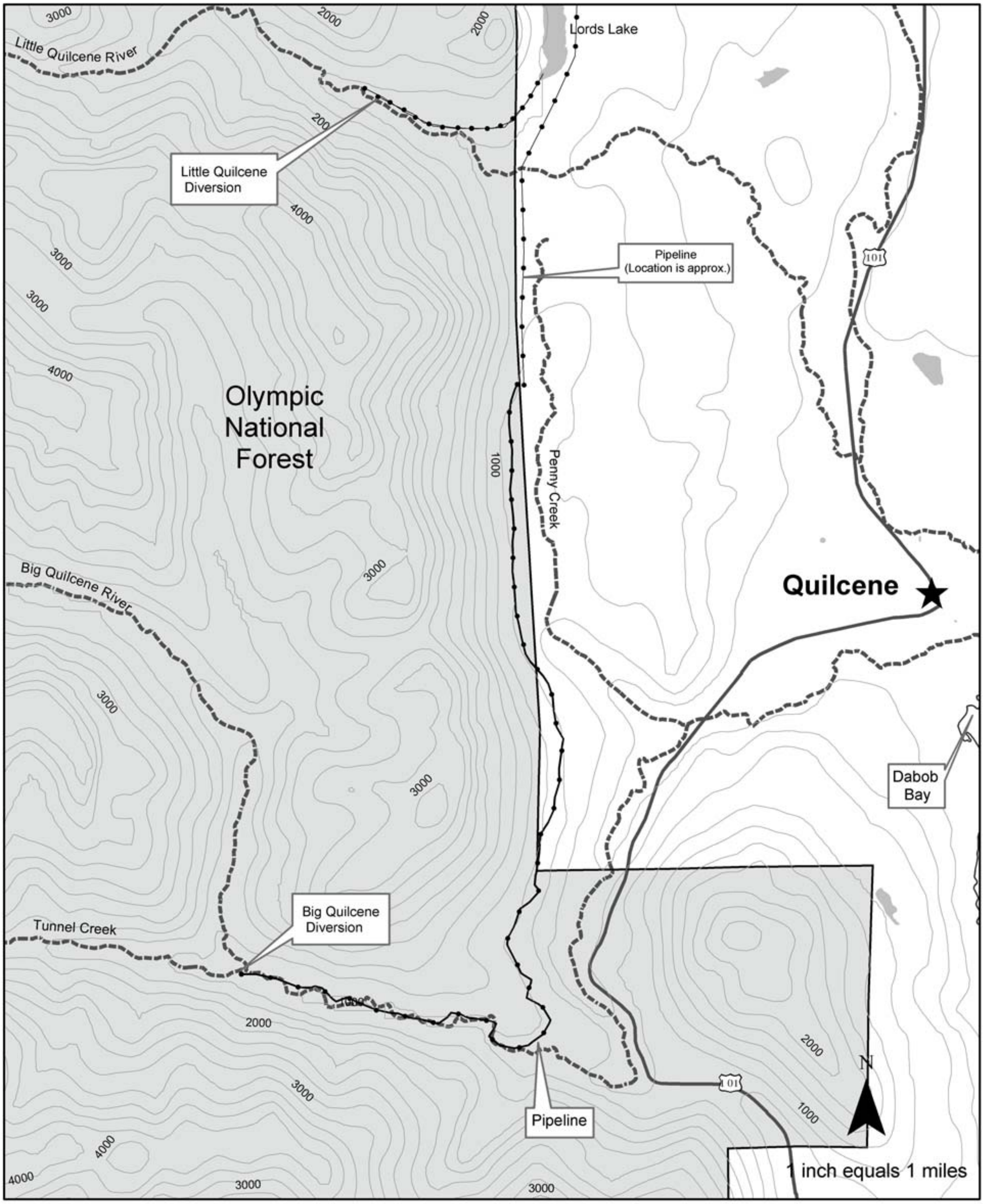
Permit 1: This permit authorizes the use of 7.3 acres and 6 miles of 10-foot-wide right-of-way of Federal land adjacent to the Big Quilcene River. This permit covers the water diversion dam, intake structure, fencing around the intake structure, and a water transmission pipeline.

Permit 2: This permit authorizes the use of one acre and 0.4 miles of 50-foot-wide right-of-way of Federal land adjacent to the Little Quilcene River. This permit covers the water diversion structure, intake structure, and a water transmission pipeline.

Permit 3: This permit authorizes the use of two acres (within the 7.3 acres identified in Permit 1) of Federal land adjacent to the Big Quilcene River. This permit covers the caretaker residence and other improvements needed to manage and supervise the water supply system.

The action area considered in this BA is larger than the specific area authorized under the three Special Use Permits for the City's water diversion facilities. The action area is the area that may be directly or indirectly affected by the federal action and not merely the immediate area involved in the action. The action area is the area of analysis to determine potential direct, indirect, and cumulative impacts to listed species. The action area for this proposed action includes the actual areas listed in the Special Use Permits, and the aquatic habitat in the Big Quilcene and Little Quilcene Rivers downstream of their respective diversion points to Quilcene Bay. Both diversions are well above potential summer chum habitat. General descriptions of the Big and Little Quilcene watersheds are provided in the following sections. The watershed descriptions focus primarily on the action area, and therefore, describe the portion of each watershed downstream of their respective diversion point.

Figure 2. Project Area



1.3.1 Big Quilcene Watershed

The Big Quilcene River watershed, part of WRIA 17, is located on the east side of the Olympic Mountains and drains to Quilcene Bay in West Hood Canal. The watershed originates at 7,743 feet in elevation and comprises an area of approximately 70 square miles. The drainage area upstream of the diversion is approximately 49.4 square miles, approximately 71 percent of the total Big Quilcene Watershed area. Runoff is derived primarily from snowmelt and rainfall (Parametrix et al. 2000). Forests occupy approximately 96 percent of the watershed, the majority of which is designated Olympic National Forest land (Parametrix et al. 2000). Farm land, commercial property, residential development, and light industrial property comprise less than 10 percent of the watershed and are located in the lower portions of the watershed (Parametrix et al. 2000). The largest water diversions within this watershed are located at RM 9.4 for the City of Port Townsend, and at RM 3.0 for the QNFH.

Current salmonid populations within the Big Quilcene watershed include coho salmon, summer and fall chum salmon, steelhead/rainbow, coastal cutthroat trout, and brook trout. Summer/fall Chinook salmon and pink salmon may stray into the system, but are not considered self-sustaining populations (Parametrix et al. 2000). Anadromous fish production in the Big Quilcene River is dominated by coho and chum salmon production from the QNFH (USFS 1994). Anadromous salmonid use is generally restricted to the lower river; this is due to a barrier dam and an electric weir at RM 2.8 that is used to divert fish into QNFH. The electric weir is operated from October through December each year. The QNFH has out-planted juvenile salmon above the hatchery barrier and has sporadically passed a limited number of coho salmon adults above the barrier.

A natural anadromous fish barrier consisting of a steep cascade is located at RM 7.4. Little information is available on natural production of anadromous fish in the reach between the natural barrier at RM 7.4 and the hatchery barrier, although, the hatchery barrier is passable by winter steelhead, coho, and cutthroat during high flows or by a bypass ladder. The bypass ladder is currently impassable due to gravel accumulation.

Aquatic habitat within this watershed includes 18.9 miles of mainstem channel and 81.9 miles of tributary streams (Parametrix et al. 2000). Potential anadromous fish habitat (i.e. excluding human made barriers) in the lower Big Quilcene River valley (downstream of the natural barrier at RM 7.4) is estimated to include 7.4 miles of mainstem channel, 5.1 miles of tributary channel, 15.1 acres of perennial wetland, and 41.8 acres of seasonal wetland (Parametrix et al. 2000). Anadromous fish use is currently limited by the QNFH barrier at RM 2.8. Water quality in the majority of the Big Quilcene watershed is good (Parametrix et al. 2000). Temperature in the Big Quilcene River and Penny Creek is generally within state water quality standards (Parametrix et al. 2000).

Habitat quality in the lower river is considered to be poor, especially below RM 1.0 were the primary summer chum spawning grounds are located. The habitat has been degraded due to water withdrawl, low channel complexity, channelization, loss of riparian vegetation, and increased sediment transport from the upper watershed (WDFW and PNPTC 2000). The mainstem reach below the QNFH barrier (RM 2.8 to the mouth) is dominated by riffle units, contains few pieces of large wood, has few pools, and contains abundant gravel (Parametrix et al. 2000). The majority of this reach is braided and unstable (Parametrix et al. 2000).

Within the relatively recent past (1989 to 1995) approximately 24 projects have been conducted that have impacted in-stream habitat in the lower 4 miles of the Big Quilcene River (Parametrix et al. 2000). These include 11 dredging projects, 3 large wood removal projects, and 10 bank protection projects. Portions of the channel have been repeatedly dredged between RM 4.8 and RM 0. Several areas have been diked or armored including 1.1 miles of mainstem channel in the lower 2 miles of the Big Quilcene River, and 0.6 miles between RM 2 and RM 4 (Parametrix et al. 2000). Approximately 41 percent of the lower 4 miles of mainstem channel have been diked or armored (Parametrix et al. 2000).

From the river mouth to RM 4.8, 38 percent of the riparian zone is disturbed by various land uses. Roads and dikes make up the largest percent (21 percent), with agricultural use around 10 percent (Parametrix et al 2000). Overall, the lower reach riparian zone (below RM 2.8) is in poor condition (Parametrix et al. 2000). The riparian zone is less than 66 feet wide for 45 percent of the lower reach (Parametrix et al. 2000). The existing forested component of this reach is composed of young deciduous tree species, 44 percent less than 12 inches diameter at breast height (dbh) (Parametrix et al. 2000).

Between RM 4.8 and RM 6.1 the flood plain is narrow, with side slopes steeper than 60 percent; long riffles greater than 500 feet are common in this reach; and large wood is scarce (USFS 1992). Between RM 6.1 and RM 7.0 side slopes are steep terminating in rocky cliffs near the stream channel; stream gradient is approximately 6 percent; and many deep pools and high gradient cascades are present (USFS 1992). Upstream of RM 4.8 riparian vegetation is dense, but dominated by young deciduous trees and shrubs (USFS 1992). From RM 6.1 to RM 7.0 the riparian zone contains large evergreen trees, but is dominated by bedrock and cliffs (USFS 1992).

1.3.2 Little Quilcene Watershed

The Little Quilcene River watershed is also part of WRIA 17, draining into Quilcene Bay approximately 0.5 miles north of the mouth of the Big Quilcene River. The largest tributaries to the Little Quilcene River are Howe Creek, Ripley Creek, and Leland Creek. The watershed originates above 6,280 feet in elevation and comprises an area of approximately 30 square miles. The drainage area upstream of the Little Quilcene diversion encompasses approximately 33 percent of the total Little Quilcene watershed area. Runoff is derived primarily from snowmelt and rainfall (Parametrix et al. 2000). Forestland accounts for approximately 72 percent of the watershed, 40 percent within the Olympic National Forest and 32 percent privately held (Parametrix et al. 2000). Farmland, commercial property, rural residential development, and light industrial property comprise less than 28 percent of the watershed and are located in the lower portion of the watershed (Parametrix et al. 2000).

Salmonid fish species currently found within the Little Quilcene watershed include coho salmon, summer and fall chum salmon, steelhead/rainbow trout, coastal cutthroat trout, and brook trout. Chinook and pink salmon may stray into the system, but are not considered self-sustaining populations (Parametrix et al. 2000; Lichatowich 1993). Anadromous fish production in the little Quilcene River is dominated by natural production of coho and chum salmon. Anadromous salmonid use is restricted to the lower river by a natural upstream migration barrier at RM 6.6.

Aquatic habitat within this watershed includes 12.2 miles of mainstem channel and 81.2 miles of tributary streams (Parametrix et al. 2000). The upper watershed (upstream of RM 6.6) consists of high gradient, confined stream channels, and the lower watershed consists of moderate to low gradient channels within a broad valley. Water quality in the majority of the Little Quilcene watershed is good; generally, temperature, dissolved oxygen, and fecal coliform bacteria levels have not exceeded state standards (Parametrix et al. 2000).

Habitat quality is considered poor, especially below RM 0.8. Habitat has been degraded due to water withdrawl, low channel complexity, diking, channel aggradation, and removal of riparian vegetation (WDFW and PNPTC 2000). The lower 0.8 miles of the mainstem have been diked and the banks armored (Parametrix et al. 2000). The reach from RM 0.0 to 1.3 is reported to be less than 1 percent in gradient; confined by dikes; lacking large wood; with a substrate dominated by sand and gravel (Parametrix et al. 2000). The large majority of summer chum in the Little Quilcene River spawn within this reach. The reach from RM 1.3 to 3.3 is reported as moderately confined with a gradient between 1-2 percent; containing more LW than the lower reach, but infrequent pools with a substrate dominated by gravel (Parametrix et al. 2000).

Major tributaries, such as Howe Creek and Ripley Creek, are in better condition than the Little Quilcene mainstem. Large wood, pool frequencies, canopy closure, and wetland areas are reported to be substantially higher than the mainstem Little Quilcene River for the lower 2.8 miles of Howe Creek and 1.5 miles of Ripley Creek (Parametrix et al. 2000). However another major tributary, Leland Creek, is reported to be degraded with culverts that block fish passage, low levels of large wood, and riparian cover dominated by reed-canary grass (Parametrix et al. 2000).

Approximately 60 percent of the riparian zone downstream of RM 3.0 is developed and consists of approximately 33 percent agricultural use, 11 percent roads and dikes, 6 percent commercial forestry, and 10 percent commercial property and residential development (Parametrix et al. 2000). In undeveloped areas the riparian zone is dominated by young deciduous or mixed-species forest (Parametrix et al. 2000).

1.3.3 Hydrologic Modeling for the Big and Little Quilcene Rivers

Hydrologic modeling was conducted by Orsborn and Orsborn (2000) for the Big and Little Quilcene Rivers to estimate the stream flow characteristics for the Big and Little Quilcene Rivers during time periods without gage records given the incomplete historical record of flows for both systems. The study estimated the high, low, and average flow characteristics, and seasonal flows and durations during the summer chum salmon migration and spawning periods of August through October.

U.S. Geological Survey flow data for the Big Quilcene River is limited to 1926-27, 1951-52, 1971-72 in the lower river and 1993-present on the Big Quilcene River at the diversion. Flow data for the Little Quilcene River is available for 1926-27 and 1951-57 near highway 101. Data from other USGS stations on the north and east sides of the Olympic Mountains with longer periods of records were correlated with each other, and with the data from the Big and Little Quilcene Rivers, to estimate high, average and low flows per month.

Other regional models used to analyze flows included combining basin area, basin relief, and average annual precipitation. Characteristic flows were developed by regional relationships of flows to basin characteristics and by a simplified method of correlating annual minimum, average, and maximum daily flows between stations in the region. Low flows were estimated from the seven-day average low flow with a two-year recurrence interval using USGS regional statistical data.

Table 1. Average monthly natural flows (modeled flows without diversion) for the Big Quilcene River and Little Quilcene River below the diversions.

Flow Estimations (cfs)						
	Big Quilcene River			**Little Quilcene River**		
	Average Annual Flow: 165 cfs			**Average Annual Flow: 24 cfs**		
Month	**Maximum**	**Mean**	**Minimum**	**Maximum**	**Mean**	**Minimum**
Oct	267	94	24	31	11	4
Nov	416	180	38	43	21	7
Dec	581	245	77	90	38	11
Jan	588	251	53	120	47	9
Feb	492	224	54	91	40	10
Mar	375	178	66	70	34	11
Apr	310	177	94	60	31	16
May	370	204	101	50	27	12
Jun	334	175	78	37	18	8
Jul	228	101	41	25	10	5
Aug	115	56	25	11	6	3
Sep	128	46	21	15	5	3

Source: Orsborn, unpublished data, 3/12/2003.

The lowest annual streamflows within the Big Quilcene and Little Quilcene Rivers typically occur in September and October. Low flows have been recorded as low as 14cfs in the Big Quilcene River and 4.1 cfs in the Little Quilcene River (Orsborn and Osborn 2000). Natural flow duration curves developed by Osborn and Orsborn (2000) estimated the lowest natural streamflows in the Big Quilcene River in September and October as:

September 23 to 32 cfs, median 30 cfs
October 21 to 32 cfs, median 22 cfs

The estimated 7-Day Average Low Flow with a 2-year return interval is 26 cfs for the Big Quilcene River at the diversion (Osborn and Orsborn 2000).

These flow estimates are generally consistent with flow modeling done by Caldwell as part of the IFIM study (Caldwell 1999). Using duration curves, he estimated median flows during September and October to be between 30 to 40 cfs. Average daily low flows (flows which would be exceeded 90% of the time) ranged from 17 to 22 cfs.

Flow records from the USGS at the Big Quilcene diversion between 1993 and 2004 are also generally consistent with the above estimates. For the seven years with complete records, undiverted natural flows in the Big Quilcene in September and October ranged from a low of 23 cfs to a high of 225 cfs, with an overall average of about 58 cfs. When the occasional large high flow events greater than 200 cfs are subtracted from the data set, the overall average flow drops to about 46 cfs.

Lowest natural streamflows estimated for the Little Quilcene River in September and October are:

September	5.3 to 8 cfs, median 7.0 cfs
October	4.7 to 8 cfs, median 5.0 cfs

The estimated 7-Day Average Low Flow with a 2-year return interval is 3 cfs for the Little Quilcene River at the diversion (Osborn and Orsborn 2000).

2.0 LISTED SPECIES AND SUMMARY OF FINDINGS

Requests for documentation of the potential presence of federally proposed, or listed threatened or endangered species, candidate species, and designated critical habitat in the action area were made to the U.S. Fish and Wildlife Service (USFWS) and NOAA) Fisheries. The Washington Department of Natural Resources Natural Heritage Program and Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) Program were also contacted for information on listed and sensitive species occurrence in the action area.

Table 3 lists the ESA species evaluated for this BA, gives their listing status, status of designated critical habitat, and presents the effects determination with regard to the proposed action. The effects determination was based on the analysis and conservation measures presented in this BA.

Table 3. Summary for Endangered Species Act (ESA) Species.

Species	***ESA Status (Listing Unit)***	***Designated ESA Critical Habitat***	***ESA Effects Determination***
Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened (Puget Sound ESU[1])	None	No Effect
Chum salmon (*Oncorhynchus keta*)	Threatened (Hood Canal summer-run chum ESU[1])	Proposed	May affect, likely to adversely affect.

[1]Evolutionary Significant Unit

3.0 EVALUATION OF SPECIES

3.1 Hood Canal Summer-run Chum Salmon

3.1.1 Status of Hood Canal Summer-run Chum Salmon

The Hood Canal summer-run chum salmon ESU was listed as “threatened” under the ESA on March 25, 1999. Hood Canal summer-run chum populations are one of three genetically distinct lineages of chum salmon in the Pacific Northwest region and have a distinct life history (Johnson et al. 1997). The listing was based on strong downward trends in abundance shown by most of the spawning populations of summer chum salmon in Hood Canal over the past 30 years. Declines of Hood Canal summer-run chum salmon have been attributed to over-harvest, spawning habitat degradation, habitat blockages, and low summer flows.

Of the sixteen populations of summer chum salmon identified in this ESU, seven are considered to be "functionally extinct" (Skokomish River, and Finch, Anderson, Dewatto, Tahuya, Big Beef, and Chimacum creeks). The remaining nine populations are well distributed throughout the ESU, and are located in the Dosewallips, Duckabush, Dungeness, Hamma Hamma, Big and Little Quilcene, and Union Rivers and Lilliwaup, Snow, Salmon, and Jimmycomelately Creeks. Although abundance was high in the late 1970's, abundance for most Hood Canal summer chum salmon populations declined rapidly beginning in 1979, and has remained at depressed levels. The terminal run size for the Hood Canal summer chum salmon stocks averaged 28,971 fish from 1974 to 1978 and declined to an average of 4,132 fish from 1979 to 1993 (WDFW and PNPTC 2000). Abundance during the 1995 to 1998 period improved and averaged 10,844 fish; however, much of the increase in abundance can be attributed to the QNFH supplementation program for the Big Quilcene River summer chum stock begun in 1992.

Table 4. Status of Hood Canal summer-run chum salmon ESU populations as indicated by spawner abundance, stock status, and extinction risk determinations for remaining stocks (WDFW and PNPTC 2000).

Stock	Spawner Abundance [1]	Stock Status	Extinction Risk Rating
Union	269	Healthy	Moderate
Lilliwaup	47	Critical	High
Hamma Hamma	73	Depressed	Moderate
Dosewallips	207	Depressed	Low
Duckabush	185	Depressed	Low
Quilcene [4]	100	Depressed	High [2]
Snow / Salmon	296	Depressed	High [2]
Jimmycomelately	85 [3]	Critical	High [3]
Dungeness	Unknown	Unknown	Special Concern

[1] Five year (1988-93) pre-supplementation program average annual spawner escapement levels.

[2] Extinction risk rating is based on population status prior to implementation of a supplementation program.

[3] Abundance and extinction risk ratings are based on 1994-98 average escapements.

[4] Includes the Quilcene Bay aggregate population.

3.1.2 Hood Canal Summer-run Chum Salmon Populations in the Action Area

The summer chum salmon population from the Big Quilcene and Little Quilcene Rivers is a composite of natural and hatchery production and is managed within the aggregate Quilcene and Dabob Bay stock. Natural spawning escapement of summer chum salmon to the Big and Little Quilcene Rivers has been highly variable. Historical escapements from 1968 to 1978 ranged from 655 to 5,797 in the Big Quilcene and from 12 to 1,816 in the Little Quilcene River, respectively. Populations in both rivers declined precipitously beginning in 1979 and continuing into the 1980s. Populations reached a low point in 1989 when only one fish was recorded in the Big Quilcene and one fish was recorded in the Little Quilcene.

From 1992 to 2003 the QNFH implemented a supplementation program for summer chum using broodstock collected from the tribal coho salmon fishery in Quilcene Bay, in-river collection, and from fish captured at the hatchery. Average spawning escapement to the Big Quilcene River from 1995 to 2003 was 5,730 fish. A total of 35,000 summer chum returned to the Big Quilcene River in 2004. (WDFW and PNPTC 2000, QNFH, unpublished data 2005). These numbers include returns of fish derived from both natural production and hatchery supplementation. In 1997 QNFH began marking juvenile summer chum so the proportions of hatchery-origin and natural-origin adults could be determined. Between 2001 and 2003, natural-origin escapement back into the Big Quilcene ranged from 2,757 to 9,959 fish. In 2004, almost 33,000 natural-origin summer chum returned back into the Big Quilcene to spawn. Recent escapements of summer chum in the Big Quilcene appear to compare favorably with historical runs.

Spawning escapement of summer chum in the Little Quilcene have rebounded somewhat since 1992. Between 1992 and 2002 they have ranged from 0 to 470 fish with an average of about 150 fish. (WDFW and PNPTC 2003). Summer chum in the Little Quilcene River are presumed to be predominately of natural origin.

3.1.3 Life History Requirements

Description of life history requirements focuses on life stages that occur in freshwater and nearshore habitats that could potentially be impacted by the reissual of the Special Use Permits. These life stages include adult migration and spawning, juvenile rearing and out-migration, and near-shore rearing.

Summer chum salmon mature primarily at three or four years of age in Washington (USFWS 1988). Summer chum salmon enter Hood Canal from early August through the end of September (WDF et al. 1994), and enter Quilcene Bay from the third week in August, through the first week in October (Lampsakis 1994). Summer chum salmon typically spawn soon after entering freshwater in the lowest reaches of natal streams (Koski 1975, Schoder 1977, Johnson et. al. 1997). Summer chum salmon spawning occurs from late August through late October, and anadromous habitat is limited to habitat downstream of RM 2.8 in the Big Quilcene River and RM 6.6 in the Little Quilcene River. The majority of summer chum spawning occurs within about the lower 1 mile in the Big Quilcene and within about the lower 1.8 miles in the Little Quilcene (WDFW and PNPTC 2000). Optimum temperature identified for successful upstream migration of adult chum salmon is 10.1ºC with a range of 8.3 to 15.6ºC (Bell 1973, Reiser and Bjornn 1979). Spawning temperatures for chum salmon range between 7.2 and 12.8°C (Reiser and Bjornn 1979). Chum salmon eggs are thought to survive best from 4.4 to 14°C (Schroder 1977, Koski 1975, Reiser and Bjornn 1979).

Depending on temperature regimes in spawning streams, hatching occurs approximately 8 weeks after spawning. Alevins develop within the gravel for an additional 10 to 12 weeks before emerging as fry between February and the end of May. Bakkala (1970) reported total gravel residence times for chum salmon ranging from 78 to 183 days across the range of chum salmon distribution, depending on stream temperature. Fry emergence timing in Hood Canal can range from the first week in February to the second week in April (Tynan 1997). Estimated peak emergence time for Hood Canal summer chum salmon populations is approximately mid-March (Tynan 1997).

Fry emerge with darkness and immediately commence migration downstream to estuarine areas. In shorter rivers the migration is over in about 30 days after fry emergence, whereas the migration is prolonged in longer rivers (Salo 1991). Brett (1952) observed chum salmon fry to prefer temperatures of 12 to 14°C and to avoid temperatures above 15°C. The upper lethal temperature for young chum salmon has been documented at 23.8°C.

Fry enter the estuary areas usually by June and remain until mid to late summer (USFWS 1988). Chum salmon fry arriving in the Hood Canal estuary are initially widely dispersed (Bax 1983), but form loose aggregations oriented to the shoreline within days (Schreiner 1977, Bax 1983, Whitmus 1985). Chum salmon fry at this initial stage of outmigration use areas predominantly close to shore. This behavior is thought to be a preference for lower salinity water, and an adaptation for predator avoidance (Schreiner 1977). Young chum salmon spend up to three weeks rearing in the estuaries, and occupy tidal creeks and sloughs in the delta area (Salo 1991). The Hood Canal early run chum fry usually occupy sublittoral eelgrass beds with residence time of about one week (Wissmar and Simenstad 1980). Schriener (1977) reported that Hood Canal chum salmon maintained a nearshore distribution until they reached a size of 45 to 50 mm; at that time they moved to deeper offshore areas. By mid August to September, all juveniles have left the river estuaries for the offshore ocean environment (Hale 1981).

3.1.4 Designated Critical Habitat

ESA critical habitat was designated to include all marine, estuarine, and river reaches accessible to listed Hood Canal Summer-run chum salmon; however, on April 30, 2002, the U.S. District Court for the District of Columbia approved a NMFS consent decree withdrawing critical habitat designations for 19 salmon and steelhead populations on the West Coast (including the Hood Canal summer-run chum salmon ESU).

New critical habitat for Hood Canal summer chum was proposed by NOAA Fisheries on December 14, 2004. Proposed critical habitat includes the lower 2.7 miles of the Big Quilcene River from the QNFH to the river mouth and the lower approximately 2.5 miles of the Little Quilcene River. Final critical habitat designation is anticipated in mid 2005.

3.2 Puget Sound Chinook Salmon

3.2.1 Status of Puget Sound Chinook Salmon Populations in the Action Area

Puget Sound Chinook salmon were designated as threatened under the Endangered Species Act (ESA) on March 24, 1999. The listing includes all natural spawning populations within the evolutionarily significant unit (ESU) except the naturally-spawning descendants from the spring-run Chinook salmon program at the Quilcene National Fish Hatchery and their progeny. The Quilcene hatchery Chinook salmon salmon stock was also excluded from the ESU. Because the Quilcene River Chinook stock is not included in the Puget Sound Chinook salmon ESU (CFR 1999), and is not considered threatened under ESA.

3.2.2 Designated Critical Habitat

ESA critical habitat was designated to include all marine, estuarine, and river reaches accessible to listed Chinook salmon in Puget Sound; however, on April 30, 2002, the U.S. District Court for the District of Columbia approved a NMFS consent decree withdrawing critical habitat designations for 19 salmon and steelhead populations on the West Coast, including Puget Sound Chinook salmon.

New critical habitat for Puget Sound Chinook was proposed by NOAA Fisheries on December 14, 2004. Proposed critical habitat does not include any potions of either the Big Quilcene River or the Little Quilcene River. Final critical habitat designation is anticipated in mid 2005.

4.0 ANALYSIS OF EFFECTS OF THE PROPOSED ACTION

4.1 Environmental Baseline and Effects Matrix

The NMFS Matrix of Pathways and Indicators can be used to summarize the current environmental baseline conditions in the action area and the effect of a proposed project on relevant aquatic habitat indicators. The Matrix of Pathways and Indicators for this project for the Big Quilcene River and the Little Quilcene River are shown in Tables 5 and 6, respectively.

The two environmental indicators that may be affected by the proposed project are water temperature and change in peak/base flows. Current water temperatures are assumed to be “at risk” for both the Big and Little Quilcene Rivers based on information contained in the baselines completed in 1999 for the Olympic National Forest programmatic consultations with USFWS and recent information. Current change in peak/base flows is rated as “not properly functioning” for the Big Quilcene River and “at risk” for the Little Quilcene River. The current degraded condition of these indicators can be attributed to the municipal water withdrawals and to urbanization, riparian vegetation removal, dredging, and diking in the lower watersheds.

Although the peak/base flows indicator continues to be rated as “not properly functioning” in the Big Quilcene, it should be noted that substantial improvements have been made in maintaining instream flows for summer chum over the past decade. These improvements are described in Section 1.2.5 Water Conservation Measures.

The proposed action does not involve any new construction or new land management activities. The water diversion structures, pipeline right-of-way, and associated facilities covered under the Special Use Permits have been in existence for several decades. Operation and maintenance of the existing physical facilities will not have any effect on any of the indicators in the matrix of pathways and indicators. See section 4.2 Direct Effects of the Proposed Action for a more detailed discussion of potential effects from operation and maintenance of the existing physical facilities.

Reissuing the three Special Use Permits would allow the City of Port Townsend water diversions that have historically occurred on the Big and Little Quilcene Rivers to continue. These diversions have operated at similar or greater levels since 1928. Substantial improvements have been made in maintaining instream flows for summer chum over the past decade. Additional improvements such as establishing a mandatory rather than a voluntary minimum instream flow level for the Big Quilcene River during the critical summer chum spawning period would be an improvement over existing baseline conditions, but they would not be enough to change the peak/base flow indicator from its current "not properly functioning" status.

The primary effect of the City's flow diversions on summer chum is a reduction in the amount of potential spawning habitat available. There could also potentially be a small increase in stream temperatures early in the spawning period. See section 4.3 Indirect Effects of the Proposed Action for a detailed discussion of potential effects from water diversion.

Table 5. Environmental Baseline and Effects of the Proposed Action on Aquatic Indicators in the Big Quilcene River.

In the appropriate column(s), mark **S** for short-term impacts (within first year), **L** for long-term impacts (>1 year).

Indicator	BASELINE 5th Field Watershed Scale			EFFECTS OF ACTION 5th Field Watershed Scale			EFFECTS OF ACTION Project Action Area Scale		
	Proper Function	At Risk	Not Properly Functioning	Restore	Maintain	Degrade	Restore	Maintain	Degrade
Temperature		X			L			L	
Sediment		X			N/A			N/A	
Chemical Contaminants	X				N/A			N/A	
Passage Barriers			X		N/A			N/A	
Substrate Embeddedness		X			N/A			N/A	
Large Woody Debris			X		N/A			N/A	
Pool Frequency		X			N/A			N/A	
Pool Quality		X			N/A			N/A	
Off-channel Habitat			X		N/A			N/A	
Refugia			X		N/A			N/A	
Width/ Depth Ratio		X			N/A			N/A	
Streambank Condition			X		N/A			N/A	
Floodplain Connectivity			X		N/A			N/A	
Change in Peak/Base Flows			X	L			L		
Drainage Network Increase		X			N/A			N/A	
Road Density & Location			X		L			L	
Disturbance History			X		N/A			N/A	
Riparian Reserves			X		L			L	

Restore = project is likely to have a beneficial impact on habitat indicator
Maintain = project may affect indicator, but impact is neutral
Degrade = project is likely to have a negative impact on the habitat indicator
N/A = project does not have the potential to impact the habitat indicator

Table 6. Environmental Baseline and Effects of the Proposed Action on Aquatic Indicators in the Little Quilcene River.

In the appropriate column(s), mark **S** for short-term impacts (within first year), **L** for long-term impacts (>1 year).

Indicator	BASELINE 6th Field Watershed Scale			EFFECTS OF ACTION 6th Field Watershed Scale			EFFECTS OF ACTION Project Action Area Scale		
	Proper Function	At Risk	Not Properly Functioning	Restore	Maintain	Degrade	Restore	Maintain	Degrade
Temperature		X			L			L	
Sediment	X				N/A			N/A	
Chemical Contaminants	X				N/A			N/A	
Passage Barriers	X				N/A			N/A	
Substrate Embeddedness		X			N/A			N/A	
Large Woody Debris		X			N/A			N/A	
Pool Frequency		X			N/A			N/A	
Pool Quality			X		N/A			N/A	
Off-channel Habitat			X		N/A			N/A	
Refugia			X		N/A			N/A	
Width/ Depth Ratio		X			N/A			N/A	
Streambank Condition		X			N/A			N/A	
Floodplain Connectivity		X			N/A			N/A	
Change in Peak/Base Flows		X			L			L	
Drainage Network Increase					N/A			N/A	
Road Density & Location	X				L			L	
Disturbance History		X			N/A			N/A	
Riparian Reserves		X			L			L	

Restore = project is likely to have a beneficial impact on habitat indicator
Maintain = project may affect indicator, but impact is neutral
Degrade = project is likely to have a negative impact on the habitat indicator
N/A = project does not have the potential to impact the habitat indicator

4.2 Direct Effects of the Proposed Action

The Forest Service proposes to reissue three Special Use Permits for the occupancy and use of Federal land by the City of Port Townsend. The parcels listed under the Special Use Permits contain improvements for the purpose of operating and maintaining the municipal water supply for the City of Port Townsend. The Special Use Permits only cover the use of the sites and permit existing structures, such as the caretaker facilities and diversion structures. Permission to withdraw water from the Little and Big Quilcene Rivers is based on Washington State issued water rights. No substantial changes to the occupancy and use of the land and facilities are proposed during the proposed 20-year term of the permits.

Listed fish species are not present in the immediate vicinity of areas permitted for use and occupancy by the three Special Use Permits. Both water diversion facilities are well above potential anadromous habitat. The actual diversion facilities and improvements covered under the three Special Use Permits are not anticipated to have any measurable impact on Hood Canal summer chum, Puget Sound Chinook, or their habitats within the Big or Little Quilcene Rivers. Potential adverse effects caused by operating the water diversions are addressed in Section 4.3 - Indirect Effects.

Both diversions allow natural bed load movement downstream, and neither facility provides short or long-term water storage. The actual facilities do not alter the hydrograph nor alter channel processes to any great extent downstream. The pipeline and access road likely have some impact on downstream aquatic habitat by constraining the river channels and reducing riparian vegetation. These impacts are difficult to quantify, but are thought to be small in comparison with indirect impacts presented in Section 4.2. Because both diversions are run-of-the river facilities, water temperatures within the Big and Little Quilcene are not likely to be affected by the physical facilities.

Road and maintenance activities would be included under the Olympic National Forest road maintenance program, and any future road and facility maintenance activities would conform to the Programmatic Biological Assessment for Selected Forest Management Activities (Olympic National Forest 2003-2008) if the special use permits were reissued. Maintenance actives covered under this programmatic BA include culvert cleaning, replacement, and installation; road grading, erosion control, brushing, hazard and downed tree removal, pavement repair, bridge maintenance, gate installation and maintenance, painting, and shoulder maintenance. The Programmatic BA requires that specific conservation measures be implemented, which apply to these activities, and these conservation measures be made conditions of all re-issued special use permits. The conservation measures specified in the 2003-2008 Olympic National Forest Programmatic BA are incorporated in this BA by reference (USDA Forest Service 2003). By implementing the conservation measures specified in the Programmatic BA, impacts to listed fish species, as a result of road or facility maintenance, would be minimized or avoided.

4.3 Indirect Effects

Water withdrawals associated with the water diversion facilities would have a direct effect on downstream water quality and fish habitat quantity. Reduced flows caused by the water diversion are considered an indirect effect of the proposed action because the three Special Use Permits are independent of the City's water rights to withdraw water from the Big and Little Quilcene Rivers. Regardless of whether potential effects caused by water diversion are considered direct or indirect, they must be analyzed for ESA and MSA consultation purposes. The diversion of water directly impacts water quantity downstream. Aquatic habitat quantity and water temperature are the downstream habitat parameters that have the greatest potential to be impacted by water withdrawals at the Big and Little Quilcene diversions. Fish migrations could also be impacted by flow reductions. The analysis of indirect effects will be limited to these three parameters.

4.3.1 Effects on Aquatic Habitat Quantity

Water diversions on the Big and Little Quilcene Rivers have a direct impact to water quantity and, therefore, instream habitat quantity downstream of the diversion points. Impacts would be relatively minor at high flow levels during the late fall, winter, and spring because the diversion would account for only a small percentage of the overall streamflow. Impacts would be greatest during moderate flows in mid-summer and early fall because the percent diversion of water is highest during this time. At extremely low streamflows below 27 cfs (Big Quilcene) and 6.0 cfs (Little Quilcene) the City does not divert water so there would be no impacts.

4.3.1.1 Effects of Flow Diversion on the Big Quilcene River

For this analysis, we assume that instream flows at the Big Quilcene diversion are essentially equal to flows in the lower river during summer low flow periods. A comparison of the average daily flow measurements from just below the diversion point with flows measured at the hatchery for July through October, and a comparison of the measured streamflows at the diversion (City of Port Tonwnsend, unpublished data, 2005) and the streamflows measured by Beecher in the lower watershed during his 2000 instream flow work (Beecher, 2000) supported this assumption. Measured low flow values in the lower river were generally 2 to 5 cfs greater than flows measured at the diversion.

Under the worst-case scenario, during moderately low summer flows of around 57 cfs, water diversion on the Big Quilcene River could reduce instream flows by greater than 50 percent. For example: under the current operation the City voluntarily leaves a minimum instream flow of 27 cfs in the Big Quilcene River. The City's water right on the Big Quilcene River is for an instantaneous diversion of 30 cfs. Therefore, the highest percent diversion of natural available flow is 53 percent and occurs at 57 cfs (27 cfs + 30 cfs). The percentage reduction of flow caused by the diversion would be smaller if the streamflow was either greater than 57cfs, or less than 57 cfs, or if the amount of the diversion was less than the full 30 cfs water right. Actual percentage reductions of flow caused by the diversion during the late summer and fall would range from 53% to 0% depending on streamflows and water needs. Over the past 7 years, typical percentage reductions of flow caused by the diversion during late August, September, and October have ranged from 0% to 55% with an average flow diversion of about 22% (City of Port Townsend, unpublished data, 2005).

Figure 3 shows the frequency distribution for the percent of Big Quilcene River flow diverted by the city during the months of September and October from 1997 – 2003. This is the primary spawning period for summer chum in the Quilcene system. Figure 4 shows the frequency distribution of the actual daily flow diversions during the same period (City of Port Townnsend, unpublished data, 2005). Because the intent is to understand how diversions affect typical low summer flows, days with unusually high natural streamflows exceeded 200 cfs were excluded from this analysis. The median percent flow diverted from the Big Quilcene during the September-October low flow period was 20%. The median amount of flow diverted from the Big Quilcene during the September-October low flow period was 9 cfs.

Figure 3. Percent of Big Quilcene Flow Diverted in September and October during typical flows (high flows > 200 cfs removed from data set).

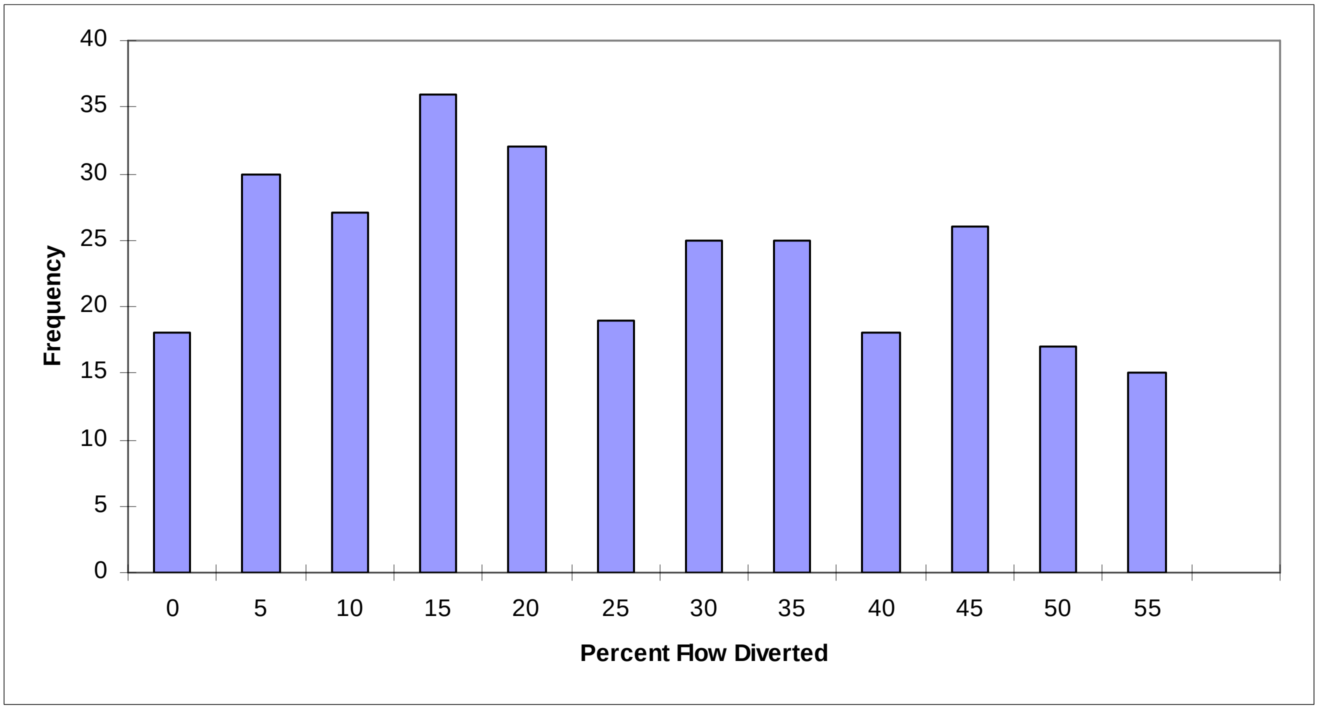
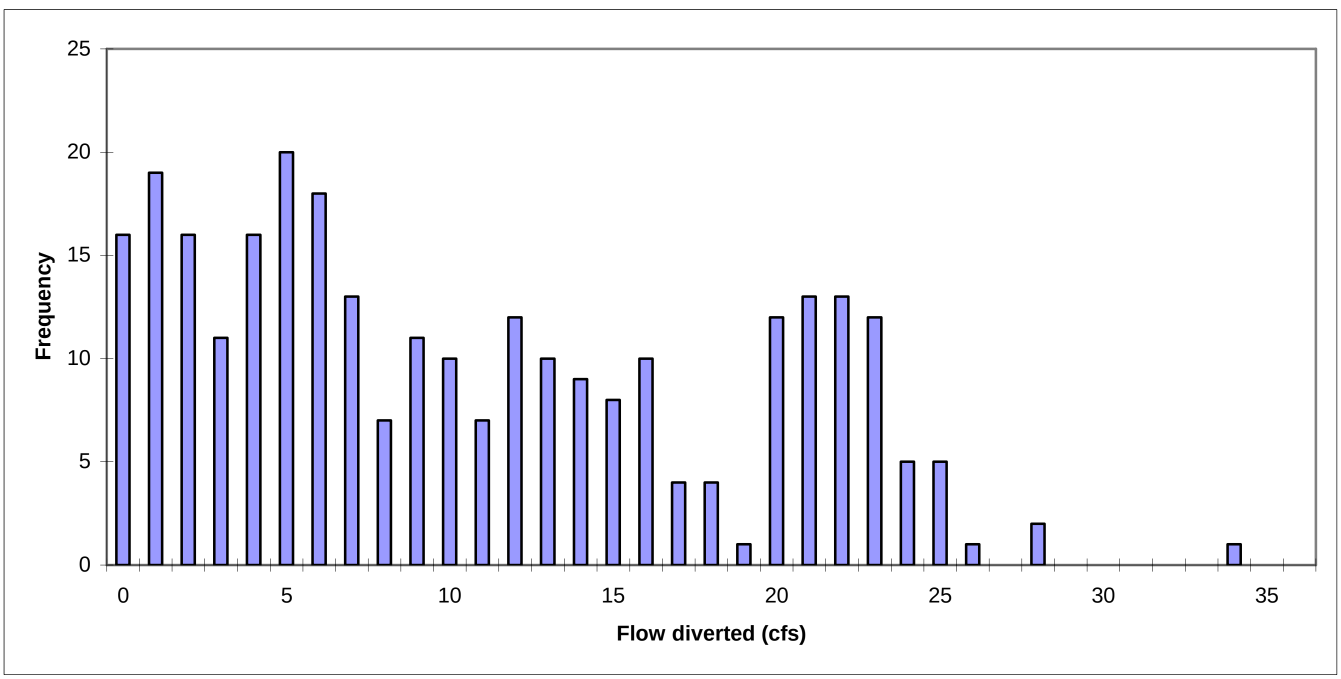


Figure 4. Frequency Distribution for Amount of Big Quilcene Flow Diverted in September and October during typical flows (high flows > 200 cfs removed from data set).



Operating the city's diversion could substantially reduce streamflows in the lower Big Quilcene River during the summer chum salmon spawning season. The largest percentage reductions in flow would tend to occur in early to mid September, before streamflows drop to their annual lows. Large percentage reductions in flow would also occur during wet years when natural streamflows in the Big Quilcene remained in the 40 to 50 cfs range.

A given reduction of the available flow does not necessarily mean available habitat is reduced by the same percentage. Beecher (2000) conducted a coarse study to examine the relationship of instream flow to wetted stream width and width with spawnable depth (spawnable width) for summer chum salmon at two locations heavily used by summer chum salmon for spawning on the lower Big Quilcene River. One study site was located 150-300 yards upstream from Rodgers Street and the other site was located at the power line crossing. Beecher (2000) determined that spawnable width was a crude, but representative and conservative index of summer chum salmon spawning habitat for the two study sites. We used the flow versus spawnable width data from Beecher (2000) to estimate the potential reduction in spawnable width caused by the City's water diversion.

An exponential equation was fit to the flow and width data sets for each location (Figure 5 and Figure 6). An exponential function was chosen for the data because at 0.0 cfs there would be zero spawnable width, and an asymptote should exist for spawnable width, where at ever increasing flows, spawnable width would no longer increase because the natural channel width would be fully submerged. The R^2 values for the power line site and Roger's Street site were 0.95 and 0.91, respectively, indicating an excellent to very good fit of the exponential functions to the data sets.

A major assumption of the following spawnable width calculations is that the two sites studied by Beecher (2002) are representative of all available summer chum spawning habitat. As Beecher (2002) noted, both sites were heavily used by summer chum salmon for spawning. Minimum depth was the only criteria used to define spawnable width. Other factors, such as velocity, substrate, upwelling, distance to cover, and resistance to scour, were not evaluated in the spawnable width estimate. Adding additional parameters to determine the amount of spawnable area would tend to decrease estimates of spawnable area. Therefore, the following estimates of how spawnable width varies with flow are likely conservative and overestimated, meaning that the estimate of impact is likely greater than the actual impact.

Figure 5. Spawnable width vs. flow for the power lines site.

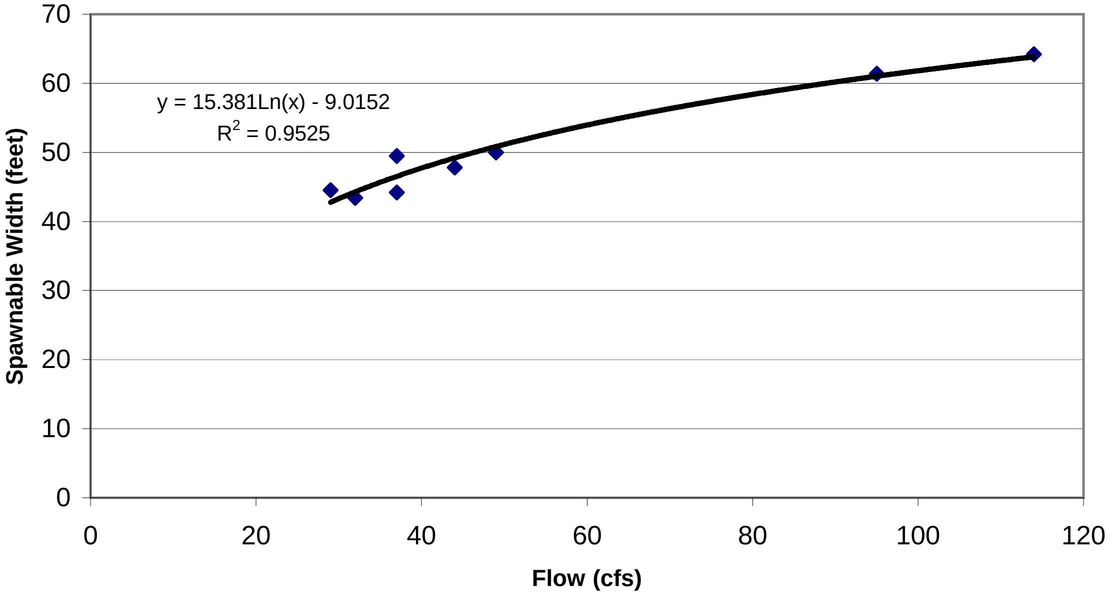
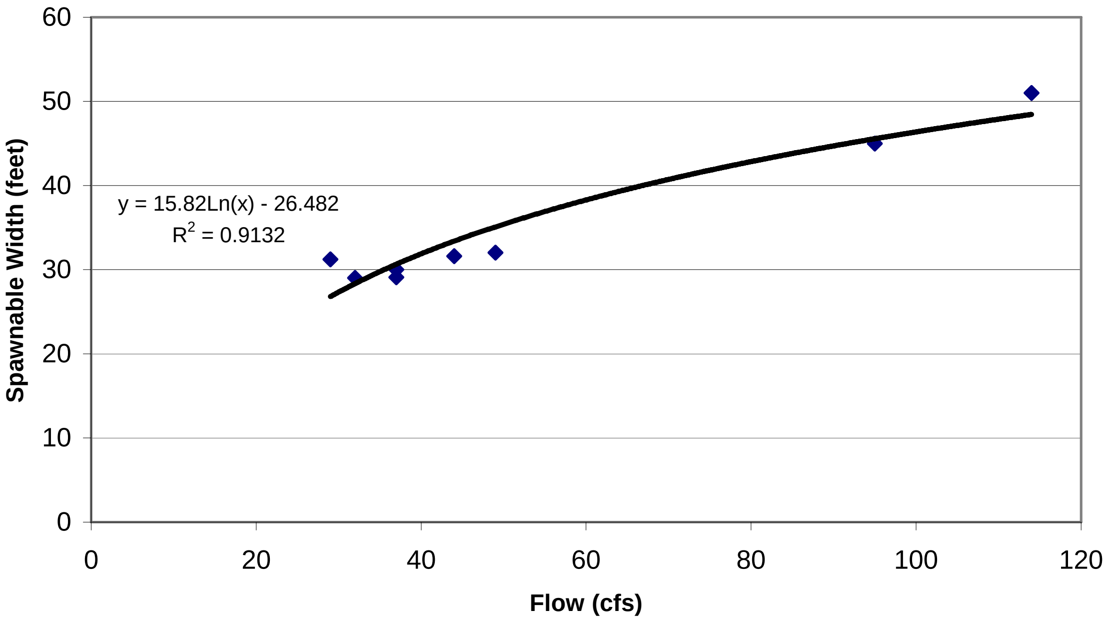


Figure 6. Spawnable width vs. flow for the Rogers Street site.



The regression equations from Figures 3 and 4 were used to calculate the worst case scenario in terms of the maximum percent decrease in spawnable width for summer chum that could possibly occur at diversions equaling the City's full water right of 30 cfs (Big Quilcene). At a maximum diversion of 30 cfs the maximum percent diversion of 53 percent is realized at an available instream flow of 57 if the voluntary 27 cfs instream flow is maintained. Under these conditions, there would be a 21.6 percent decrease in spawnable width at the power lines site and a 31.5 percent at the Rogers

Street site. Averaging the two sites gives a maximum decrease of approximately 27 percent in summer chum spawning habitat.

This value substantially overstates the likely impact of the City's flow diversions on summer chum spawning habitat in the Big Quilcene River. As Figures 3 and 4 show, percentage flow reductions in the Big Quilcene as a result of the diversion are highly variable and more typically are in the range of a 20 percent reduction in flow rather than the 53 percent reduction used above. Typical flow diversions in September and October almost never reach 30 cfs. The median value for flow diversions during this period is only 9 cfs.

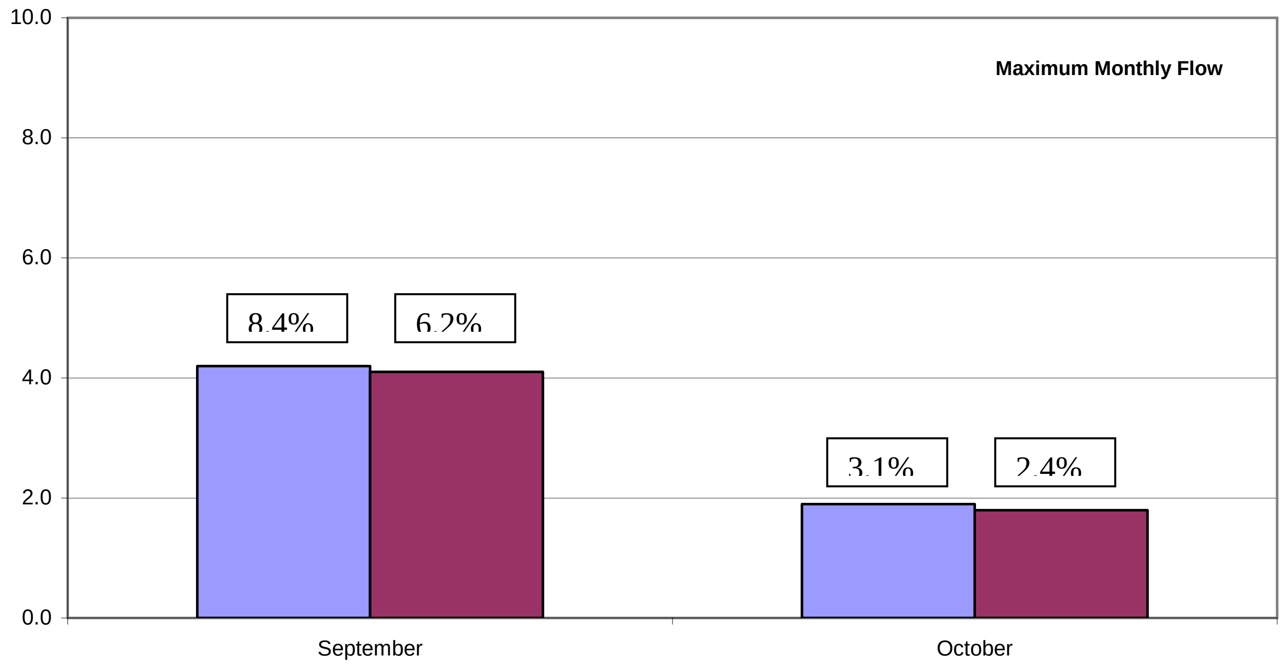
Estimated average maximum, mean, and minimum monthly flows for September and October for the Big Quilcene River were evaluated using the exponential functions fitted to the Beecher (2000) data set to determine the actual decrease and percent decrease in chum salmon spawnable width expected at the two study sites (Figure 7). The actual decrease in spawnable width is represented by the bar. The percent decrease is represented by the number above the bar. Figure 8 assumes a maximum diversion of 30 cfs, which is the City's full water right. The voluntary 27 cfs minimum instream flow was maintained when modeled flows allowed at both diversion rates.

For the estimated mean monthly flow during the peak summer chum salmon spawning period in September, spawnable width (i.e. spawning habitat) decreased by 24 percent at the Rogers Street site and 16 percent at the power lines site. The magnitude of decrease in potential spawning habitat was less in October because lower streamflows limit the amount of the diversion. The magnitude of decrease in potential spawning habitat was also less for average maximum monthly monthly flows because the diversion was a smaller proportion of the overall streamflow during high flow events. There were no decreases in spawnable width due to the diversion for the estimated minimum flows for either September or October because the available flow was less than 27 cfs and no diversion was possible. The greatest loss of spawning habitat occurs during average (Mean) flows. This is somewhat counter intuitive, but happens because at high flows the diversion is a relatively small proportion of the total streamflow and at very low flows during dry years the voluntary 27 cfs instream flow for the Big Quilcene is greater than actual instream flows so no diversion occurs.

Actual daily flow and diversion data for September and October for 1997 - 2003 for the Big Quilcene River were evaluated using the exponential functions fitted to the Beecher (2000) data set to determine the percent decrease in chum salmon spawnable width expected at the two study sites. The voluntary 27 cfs minimum instream flow was maintained when modeled flows allowed at both diversion rates. The results are shown in Figure 8. Modeled decreases in spawnable width ranged from 0 percent to 31 percent. The median decrease in spawnable width was about 10 percent.

Reductions in spawnable area were generally greatest in early September when streamflows were highest and declined through mid-October when streamflows generally reached their annual minimums (Figure 9).

Figure 7. Projected actual and percent decrease in summer chum salmon spawnable stream width at two spawning sites in the lower Big Quilcene River caused by a 30 cfs diversion.



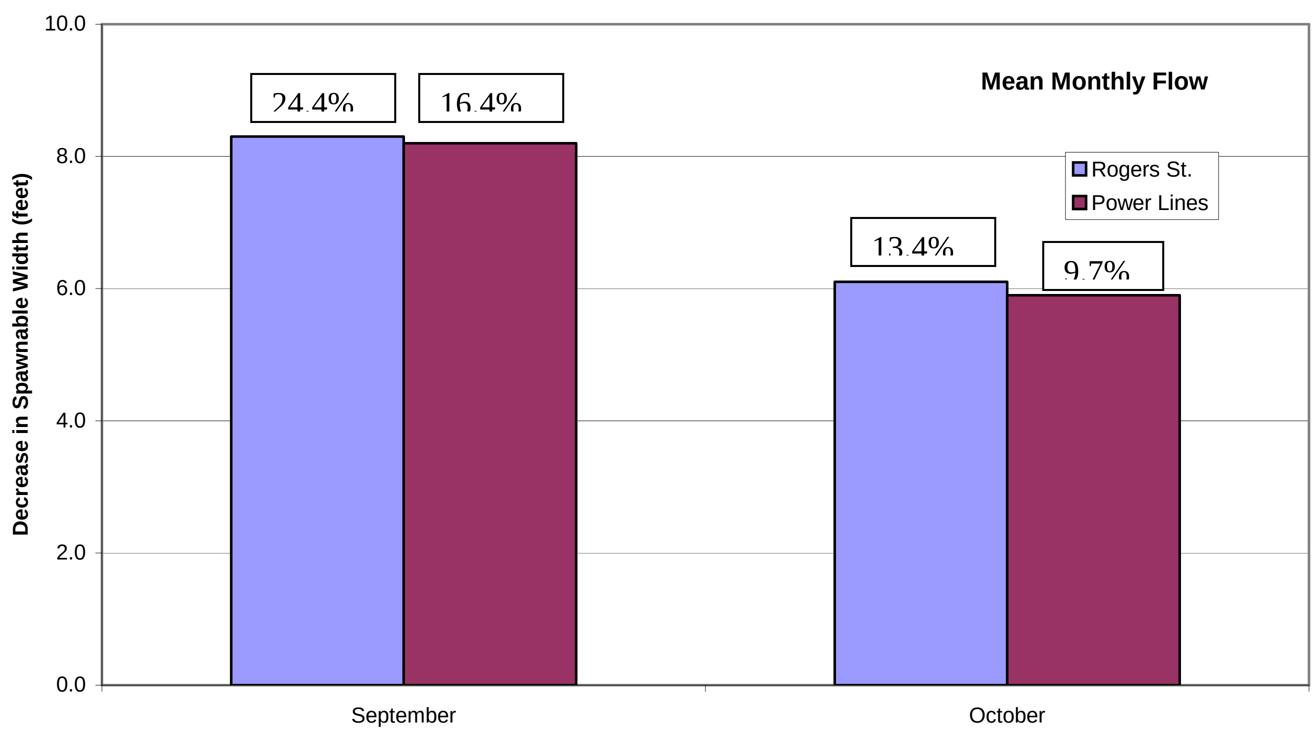


Figure 8. Frequency Distribution of Percent Reduction in Spawnable Area in September and October Due to Diversion (Rogers and Powerline sites combined).

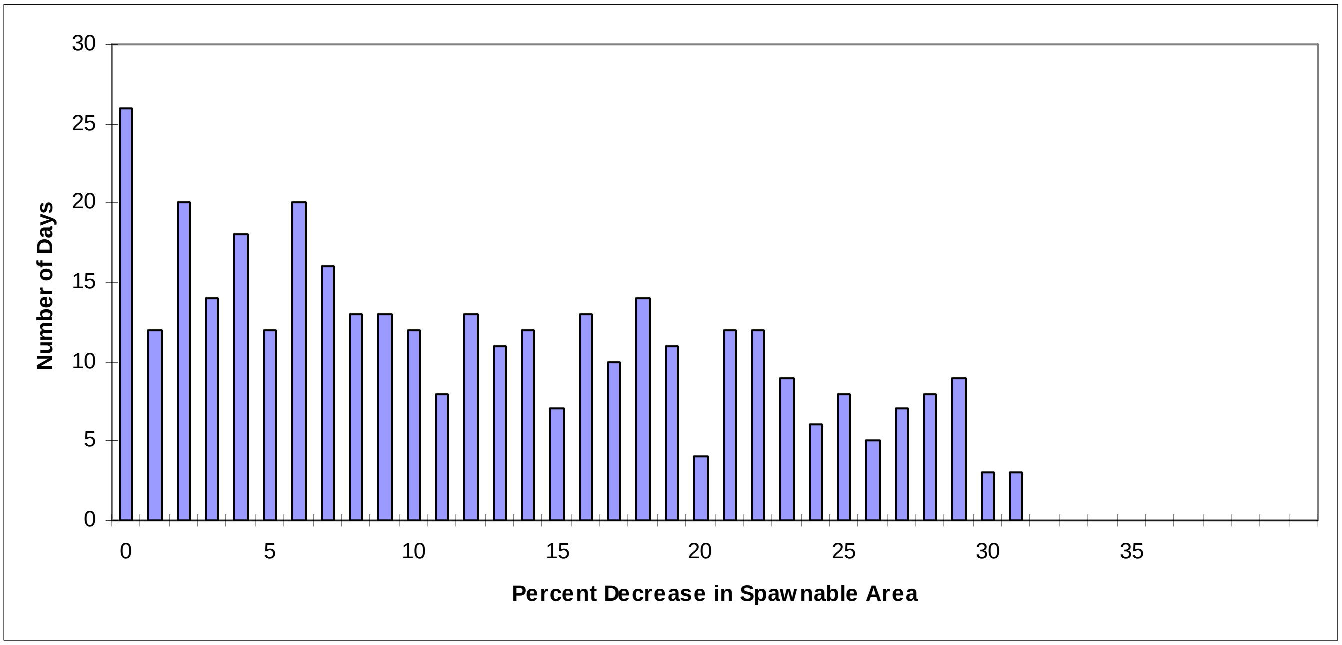
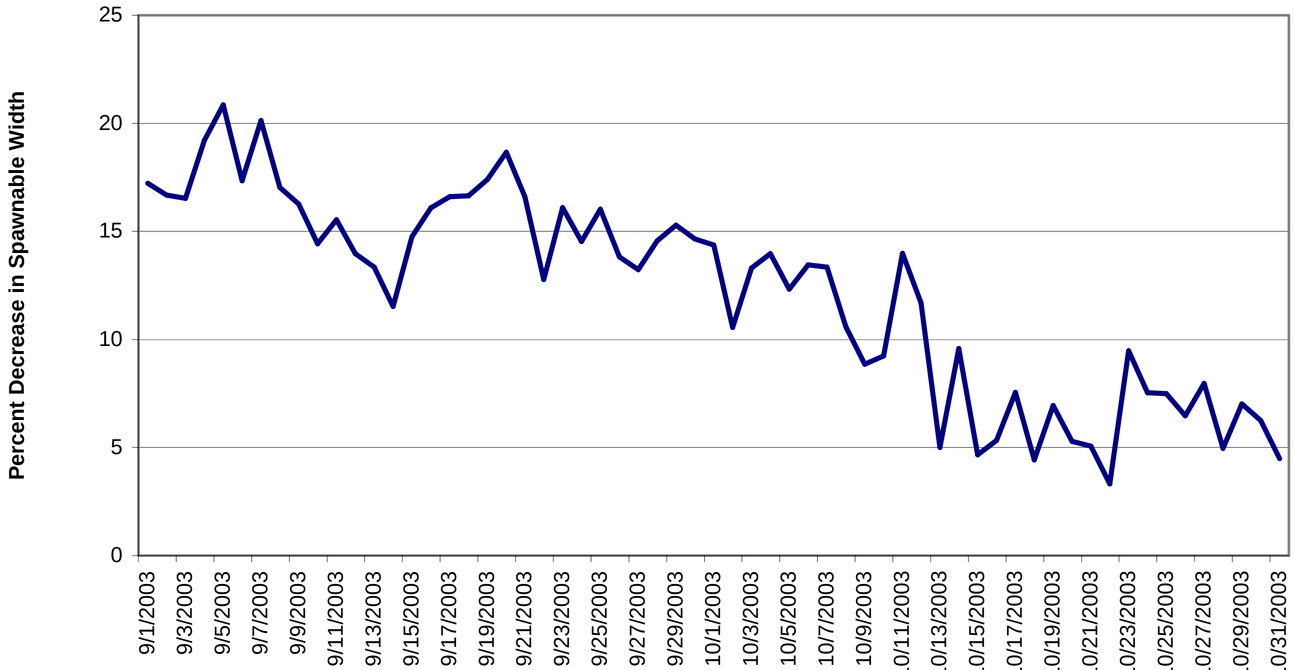


Figure 9. Average Percent Reduction in Spawnable Area by Date.



During wet years, the flow diversion may result in a consistent 15 - 20 percent reduction in available summer chum spawning habitat throughout the entire spawning season. During dry years, a 15 – 20 percent reduction in available spawning habitat could occur early in the season, but the magnitude of the reduction in spawning habitat would decline to 5 percent or less by late October as natural streamflows decline. Once natural streamflows in the Big Quilcene River reach 27 cfs, the diversion is turned off so there would be no reduction in available spawning habitat over natural conditions.

Based on recent flow records at the Big Quilcene diversion, daily streamflows in the Big Quilcene dropped below 27 cfs in three out of the five years with complete data. This is consistent with Orsborn and Orsborn's (2000) 7-day low flow estimate of 26 cfs that is calculated to occur about once every two years.

Quantitative impacts of the water diversions in the Big Quilcene on summer chum are uncertain. As described above, flow reductions of up to 55 percent in the lower 1 mile of river during the September - October summer chum spawning period would result in less spawning habitat being available during wet years or early in the spawning season. Reductions in potential spawning habitat could adversely affect summer chum by limiting the amount of spawning habitat available, eliminating preferred spawning areas, increasing redd super-imposition, and encouraging spawning within the main channel rather than along channel margins where redd scour during high flow may be less. All of these factors could reduce survival of eggs and incubating fry.

Adverse impacts to summer chum spawning from flow reductions associated with the diversion would be expected to be greater during wet years than in dry years. During wet years, flow reductions would cause a 15 – 20 percent decline in available spawning habitat. These reductions would be relatively consistent throughout the summer chum spawning period.

During low flow years, adverse impacts to summer chum spawning from the diversion would likely be much less than during wet years. Flow reductions would cause the same 15 – 20 percent decline in available spawning habitat early in the season. Early returning fish would be unable to spawn along some channel margins or in some shallow backwater areas. However, these same areas would naturally go dry as streamflows declined later in the season, potentially causing high mortalities in any incubating eggs. By reducing early season flows and maintaining a more-or-less consistent streamflow during low flow years, the diversion may actually benefit summer chum by discouraging early fish from spawning in areas that will go dry later in the year as flows drop. During extreme low flow periods, when the streamflow drops below 27 cfs, the diversion is shut off so it has no effect on the magnitude of the lowest natural streamflows.

Using data from Beecher's (2000) study on changes in spawnable width at two representative summer chum spawning sites on the lower Big Quilcene River, coarse estimates of total summer chum spawning habitat available in the lower mile of the Big Quilcene were calculated for various streamflows. Measured spawnable width information at the two sites were averaged and expanded to the entire lower 1.0 miles of the Big Quilcene where the majority of summer chum spawning typically occurs. Note this analysis may overestimate the abundance of spawning habitat present because it does not incorporate any notion of the quality of the available habitat and that some areas that appear to be potential spawning habitat would not be utilized.

At a streamflow of 46 cfs that would typically occur during a wet year or during the early portion of a dry year, there would be approximately 216,480 square feet of potential summer chum spawning habitat in the lower 1.0 miles of the Big Quilcene. At a streamflow of 27 cfs, which would be typical of the maximum diversion during wet years and the natural low flow during dry years, there would be approximately 191,136 square feet of potential spawning gravel. An average chum spawning density of between two fish per 62 sq. ft. and two fish per 248 sq. ft. was used to calculate the number of chum the habitat would support. These values correspond to the average area of a chum redd and the area recommended per pair of fish in artificial spawning channels, respectively (Bjornn and Reiser 1991). The information is displayed in Table 7.

Table 7. Potential summer chum spawning habitat capability in the lower 1.0 miles of the Big Quilcene River.

Flow (cfs)	Average Spawnable Width	Estimated Spawning Habitat	Spawning Capability (based on redd size)	Spawning Capability (recommended spawning density)
46 cfs	41 ft	216,480 sq ft	6972 fish	1743 fish
27 cfs	36.2 ft	191,136 sq ft	6156 fish	1539 fish

Based on average redd size, it appears that enough spawning habitat exists in the Big Quilcene River to support historical summer chum populations of between 650 and 5800 fish, even with the diversions. Adequate spawning habitat would also appear to be available to support the full Interim Summer Chum Salmon Recovery Goal for the Quilcene system (an escapement of 2860 fish) (WDFW and PNPTC 2003). The area recommended per pair of fish in artificial spawning channels likely underestimates summer chum spawning densities in the Big Quilcene because adequate spawning habitat to support observed historical escapements would not occur under either the typical natural streamflow or the diverted flow.

An analysis of historical and recent summer chum escapements in the Big Quilcene River tend to support the conclusion that adequate spawning habitat is available, even with the current diversion. During the late 1960s and early 1970s, summer chum escapements in the Big Quilcene ranged from 655 to 5,797. Typical escapements ranged from 1,300 to 3,000 fish. The diversion was operating during this entire period. Recent escapements of natural-origin fish in the Big Quilcene between 2001 and 2004 have ranged from a low of 2,757 to a high of 33,000 fish (QNFH Unpublished data, 2005). Although the recent escapements were undoubtedly influenced by the summer chum hatchery program, the fact that enough summer chum spawned naturally in the Big Quilcene to produce these large escapements supports the conclusion that adequate spawning habitat is available in the Big Quilcene, even with the current flow diversion.

4.3.1.2 Effects of Flow Diversion on the Little Quilcene River

Data was not available to conduct a similar detailed analysis for the Little Quilcene River. Given the modeled flows by Orsborn and Orsborn (2002), the percent diversion for the average monthly mean flows for August to October ranges from 29 to 60 percent if diversion is equal to the 9.56 cfs maximum allowed. Under the worst case scenario, given the City's water right (9.56 cfs) and instream flow requirement (6 cfs), the City could reduce instream flows by as much as 61 percent (at flows equaling 15.56 cfs) during the summer chum salmon spawning season.

Under normal operation in the summertime, the reservoir is full and the amount of flow diverted from the Little Quilcene is typically small. In dry years, low natural streamflows fall below the required 6 cfs minimum so the diversion is shut off. Unpublished data from the City of Port Townsend for 1992 through 2004 showed an average diversion from the Little Quilcene in September and October of only 1.1 cfs. A diversion of 1.1 cfs represents 22 and 10 percent of the average monthly mean flows for September and October, respectively. Decreasing instream flow by 10 to 20 percent would be expected to decrease chum salmon spawning habitat by 5 to 10 percent if the relationship between flow and spawnable area for the Big Quilcene and Little Quilcene rivers is similar.

Not all water diverted from the Little Quilcene River during the summer and fall is lost to the anadromous zone. The City likes to keep some water running through the reservoir to keep it fresh and replace water lost through evaporation. Under normal operation when the reservoir is usually full in the summer and fall (Lords Lake level 34.4 feet) and given average instream flows the water diverted to refresh the reservoir is almost entirely returned to the Little Quilcene River as additional water spills over the reservoir outlet to Howe Creek, which drains into the Little Quilcene River well above potential summer chum habitat. The only water lost to the anadromous zone due to this diversion in a typical or wet year is through evaporation. During a low water year, such as in the fall of 2002, diverted water was not returned via Howe Creek because the reservoir dropped below 34.5 feet and eventually dropped to –2.0 feet during the drought, as the City relied on reservoir water from late September to early November. Of note during this period is that no water was diverted from the Little Quilcene River between late September and early November in order to maintain the mandatory instream flow on the Little Quilcene River.

4.3.2 Effects on Water Temperature

The City of Port Townsend collected data on water temperature in 2002 and the Port Gamble S'Klallam Tribe collected water temperature data in 2001 and 2002 using instream data loggers in the Big and Little Quilcene Rivers. Daily maximum water temperatures from these data are presented in Figures 8, 9, 10, and 11 (note: the number in parentheses in the legend of each figure refers to the location of each data logger in river miles).

Figure 8. Big Quilcene River 2001

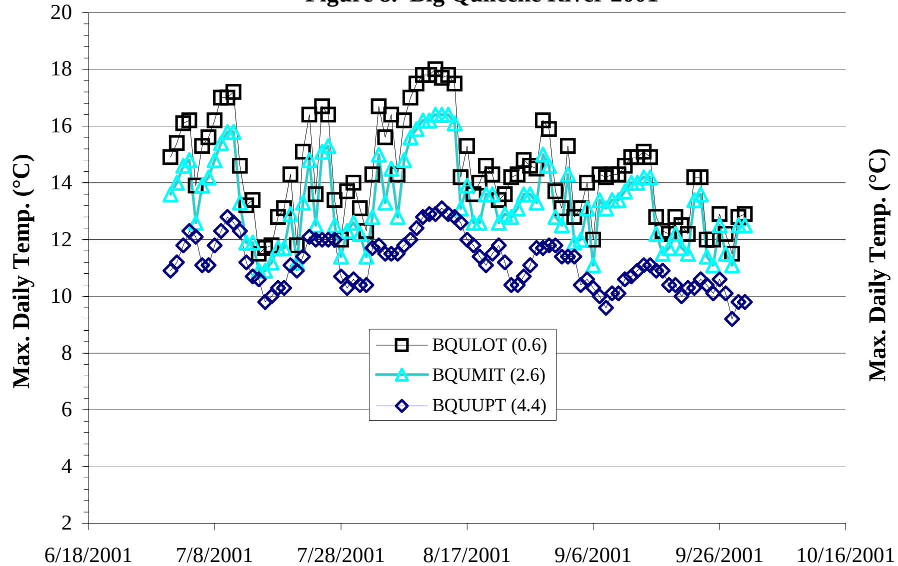


Figure 9. Big Quilcene River 2002

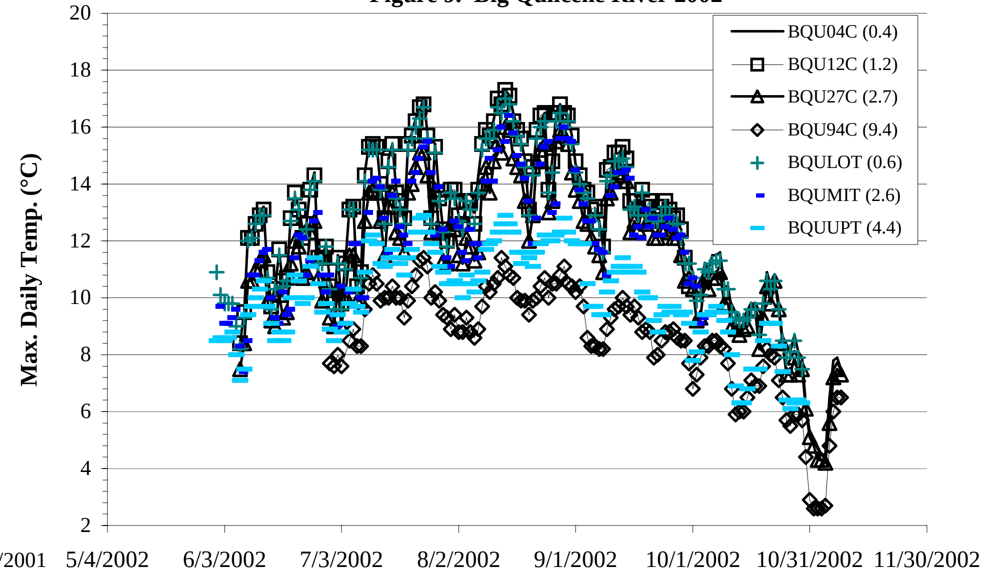


Figure 10. Little Quilcene River 2001

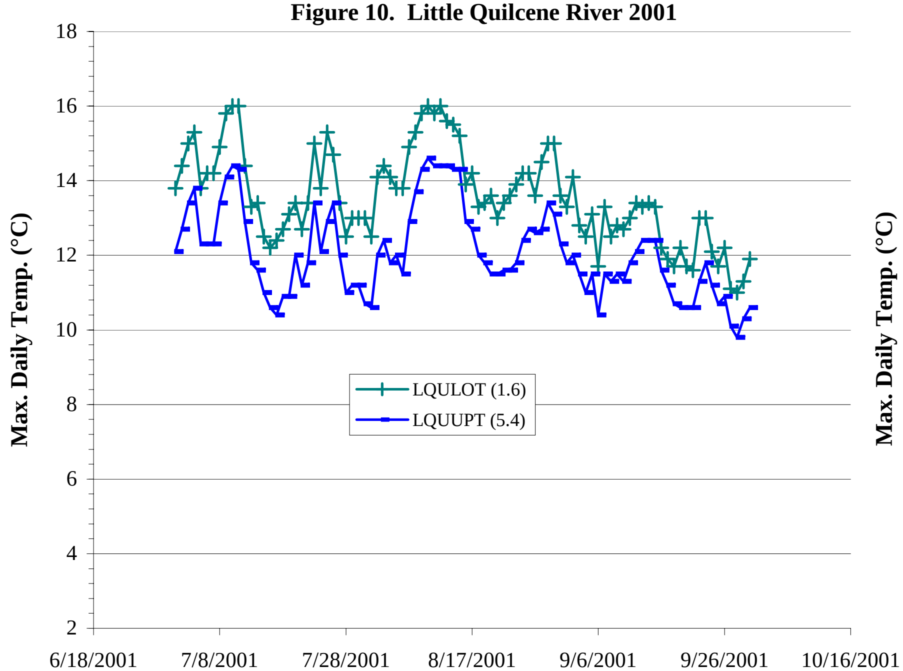
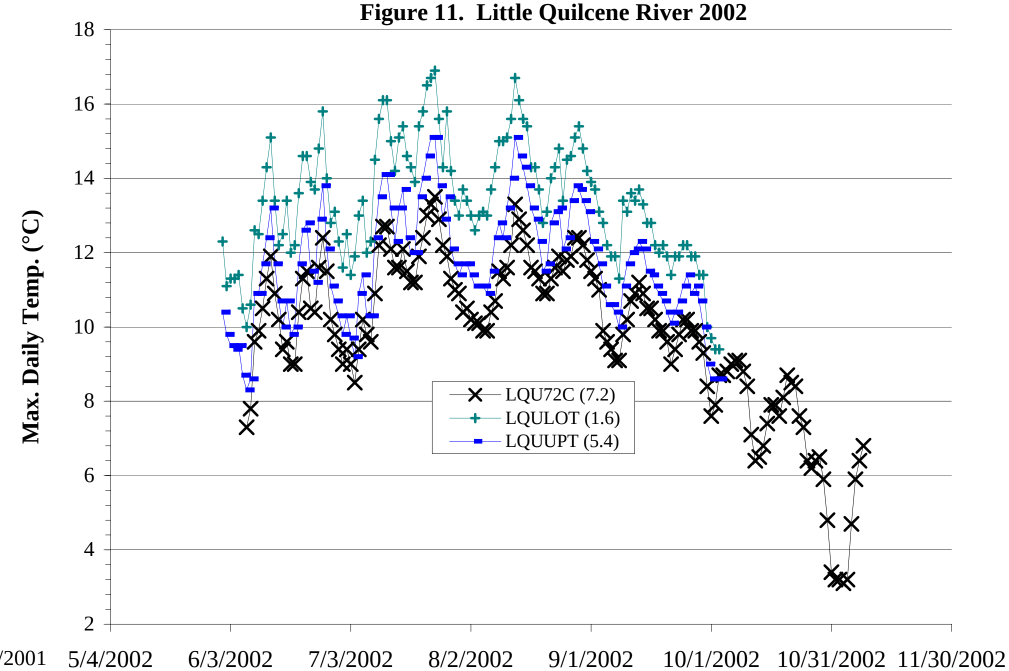


Figure 11. Little Quilcene River 2002



The Big and Little Quilcene Rivers are designated as Class AA surface water of the state (Washington Administrative Code (WAC) 173-201A). The following temperature criteria apply to Class AA surface waters in the state of Washington per WAC 173-201A-030:

> (iv) Temperature shall not exceed 16.0 C due to human activities. When natural conditions exceed 16.0 C, no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 C.

Note, these standards are based on the 7-day maximum average, not individual daily measurements.

Table 8. Number of days temperature exceeded 16ºC at various locations in the Big Quilcene River in 2001 and 2002.

River Mile (data source)	Period of Record	Month / Year	# Days Daily Max. Temp. Exceeded 16ºC	Maximum Temp. Recorded (ºC)
0.4 (Port Townsend)	June 7-Nov. 8	July 2002	3	17.0
		August 2002	12	17.3
0.6 (Port Gamble S'Klallam)	July 1-Sep. 30	July 2001	9	17.2
		August 2001	12	18.0
	June 1-Oct. 29	July 2002	2	16.7
		August 2002	9	17.0
1.2 (Port Townsend)	June 7-Sep. 30	July 2002	3	16.8
		August 2002	12	17.3
2.6 (Port Gamble S'Klallam)	July 1-Sep. 30	August 2001	6	16.4
	June 1-Oct. 3	August 2002	1	16.4
2.7 (Port Townsend)	June 7-Nov. 8	2002	None	16.0
4.4 (Port Gamble S'Klallam)	July 1-Sep. 30	2001	None	13.1
	June 1-Oct. 29	2002	None	12.9
9.4 (Port Townsend)	June 30-Nov. 8	2002	None	11.4

Note: Grey highlight indicates year 2002 and white indicates 2001.

Table 9. Number of days temperature exceeded 16ºC at various locations in the Little Quilcene River in 2001 and 2002.

River Mile (data source)	Period of Record	Month / Year	# Days Daily Max. Temp. Exceeded 16ºC	Maximum Temp. Recorded (ºC)
1.6 (Port Gamble S'Klallam)	July 1-Sep. 30	2001	None	16.0
	June 1-Oct. 3	July 2002	5	16.9
		August 2002	2	16.7
5.4 (Port Gamble S'Klallam)	July 1-Sep. 30	2001	None	14.6
	June 1-Oct. 3	2002	None	15.1
7.2 (Port Townsend)	June 7-Nov. 8	2002	None	13.5

Note: Grey highlight indicates year 2002 and white indicates 2001.

Tables 8 and 9 show that water temperatures on both the Big Quilcene and Little Quilcene Rivers fall within the state temperature standards during all months except July and August. Individual daily maximum temperatures exceeded 16ºC in both 2001 and 2002 during July and August in the lower Big Quilcene River. During the summer of 2002, which was a very low water year, individual daily maximum temperatures exceeded 16ºC 3 days during July and 12 days during August at RM 0.4

(Port Townsend Data). The highest recorded water temperature in the anadromous fish zone of the Big Quilcene River was 18.0ºC in 2001 and 17.3ºC in 2002.

Individual daily maximum temperatures reached 16ºC in the Little Quilcene River during the summer of 2001. Individual daily maximum temperatures exceeded 16ºC on 5 days in July and 2 days in August of 2002. The highest water temperature recorded in the anadromous fish zone of the Little Quilcene River was 16.0 in 2001 and 16.9 in 2002.

Spawning ground entry timing for summer chum in Hood Canal ranges from late August to mid-October. Summer chum primarily spawn from September to October (WDFW and PNPTC 2000). In September and October stream temperatures do not exceed 16ºC. With the exception of occasional days in late August, stream temperatures only exceed 16ºC when summer chum are not in the river.

The state standard of 16ºC is the approximate upper water temperature limit for bull trout. Other salmonids such as summer chum salmon are routinely found at water temperatures above 16ºC during the summer in the Puget Sound region. The upper lethal level for most adult salmonids is above 23ºC (Table 10).

The high end of the preferred water temperate reported in the literature for chum salmon spawning is approximately 12ºC, and egg incubation ranges up to approximately 14ºC. These preferred temperatures are mostly likely for fall chum. Temperature ranges for summer chum would likely be somewhat higher, because they typically spawn during warmer months than fall chum.

During the summer chum salmon spawning season, late August through October, daily maximum water temperatures in the Big Quilcene are generally below 16ºC in late August and drop below 14ºC by late September. In addition, chum salmon, like other salmonids, are generally thought to seek out upwelling zones for spawning that are likely cooler than the general river water temperature.

In August of 2002, the City of Port Townsend conducted a flow test on the Big Quilcene to determine the effect of flow diversion on temperature. They shut off the diversion for 24 hours to see it would affect the water temperature lower down the river. Flows in the Big Quilcene River increased from approximately 35 cfs to 60 cfs, which resulted in about a 1ºC decrease in stream temperature (Pers. Comm. I. Jablonski, City of Port Townsend, 2004).

In December of 2004, the Port Gamble S'Klallam Tribe, Jefferson County Conservation District, and Watershed Sciences, Inc built a stream temperature model for various streams in WRIA 17, including the Big Quilcene River. They evaluated a number of scenarios including reducing streamflows by 10%, reducing streamflows by 30%, increasing streamflows by 10%, and restoring 50% of withdrawal flows. Results from the model yielded an increase of 0.5ºC, increase of 1ºC, decrease of 0.5ºC, and decrease of 1ºC, respectively.

Results from both of the above studies support the conclusion that flow in the Big Quilcene has only a small influence on water temperatures in the lower river. Varying the quantity of the diversion or shutting off the diversion completely would have only a minor effect on stream temperature.

It should be noted that both of the above studies were conducted with a diversion of between 25 and 30 cfs. As Figures 4 shows, the typical diversion from the Big Quilcene during the peak summer chum spawning months of September and October is well below 25 cfs, so actual temperature changes would likely be substantially smaller than those suggested by the studies.

Table 10. Biological temperature (ºC) requirements reported in the literature for fish species.

Species	Adult Migration	Spawning	Egg Incubation	Fry	Parr-smolt	Upper Lethal Level
Chum salmon	10.1[b] 8.3-15.6[a]	7.2-12.2[a]	4.4-14.4[b]	12-14[c]	*****	23.8
Chinook salmon	*****	5.6-13.9[c]	5-14.4[a] 11	12.2-13.8[c]	17[b]	25
Coho salmon	*****	5.4-9.4[a]	*****	10-15[b]	10-15[b]	25.8
Pink salmon	5.6-14.6[c]	7.2-12.8 5-15[a]	4.4-13.3[a]	*****	*****	25.8

[a] Range; [b] Optimal; [c] Preferred; [d] Maximum; ***** (no specific reference);

4.3.3 Effects on Fish Migration

Salmon species migrate up the Big Quilcene and Little Quilcene Rivers in the late summer and fall to spawn. Juvenile salmon migrate downstream to the marine environment primarily in the winter and spring. Project operations have the potential to affect fish migration patterns by altering flow regimes. NMFS has draft internal guidance to assess impacts to fish migration for adult and juvenile salmon (Pers. comm. M. Longenbaugh, NMFS, 2003). Following are analyses of how flows in the Big Quilcene and Little Quilcene Rivers compare to the NMFS draft internal guidance for adult upstream and juvenile downstream migration.

Adult Salmon Upstream Migration

Adequate water depth for adult upstream migration is one factor affecting the proportion of the adult population succeeding in this migration. Migration requirements found in Bjornn and Reiser (1991) suggest that adult Chinook salmon require 24 cm (approximately 9 inches) minimum water depth for migration. This criteria was used by NMFS to evaluate flows in the White River, Puyallup River basin (NMFS 2002a). As a rule of thumb, NMFS has indicated that chum-sized salmon generally need 0.6 foot depth (approximately 7 inches) to surmount shallow riffles during upstream passage from late August through October (Pers. comm. M. Longenbaugh, NMFS, 2003). This rule of thumb is the NMFS draft internal guidance for adult upstream migration.

Cross-section and longitudinal data for critical riffle reaches in the Big Quilcene and Little Quilcene Rivers is not available to make quantitative assessments of how water diversion may influence minimum adult salmon migration flows. However, direct observation of chum and coho salmon in the Big Quilcene River by QNFH personnel has not identified problems with adult salmon migration upstream in relation to flows or water depths (Pers. comm. L. Telles, QNFH, 2002). The QNFH relies on fish to migrate up to the hatchery in order to collect brood stock. Direct observations by QNFH personnel lead to the conclusion that upstream fish migration of chum and coho salmon is not hindered by low flows in the late summer and fall; and therefore, diversion of water likely does not limit adult salmon upstream migration in the Big Quilcene River. Similar agency observations are not available for the Little Quilcene River. However, at this time problems with adult salmon upstream migration are not known to occur in the Little Quilcene River.

Juvenile Salmon Downstream Migration

At an agency meeting on March 3, 2003 regarding the Port Townsend special use permits, NMFS presented their draft internal flow guidance for assessing juvenile downstream migration flows. It is not known how the NMFS juvenile emigration flow guidance actually applies to juvenile emigration in the Big Quilcene and Little Quilcene Rivers. As a general rule of thumb, NMFS suggests that juvenile emigration flows can be met with 80 percent of mean monthly flows and 50 percent for years that are substantially dryer than normal (Pers. comm. M. Longenbaugh, NMFS, 2003).

As discussed previously, emigration of summer chum juveniles occurs during February to April in Hood Canal and peaks in mid-March.

Based on the QMmean and QMmin flows presented in Table 1, where QMmean flows represent mean-monthly flows for an average water year and QMmin flows represent a dry year, Table 11 displays the instream flow with diversion as a percent of undiverted flow during periods of juvenile chum salmon emigration. The results in Table 10 assume that the maximum flow within Port Townsend’s water right is diverted, while maintaining the voluntary 27 cfs flow in the Big Quilcene River and the required 6 cfs flow in the Little Quilcene River. This analysis is conservative and would tend to overestimate diversion affects because the maximum water right is not exercised at all times; as described in the Project Hydrology section, the average daily diversion amount is approximately 23 cfs in the Big Quilcene River and 2 cfs in the Little Quilcene River.

Table 11. Instream flow with diversion presented as percent of natural undiverted flow for estimated average monthly mean (QMmean) and minimum (QMmin) flows. Exceedence under QMmean and QMmin are flows less than 80 and 50 percent, respectively, of undiverted flows.

Big Quilcene River			Little Quilcene River	
Maximum Diversion: 30 cfs Maintained 27 cfs min. instream flow			Maximum Diversion (QAA): 9.56 cfs Maintained 6 cfs min. instream flow	
Month	QMmean	QMmin	QMmean	QMmin
Feb	87.7	53.1	83.8	40.0
Mar	84.0	55.2	78.8	40.3
Apr	84.3	70.9	79.2	61.8

Note: Grey highlight indicates flows less than the NMFS internal flow guidance.

Based on this analysis, flows in the Big Quilcene River would meet the NMFS juvenile emigration flow criteria for all juvenile summer chum salmon emigration months during both average water year and low water years.

Flows in the Little Quilcene River would nearly meet the NMFS juvenile emigration criteria during an average water year. Flows in the Little Quilcene River would not meet the NMFS juvenile emigration flow criteria in low water years during the peak emigration of summer chum.

4.3.4 Dam Safety

Dam safety is of increased concern in the United States. Catastrophic failure of the Lords Lake dams could have severe impacts downstream in the Little Quilcene River and could adversely affect salmon habitat. Washington State Department of Ecology Dam Safety Section (DSS) inspected the dams at Lords Lake in 1996 and completed an inspection report and seismic analysis (WDOE 1999). The north dam was determined by DSS to be seismically stable. However, the east dam was determined to be susceptible to liquefaction induced settlement and cracking. However, DSS determined that the liquefaction is insufficient to cause a massive slide capable of allowing the uncontrolled release of reservoir water. Therefore, the likelihood of a Lords Lake dam failure would be negligible.

4.4 Cumulative Effects

Factors, other than the proposed action, that are currently affecting the action area environment and salmonid species abundance include the Quilcene National Fish Hatchery, commercial and recreational harvest, urbanization, and forest practices. The Forest Service also is in the process of completing some restoration and road stabilization work in this area.

The QNFH located on the Big Quilcene River at approximately RM 2.8 raises fall chum salmon and coho salmon, which are outplanted in the Big and Little Quilcene Rivers. Until 2003 QNFH also had a large summer chum supplementation program. The hatchery limits natural production for anadromous fish in the Big Quilcene River to areas below the electric weir at RM 2.8; however, historic distribution extended to at least RM 7.4. The QNFH has out-planted juvenile salmon above the hatchery barrier and has passed a limited number of coho adults above the barrier sporadically in the past. Good coho salmon juvenile rearing habitat is present upstream of the hatchery in the mainstem Big Quilcene River and Penny Creek and some spawning habitat is present upstream of the hatchery. Natural spawning habitat and juvenile rearing habitat has been limited to an extent by hatchery practices; however, the highest quality spawning habitat is located downstream of the hatchery.

Releases from the QNFH of hatchery origin coho and chum salmon may have negative density dependant effects on naturally spawning and rearing chum salmon through competition for space, food, and spawning habitat. Although density dependent effects caused by hatchery programs in the Hood Canal region were discussed in NMFS (2002b) with respect to hatchery program effects on summer chum salmon, a detailed treatment of effects in the Big Quilcene River was not included, only broad statements about the region as a whole were made. Based on the limited spawning and rearing habitat available in the Big Quilcene River, there is potential that hatchery releases could lead to negative density dependant effects on all aquatic species present.

The QNFH summer chum supplementation program was terminated in 2003. For the past decade, the hatchery program has helped to increase the numbers of summer chum in the Big Quilcene and to compensate for any potential losses in summer chum production due to poor instream habitat, reductions in streamflow during the spawning period, and winter floods. Now that the summer chum salmon stocking program has terminated, long-term population maintenance for the Big and Little Quilcene Rivers will be dependent on the quality and quantity of spawning habitat within these two river systems. The QNFH summer chum salmon hatchery production will no longer be available to buffer any negative effects caused by instream habitat degradation or natural weather fluctuations.

There is potential that the QNFH operations could impact water quality in the lower Big Quilcene River due to their water diversion and operations; however, these effects are unknown. Potential for water quality impacts were dismissed in NMFS (2002b) because the QNFH operates under an NPDES discharge permit (permit number WA-187-2). Therefore, NMFS assumed no impact to water quality and water temperature would be caused by QNFH operations and water diversions. However, the QNFH can withdraw up to 65 cfs total from the Big Quilcene River and Penny Creek, which is more than twice the City’s water right of 30 cfs. No information is available to assess potential water quality impacts that may be caused by the QNFH; however, due to their relatively large water right they have the potential to influence a substantial portion of water reaching the lower Big Quilcene River even though this water is returned after flowing through the hatchery system.

A recreational fishery exists for coho salmon in the Big Quilcene River during the summer chum salmon spawning period. This fishery results in incidental harvest (unintentional and intentional poaching) of summer chum salmon and likely causes damage of their redds by anglers targeting coho salmon. In addition, MWH personnel observed anglers retaining chum salmon in August (2002) on the Big Quilcene River. QNFH personnel have noted high angler pressure on the Big Quilcene River during the chum and coho salmon spawning season, and have observed many anglers exceeding the coho salmon bag limit and the poaching of summer chum salmon (Pers. comm. L. Telles, QNFH, 2002). Commercial fisheries in Hood Canal and Puget Sound targeting coho salmon have some level of incidental catch and mortality on summer chum salmon, although in recent years management practices have reduced the incidental summer chum salmon catch in the Quilcene Bay fishery (Parametrix et al. 2000).

Habitat in the lower Big Quilcene River has been greatly affected by channelization, increased sediment transport from the upper watershed and loss of large wood recruitment and retention. Diking activities have constrained the channel to a narrow corridor, resulting in the aggradation of the stream channel bed. Dredging and the maintenance of gravel traps have been used to control the amount of aggradation in the lower reaches of the river and assist with flood control efforts. These activities have been concentrated below RM 2.8 of the Big Quilcene River. Extensive diking and bank armoring has also occurred in the lower Little Quilcene River. The poor condition of habitat in the lower rivers may exacerbate the impact of reduced summer low flows caused by water diversion during the summer chum salmon spawning season.

Over the past several years, Jefferson County, Jefferson Conservation District, the Skokomish Tribe, private landowners, and the Hood Canal Salmon Enhancement Group have initiated several restoration projects in the lower Big Quilcene River and estuary aimed at improving spawning habitat for summer chum. Projects have ranged from installing instream large wood structures to riparian revegetation, acquiring key land parcels, and pulling back dikes.

5.0 CONSERVATION MEASURES

The following conservation measure will be implemented as part of the proposed action:

1. The City of Port Townsend will maintain a minimum instream flow in the Big Quilcene River of 27 cfs below the diversion dam at RM 9.4, when the natural flow above the diversion exceeds 27 cfs. The instream flow will be measured at the USGS staff gage installed immediately below the diversion dam. It is recognized that streamflows may drop below 27 cfs occasionally due to unintentional measurement error or rapid fluctuations in streamflows. Instances where streamflows might drop below 27 cfs due to diversion would have a magnitude of 2 cfs or less, and a duration of less than 24 hours.

   Note: Operators will measure streamflow utilizing the most current USGS supplied rating table. Published USGS streamflow data may differ from the daily recordings due to the averaging of multiple measurements, differences between the staff gage reading and pressure data recording, and adjustments to the rating table that reflect changes in the stream channel profile.

6.0 ESA EFFECTS DETERMINATION

The primary adverse effect of the proposed reissuance of the three special use permits would be the indirect effect of continued water withdrawals from the Big and Little Quilcene Rivers.

Although, water diversion from the Big and Little Quilcene Rivers has occurred at similar or greater levels compared to current withdrawals for several decades, an indirect effect of the reissual of the Special Use Permits is that water diversions will continue to maintain the “not properly functioning” status of the “peak/base flow” indicator. The City’s water diversion is likely the main historic factor that has reduced base flows in the lower Big and Little Quilcene Rivers, as water diversions can amount to over half of the instream flow during the late summer for both rivers. Therefore, the reissual of the three Special Use Permits will continue the indirect impairment of the hydrologic regime for both rivers over pre-diversion conditions by allowing the continued use of facilities designed for the use of diverting water from the Big and Little Quilcene Rivers.

Because water diversions associated with the reissuance of the three Special Use Permits have the potential to reduce streamflows and available spawning habitat in the Big and Little Quilcene Rivers substantially during the summer chum spawning period, the proposed action is “may affect, likely to adversely affect” Hood Canal summer chum salmon. The proposed action “will not adversely modify” proposed critical habitat for Hood Canal summer chum salmon.

Big and Little Quilcene River stocks are not included as part of the Puget Sound Chinook ESU. The proposed project will have “no effect” on Puget Sound Chinook salmon or on proposed critical habitat for Puget Sound Chinook.

7.0 ESSENTIAL FISH HABITAT EFFECTS DETERMINATION

Freshwater MSA Essential Fish Habitat for Chinook, coho, and pink salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except those areas upstream of certain impassable man-made barriers (as identified by the PFMC), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). The reaches downstream of the natural fish passage barriers at RM 6.6 (Little Quilcene) and RM 7.4 (Big Quilcene) that may have historically been accessible to Chinook, pink, and coho salmon are designated as freshwater Essential Fish Habitat for these species.

The reduction of streamflow in the lower Big and Little Quilcene Rivers in the summer and fall is an indirect effect of the proposed action. The reductions in streamflow could potentially limit the quantity and quality of available spawning and/or rearing habitat. Therefore, the proposed action is “likely to adversely affect” freshwater EFH. The impact to Chinook and pink salmon is expected to be insignificant because self-sustaining populations of Chinook or pink salmon do not exist in either the Big or Little Quilcene River.

The potential adverse impact to coho salmon due to flow diversion may be substantial. Diversions from the Big Quilcene could reduce natural flows by up to 50 percent in August and early September. This can be assumed to equate to similar reductions in available rearing habitat in the lower 2.7 miles of the Big Quilcene for juvenile coho during these periods. Juvenile coho populations in this reach of stream are heavily dominated by hatchery releases from the QNFH immediately upstream.

8.0 REFERENCES

Anvil Corporation. 1989. Deviation of the Weir Formula for Big Quilcene River Diversion Dam. Prepared for the Port Townsend Paper Company. Port Townsend, Washington.

Bakkala, R.G. 1970. Synopsis of Biological Data on the Chum Salmon, *Oncorhynchus keta* Walbaum 1792. FAO Species Synopsis No. 41, U.S. Fish and Wildlife Service Circular 315.

Bax, N.J. 1983. The Early Migration of Juvenile Chum Salmon *(Oncorhynchus keta)* through Hood Canal – its Variability and Consequences. Ph.D. dissertation, University of Washington. Seattle, Washington.

Beecher, H. 2000. Memo to Quilcene River water management group, subject: sensitivity of summer chum salmon spawning habitat to flow change in the Quilcene River, October 14, 2000.

Bell, M.C. 1973. Fisheries handbook of engineering requirements and biological criteria. Fisheries Engineering Research Program, U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Brett, M.C. 1952. Temperature tolerance in young Pacific salmon, genus *Oncorhynchus*. J. Fish. Res. Board Can. 9(2):265-323.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19:83-138.

CH2M Hill. 1998. City of Port Townsend 1998 Water System Plan. Prepared for the City of Port Townsend. Port Townsend, Washington.

CFR. 1999. Endangered and Threatened Species: Threatened Status for Three Chinook Salmon Evolutionarily Significant Units in Washington and Oregon. National Oceanic and Atmospheric Administration Fisheries. Federal Register. March 24, 1999.

Collings, M.R. 1974. A methodology for determining instream flow requirements for fish. Pages 72-86 in Proceedings, Instream flow methodology workshop. Washington State Water Program, Olympia, Washington.

Davis, S.K. 1981. Determination of body composition, condition, and migration timing of juvenile chum and Chinook salmon in lower Skagit River, Washington. M.S. Thesis. University of Washington, Seattle.

Hale, S.S. 1981. Freshwater habitat relationships for chum salmon (*Oncorhynchus keta*). Alaska Department of Fish and Game, Anchorage. Contract Rep. No. 14-16-0009-79-119.

Hargreaves, N.B., and R.J. LeBrassseur. 1985. Species selective predation on juvenile pink (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*) by coho salmon (*O. kisutch*). Can. J. Fish. Aquat. Sci. 42(4):659-668.

Harza Engineering Company. 2000. Big Quilcene River streambank stabilization project biological evaluation. Prepared for USFWS Quilcene National Fish Hatchery, Quilcene, Washington.

Healey, M. C. 1991 . Life history of Chinook salmon (Oncorhynchus tshawytscha). Pages 311-393 in C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press. Vancouver, B. C.

Horrall, R. M. 1981. Behavioral stock-isolating mechanisms in Great Lakes fishes with special reference to homing and site imprinting. Can. J. Fish. Aquat. Sci. 38:1481-1496.

Hosey and Associates Engineering Company. 1985. The instream flow and aquatic mitigation proposal for the Big Quilcene Hydroelectric Project. Prepared for Jefferson County PUD No. 1. FERC Project No. 5202-00.

Johnson, O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997. Status Review of chum salmon from Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memo NMFS-NWFSC-32. U.S. Department of Commerce, National Marine Fisheries Service, Northwest Science Center. Seattle, Washington.

Koski, K.V. 1975. The Survival and Fitness of Two Stocks of Chum Salmon *(Oncorhynchus keta)* from Egg Deposition to Emergence in a Controlled Stream Environment at Big Beef Creek. Ph.D. Thesis. University of Washington. Seattle, Washington.

Kraemer, C. 1996. Grandy Creek Biological Assessment (Draft). Washington Department of Fish and Wildlife, Mill Creek, Washington.

Lampsakis, N. 1994. Entry Pattern Information for Puget Sound Management Periods document. Memorandum to Tim Tynan, Washington Department of Fish and Wildlife and Keith Lutz, Northwest Indian Fisheries commission. Point No Point Treaty Council. Kingston, Washington.

Lee, D. C. et. al. 1996. Broadscale assessment of aquatic species and habitats. in T. M. Quigley and S. J Arbelbide, editors. An assessment of ecosystem components in the interior Columbia Basin and portions of the Klamath and Great Basins. Gen. Tech. Rpt. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

Levy, D.A., and T.G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Frazer River estuary. Can. J. Fish. Aquat. Sci. 39(2):270-276.

Lichatowich, J. 1993. The Status of Anadromous Fish Stocks in the Streams of Eastern Jefferson County. report prepared for the Dungeness-Quilcene Pilot Project, Jamestown S'Klallam Tribe, Sequim, WA.

Lucas, K.C. 1959. The Robertson Creek spawning channel. Can. Fish. Cult. 25:4-23.

Myers and 10 co-authors. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-35.

Neave, F. 1963. Life history of the pink salmon of British Columbia. Int. N. Pac. Fish. Comm. Doc. 665.

Nehlsen, W., J.E. Williams, and J.A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21.

NMFS. 1995. Endangered and threatened species; West Coast pink salmon petition determination. October 1995 50 CFR Part 227.

NMFS. 1996. Making endangered species act determinations of effect for individual or grouped actions at the watershed scale. Environmental and Technical Services Division, Habitat Conservation Branch.

NMFS. 2001. Guidance for integrating Magnuson-Stevens Fishery Conservation and Management Act EFH Consultations with Endangered Species Act Section 7 Consultations. United States Department of Commerce, National Oceanic and Atmospheric Administration, NMFS, Silver Spring, Maryland.

NMFS. 2002a. Endangered Species Act Section 7 Consultation, Preliminary Draft Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation, White River Hydroelectric Project, FERC Project Number 2494-002. NMFS Log Number F/NWR/1999/01862. October 8, 2002.

NMFS. 2002b. Endangered Species Act Section 7 Consultation and Magnuson-Stevens Act Essential Fish Habitat Consultiaton, Biological Opinion on Artificial Propocation in the Hood Canal and Eastern Strait of Juan De Fuca Regions of Washington State, Hood Canal Summer Chum Salmon Hatchery Programs by the USFWS and the WDFW and Federal and Non-Federal Hatchery Programs Producing Unlisted Salmonid Species. March 4, 2002.

Olympic National Forest, Olympic National Park, and U.S. Fish and Wildlife Service. 1996. Programmatic Biological Assessment for Forest Management and Federally funded Watershed Restoration on Non-Federal Lands on the Olympic Province. April 18, 1996.

Orrell, R. 1976. Skagit Chinook race differentiation study. NMFS Proj. Rep. 1-98-R.

Orsborn, J.F. and M.T. Orsborn. 2002. Summary Notes on the Streamflow Characteristics of the Big and Little Quilcene Rivers. Prepared for Montgomery Watson Harza and the City of Port Townsend. April, 2002.

Parametrix, Inc., Pacific Groundwater Group, Inc., Montgomery Water Group, Inc., and Caldwell and Associates. 2000. Stage 1 technical assessment water resource inventory area 17. Prepared for Water Resource Inventory Area 17 Planning Unit. Washington Department of Ecology Project No. 553-1820-007.

Parker, R.R. 1971. Size selective predation among juvenile salmonid fishes in a British Columbia inlet. J. Fish. Res. Board Can. 28(10):1503-1510.

Pers. comm., M. Hodgkins, USFWS, conference call regarding the reissual of the Port Townsend Special Use Permits, 12/12/02.

Pers. comm. P. J. Howell, United States Forest Service, Pacific Northwest Research Station, La Grande, Oregon (2000).

Pers. comm. M. Longenbaugh, NMFS, Lacey, Washington (2003).

Pers. comm. C. Kraemer, WDFW Fisheries District Manager, Mill Creek, Washington (2001).

Pers. comm.. I. Jablonski, City of Port Townsend, Washington (2002).

Pers. comm. S. Spalding, USFWS, Lacey, Washington (2002).

Pers. comm. L. Telles, USFWS QNFH, Quilcene, Washington (2002).

Pers. comm. L. Telles, USFWS QNFH, Quilcene, Washington (2003).

Port Townsend Paper Company. 2002. Operations and Maintenance Manual for the Olympic Gravity Water Supply System.

Quilcene National Fish Hatchery (USFWS), unpublished data 1912 to 2002. Quilcene, Washington.

Reimers, P.E. 1968. Social behavior among juvenile fall Chinook salmon. J. Fish. Res. Board. Can. 25(9):2005-2008.

Reiser, D.W., and T.J. Bjornn. 1979. Habitat requirements of anadromous salmonids. Pages 1-54 in W.R. Meechan, ed. Influence of forest and rangeland management on anadromous fish habitat in the western United States and Canada. USDA Forest Service, Portland, OR. Gen. Tech Rep. PNW-96.

Roppel, P. 1982. Alaska s salmon hatcheries 1891-1959. Alaska Hist. Comm. Stud. Hist. No. 20.

Rounsefell, G. A. 1938. Pink salmon. In Rounsefell, G. A., and G. B. Kelez, The salmon and salmon fisheries of Swiftsure Bank, Puget Sound, and the Fraser River, p. 804-813. U.S. Bur. Fish. Bull. 27.

Salo, E.O. 1991. Life History of Chum Salmon, *Oncorhynchus keta*. In: Groot, C., and L. Margolis (editors), Pacific Salmon Life Histories. University of British Columbia Press. Vancouver, B.C.

Sandercock, F. K. 1991. Life history of Coho. Pages 396-445 in C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press, University of British Columbia, Vancouver.

Schroder, S.L. 1977. Assessment of Production of Chum Salmon Fry from the Big Beef Creek Spawning Channel. Fisheries Research Institute Final Report No. FRI-UW-7718. University of Washington. Seattle, Washington.

Schreiner, J.V. 1977. Salmonid Outmigration Studies in Hood Canal, Washington. M.Sc. Thesis. University of Washington. Seattle, Washington.

Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Bulletin 184, Fisheries Research Board of Canada. Ottawa.

Shepard, M.F. 1981. Status and review of the knowledge pertaining to the estuarine habitat requirements and life history of chum and Chinook salmon juveniles in Puget Sound. Final Rep. Wash. Coop. Fish. Res. Unit, University of Washington. Seattle, Washington.

Simenstad, C.A., W.J. Kinney, S.S. Parker, E.O. Salo, J.R. Cordell, and H. Buechner. 1980. Prey Community Structure and Trophic Ecology of Outmigrating Juvenile Chum and Pink Salmon in Hood Canal, Washington: A Synthesis of Three Years' Studies, 1977-1979. UW Fisheries Research Institute Report. FRI-UW-8026. University of Washington. Seattle, Washington.

Seymour, A.H. 1956. Effects of temperature upon young Chinook salmon. Ph.D. Dissertation. University of Washington. Seattle, Washington.

Tynan, T.J. 1992. Hood Canal early chum Harvest and Escapement Assessment: A review of Hood Canal early chum escapements and inside Hood Canal commercial net fishery harvests (1968-91) with recommendations for short and long term management measures to assist stock rebuilding. Washington Department of Fish and Wildlife. Olympia, Washington.

Tynan, T.J. 1997. Life History Characterization of Summer Chum Salmon Populations in the Hood Canal and Eastern Strait of Juan de Fuca Regions. Technical Report No. H 97-06. Hatcheries Program, Washington Department of Fish and Wildlife. Olympia, Washington.

U.S. Department of the Interior (USDI), Bureau of Land Management. 1996. Management of anadromous fish habitat on public lands. Report No. BLM-ID-PT.

USFWS. 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) – Chinook salmon. USFWS, Division of Biological Services, FWS/OBS-82/11.6. U.S. Army Corps of Engineers, TR EL-82-4.

USFWSb. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) – coho salmon. USFWS Biol. Rep. 82(11.48) U.S. Army Corps of Engineers, TR EL-82-4.

USFWS. 1988. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) – chum salmon. USFWS Biol. Rep. 82(11.81) U.S. Army Corps of Engineers, TR EL-82-4.

USFWS. 1997a. Documents submitted to the ESA Administrative Record for west coast Chinook salmon by D. Finberg, 26 February 1997. Available from Environmental and Technical Services Division, National Marine Fisheries Service, 525 N.E. Oregon St., Suite 500, Portland, Oregon.

USDA Forest Service (USFS). 1992. Big Quilcene stream survey report. Quilcene Ranger District, Quilcene, Washington.

USDA Forest Service. 1994a. Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. USDA Forest Service, USDI Bureau of Land Management, and Fish and Wildlife Service. February 1994.

USDA Forest Service. 1994b. Big Quilcene Watershed Analysis, an Ecological Report at the Watershed Level. U.S. Department of Agriculture, Forest Service. Olympic National Forest. Olympia, Washington.

USDA Forest Service. 2003. Programmatic Biological Assessment for Selected Forest Management Activities, Olympic National Forest 2003-2008.

WDF (formerly Washington Department of Fisheries and Game - Fisheries Division). 1916-64. Annual reports. Wash. Dep. Fish., Olympia, Washington.

WDFW, Wildlife Management, Fish Management, and Habitat Management Divisions. 1991. Management recommendations for Washington's priority habitats and species. Washington Department of Wildlife, Olympia, Washington.

WDF, WDW, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington state Salmon and Steelhead Stock Inventory. Washington Department of Fish and Wildlife. Olympia, Washington.

WDF, WDW, and Western Washington Treaty Indian Tribes. 1994. 1992 Washington state Salmon and Steelhead Stock Inventory (SASSI). Appendix One, Puget Sound Stocks. Hood Canal and Strait of Juan de Fuca volume. Internal Report to Washington Department of Fish and Wildlife.

WDFW. 1998. Salmonid stock inventory, appendix: bull trout and Dolly Varden. Washington Department of Fish and Wildlife, Olympia, Washington.

WDFW and PNPTC. 2000. Summer Chum Salmon Conservation Initiative: An Implementation Plan to Recover Summer Chum in the Hood Canal and Strait of Juan de Fuca Region. Prepared by the Washington Department of Fish and Wildlife and the Point-No-Point Treaty Council. April 2000.

WDFW and PNPTC. 2003. Summer Chum Salmon Conservation Initiative: An Implementation Plan to Recover Summer Chum in the Hood Canal and Strait of Juan de Fuca Region. Supplemental Report No. 5 Interim Summer Chum Recovery Goals. Prepared by the Washington Department of Fish and Wildlife and the Point-No-Point Treaty Council. October 2003.

WDFW. 2002a. Pre-Season Salmon Forecast. www.wa.gov/wdfw/fish/northfalcon/Chinook.htm).

WDFW. 2002b. Priority Habitats and Species database information, total Big and Little Quilcene Watershed coverage, reported dated October 25, 2002.

WDNR. 2000. Forest Practices Rules and Board Manual. Washington Department of Natural Resources Forest Practices Board. Olympia, Washington.

WDOE. 1999. Dam Safety Section, Open File Technical Report, Lords Lake North and East Dams, Second Periodic Inspection Report. OFTR 99-01, dated February 1999.

Weitkamp, L. A. et al. 1995. Status review of coho from Washington, Oregon, and California. U.S. Department of Commerce. NOAA Technical Memo NMFS-NWFSC-24.

Wissmar, R.C. and C.A. Simenstad. 1980. Optimal Management of Chum Salmon based on Estuarine and Nearshore Carrying Capacity for Outmigrating Juveniles in Hood Canal. NSF Research Grant Proposal. UW Fisheries Research Institute. University of Washington. Seattle, Washington.

Wydoski, R. S. and R. R. Whitney. 1979. Inland fishes of Washington. University of Washington Press. Seattle, Washington.