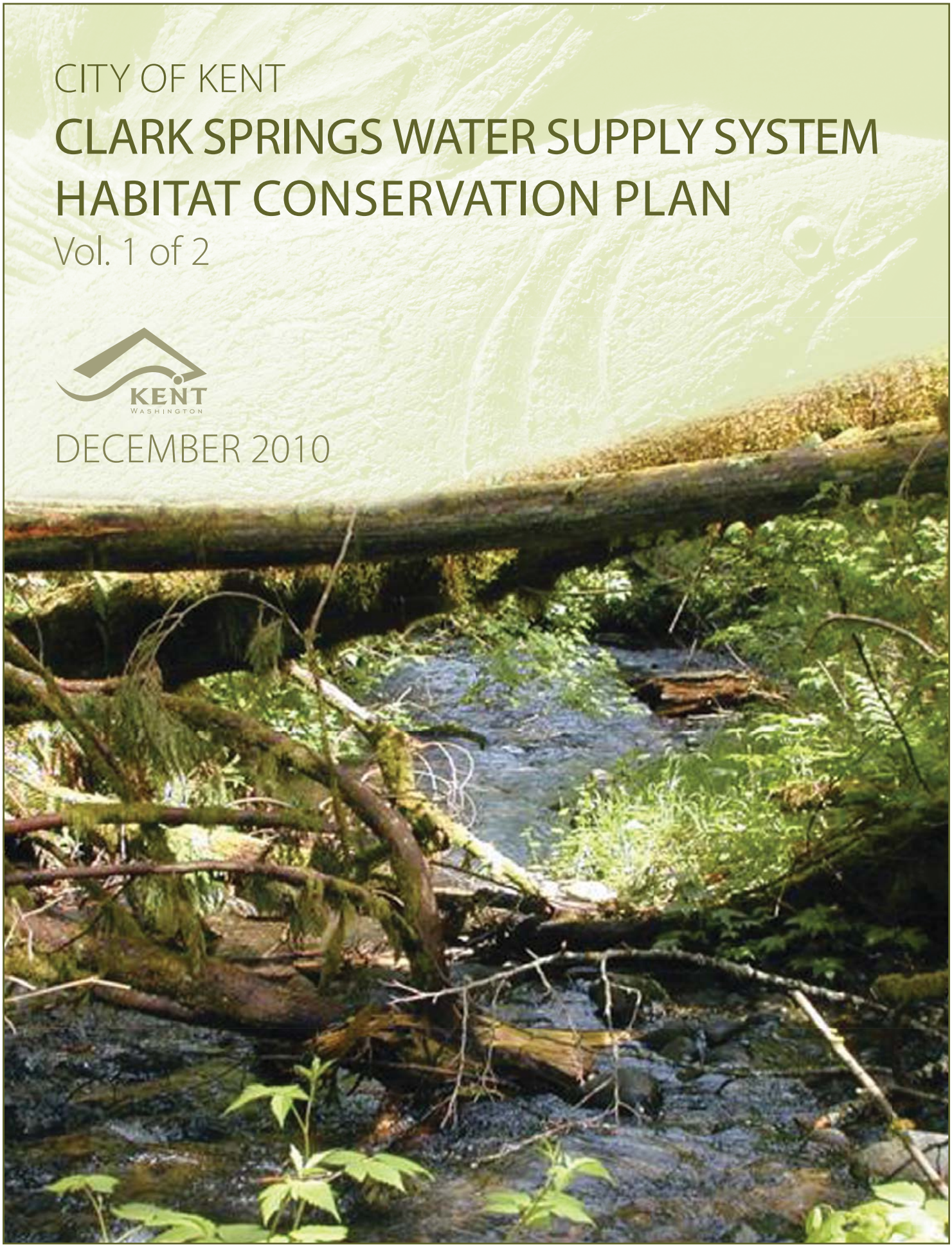
CITY OF KENT

# CLARK SPRINGS WATER SUPPLY SYSTEM HABITAT CONSERVATION PLAN

Vol. 1 of 2

KENT
WASHINGTON

DECEMBER 2010



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# Clark Springs Water Supply System
# Habitat Conservation Plan

## For the Issuance of a Permit to Allow
## Incidental Take of Threatened and Endangered Species

## City of Kent

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December 2010

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# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| 7-DADMax | 7-day average daily maximum temperature |
| BO | Biological Opinion |
| CWA | Cascade Water Alliance |
| CWA | Clean Water Act |
| DO | Dissolved Oxygen |
| DOC | Department of Commerce |
| DOI | Department of Interior |
| EDT | Ecosystem Diagnosis and Treatment |
| EIS | Environmental Impact Statement |
| EPA | Environmental Protection Agency |
| ESA | Endangered Species Act |
| ESU | Evolutionarily Significant Unit |
| GIS | Geographic Information Systems |
| HCM | Habitat Conservation Measure |
| HCP | Habitat Conservation Plan |
| HPA | Hydraulic Project Approvals |
| HSC | Habitat Suitability Curves |
| HSI | Habitat Suitability Index |
| HSPF | Hydrological Simulation Program Fortran |
| ITP | Incidental Take Permit |
| LWD | Large Woody Debris |
| MEM | Monitoring and Evaluation Measures |
| mgd | million gallons per day |
| msl | mean sea level |
| NEPA | National Environmental Policy Act |
| NMFS | National Marine Fisheries Service |
| NTU | Nephelometric Turbidity Units |
| PHLOAT | PHABSIM/HSPF Linked Operations Analysis Tool |

| | |
|---|---|
| PHABSIM | Physical Habitat Simulation System |
| RM | River Mile |
| SEPA | State Environmental Policy Act |
| SSP | Second Supply Project |
| TMDL | Total Maximum Daily Load |
| USACE | U.S. Army Corps of Engineers |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| WDF | Washington Department of Fisheries |
| WDFW | Washington Department of Fish and Wildlife |
| Ecology | Washington State Department of Ecology |
| WHPP | Wellhead Protection Program |
| WRIA | Water Resource Inventory Area |
| WSE | Water Surface Elevation |
| WSP | Water Surface Profile |
| WUA | Weighted Usable Area |

# 1. INTRODUCTION

## 1.1 Background

The City of Kent, a municipality with over 80,000 residents located in South King County, Washington, owns and operates its own water supply system. The City of Kent water supply system is comprised of both ground and surface water rights, and provides water to meet domestic, commercial, irrigation, manufacturing, residential, fire and life safety requirements of its residents and businesses. The City's Clark Springs Water Supply System (Clark Springs System) serves as its largest and primary water source that provides up to 60 percent of the City's total water supply.

The Clark Springs System is located in the Rock Creek basin at river mile (RM) 1.94 and is comprised of three wells and a spring-fed infiltration gallery. Rock Creek is located in eastern King County, east of the City of Maple Valley, and is a tributary to the Cedar River (Figure 1-1). The perennial headwaters for Rock Creek begin at RM 2.8 (262nd Avenue SE), located 0.2 miles to the east of the Clark Springs Watershed. The Clark Springs property was annexed to the City in 1958 for municipal water supply purposes and is bisected by Kent Kangley Road. The Clark Springs watershed is 320-acres that is geographically separate from the City proper. The balance of the area falling outside of the City's annexed property is bounded and regulated by the City of Maple Valley on the west, and unincorporated King County to the north, south, and east. Consequently, the City does not have the ability to regulate land use activities within the Rock Creek basin, except within the 320-acre Clark Springs Watershed.

The Clark Springs System extracts water from the shallow unconfined aquifer at Clark Springs throughout the year and is comprised of three separate, but conjunctively managed primary sources and/or water rights: Clark Springs Infiltration Gallery, Rock Creek Surface Water Diversion, and Clark Springs Wells. Each of these sources draw upon the same shallow aquifer and at times are in hydraulic continuity with each other. The primary means of supply occurs through an infiltration gallery (Figure 1-2) that was constructed in 1957 and withdraws groundwater from a depth of about 18 feet below the ground surface, in

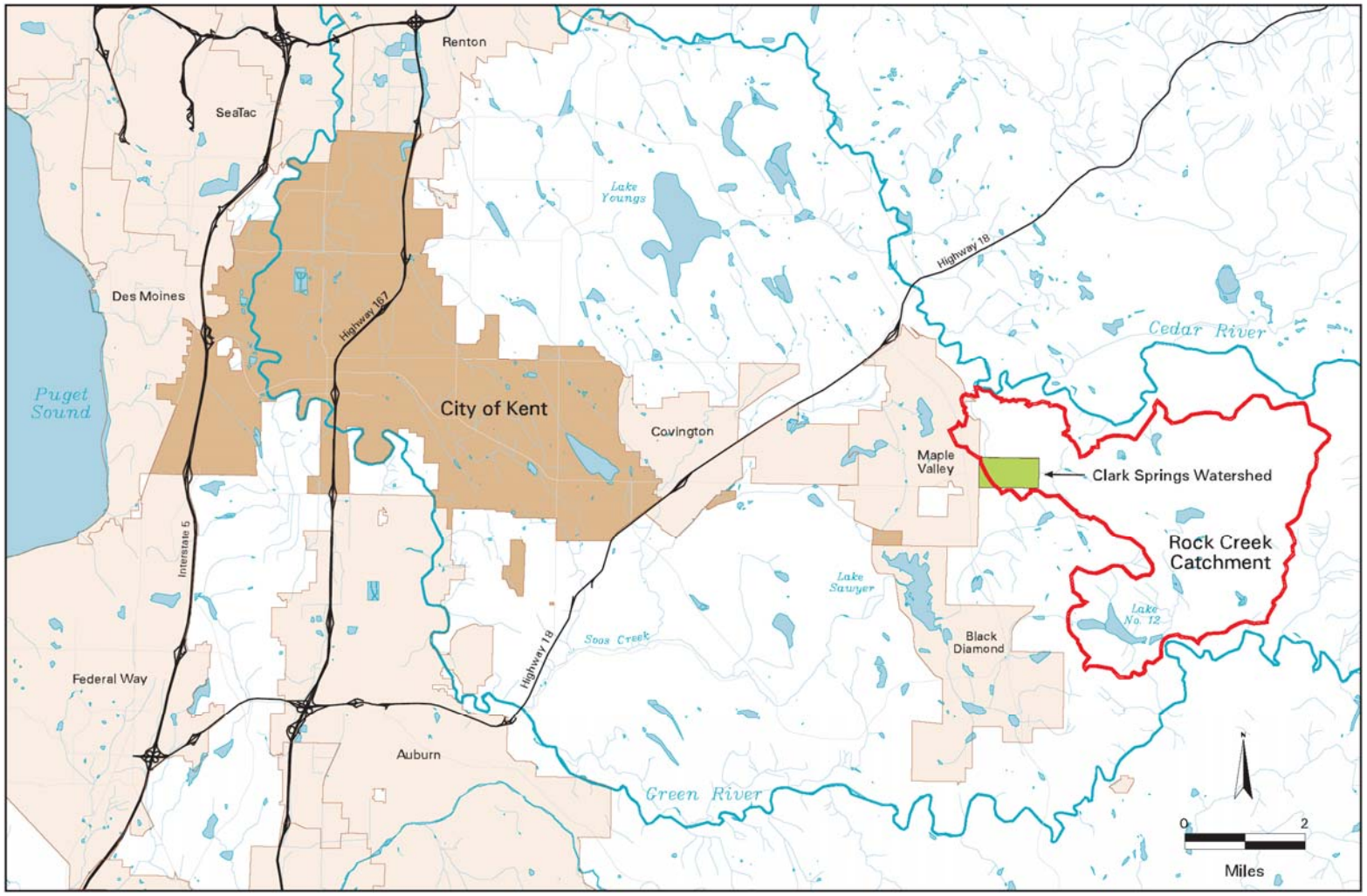


Figure 1-1. Vicinity map of the Rock Creek Basin relative to the City of Kent.

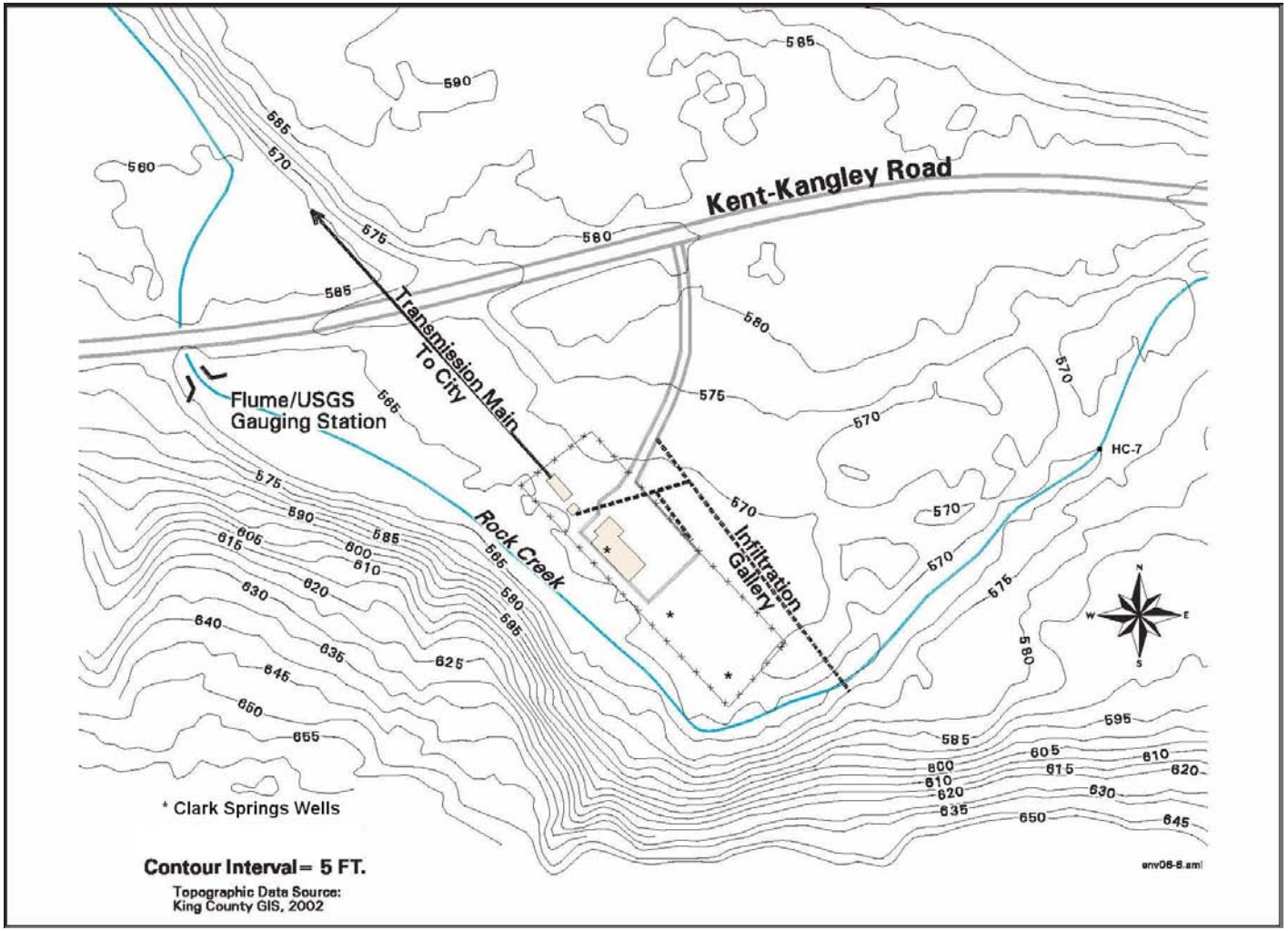


Figure 1-2. Site map of the Clark Springs Water Supply facility.

an area where the flow historically branched around a small island. The main channel of Rock Creek was diverted into a single channel that flows across the south end of the infiltration gallery. The infiltration gallery discharges by gravity into a clear well and then to the City's 24-inch transmission pipeline, which follows SR 516 (Kent-Kangley Road) to a 6 million gallon reservoir in the City. Three water supply wells were added to the Clark Springs System in 1968 and are used as needed to meet demands. Daily withdrawal measurements recorded by the City between October 1985 and September 1998 indicate the long-term average production rate from the three sources at Clark Springs has been about 6.2 cfs.

Although the infiltration gallery draws directly on groundwater contained in shallow gravels and cobbles at Clark Springs, the gallery appears to be situated within the hyporheic zone of Rock Creek, which is the saturated zone under a river or stream (Edwards 1998), comprised of substrate with the interstices filled with water. Water is not extracted directly from the creek; however, during periods of high aquifer levels, generally in the winter and spring, groundwater extraction increases water table gradients towards the infiltration gallery, capturing some of the baseflow that would otherwise enter Rock Creek. The wells, when in operation, have an analogous effect on the water table. During extended periods of low precipitation, which generally occur in late-summer and early fall, streamflow becomes “perched” above the aquifer, and groundwater levels lower and the infiltration gallery captures groundwater that would remain in the aquifer and flow under the creek and out of the basin.

The potential for water withdrawals to affect streamflow in Rock Creek depends on the relative magnitude of withdrawals and the overall flow of groundwater through the aquifer, as well as the spatial variability of the creek bed elevation and the elevation of the aquifer's water table, both upstream and downstream of Clark Springs. The relationship between groundwater levels, surface flow in Rock Creek, and the Clark Springs System operations is quite complex and is discussed in detail elsewhere (Section 3.1.4 and Appendix C) in this document.

In 1997, the City voluntarily installed a streamflow augmentation system that, depending on the aquifer levels, will supply up to approximately 900 gpm (2.0 cfs) of water to be discharged into Rock Creek (Figure 1-3) during low flow periods when listed salmonid species are spawning. The augmentation system operates by pumping water from the clearwell in the Clark Springs System, from which it is discharged to Rock Creek after aeration. The water available for discharge is subject to hydrologic conditions affecting the infiltration gallery. This system has been operated periodically on a voluntary basis, especially when streamflows have fallen below 3 cfs during October, November, and December salmonid spawning periods. Augmentation reduces the instantaneous amount of water available for the water supply by the amount pumped.

Figure 1-3. Aerating groundwater at the Clark Springs augmentation pipe. Flow = 1-2 cfs.

Rock Creek has a perennial flow starting 0.2 miles upstream of the eastern boundary of the Clark Springs property and supports several species of salmonids, including introduced sockeye salmon (*Oncorhynchus nerka*), and native Chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*) and cutthroat trout (*O. clarki*). On March 24,

1999, National Marine Fisheries Service (NMFS) formalized the listing of Puget Sound Chinook salmon as threatened under the federal Endangered Species Act (ESA) (64 FR 14308). The NMFS also designated Puget Sound coho salmon as a species of concern (69 FR 19975, April 15, 2004). The U.S. Fish and Wildlife Service (USFWS) listed bull trout (*Salvelinus confluentus*) in Puget Sound as threatened, effective November 1, 1999 (64 FR 58909). Bull trout have not been observed in Rock Creek, but are present in the upper Cedar River and Lake Washington and could potentially utilize Rock Creek. Puget Sound Steelhead were listed as threatened under the ESA on May 8, 2007 (72 FR 26722).

## 1.2 Purpose and Need for the Habitat Conservation Plan

Major goals of the City of Kent's proposed plan to operate the Clark Springs System are to create, enhance, and conserve valuable fish habitat while not compromising the City's obligation of providing water to meet the health and life safety requirements of its customers. The recent and proposed listings of salmon and trout stocks in the Puget Sound Region resulted in a decision by the City of Kent to voluntarily formalize its conservation activities under a Habitat Conservation Plan (HCP), and in so doing, obtain an Incidental Take Permit (ITP) under Section 10(a)(1)(B) of the ESA. The ITP would allow the City of Kent to operate its existing and proposed water supply operations in a lawful manner without threat of prosecution for incidental take that may occur to species covered by the ITP. Further, the HCP would formalize the City of Kent's voluntary efforts to conserve and enhance important fish and wildlife habitat on the site and elsewhere in the Rock Creek basin.

This HCP has been prepared in support of the City of Kent's application for an ITP in conformance with Section 10(a)(2)(A) of the ESA. The listing of Puget Sound Chinook salmon and bull trout as threatened under the ESA includes populations in the Cedar River and its tributaries, which includes Rock Creek. The existing operations at the Clark Springs System could potentially incidentally "take" a listed species, as the term is defined under the ESA and rules adopted by NMFS and the USFWS. Conversely, avoiding the risk of take could ultimately cause the City to curtail operations during a portion of the year, thereby causing significant impacts on the water supply within the City of Kent's service area.

Implementing this HCP and securing an ITP would ensure that activities to supply domestic water within the service area will include measures that benefit fish resources over both the short- and long-term.

## 1.3 Overview of the Rock Creek Basin, Fish Resources, and City of Kent's Water Supply Operations

### 1.3.1 Overview of the Rock Creek Basin

The mouth of Rock Creek is located at latitude 47°22'54" N and longitude 122°1'00" W, in King County, Washington (Figure 1-4). The drainage basin is approximately 15.7 square miles, with a perennial stream length of around 2.8 miles. Rock Creek drains into the Cedar River on the left bank (looking downstream) at RM 18.2 and is about 3.6 miles downstream of the City of Seattle's Landsburg diversion dam. The Rock Creek Basin, categorized as part of Water Resources Inventory Area 8 (WRIA 8; Lake Washington-Cedar River Basin), drains towards the northwest. The basin is relatively narrow (about 1.5 miles wide) northwest of Ravensdale, but widens to about 5 miles wide further to the southeast.

Included within WRIA 8 are some of the most highly urbanized areas of western Washington. In addition, anthropogenic activities have resulted in dramatic changes in the hydrologic regime and river routing, which have caused a major disruption to the historic migration route of anadromous salmon and trout from the Cedar River Basin. According to EPA (2005), "Historically, the Cedar, Black and White Rivers all joined the Green/Duwamish River. In 1907 the White River was permanently diverted into the Puyallup River, causing the loss of over 50 percent of the river flow. The Black River was the outlet channel of Lake Washington and the Cedar River. When the Lake Washington Ship Canal and Hiram Chittenden Locks were built in 1916, Lake Washington was lowered nine feet, and the Black River was cut off from the Duwamish. The Cedar River was redirected to Lake Washington, disconnecting it as well. Now the Green River becomes the Duwamish at the historic confluence of the Green and Black." Despite these changes, portions of the upper Cedar River and Rock Creek contain some of the highest quality habitats and watershed conditions in WRIA 8.

The upper Cedar River Basin has been a regional source of water for more than a century (City of Seattle 1999). Seattle began diverting Cedar River water for municipal supplies in 1901. Shortly after the construction of the Landsburg Diversion Dam, water storage was developed through the construction of Masonry Dam, which incorporates a hydroelectric facility that is capable of producing 30 megawatts of electricity. Unsupervised access to the Cedar River Municipal Watershed, which is upstream of Landsburg, ceased in 1917 to protect the integrity of the watershed and maintain its' high water quality characteristics. In addition to water and electricity supplies, the City of Seattle historically conducted some level of commercial forest practices within the Municipal Watershed. However, these commercial practices have ceased since the development of Seattle's Cedar River Habitat Conservation Plan in 1999.

Land use within the Rock Creek basin is primarily forested, which is an important factor contributing to its high watershed quality (WRIA 8 Steering Committee 2005). Different sources have estimated the level of forested cover in the basin between 45 percent (Simmonds et al. 2004) and 72 percent (Friends of Rock Creek 2004). MGS (unpublished data) estimated approximately 67 percent of the basin was forested as of 1999, followed by about 26 percent grass or pasture. Only about 3 percent of the land cover was considered impervious surface in 1999 and the remaining 4 percent was water and wetlands (MGS unpublished data). Other sources have estimated impervious surface in the basin of 5 percent as of 2001 (Simmonds et al. 2004).

The lower Rock Creek basin, which supports anadromous salmonids, includes the City's Clark Springs property and the 141.2-acre Rock Creek Natural Area owned by King County (Figure 1-5). This ownership pattern assures that land use adjacent to the lower 2.6 miles of Rock Creek will remain largely unaltered for the foreseeable future. In contrast, there is potential for continued build-out and development in the upper watershed. Based upon predicted build-out conditions, future land use is estimated to include approximately 51 percent forested, 40 percent grass and pasture, and 5 percent impervious surface (MGS unpublished data).

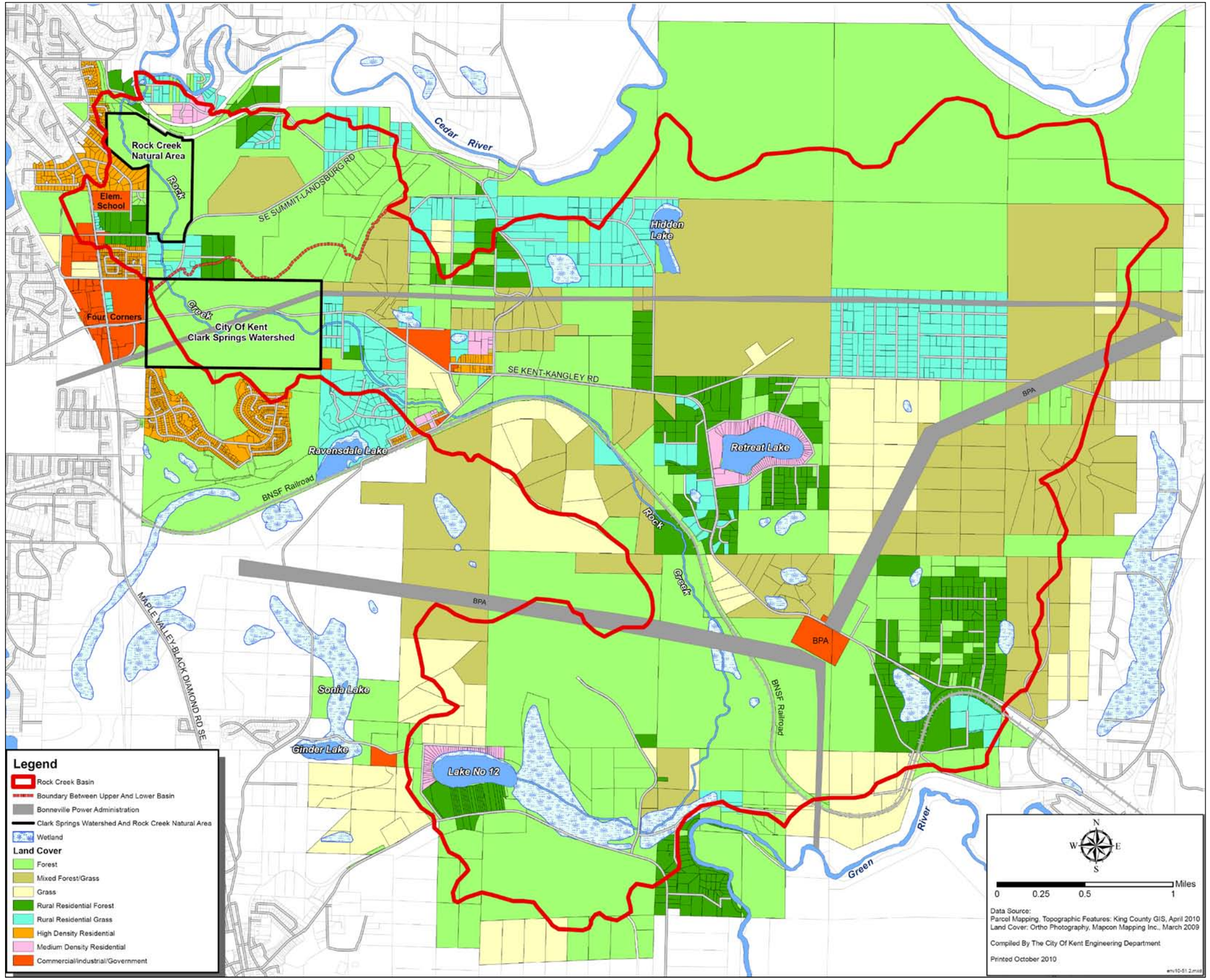


Figure 1-4. Rock Creek basin map.

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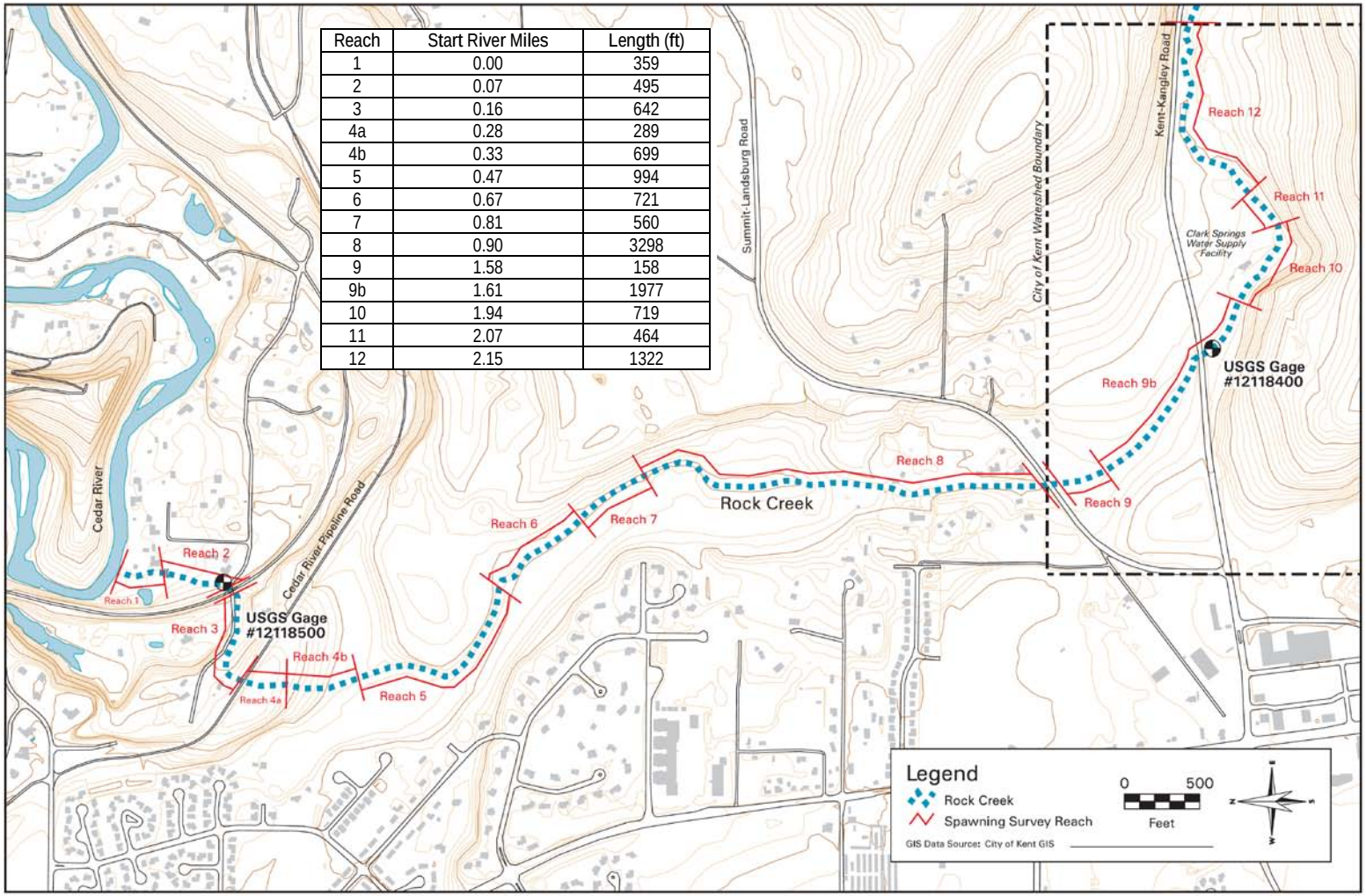


| Reach | Start River Miles | Length (ft) |
|---|---|---|
| 1 | 0.00 | 359 |
| 2 | 0.07 | 495 |
| 3 | 0.16 | 642 |
| 4a | 0.28 | 289 |
| 4b | 0.33 | 699 |
| 5 | 0.47 | 994 |
| 6 | 0.67 | 721 |
| 7 | 0.81 | 560 |
| 8 | 0.90 | 3298 |
| 9 | 1.58 | 158 |
| 9b | 1.61 | 1977 |
| 10 | 1.94 | 719 |
| 11 | 2.07 | 464 |
| 12 | 2.15 | 1322 |

Figure 1-5. Map of Rock Creek from its confluence with the Cedar River through the City of Kent Watershed at Clark Springs.

Much of the upper portion of the watershed is situated on glacial outwash that remained following the retreat of the Vashon Glacier about 12,000 years ago, while higher elevations are bedrock overlaid with Vashon Till on their lower slopes (Hart Crowser 2003) (Appendix C). Due to the highly porous nature of the recessional glacial outwash, nearly all precipitation in the upper watershed infiltrates into the groundwater, except during extremely high precipitation events.

### 1.3.2 Fish Resources

Sockeye salmon, Chinook salmon, coho salmon, and steelhead and cutthroat trout are known to utilize Rock Creek. Between RM 0.0 and 2.6, Rock Creek is considered by King County (1997) to be a regionally significant resource area because of its high quality habitat and potential for salmonid production. Non-salmonid species that may utilize Rock Creek include Pacific lamprey (*Lampetra tridentata*) found in the Cedar River, river lamprey (*L. ayresi*) found in tributaries to the Cedar River above Landsburg Diversion Dam, and various species of sculpin (*Cottus sp*.).

Rock Creek is considered an important spawning ground for the Cedar River sockeye salmon, a stock that is recognized as depressed (WDF et al. 1994). The extent of historic use of Rock Creek by Chinook salmon is uncertain, and recent use has been infrequent and unlikely to include any actual spawning (Berge et al. 2006; R2 Resource Consultants, Inc. 2004, 2005a; MCS Environmental 2003). Rock Creek is also considered an important stream for coho salmon. The Washington Department of Fish and Wildlife (WDFW) has conducted spawning surveys in Rock Creek from the mouth to Summit Landsburg Road each fall and early winter since 1960 (see Appendix A) and most of these surveys, particularly during the 60s and 70s, were targeted for the coho salmon spawning period. More recently, with the increased importance of the sockeye fishery and ESA listing of Chinook salmon, spawning surveys have occurred more frequently and extend over a broader period than previous surveys.

### 1.3.3 City of Kent's Water Supply Operations

This section describes some of the infrastructure that comprises the Clark Springs System facilities within the Clark Springs Watershed. Source material from this section was derived primarily from Hart Crowser (2003) (Appendix C). As described earlier, the Clark Springs System consists of an infiltration gallery located about 18 feet below the ground surface and 3 pumping wells. The pumping wells were installed to depths of 51 to 60 feet in the shallow aquifer beneath the infiltration gallery as shown in Figure 1-2, and have a combined pumping capacity of 5,400 gpm (12 cfs). All three of the City's water rights comprising the Clark Springs System are conjunctively managed because of their close hydraulic connection, whereby the instantaneous and annual withdrawals of the System are limited to the cumulative totals allowed under the combined surface water, springs, and groundwater rights. Thus, the total, primary instantaneous and annual quantities are 5,400 gallons per minute (gpm) and 8,710 acre-feet per year, respectively.

The infiltration gallery consists of perforated pipes laid perpendicular to the main direction of flow in Rock Creek (Figure 1-2). The pipework was laid with an invert level (i.e., the lowest level) of 548 feet MSL, which is approximately 12 feet below the clear well overflow level of 560 feet MSL. The main gallery consists of 270 feet of 16-inch-diameter perforated pipe (slotted well casing). Aquifer materials in the vicinity of the gallery are believed to be highly permeable sands, gravels, and cobbles.

Water from the gallery flows by gravity into the transmission main via a structure known as the Clear Well building (Figure 1-2). The intake velocity through the gallery screen is estimated to be around 0.1 feet per second, which induces minimal head loss as water enters the gallery from the aquifer. Under some conditions, the head in the Clear Well is only slightly lower (by a few tenths of a foot) than the average groundwater level immediately above the main gallery.

The system flows steadily under gravity at a rate of around 2,000 to 4,000 gallons per minute (between 4.4 and 8.9 cfs). Changes in flowrate are driven by operational fluctuations in the

transmission line backpressure and by changes in groundwater level. There is a seasonal change in groundwater level at the gallery of up to 5 feet. Higher gravity flows are typically recorded during the winter, when a higher groundwater table increases the hydraulic head available to supply the gallery.

The transmission pipeline from Clark Springs has a capacity of about 3,700 gallons per minute (8.2 cfs) under gravity flow (URS 1985) and a full storage reservoir (designated 6 MG #1 or the James Street Tank) in the City of Kent. These conditions apply when the gallery is flowing by gravity and the well pumps are not operating. During the summer months, additional downstream inputs to the transmission line (from Seven Oaks Well and Armstrong Springs) reduce the gravity-flow capacity from Clark Springs to between 2,200 and 3,400 gallons per minute (4.9 and 7.6 cfs).

Under pumping conditions the transmission pipeline from Clark Springs has a capacity of about 5,400 gallons per minute (12 cfs) with an applied head of around 170 feet (URS 1985). Pumping conditions only come into effect when the wells at Clark Springs are being used.

#### *1.3.3.1 Current Operations and Water Production*

The City has collected daily flow data since 1978, from flow meters on each of the three wells, and a master flow meter located on the main transmission pipeline that records either total flow from the wells or gravity flow from the infiltration gallery. Data on water production at Clark Springs from 1986 through 1997 are summarized as monthly average flowrates in Figure 1-6. These data show an overall rate of extraction that averages 6.2 cfs during this period. In some years, the wells at Clark Springs have been used to provide a significant portion of water production, but in most years, water production has been primarily from the infiltration gallery.

A pumping system for augmentation of stream flows in Rock Creek during the fall months was implemented by the City on a voluntary basis beginning in 1997. This augmentation was designed to improve streamflows as part of the City's Rock Creek Resource Protection Program. At times, beginning in 1997, the City has augmented low flows in Rock Creek by

pumping water from the infiltration gallery directly into the creek (via the clear well). In some years (e.g., 2002), because of low flow conditions, the City extended the duration of the augmentation over several months. This extension had a direct effect on the City's ability to supply water from the Clark Springs System.

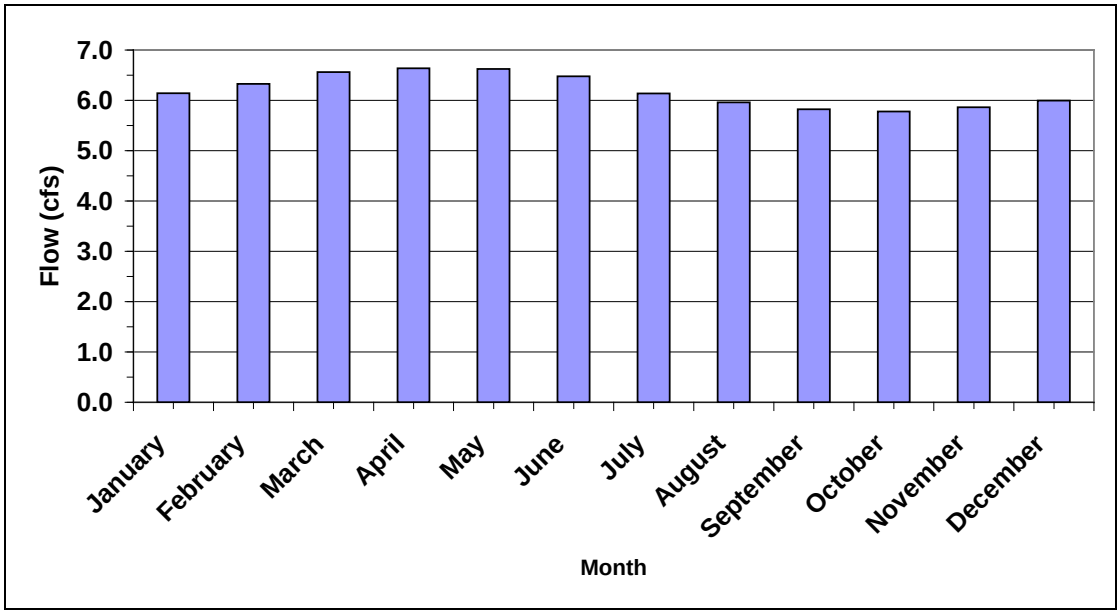


Figure 1-6. Mean monthly water supply withdrawals between 1986 and 1998.

### *1.3.3.2 Future Operations*

The City of Kent is committed to continue operating the Clark Springs System within the requirements of its State water rights. Water supply operations at Clark Springs are constrained by factors that are described in detail in Chapter 3 and Appendix G of this HCP. These constraints include:

- Water rights associated with the water supply (Section 3.2)
- Seasonal changes in the groundwater level (Section 3.1).

Within the requirements of its existing water rights, the City is permitted to withdraw up to 12 cfs (Qi); however, during the time period of 1986-1997, the typical amount of withdrawal

varied between 4.9 and 7.6 cfs, with an average of 6.2 cfs. The maximum annual quantity (Qa) of water that can be withdrawn under the Trench and Surface Water rights is 4,950 af/year. These two water rights have no requirement for maintaining minimum instream flows. On an annual basis, the City normally withdraws close to the Qa (4,950 af/year) limit of these two water rights with gravity flow. Therefore, an increase in future annual withdrawals would be under the City's well, or pumping, water right. This water right requires the City to maintain the following minimum instream flows when the wells are pumped: 15 cfs between November 1 and April 30, 2 cfs between July 1 and October 31, and between May 1 and June 30 minimum instream flows decline arithmetically between 15 cfs and 2 cfs.

Groundwater movement from the upper Rock Creek Basin (east of approximately RM 2.8) may not always be of a sufficient quantity to sustain the groundwater levels in the local Clark Springs aquifer to make sustainable operation of the wells feasible. Furthermore, well operation reduces the local groundwater levels, which jeopardizes the City's ability to augment creek flows with the augmentation pump because the groundwater table that is otherwise available to the clear well pump from the infiltration gallery is lost to the wells. Consequently, use of the wells is limited to periods when groundwater levels are sufficiently high to meet the instream flow requirement of their water right without augmentation from the clear well.

Collectively, the constraints summarized above and described in detail within Chapter 3 and Appendix G, mean that under the HCP withdrawals from Clark Springs from June through December are anticipated to be similar to those during the 1986-1997 baseline period. During periods of high flows, which primarily occur from January to May, but may also occur in late November or December during wet falls, additional withdrawals over the baseline amount may occur. Additional withdrawals during these periods will likely require the use of the wells, which would require the City to maintain the minimum instream flows stated above.

### 1.3.4 WRIA 8 Technical Committee

The City of Kent, via its consultants, has been an active participant on the WRIA 8 Technical Committee, which has supported development of the WRIA 8 Chinook Conservation Plan (WRIA 8 Steering Committee 2005). The WRIA 8 Chinook Conservation Plan was developed jointly by 27 local governments as a proactive response to the ESA listing of Chinook salmon with the ultimate goal of protecting and restoring the environmental features needed for the recovery of Chinook salmon populations. The WRIA 8 Conservation Plan desires not only the recovery and delisting of Chinook salmon under the ESA, but also population levels and productivity that can support viable sport and commercial fisheries.

While the 320 acres of land encompassing the Clark Springs Watershed are the only lands under the jurisdiction of the City of Kent in WRIA 8, the City recognizes the responsibility of participating in appropriate environmental stewardship with other stakeholders in the Rock Creek Basin. Consequently, the City has remained an active participant in the WRIA 8 process and Conservation Plan development. The City has also provided technical data and information collected as part of the preparation of this HCP for use in development of the Ecosystem Diagnosis and Treatment (EDT) model, which was a component used for scientific analyses conducted as part of the development of the WRIA 8 Chinook Conservation Plan (WRIA 8 Steering Committee 2005). The City of Kent has also funded the participation of technical consultants at meetings and contributed to the development of protection and enhancement measures for Rock Creek that are present in the WRIA 8 Chinook Conservation Plan.

## 1.4 Proposed Habitat Conservation Plan

This HCP is the culmination of more than 5 years of study and planning and represents a long term commitment by the City of Kent to protect important fish resources that may be impacted by future operations of the Clark Springs System and to mitigate those potential impacts to the maximum extent practical. The HCP is the product of a collaborative effort between the City of Kent and the Services to meet both the requirements of the ESA and the

domestic, industrial, commercial, fire, and life safety water supply needs of the City. The HCP is more fully described in later chapters. Briefly, the major habitat conservation measures include:

- Flow augmentation during October, November, and December;
- On-going protection of the Clark Springs Watershed from development other than that needed for water supply, water treatment, and security purposes;
- Improvement of low flow passage conditions at the mouth of Rock Creek;
- Partnering with other responsible stakeholders for the replacement of the stream crossing at Summit-Landsburg Road to meet WDFW passage specifications;
- Improved stream connectivity and enhancement of two off-channel wetlands near the lower reaches of Rock Creek;
- Stream enhancement projects at several locations in Rock Creek; and
- Creation of a Rock Creek Protection and Enhancement Fund to be utilized for environmental easements, buy-outs, or enhancement projects within riparian areas along Rock Creek.

In addition to habitat conservation measures, this HCP includes monitoring and adaptive management programs. The monitoring program is designed to ensure the habitat conservation measures are implemented and that the expected benefits to the covered species are achieved. The adaptive management program provides an ongoing process to ensure continued protection for covered fish species, particularly during water years when dry conditions make the balancing of needs for both the covered species and water supply especially difficult and when wet conditions provide opportunities for added benefits to the covered species.

## 1.5 Areas Proposed for Coverage Under the Incidental Take Permit and Habitat Conservation Plan

The proposed ITP and HCP coverage area consists of: 1) areas affected by the operational withdrawal of the Clark Springs System; 2) areas in the watershed where mitigation and

restoration activities will occur as described in this HCP; and 3) all 320 acres of land that is owned by the City of Kent and collectively called the Clark Springs Watershed (Figure 1-4).

## 1.6 Activities Proposed to be Covered by the Incidental Take Permit

The proposed ITP covered activities include all water withdrawal and maintenance activities related to the Clark Springs Water Supply System, the mitigation measures described below, and other City operation and maintenance requirements within the Clark Springs Watershed. The City of Kent will follow all applicable regulations and obtain all required permits, and will install and use all appropriate and applicable BMPs such as erosion and sedimentation control devices identified in the most recent version of the City of Kent Construction Standards at the time work is completed and when implementing covered activities.

The proposed ITP covered activities are:

- Water supply withdrawals from the Clark Springs System pursuant to the City's water rights.
- Augmentation flows pumped from the Clark Springs Water Supply Facility into Rock Creek as described for HCM-1 in Chapter 4 (Habitat Conservation Measures to be Implemented under the HCP).
- Operations, maintenance, replacement, monitoring, and improvements to the augmentation system. This includes relocating the augmentation system; maintaining, additions to, and/or replacing all augmentation infrastructure as needed.

  The City of Kent will be relocating the augmentation discharge point downstream from its current location to a point near the Parshall Flume which is the location of the USGS stream gage #12118400. The new augmentation pipe will be located within or adjacent to the surface of an existing cleared corridor from the beginning point at the clear well, north towards Kent Kangley Road. Some clearing will be required along the existing corridor and between the existing corridor and the creek to reach the discharge point. An upright discharge structure, similar to the existing

structure (Figure 1-3), will be placed near the edge of the stream to oxygenate the augmented water. Discharged water will have an energy dissipation BMP such as quarry spalls and also a geo-textile membrane / liner similar to the existing discharge point to prevent erosion of the creek bank from water turbulence at the discharge point, as illustrated in Figure 1-3.

The City of Kent will utilize appropriate Temporary Erosion and Sedimentation Control BMPs such as silt fencing, straw mulch, waddles or other measures identified in the adopted City of Kent Construction Standards at the time the augmentation pipe is relocated. Current erosion and sediment control BMPs are located in Appendix K.

- Operations, maintenance, and improvements to the water supply facilities located in the Clark Springs Watershed such as the buildings, wells, access roads, fences and security infrastructure, infiltration gallery, and water transmission main, except for portions within the ordinary high water boundaries of Rock Creek. This includes replacement of the facilities and infrastructure as needed in the future.

  The City of Kent operates, improves and maintains the Clarks Springs Water Supply facility and related infrastructure. Maintenance includes cleaning, painting and repairing all portions of the buildings, wells, access roads, fences and transmission mains. The City of Kent will install and use all appropriate and applicable BMPs such as erosion and sedimentation control devices as appropriate at the time work is completed. Current erosion and sediment control BMPs are located in Appendix K.

- Vegetation management as needed by the City to maintain its facilities. This includes, but is not limited to, maintaining open areas, service roads, and clearing/trimming fence lines and power line/telephone line areas associated with the facilities. All vegetation management on the Clark Springs property will be via mechanical methods, chemical applications will not be used. Vegetation management may also include relocation of LWD/vegetation to protect the integrity of the water supply and infrastructure. This activity does not include vegetation

management activities conducted by the Bonneville Power Administration to maintain their transmission line right-of-way and easement.

- Operation and maintenance of the Parshall Flume and USGS gaging station (No. 12118400). This includes cleaning of the flume to remove algae, repair and work to maintain the accuracy and integrity of the flume including maintaining the areas immediately up-stream and downstream.

  The City of Kent cleans the flume at Clark Springs by brushing the flume when algae builds up on the sides as needed to ensure an accurate reading for the stream gage. If the flume gets damaged, deteriorates or needs significant repairs, the City of Kent will contact applicable agencies for permits to repair or reconstruct the flume.

- Wildlife management within the Clark Springs Watershed for the purpose of protecting and enhancing the quality of the water supply. This includes trapping beavers to ensure a healthy municipal water source and removal of beaver dams to prevent stream relocation and damage to the City's infrastructure or the quality of the water supply.

  The City of Kent currently manages beaver dam-building activity on the Clark Springs property pursuant to an HPA issued by the Washington Department of Fish and Wildlife. A copy of the current HPA is included as Appendix L.

- Habitat Conservation Measures 1-6 described in Chapter 4 of this HCP.

- Electrical, control, and telemetry operations, maintenance, improvements and replacement of equipment, conduit, cabling and related infrastructure to meet the needs of the water supply facilities within the Clark Springs Watershed. Portions of this infrastructure are buried at the facility. Current erosion and sediment control BMPs described in Appendix K will be utilized as needed during implementation of this covered activity.

- The delivery and storage of chemicals, the chemical treatment processes and the operation, maintenance, replacement and improvement of equipment, conduit, piping and sampling infrastructure required to monitor and treat the City's water supply. This will include chemicals for existing treatment (chlorine liquefied gas and sodium fluoride in powder form) and chemicals needed for future treatment as required by state and federal drinking water regulations. The delivery of treatment chemicals to the Clark Springs facility are carried out per federal and state DOT regulations. Chemicals are stored per manufacturer's recommendations and Material Safety Data Sheets (MSDS) requirements. The site contains multiple spill kits, located in various strategic locations, and are capable of containing both dry and liquid releases. Currently, Clark Springs utilizes chlorine for disinfection and sodium fluoride for the prevention of dental cavities. Water quality parameters are continuously monitored for both high and low alarm feed conditions and relayed and alarmed through the City's Supervisory Control and Data Acquisition system. All treatment and alarm monitoring equipment are maintained per manufacturers recommendations and tracked through the City's Hansen preventative maintenance software. Current MSDS and Standard Operating Procedures for handling sodium fluoride and chlorine gas are located in Appendix M.

- The maintenance and replacement of storm water conveyance, control, and distribution facilities within the 320 acre Kent property boundaries at the Clark Springs facility.

  The City of Kent maintains the existing limited stormwater facilities on the City of Kent property. Currently, the stormwater systems consists of roadside ditches along Kent Kangley and Summit-Landsburg Roads, an on-site infiltration system, and roadway culvert crossings. If Kent Kangley Road or Summit-Landsburg Road are reconstructed in the future, design of the stormwater system and BMPs will be implemented as described in the most recent version of the City of Kent Construction Standards. Current erosion and sediment control BMPs are located in Appendix K.

- The City may elect to install monitoring wells along the eastern boundary of the Clark Springs property to monitor groundwater quality and provide a network of wells to help detect any contamination that may come from Landsburg Mine, the residential and semi-commercial properties along the eastern boundary of the Clark Springs property, or other contaminant sources in the watershed. Installation of wells may require constructing access roads for drilling rigs to reach desired locations and for personnel to perform regular sampling and monitoring of the water quality in the aquifer. Access roads will be constructed pursuant to standards in Appendix K or the most recent version of the City of Kent Construction Standards in place at the time access roads are constructed, which are rigorously designed to prevent movement of soils into, or increased turbidity of, adjacent surface waters. Access roads are anticipated to be short spur roads branching off of SE Kent-Kangley Road, SE 269th Street, or other existing roads and will be located to have the least possible impacts on stream and wetland buffers. Access roads and wells will be located at least 50-feet from the ordinary high water mark and outside wetland boundaries. All work associated with the installation of the monitoring wells will be completed in accordance with Kent City Code.

  The City of Kent is very concerned about the potential impacts to groundwater and surface water quality in the Rock Creek Watershed. Of particular concern is known contaminant sites such as the Landsburg Mine located to the northeast of the Clark Springs property. Industrial waste was disposed in Landsburg Mine from approximately 1969-1978 in the form of 4,500 55-gallon drums and approximately 200,000 gallons from tanker trucks. The fate of the waste has not been determined. As a result the City is very concerned that waste will migrate into groundwater resources and contaminate the aquifer in the Rock Creek watershed, and subsequently the Clark Springs water supply, all of which could happen very rapidly due to the significant level of transmissivity of the aquifer.

## 1.7 Relationship Between the City of Kent's ITP and Activities of WRIA 8

This HCP and the City Kent's ITP are highly compatible with the ongoing activities in WRIA 8 to recover Chinook salmon. Indeed, many of the Habitat Conservation Measures (HCM) proposed for implementation under the HCP are identical or similar to the enhancement and protection projects identified for Rock Creek in the WRIA 8 Chinook Conservation Plan (WRIA 8 Steering Committee 2005). This HCP provides a significant contribution towards protecting the current high quality salmonid fish habitat in Rock Creek and providing improvements in areas where it is deficient. Furthermore, the HCP and ITP provide certainty that these enhancement and protection measures will be implemented in the near future. Without the HCP and ITP, it is possible that many or all of the enhancement and protection projects identified in the WRIA 8 Chinook Conservation plan would not be implemented or that implementation would be delayed until some other organization retained sponsorship.

## 1.8 Proposed Term of the Incidental Take Permit and Habitat Conservation Plan

The City of Kent's planning horizon for water supplies is typically on the order of 40 years. Consequently, the City of Kent is seeking an ITP for 50 years. The ITP will be running concurrently with this HCP.

## 1.9 Species Proposed for Coverage Under the Incidental Take Permit

The species of fish to be covered under the HCP and ITP include:

**City of Kent Clark Springs Water Supply Facilities**
**Habitat Conservation Plan**
**Fish Species Covered by this HCP and ITP**

**THREATENED SPECIES**

Chinook salmon *(Oncorhynchus tshawytscha)*

Steelhead *(Oncorhynchus mykiss)*

Bull trout *(Salvelinus confluentus)*

**SPECIES OF CONCERN**

Coho salmon *(Oncorhynchus kisutch)*

Sockeye salmon *(Oncorhynchus nerka)*

Chum salmon (*Oncorhynchus keta)*

Coastal cutthroat trout *(Oncorhynchus clarki clarki)*

Pacific lamprey *(Lampetra tridentata)*

River lamprey *(Lampetra ayresi*)

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# 2. REGULATORY REQUIREMENTS AND PROCESSES

This chapter discusses federal, state, and local regulations and processes that govern the activities proposed by the City of Kent at the Clark Springs System and that could affect the Habitat Conservation Plan.

## 2.1 Federal Requirements

### 2.1.1 Endangered Species Act of 1973

The Endangered Species Act of 1973, as amended (16 U.S.C. §1531 et seq.; i.e., Title 16 of the United States Code Section 1531 and following sections), provides "...a means whereby the ecosystems upon which endangered species depend may be conserved" (16 U.S.C. §1531[b]). The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) (collectively the Services) are responsible for listing candidate species, subspecies, or distinct population segments as threatened or endangered (16 U.S.C. §1533). Once a species is listed, the ESA, through several mechanisms, protects the species and its habitat (16 U.S.C. §§1538, 1540).

Under Section 7 of the ESA, federal agencies are required to further the purposes of the ESA and consult with the Services to ensure federal actions are not likely to jeopardize the continued existence of a listed species or adversely modify or destroy critical habitat (16 U.S.C. §1536[a][1] and [2] t). The term "federal action" is defined by regulation so as to include actions such as the granting of permits, entering contracts or leases, or participating in projects or funding such projects (50 CFR §402.02; i.e., Title 50 of the Code of Federal Regulations Section 402.02). Approval of an ITP is a federal action and, therefore, subject to consultation under Section 7 of the ESA (15 U.S.C. §1536[a][2]). If after consultation the Services determine that the action would not jeopardize the continued existence of an endangered or threatened species or result in the destruction or adverse modification of critical habitat, the Services would prepare a written statement (Biological Opinion) that specifies (1) the impact of the incidental take on the species, (2) the reasonable and prudent

measures necessary or appropriate to minimize such impact, and (3) the terms and conditions that must be complied with to implement necessary reasonable and prudent measures.

Section 9 of the ESA (16 U.S.C. 1532 *et seq*.) and implementing regulations prohibit the "taking" of animal species listed as endangered or threatened. The term "take" is defined to include "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" or attempt to engage in any such conduct (16 U.S.C. §1532[19]). Harm is defined by the USFWS to include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, and sheltering. NMFS' definition of harm includes significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, spawning, migrating, rearing, and sheltering (64 FR 60727), November 8, 1999).

The regulatory definition of "harm" (as defined by the USFWS) has been upheld by the U.S. Supreme Court in Sweet Home Chapter of Communities for a Great Oregon v. Babbitt, 515 U.S. 687, 132 L.Ed. 597 (1995). The Sweet Home court held that "the broad purpose of the ESA supports the Secretary's decision to extend protection against activities that cause the precise harms Congress enacted the statute to avoid," (emphasis added).

Section 10 of the ESA specifies requirements for the issuance of ITPs to non-Federal landowners for the take of endangered and threatened species. Any proposed take must be incidental to otherwise lawful activities, not appreciably reduce the likelihood of the survival and recovery of the species in the wild, and minimize and mitigate the impacts of such take to the maximum extent practicable (16 U.S.C. §1539[a][1][B]; 50 CFR §17.3). Without an ITP, individuals and non-federal entities, who undertake otherwise lawful actions that may take a listed species, risk violating the Section 9 take prohibition and related sanctions. Congress through Section 10 established the ITP process to resolve this dilemma. To obtain an ITP, the applicant must submit a "conservation plan" that specifies, among other things, the impacts that are likely to result from the taking and the steps that would be undertaken to minimize and mitigate such impacts (16 U.S.C. §1539[a][2][A]; 50 CFR §17.22[b][1]).

However, the Services may not issue ITPs or approve HCPs if so doing would jeopardize the continued existence of a listed species (16 U.S.C. §1539[a][2]). In short, this means that the proposed federal action would not "reasonably…be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02).

Although recovery of listed species is not the primary objective of the conservation planning process, the ESA's HCP approval criteria help to ensure that HCPs are consistent with recovery goals prepared for each listed species. The HCP must show that the applicant's conduct "will not appreciably reduce the likelihood of the survival and recovery of the species in the wild" (16 U.S.C. §1539 [a][2][B][iv]). If there is no recovery plan for a species, an HCP should ensure that recovery opportunities are thoroughly "considered" based on known limiting factors for the species. At the same time, an HCP is not a replacement or substitute for a recovery plan. An HCP is only a small but consistent part of efforts to "recover" a species.

## 2.1.2 HCP Requirements

### *2.1.2.1 Criteria for Issuance of a Permit for Incidental Taking*

In deciding whether to issue a Section 10(a) permit for the incidental take of federally listed species, the Services must consider five criteria set forth in the ESA (16 U.S.C. §1539[a][2][A]). If the applicant's HCP satisfies the permit issuance criteria, the regulations require that the Services issue the ITP. The criteria are:

*The taking will be incidental* – All taking of listed fish and wildlife species as detailed in the HCP must be incidental to otherwise lawful activities and not the purpose of such activities.

*The applicant will, to the maximum extent practicable, minimize and mitigate the impact of such taking* – Under this criterion, the Services would determine whether the mitigation program the applicant proposes in the HCP is adequate to "protect" the species and meets statutory requirements. This determination typically requires consideration of two factors: adequacy

of the minimization and mitigation program, and whether it is the maximum that can practically be implemented by the applicant.

*The applicant will ensure adequate funding for the HCP* – The Services must ensure that funding sources and levels proposed by an applicant are reliable and would meet the purposes of the HCP. Absent these findings, a Section 10 permit cannot be issued.

*The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild* – This criterion considers the effects of the project on the likelihood of survival and recovery of affected species, and establishes a fundamental "threshold" standard for any listed species affected by an HCP.

*The applicant will ensure that other measures that the Services may require as being necessary or appropriate will be provided* – Because the HCP process addresses a variety of proposals and species, this criterion authorizes the Services to impose additional measures to protect listed species where deemed necessary. The Services must ensure that an applicant has included all measures considered necessary for purposes of the plan before issuing the permit. The Services will require an Implementing Agreement (IA), which prescribes each parties obligations under the Conservation Plan and Section 10(a)(1)(B) permit, and provides remedies should any party fail to fulfill their obligations.

#### *2.1.2.2 Unforeseen Circumstances and No Surprises*

Unforeseen circumstances means changes in circumstances surrounding an HCP that were not or could not be anticipated by HCP participants and the Services that result in a substantial and adverse change in the status of a covered species. The legislative history of the ESA addresses the desirability and need to address "unforeseen circumstances" during the term of an ITP; that is, unforeseen circumstances that might jeopardize a listed or threatened species while the permit is in force. To address the problem of maintaining regulatory assurances and providing regulatory certainty in exchange for conservation commitments, the Department of Interior (DOI) and Department of Commerce (DOC)

jointly established a "No Surprises" policy for HCPs. This policy sets forth a clear commitment by the USFWS, NMFS, DOI, and DOC that, to the extent consistent with the requirements of the ESA and other Federal laws, the government would honor its agreements under an approved HCP for which the permittee is in good faith implementing the HCP's terms and conditions. Generally, if unforeseen circumstances occur during the life of an HCP, the Services would not require additional lands, funds or restrictions on lands or other natural resources released for development or use, from a permittee, who is adequately implementing or has implemented an approved HCP in good faith. If unforeseen circumstances warrant the requirement of additional mitigation from an HCP permittee who is in compliance with the HCP's obligations, such mitigation would need to maintain the original terms of the HCP to the maximum extent possible. Any changes would be limited to modifications within conserved habitat areas or to the HCP's operating conservation program for the affected species. Additional mitigation requirements would not require the payment of additional compensation or be applied to land available for development or management under the original terms of the HCP without the permittee's consent. Other methods of responding to unforeseen circumstances, such as government action and/or voluntary conservation measures by the permittee would remain available to assure the requirements of the ESA are satisfied.

The uncertainty problem is the subject of the "No Surprises" rule (formerly a USFWS/ NMFS policy) published on February 23, 1998 (63 FR 8859; 50 CFR 17.22 & 17.32, 50 CFR 222.22). The No Surprises concept is simply that "a deal is a deal." Under a properly functioning HCP, the Services will not ask the applicant for more mitigation or funding, even if the affected species should continue to decline. Even in "extraordinary" or "unforeseen" circumstances, the permit holder can only be asked to explore available alternatives for making previously agreed mitigation measures more effective, but no additional cost to the permit holder can be mandated once an HCP has been approved and is being implemented. This provides certainty to the permit holder and any different or additional mitigation or conservation measures becomes the responsibility of the Services, unless the permit holder agrees to such terms voluntarily. The terms of the No Surprises regulation would be built into the contractual language of the Implementation Agreement

(50 CFR 17). Without some meaningful certainty of the type provided by a concept like No Surprises rule, applicants have little incentive on ever agreeing to the commitments of an HCP.

#### *2.1.2.3 Changed Circumstances*

This HCP covers the City of Kent's operation of the Clark Springs System, and those covered activities as listed in Section 1.6, under ordinary circumstances. In addition, the City of Kent and the Services foresee that circumstances could change during the term of this HCP. Changed circumstances mean a change or changes in the circumstances affecting a covered species or the HCP area that can reasonably be anticipated by the City of Kent and the Services, and that therefore can reasonably be planned for in the HCP. Changed circumstances are different than unforeseen circumstances because they can be anticipated, and can include events such as the addition of a newly ESA listed species, wind, and extended droughts. Examples of such changed circumstances are described in this section, along with the measures the City of Kent and the Services would implement in response to a changed circumstance. The ITP would authorize the incidental take of covered species under ordinary circumstances as well as these changed circumstances, so long as the City is operating in compliance with this HCP, the ITP, and the IA.

##### *New Listings of Species Not Covered by the Incidental Take Permit*

If a species that is present or potentially present in the HCP area and not already covered by this HCP becomes a candidate for listing, is proposed or petitioned for listing, or is listed under the federal ESA, the City of Kent would survey the HCP area to the extent it deems necessary after coordinating with the Services. Survey results would be reported to the Services for a determination of the potential for incidental take of subject species from the City's activities. The City would avoid the incidental take of newly listed species until such time as the species is added to the HCP and ITP in accordance with the provisions in the Implementation Agreement, HCP and Section 10 of the ESA. If the City chooses to pursue incidental take coverage for newly listed species by amending the HCP or by preparing a separate HCP, all three parties (City of Kent, USFWS, and NMFS) would enter into discussions to develop necessary and appropriate mitigation measures to meet ESA Section

10(a) requirements for incidental take coverage. All parties would endeavor to develop mutually acceptable mitigation measures and secure incidental take coverage prior to final listing of a new species. In determining adequate mitigation for the species, the Services would establish an environmental baseline, which would reflect conservation benefits to the subject species that may have accrued from the time the ITP was issued and the HCP was first implemented. However, additional mitigation measures may be necessary to satisfy the requirements of the ESA.

*Wind*

**Threat Assessment**: Wind is an ever-present factor in the HCP area. Daily winds control the climate, growing conditions, and fire danger in the HCP area, while seasonal storms can damage or destroy capital improvements, interrupt electrical power, and uproot trees. In forested portions of the HCP area, wind can create habitat for fish and wildlife by killing live trees and/or toppling trees to create logs or large woody debris in streams. Extreme winds can eliminate habitat, however, by blowing down all or most trees in a given area. The City of Kent believes there is a high likelihood that some trees will periodically "blow-down" in the Clark Springs Watershed during the 50 years the HCP will be in place. However, there is considerable uncertainty whether large blow-down events will occur within riparian areas along Rock Creek, but the City believes the risk to be low.

**Preventative Measures:** The City of Kent does not plan to implement any preventative measures to reduce the risk of blow-down.

**Planned Response:** The City of Kent plans to leave blow-down where it falls unless it poses a hazard (damage or risk of damage) to the City's water supply facilities, public structures (e.g., roads, bridges, or water crossings), prevents access needed to maintain water supply facilities, or presents a safety risk to Kent staff or authorized visitors. If hazardous blow-down is within the floodplain or riparian zone of Rock Creek (i.e., approximately 200 ft on either side of the stream), the City of Kent will consult with the Services prior to removal. Hazardous blow-down will be moved only as far as needed to remove the hazard. If extensive blow-down outside of the watershed results in changes to the stream morphology

such that the function of a mitigation measure is impaired, the City of Kent will consult with the Services to determine a reasonable course of action. If blow-down occurs prior to implementing a mitigation project, the City will consult with the Services to identify alternate mitigation.

*Flood Events (100 year magnitude or greater)*

**Threat Assessment:** Given the 50-year term of the ITP request, it is likely that a 50-year event (approximately 244 cfs) could occur at some time during the HCP and an event in the 50 to 100-year (276 cfs) range is possible. However, the City believes the likelihood of experiencing a larger event within the lifespan of the HCP is remote. Floods can alter the channel morphologies of streams, scour substrates and dislodge large woody debris structures within the channel. Because the flows in Rock Creek are closely linked to groundwater flow, large-scale high magnitude flood flows are rare (see Section 3.1.4 Hydrology). Nevertheless, high flow events can occur and may locally impact certain habitat conservation measures (HCMs) proposed as part of this HCP, including those related to fish passage at the mouth as well as in-channel structures.

**Preventative Measures:** The City of Kent does not plan to implement any preventative measures to reduce the risk of flood events.

**Planned Response:** Following high flood events, the City of Kent would monitor the mitigation measures to ensure they remain effective. In the event that a mitigation measure becomes ineffective following a flood event, the City of Kent will consult with the Services to develop a reasonable course of action.

*Extended Drought*

**Threat Assessment:** WAC 173-166 defines drought conditions as those conditions where a geographical area or a significant part of a geographical area is receiving, or is projected to receive, less than seventy-five percent of normal water supply. The Rock Creek aquifer is dependent upon annual precipitation for recharge. Consequently, the risk of extended drought was evaluated by examining the 1931 to 2004 precipitation record at Landsburg

where the mean annual precipitation is 56.5 inches and droughts would occur when annual precipitation is less than 42.4 inches. Over the 60-year period (excludes 14 years with missing data), 5 years could be considered drought years and two of them, 1943 and 1944, occurred as back-to-back annual droughts. Based upon the precipitation record, the City of Kent believes there is a low, but substantive risk that drought conditions could persist for multiple years during the duration of the permit. The effects of global climate change to annual precipitation levels and groundwater aquifers in the Puget Sound Region are uncertain, but local experts have suggested that winter precipitation may increase 0 to 10 percent by the middle of the 21st century, but will generally stay within the historic variability (Snover et al. 2005). The City of Kent considers any drought expected to persist for more than two years an extended drought (i.e., the Rock Creek aquifer does not recharge during successive years).

**Planned Response:** The City of Kent expects that typical drought conditions will be accommodated through the process identified in HCM-1. However, in the event an extended drought places the City of Kent at risk of being unable to meet minimum domestic, health, and fire water supply needs, the City will consult with the Services to obtain relief from HCM-1 requirements and to develop special mitigation measures to offset this relief. In addition, the City will also seek emergency drought relief from the Department of Ecology as provided by WAC 173-166.

*Toxic Spills*

**Threat Assessment**: The City of Kent stores chlorine and fluorine on site for treating the water supply. If spills of these chemicals enter Rock Creek surface waters catastrophic mortality to fish and other aquatic fauna could occur in Rock Creek and the Cedar River.

**Preventative Measures**: The City of Kent has a spill prevention and response plan designed to minimize the risk of a toxic spill entering Rock Creek.

**Planned Response**: If a spill occurs, the City will follow the spill response procedure outlined in their plan. In addition to the entities identified in the spill prevention and

response plan, the City will also contact the Services and discuss additional mitigation that may be required.

*Eminent Domain Affecting Lands within the HCP Area*

The Clark Springs Watershed HCP Area is adjacent to private land and lands whose planning and regulation authorities are controlled by other local government agencies. The land is transected by utility lines and Kent Kangley Road. It is possible one or more parties have the power to acquire or affect lands within the HCP area for the purpose of creating or extending the existing road, public utility, or other public purpose. This could occur through condemnation, or through voluntary transfer by the City of Kent under threat of condemnation. In the event lands within the HCP area are acquired or affected by any exercise of the power of condemnation, the City of Kent would not be obligated by the HCP or ITP to replace any future mitigation that would have been provided by such lands. The incidental take coverage for such lands and corresponding HCP obligations may, at the discretion of the Services, be negotiated with and transferred to the recipient of such lands.

*Permitting By State and Local Agencies*

Projects and activities within the Clark Springs Watershed may at times depend on the approval of other federal or state and local permit issuances. Should the project or activity, in whole or substantial part, fail to be implemented or operated as planned by the City due to the failure of other federal, state, or local agencies to issue necessary permits, then the City of Kent would in consultation with the Services, implement those measures that are commensurate with the level of take that occurred as a result of the project as operated up to that time and for which Kent received incidental take coverages under the permits.

#### *2.1.2.4 Changes in the Status of Covered Species*

The Services may from time to time list additional species under the federal ESA as threatened or endangered, de-list species that are currently listed, or declare listed species as extinct. In the event of a change in the federal status of one or more species, the following steps would be taken.

*New Listings of Species Covered by the Incidental Take Permit*

The ITP covers two ESA-listed species (Chinook salmon and bull trout) and seven species (coho salmon, sockeye salmon, chum salmon, cutthroat trout, steelhead trout, river lamprey, and Pacific lamprey) that currently are not listed as threatened or endangered under the federal ESA. The unlisted species covered by this HCP have been addressed as though they are listed. The ITP would take effect for listed covered species at the time it is issued. Subject to compliance with all other terms of this HCP, the ITP would take effect for any unlisted covered species upon the listing of such species.

## 2.2 National Environmental Policy Act

The purpose of NEPA is to promote analysis and disclosure of the environmental issues surrounding a proposed Federal action to reach a decision that reflects NEPA's mandate to strive for harmony between human activity and the natural world. Although NEPA requirements include an analysis of impacts to the same species as does the ESA, the scope of NEPA goes well beyond that of the ESA by considering the impacts of a Federal action not only on all fish and wildlife resources (not just those listed under the ESA), but also on non-wildlife resources such as water quality, air quality, and cultural resources. An EIS is required when the project or activity that would occur is a major Federal action with the potential to significantly affect the quality of the human environment. Issuance of ITPs are Federal actions subject to NEPA compliance. An EIS culminates in a Record of Decision. The Record of Decision will document the alternative selected for implementation, as well as any conditions that may bee required, and summarize the impacts expected to result from the action.

The City of Kent has voluntarily chosen, and the Services concur, to accomplish NEPA compliance for the HCP process through the development of an Environmental Impact Statement (EIS).

## 2.3 1996 Amendments to the Magnuson-Stevens Fishery Conservation and Management Act

The Sustainable Fisheries Act resulted in amendments and other changes to the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §1801 et seq.) that require federal agencies to consult with NMFS when undertaking actions that may adversely affect "essential fish habitat." The essential fish habitat descriptions for salmon under the Pacific Salmon Fishery Management Plan of the Pacific Fishery Management Council have recently been approved by NMFS. The essential fish habitat descriptions and recommended conservation measures are general and recognize the importance of "off-channel" salmon rearing habitat, oxbow, wetlands, and riparian vegetation that are an integral part of the HCP. The NMFS' participation in the HCP would include, as may be appropriate, Sustainable Fisheries Act review requirements.

## 2.4 State Environmental Policy Act

The State Environmental Policy Act (SEPA) (Ch. 43.21C RCW) has four main objectives as listed in the SEPA handbook (Ecology 2003a):

- to declare a state policy that will encourage productive and enjoyable harmony between people and their environment;
- to promote efforts that will prevent or eliminate damage to the environment and biosphere;
- to stimulate the health and welfare of people; and
- to enrich the understanding of ecological systems and natural resources important to the state and nation.

Keeping these purposes in mind ensures that state and local governments consider environmental issues in their decision-making processes. SEPA is similar to NEPA, which applies to federal rather than state permits. It is possible that some actions must comply with both SEPA and NEPA and related regulations.

## 2.5 Water Rights

Washington state water right laws are contained in various chapters of Title 90 of the Revised Code of Washington (RCW). Washington state allocates water rights under the appropriative water rights doctrine in which water rights are determined based on "first in time, first in right" Ch. 90.42, RCW. As described previously, several water rights are appurtenant to the City of Kent's Clark Springs System, and 8,710 acre-feet per year apply to the Clark Springs Watershed. The City is not proposing to apply for any new water rights within the Clark Springs Watershed as part of the covered actions under this HCP.

## 2.6 State and Local Regulations

Numerous federal, state, and local regulations will need to be followed as part of implementing the HCP. Among others, these will include hydraulic permits from WDFW for working within Rock Creek and Section 404 permits for working in wetlands from the US Army Corps of Engineers. During the implementation of the HCP, the City of Kent will follow all applicable regulations and obtain all applicable permits.

## 2.7 HCP Goals and Objectives

The overall goal of the HCP is to implement conservation measures designed to protect and enhance habitat of the species identified and to allow the City of Kent to continue its operations within the Clark Springs Watershed. Specific objectives of the HCP include:

- Meet all requirements of the ESA with respect to the future operation of the City of Kent's Clark Springs System;
- Meet all legal requirements for an ITP for species addressed in the HCP;
- Contribute to the conservation of unlisted species covered in the HCP and treat them as if they were listed, with the intent of reducing the potential for future listing of those species;

- Provide net benefits, compared to baseline/current conditions, for both listed and unlisted species covered by the plan, contributing to the recovery of any species that is currently listed or may be listed in the future;
- Obtain agreement that no additional commitment of resources would be required of the City of Kent if unlisted species covered by the HCP become listed during the term of the HCP, provided the HCP is being properly implemented;
- Implement scientifically and technically sound conservation measures and provide monitoring to ensure the HCP is working as intended; and
- Recognize uncertainty and incorporate management responses that are adaptive.

# 3. EXISTING CONDITION OF THE ROCK CREEK WATERSHED

## 3.1 Environmental Setting

This section describes the physical characteristics of the Rock Creek basin and the Clark Springs Watershed. Subsections include specific discussions concerning climate, geology and soils, water quality, hydrology, and land use.

### 3.1.1 Climate

The Rock Creek basin is located near the eastern edge of the Puget Sound Lowland Ecoregion (Omernik 1987). The marine waters of the Pacific Ocean influence the climate of the Rock Creek basin and Puget Sound located to the west, and the topographic effects of the Cascade Mountains to the east, which are part of the Cascades Ecoregion. Regional climate is characterized by cool, wet winters and mild, dry summers. Precipitation is mostly derived from cyclonic storms generated in the Pacific Ocean and Gulf of Alaska that move inland in a southwest to northeast direction across western Washington. Over 80 percent of precipitation falls between the months of October and April. During summer months a regional high-pressure system generally resides over most of the Pacific Northwest, which diverts storms and associated precipitation to the north.

This regional climatic pattern is modified by the presence of the Cascade Mountains, which rise to an elevation of approximately 5,000 feet at the eastern margin of the Cedar River basin. Moist, maritime air cools and condenses as it moves up in elevation from west to east, resulting in decreasing temperatures and increasing precipitation up this elevation gradient. The elevation of the Rock Creek basin ranges from approximately 405 feet above mean sea level (msl) at the confluence of Rock Creek with the Cedar River to approximately 1,000 feet msl at Sugarloaf Mountain.

Temperature and precipitation data are available from the (URL:http://www.wrcc.dri.edu), but no known weather stations are located within the Rock Creek basin other than the USGS station (12118400) installed in May 2001 within the City's Clark Springs watershed. Long

term climate information from the closest weather stations located in Landsburg, Buckley (near Enumclaw), and Palmer can be found in Table 3-1. The Rock Creek basin experiences an orographic effect due to the elevation changes that result in increasing precipitation levels from west to east (Appendix C). Additional precipitation information, obtained from the parameter-elevation regressions on independent slopes model (PRISM; Oregon Climate Service 1997), suggests that precipitation ranges from 52 to 56 inches per year in the western part of the basin and 60 to 70 inches per year in the east (Figure 3-1). Precipitation falls primarily in the form of rain, but occasional snowfall can occur during colder periods with accumulations that rarely last longer than a few days, except in the higher elevations in the eastern part of the basin. Similarly, ground freezing is relatively uncommon or short-lived.

Table 3-1. Temperatures and precipitation at three weather stations near the Rock Creek basin.

| Location | Elevation (feet) | Period of Record | Mean July Max. Temperature (°F) | Mean Jan. Min. Temperature (°F) | Mean Annual Precipitation (inches) | Mean Annual Snowfall (inches) |
|---|---|---|---|---|---|---|
| Landsburg | 540 | 1931-2003 | 76 | 31 | 57 | 10 |
| Buckley | 690 | 1931-2003 | 76 | 33 | 49 | 12 |
| Palmer | 900 | 1931-2003 | 74 | 32 | 90 | 40 |

Source: Western Regional Climate Center, 2003.

Groundwater and surface runoff during precipitation events are the major sources of water to Rock Creek. The seasonality of rainfall combined with the time required to recharge the groundwater aquifer following the dry season results in Rock Creek having most of its discharge in the winter and spring months. The climatic pattern and topography interact to determine a runoff pattern that results in wet winters and dry summers. This runoff pattern affects the availability of water for augmenting late summer/fall instream flows and municipal water supplies (see Section 3.3 below).

## 3.1.2 Geology and Soils

Detailed information on the geology and geologic history of the Rock Creek basin are provided in Appendix C. Unless specifically noted, the information provided below is derived from that document.

### *3.1.2.1 Geological History*

The Rock Creek basin is located in the southeastern part of the Puget Sound Lowland, where it transitions into the foothills of the Cascade Range. The bedrock geology consists of Tertiary volcanic and sedimentary bedrock dating from the Eocene to the Oligocene (between 24 and 37 million years old). Sedimentary rocks consist of sandstones and mudstones of the Puget Group, a series of soft and relatively easily eroded rock units that were deposited in a large coastal plain about 50 to 60 million years ago. From around 60 million years ago to 6 million years ago, repeated episodes of volcanic activity with intervening periods of erosion created the Cascade Mountains to the east of the Rock Creek basin. Rocks in the Cascades volcanic group consist primarily of andesite flows, andesitic tuffs and breccias. Volcanic deposits in the Rock Creek basin are primarily limited to isolated hills in the eastern part of the basin.

Bedrock in the Rock Creek basin is largely covered by Holocene (approximately 12,000 years ago) glacial deposits, and outcrops only sporadically throughout the basin, primarily in the vicinity of Sugarloaf Mountain to the South East and Ravensdale Ridge to the Southwest (Figure 3-2).

Episodes of glaciation in the Puget Sound lowlands began around 750,000 years ago, with glaciers up to 5,000 feet thick moving south from Canada over the underlying bedrock. Repeated glacial advances and retreats alternately deposited then compressed sediments on top of the bedrock. At its furthest extent, the Puget Sound lobe of the Vashon Glacier extended just east of Sugarloaf Mountain, covering the upper Rock Creek basin and extending up the Cedar River to the north and the Green River to the south. Repeated surges of glacial meltwater and runoff during the glacial recession coursed through the Rock Creek basin, creating large outwash channels composed of coarse, highly permeable sediments.

Evidence of these outwash channels is still visible on the surface of the current broad flat valley landforms.

#### *3.1.2.2 Physiography*

The upper Rock Creek basin consists of a flat valley floor bounded by isolated low bedrock hills to the east and west, the Cedar River to the north, and the Green River to the south. The elevation of the surrounding hills approaches 1,000 feet msl, while the Rock Creek valley floor rises from about 570 feet msl at Clark Springs watershed to around 750 feet msl at the foot of Sugarloaf Mountain. Downstream of Clark Springs watershed, Rock Creek descends the approximately 100-foot high southern wall of the Cedar River valley then flows across the alluvial floodplain of the Cedar River.

Detailed topographic mapping (5-foot contour intervals) of the basin was performed by Triathlon in 2001 to determine an accurate surface water drainage area for the Rock Creek basin based on surface topography. That mapping indicates that the surface water drainage area is 10,035 acres (approximately 15.7 square miles). In most watersheds, the surface watershed divide defines the drainage area and the vast majority of precipitation that falls within that drainage area flows downward across the local topography to surface waters that drain the watershed. Aquifers also have basin divides along groundwater divides that do not always follow a corresponding topographic divide. Consequently, precipitation that falls within a topographic basin and is absorbed into groundwater may cross the topographic divide and provide surface water within a different basin (Fetter 1994). A substantial portion of the precipitation that falls in Rock Creek is absorbed into the groundwater aquifer and flows along its hydraulic gradient. The groundwater follows channels to north towards Landsburg and the Cedar River, to the west through Clark Springs, and to the southwest towards Ravensdale Lake (Figure 3-3). Less than 8.0 percent of the groundwater flow is believed to flow through the Landsburg channel based upon groundwater modeling while 44.2 to 49.4 percent flows through the Rock Creek channel and 43.8 to 47.8 percent flows through the Ravensdale channel (Appendix D). Additional information of the groundwater and surface water hydrology of Rock Creek are provided in Section 3.1.4 and in Appendices C and D.

***Distribution of Mean Annual Precipitation***
***Rock Creek Basin***

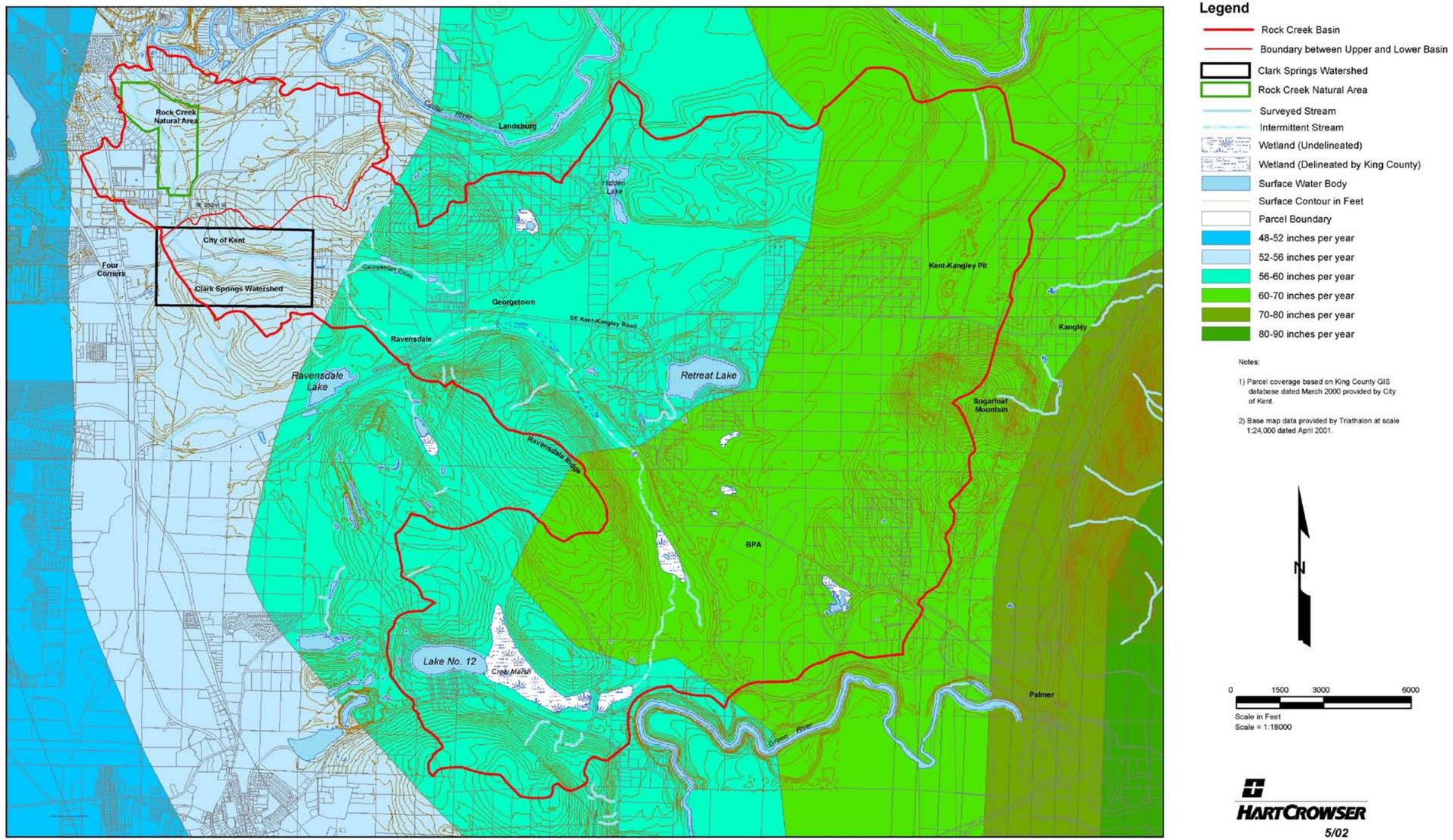


Figure 3-1. Distribution of Mean Annual Precipitation in the Rock Creek Basin.

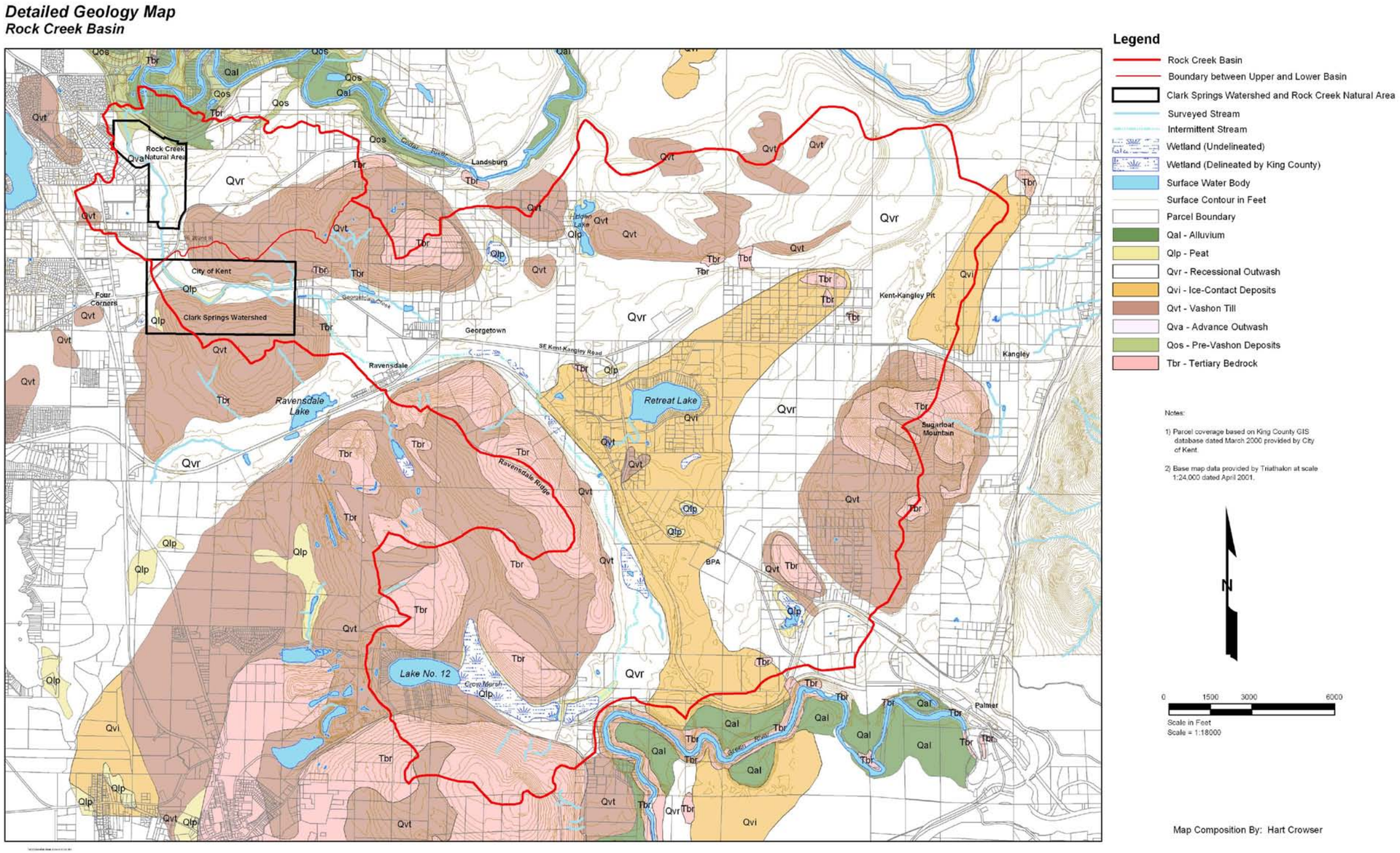


Figure 3-2. Geology of the Rock Creek Basin.

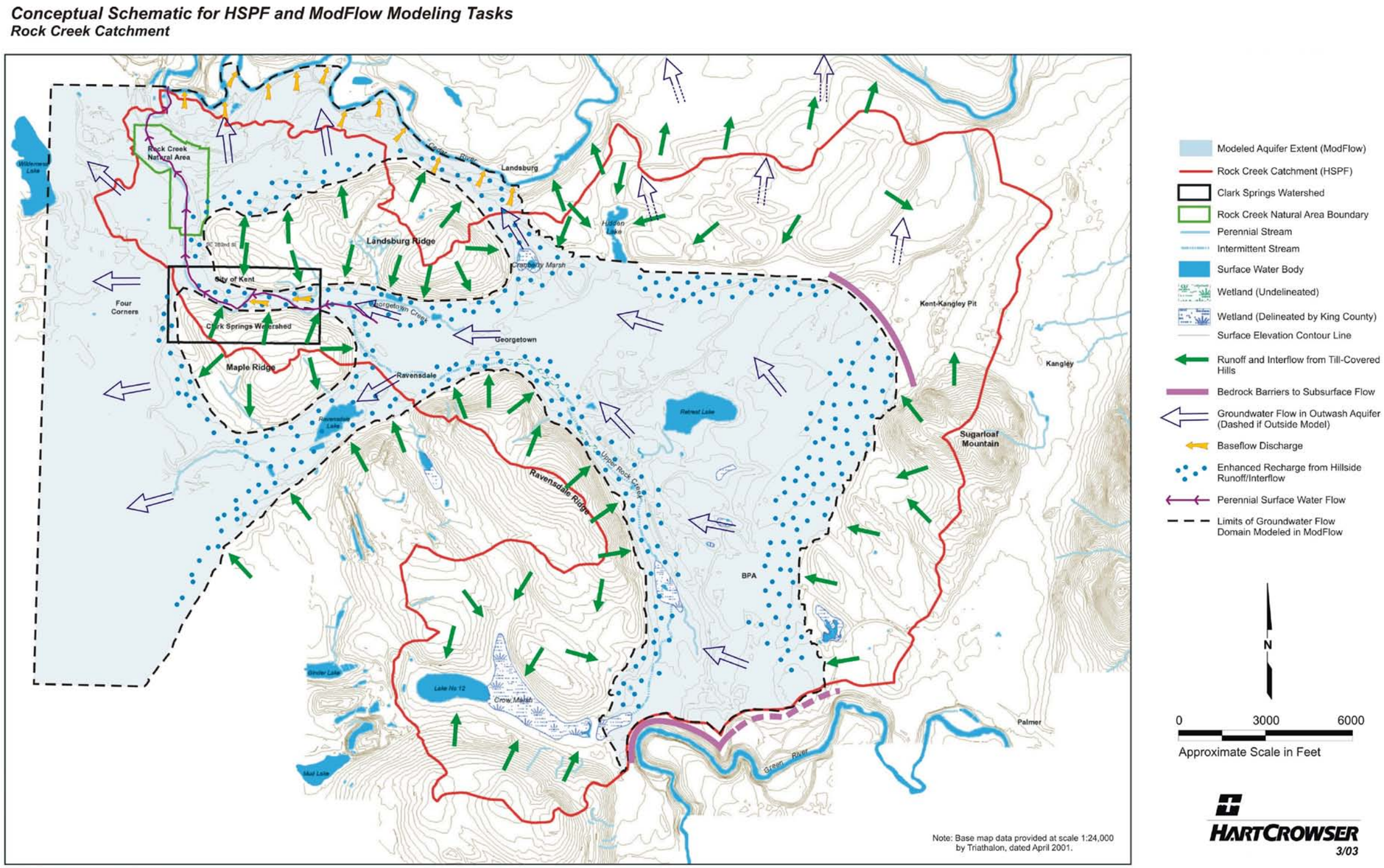


Figure 3-3. Conceptual Schematic for Surface and Groundwater Flow in Rock Creek.

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#### *3.1.2.3 Soils*

Goldin (1992) and Snyder et al. (1973) mapped soils in the Rock Creek basin that are derived primarily from glacial parent materials. Along Rock Creek and in the low gradient valley bottom areas, soils are predominantly of the Barneston series, consisting of deep, excessively well drained gravelly loam formed in volcanic ash and glacial outwash (Goldin 1992). On the higher hills, soils consist primarily of the Alderwood association; moderately well-drained soils formed on dense glacial till or soils are of the Chuckanut loam series; and deep, well drained soils formed in colluvium that are derived from sandstone. Wetland areas such as Crow Marsh in the southwest portion of the basin and around other small lakes or wetland areas are mapped as Seattle muck, which is a very deep, poorly drained soil that formed in depressions in glacial outwash plains.

### 3.1.3 Water Quality

The Washington State Department of Ecology (Ecology) has established surface water quality standards pursuant to Chapter 90.48 (Water Pollution Control Act) and Chapter 90.54 RCW (Water Resources Act of 1971). The federal Clean Water Act (CWA) stipulates the water quality standards to protect beneficial uses of water, such as swimming, fishing, aquatic habitat, agricultural and drinking water supply.

In 2003, Ecology completed the first major revision of Washington's water quality standards in a decade. The revised standards reflected the latest scientific information and new state and federal requirements. In March 2006, EPA formally disapproved parts of the 2003 revised standards and Ecology responded with further revisions. The final adoption of rule language occurred in late 2006. As of July 2006 EPA had not formally approved the revised standards; however, the Biological Evaluation (EPA 2007) submitted to the services stated its intention to do so and Ecology has begun implementing the standards.

As part of the 2006 revision, fresh water beneficial uses and criteria were reformatted from class-based standards to use-based standards. Four types of uses are recognized: Aquatic Life Uses, Recreational Uses, Water Supply Uses, and Miscellaneous Uses. The redesigned

standards allow consideration and protection of only those uses that actually can be attained in those waters under natural conditions (Ecology 2006). Under the revised 2006 standards, designated uses for the Cedar River and tributaries from RM 4.1 to the Landsburg diversion (including Rock Creek) are: 1) core salmon and trout spawning, rearing and migration; 2) extraordinary primary contact recreation; and 3) domestic, industrial, agriculture and stock water supply. Miscellaneous designated uses include wildlife habitat, harvesting, commerce and navigation, boating and aesthetics. Table 3-2 summarizes the 2006 standards. Additional information on individual criteria that are relevant to aquatic habitat is presented in Sections 3.1.3.1 through 3.1.3.5.

In addition to the use standards described above, Ecology also identifies specific waters that require supplemental spawning and incubation protection for salmonid species (Ecology 2006b). Rock Creek has been identified as a salmonid spawning area and is required to meet salmon and trout spawning criteria. This criteria applies a 55.4°F (13°C) 7-Day Average Daily Maximum (7-DADMax) temperature standard to Rock Creek between September 15 through June 15 to protect spawning and incubation.

Section 303(d) of the federal Clean Water Act requires states to identify and list threatened and impaired waterbodies. The purpose of the 303(d) listing is to identify waterbody segments that are not expected to meet state surface water quality standards after implementation of technology-based pollution controls. Every 2 years, Ecology prepares a list of these “water quality limited” waterbodies and submits them to the U.S. Environmental Protection Agency (EPA) for their review and approval. The list that is currently referred to in writing permits, the 1998 Section 303(d), was approved in January 2000. No portions of Rock Creek were listed as impaired on that list. The draft Washington State Water Quality Assessment, including the 2002/2004 Section 303(d) list was available for public review from November 3 to December 17, 2004. No portion of Rock Creek was proposed for listing as impaired on the 2002/2004 Section 303(d) list.

Table 3-2. Water quality standards intended to protect aquatic life uses that are applicable to Rock Creek under the 2006 Ecology implemented Water Quality Standards.

| | **2006 Ecology Water Quality Standards (WAC 173-201A)** |
|---|---|
| Temperature | Shall not exceed 60.8ºF (16ºC) 7-day average of the daily maximum temperatures (7-DADMax) for Core Summer Salmonid Habitat.<br>Shall not exceed 55.4ºF (13ºC) 7-DADMax between September 15 to June 15 for supplemental spawning and incubation protection. |
| Dissolved oxygen | Shall exceed 9.5 mg/L. |
| Turbidity | Shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when the background turbidity is more than 50 NTU. |
| Total Dissolved Gas | Total dissolved gas shall not exceed 110% of saturation at any point of sample collection. |
| pH | Shall be within the range of 6.5 to 8.5 with a human-caused variation within a range of less than 0.2 units. |
| Bacteria (fecal coliform) | Not to exceed a geometric mean value of 50 colonies/100 ml and not have more than 10% of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 ml. |

A range of anthropogenic impacts including agriculture, forestry practices, stormwater runoff from urbanized areas, and contaminated sediments and groundwater from industrialized areas can potentially affect water quality in Rock Creek. Specific water quality data for temperature, dissolved oxygen (DO), turbidity, fecal coliform bacteria, and metals and toxics levels in Rock Creek are discussed in detail later in this chapter.

The Landsburg Mine, a coalmine that operated from 1959-1975, is located within the Rock Creek basin just up stream of the Clark Springs watershed. The collapsed trench of the mine was used to illegally dispose of 4,500 55-gallon drums and approximately 200,000 gallons of oily sludge from 1969-1978. Wastes disposed of in the trench include, but are not limited to: paint, solvents, heavy metals, oily water and sludges. The City has spent considerable time and resources reviewing documents and commenting on the cleanup of the site since the early 1990s due to the close proximity of the site to Clarks Springs. Landsburg Mine was

ranked as the highest potential contaminant source to Clark Springs System in the City's Wellhead Protection Program adopted by the Kent City Council on February 15, 2000.

#### *3.1.3.1 Temperature*

As a general rule, surface water or creek temperatures above 15.5ºC (60ºF) are limiting for coldwater fish, such as salmon and steelhead, and also contribute to low DO, another potentially limiting water quality parameter. It is also thought that high water temperatures can affect the movement of migrating adult salmonids, particularly during August and early September and may affect salmon egg viability and survival (Caldwell 1994).

Stream water temperature is influenced by water source, elevation, aspect and canopy cover. Large wetlands that have shallow water depth and lack overhead cover may have a warming effect on downstream water quality if they have a direct surface connection. The influence of wetland inflows is related to the size of the wetland and the path to the stream. If wetlands only have subsurface connections to streams, the thermal heating input would be very low since groundwater or hyporheic stream flows generally tend to cool surface water temperatures.

Although there are numerous wetlands in the headwaters of the Rock Creek basin, most are not directly connected to the stream during the late summer, when the vulnerability to temperature increases is highest. Instead, Rock Creek is fed primarily by groundwater, which tends to have a cooling effect on in-stream water temperature during the warm summer months.

As previously noted, Rock Creek is designated as core summer salmonid habitat under the revised 2006 State Water Quality Standards (Ecology 2006). Under the revised rules adopted by Ecology and currently being considered by the EPA, the annual 7-day average daily maximum temperature (7-DADMax) shall not exceed 16ºC. In addition, a criterion of 13ºC 7-DADMax applies to Rock Creek over the period from September 15 through June 15 to protect spawning and incubation. The revised 2006 standards establish that the criteria are only expected to be met nine out of every ten years on average.

The City of Kent has collected water temperature data in Rock Creek since 1997. Spot measurements collected from Rock Creek within the Clark Springs watershed on an approximately monthly basis between June 1997 and December 2001 documented no instances of water temperatures in excess of 13ºC. Continuously recording temperature monitors were used to periodically monitor water temperature in Rock Creek at the flume just upstream of Kent-Kangley road (RM 1.83) in 1999 and 2002 (City of Kent, unpublished data) (Figure 1-2). Between October 7 and December 2, 1999 the maximum water temperature recorded was approximately 9.8ºC on October 7 and October 13. Between June 1 and September 21, 2001, the maximum average daily temperature at Kent-Kangley Road was approximately 10.4ºC on August 31 and approximately 12.7ºC at 248th Street on August 13. Between August 1 and October 10, 2002, the maximum temperature recorded was approximately 10.2ºC on August 16.

In the summer of 2004, continuous temperature recorders were installed at four locations in Rock Creek, and in the Cedar River up and downstream of the confluence with Rock Creek. Maximum daily water temperatures in Rock Creek were less than 16.0ºC throughout the measurement period at all Rock Creek Stations (Figure 3-4). The highest 7-DADMax recorded at any station in Rock Creek was 14.9ºC (July 27) near the confluence with the Cedar River. Water temperatures tended to increase moving downstream (Figure 3-4); the maximum temperature recorded at Kent-Kangley road was 12.9ºC, while the maximum temperature recorded in Rock Creek near the confluence was 16.0ºC.

Rock Creek appears to at times have a slight cooling effect on temperatures in the Cedar River; mean daily water temperatures at the temperature recorder along the left bank in the Cedar River were up to 0.5ºC cooler about 130 feet downstream of Rock Creek than upstream during the early summer. However, by the end of July temperatures downstream of Rock Creek were slightly higher, despite the fact that Rock Creek inflows were typically 1ºC to 3ºC cooler than the Cedar River. Rock Creek inflows typically represent a small percentage of the Cedar River flow in the summer. Consequently, the cooling effect of Rock Creek is likely to be localized around the mouth of the creek.

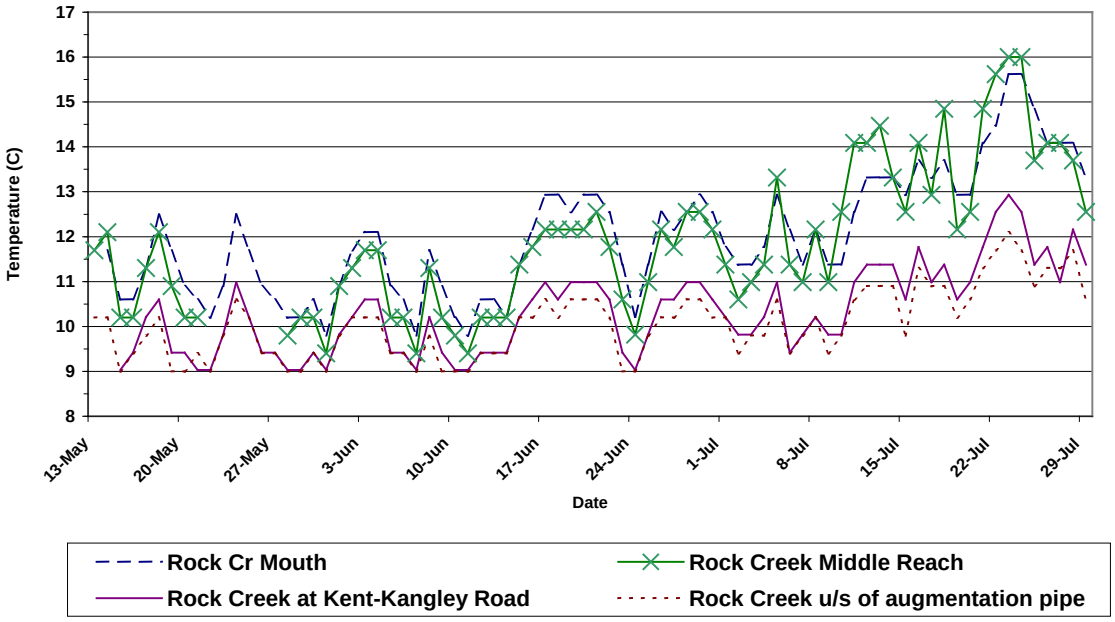



Figure 3-4. Maximum Daily Water Temperature at Three Locations in Rock Creek during 2004.

### *3.1.3.2 Dissolved Oxygen*

Dissolved oxygen (DO) levels in streams are not generally a concern due to high re-aeration rates in turbulent flowing water. However, DO levels of groundwater sources generally tend to be lower than for surface water sources (Edwards 1998). Dissolved oxygen concentrations in streams may also be adversely influenced under special cases where the decomposition of high levels of organic matter results in high oxygen demand; in areas supporting very warm stream temperatures; in shallow, slow-moving stream environments (<1% gradient); or at the location a wetland discharges to a stream. Because Rock Creek is fed by a combination of groundwater and wetland sources, DO levels might be expected to be lower than in other tributary streams. DO data are limited for Rock Creek, but measurements taken on a weekly basis from February 4 through August 2, 2005 (range: 9.3 to 12.1 mg/L) suggest that DO levels are at or close to saturation values (minimum 81.3% saturation).

Dissolved oxygen can be severely limiting to aquatic organisms, and species differ in their abilities to tolerate low DO levels. Since DO levels in clean waters are inversely related to temperature, low DO levels have the highest potential to occur during periods of high temperatures. Low DO can impair successful migration by fish and may affect reproductive success, especially during periods when eggs and alevins are within the gravel strata. The state standard for DO for Class AA waters is 9.5 mg/L. Given the relatively cold year-round water temperatures that occur in Rock Creek resulting largely from groundwater influence and the increased capacity of cold water to store dissolved oxygen, it is likely that DO levels would largely remain at or above the state standards. However, two DO measurements taken during February 2005 were at or below the 9.5 mg/L standard.

Turbidity varies naturally in response to stream flows and sediment inputs. Turbidity is generally highest during storm events when surface runoff contributes water to the stream channel. Turbidity effects may be most pronounced during the first storms of the season as fine sediments that have accumulated during low flows are flushed downstream.

There are few specific data on the effects of turbidity on fish, although studies have documented impacts of high levels of turbidity on salmonids related to gill abrasion, as well as reduced feeding by juvenile fish (Sigler et al. 1984). Newcombe and Jensen (1996) developed a general conceptual model of fish response to suspended sediments. That model suggest that adverse effects to fish as a result of high turbidity may occur through exposure to short-duration, extreme high concentrations or from chronic exposure to moderately high concentrations. State water quality standards for turbidity are generally focused on preventing increases relative to natural background conditions and do not include specific numeric thresholds.

The City of Kent has collected water quality data in Rock Creek since 1997. Spot measurements of turbidity were collected from Rock Creek within the Clark Springs watershed on an approximately monthly basis between June 1997 and December 2001; the highest turbidity level documented by those measurements was 1.36 Nephelometric

Turbidity Units (NTUs). The median measured turbidity (of 57 samples) was 0.47 NTUs over a range of flows from 1.8 to over 36 cfs (the flow at which the Parshall Flume overflows). Examination of a plot of turbidity versus flow suggested no relationship between these variables. The results of those measurements suggest that turbidity levels are generally low (most likely related to its strong influence by groundwater) and would not likely limit salmonid populations in Rock Creek.

#### *3.1.3.3 pH*

The City of Kent has periodically measured the pH monthly in Rock Creek from June 1997 to August 2002. Spot measurements of pH in Rock Creek within the Clark Springs watershed indicated a range from 5.3 to 7.9, with a median value of 6.9. Of the 56 samples taken, eight had a pH of less than 6.5. Six of the eight occurred from December 1997 and July 1998.

#### *3.1.3.4 Fecal Coliform*

Fecal coliform are not generally considered to adversely affect aquatic biota. State water quality standards for fecal coliform are aimed at preventing adverse effects to recreation or water supply beneficial uses. Few data on fecal coliform are available for Rock Creek. The City of Kent collected and tested five samples between October 9, 2001, and September 18, 2002, as part of the Wellhead Protection Program (WHPP). The highest fecal coliform concentration measured in those samples was 16 colonies per 100 ml, and the geometric mean of the five samples was 7.6 colonies per 100 ml. These values are well below the existing or revised 2003 water quality criteria (Table 3-2).

#### *3.1.3.5 Metals and Toxics*

Rock Creek was not listed on the state's 1998 303(d) list or the preliminary 2002/2004 303(d) list for metals or toxics. The preliminary 2002/2004 303(d) list included all waterbodies for which data were available, and categorized those water bodies as:
1) meeting state standards; 2) water of concern (some evidence of water quality problem, but not sufficient to require a Total Maximum Daily Load (TMDL) determination; 3) no data; 4) polluted, but no TMDL required; and 5) polluted with TMDL required. If no data are

available (i.e., Category 3), the water body is not listed individually. If the waterbody is not on list, it is assumed to be Category 3. As Rock Creek is not listed on the 2002/2004 list, it is therefore assumed to be a Category 3 waterbody.

From 1997 through 2002, as part of the WHPP, the City periodically tested Rock Creek at the Clark Springs facility for metals and toxics. The 21 samples analyzed (City of Kent, unpublished data) during that period documented no exceedances of the maximum contaminant levels for drinking water established by EPA (EPA 2002). Parameters monitored included antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc. Of these parameters, only 3 measurements taken during the 21 sampling dates had values that were higher than the detection limits. These measurements include cadmium at 0.004 mg/L on March 9, 2000, iron at 0.06 mg/L on July 18, 1998, and manganese at 0.022 mg/L on December 11, 2001. The cadmium concentration taken on March 9, 2000 exceeds the Washington State surface water quality standard for cadmium at the measured level of water hardness (Ecology 2006a). The water supply operations at Clark Springs should not affect these ambient water quality parameters.

### 3.1.4 Hydrology

The flow regime of Rock Creek is influenced by both surface water and groundwater sources and is thus quite complex. The groundwater drainage patterns are in some cases markedly different from the surface drainage patterns. The following sections provide a brief overview of the surface and groundwater hydrology of the Rock Creek basin. Additional technical detail is contained in Appendix C - The Hydrogeology of Rock Creek (Hart Crowser 2003a); Appendix D - Rock Creek Basin Groundwater Flow Model (Hart Crowser 2003b); and Appendix E - Hydrologic Analysis of the City of Kent Clark Springs Water Supply Operations in the Rock Creek Catchment using the HSPF Model (MGS 2005). Unless otherwise noted, material presented below was derived from the Appended Technical Reports cited above.

#### *3.1.4.1 Surface Water*

Rock Creek has a surface catchment area of 10,035 acres (approximately 15.7 square miles). Surface water bodies in the Rock Creek basin include Rock Creek and its tributaries as well as a number of small lakes (Figure 1-4). Lake 12 and Retreat Lake are the largest lakes, and are located in the upper basin. Although Ravensdale Lake is located just outside the Rock Creek basin, the source of water is the Rock Creek basin and it is an expression of the local water table. Most of the information summarized in this section is drawn from Appendix C (Hydrogeology Report). The physical attributes of the larger lakes and their relationship to Rock Creek are summarized below.

Lake 12, located in the southwest corner of the Rock Creek basin, has a surface area of 43.2 acres. The maximum depth of Lake 12 is 28 feet. Lake 12 is the headwaters of Rock Creek. Outflows from the Lake flow east and pass through a large wetland known as Crow Marsh. At RM 7.37, Rock Creek discharges from Crow Marsh through a culvert below 290th Avenue SE and enters another wetland. Flow in this wetland goes subsurface (is lost to groundwater) for extended periods except during high flows when the area becomes flooded. The outlet stream from Lake 12 through Crow Marsh also reportedly goes dry at times during the summer. Several small tributaries drain into Rock Creek from the upper basin. Flow in these tributaries is intermittent, occurring only during wet periods. From RM 7.2 to around RM 2.7, surface flow is often completely lost to groundwater, thus the stream is largely dry except during high flow periods (Appendix C). Interestingly, the Green River flows through a gorge located just south of both Lake 12 and Crow Marsh, and yet Rock Creek drains north, away from the Green River. From around the early 1960s through 1997, a diversion canal routed an unknown amount of flow from Crow Marsh to the Green River. That canal was blocked by King County in 1997. Additional information on this groundwater-surface water interaction is provided in Section 3.1.4.2.

Also of interest, the USGS 1993 revision of the 7.5-minute Cumberland quadrangle shows upper Rock Creek draining to Ravensdale Lake while lower Rock Creek originates in the Clark Springs Watershed. The topography in the area near Georgetown and Ravensdale is

relatively flat and it is possible that road building and urbanization could have affected the surface hydrology in the area, but little historic data or information is available to verify past changes in the channel configuration.

Additional uncertainty in the historical hydrography of Rock Creek is provided by the 1973 revision of the Maple Valley 7.5 minute quadrangle that suggests Rock Creek flowed east from Reach 2 joining the Cedar River approximately 1,500 feet upstream of the current confluence. However, maps from 1897 and 1900 suggest the current location is similar to its location during that early time period. Given the valley configuration and direction of flow in the Cedar River, the 1973 alignment appears unlikely and would most likely have occurred only if Rock Creek had intersected a former side channel of the Cedar River. Natural channels rarely flow upstream into mainstem rivers.

Retreat Lake is perched on ice-contact deposits with a low permeability that separate it from the underlying groundwater system. The surface outflow from Retreat Lake flows across glacial till a short distance and quickly infiltrates once the surface flows reach the recessional outwash. There is no direct surface connection between Retreat Lake and Rock Creek.

Hidden Lake is a shallow lake/wetland that varies in size seasonally in a flat depression northeast of Ravensdale. Hidden Lake is hydrologically isolated and does not have a direct surface connection to Rock Creek.

Although it is located outside of the surface catchment of Rock Creek, Ravensdale Lake merits mention because of its critical role in interbasin groundwater loss, an important aspect of the hydrology of the Rock Creek system that will be described in more detail in Section 3.1.4.2. Ravensdale Lake is a groundwater-fed lake with a surface area of 18-acres and currently no direct connection to Rock Creek. The surface of Ravensdale Lake is an expression of the water table.

Perennial flow in Rock Creek generally begins just east of the Clark Springs watershed property near RM 2.80 (near the 262nd Avenue SE bridge), just upstream of the confluence with Georgetown Creek. Georgetown Creek is the largest tributary to Rock Creek. Flow in Georgetown Creek appears to originate 0.7 miles east of the confluence with Rock Creek, and is intermittent, occurring only under wet conditions.

Downstream of RM 2.7, Rock Creek generally flows west then north, joining the Cedar River at RM 18.15. One small tributary stream joins Rock Creek within the City of Kent watershed property, entering from the north near RM 2.51. No other major tributaries join Rock Creek downstream of RM 2.5.

Stream flow data for Lower Rock Creek (RM 0 to RM 2.7) are available from a number of gage locations (Table 3-3). A detailed stream flow analysis and description of each gage is provided in Appendix C. A brief description of the overall Rock Creek flow regime is provided below.

Table 3-3. Summary of gage stations and available data for Rock Creek, a tributary to the Cedar River in western Washington.[1]

| Gage Name | Location | Period of Record | Gage Type |
|---|---|---|---|
| USGS No. 12118500 Rock Creek near Maple Valley | RM 0.15 | 1945-1973 | Stage recorder |
| | | May 2001- present | Continuous recorder |
| King County gage 31L | RM 0.15 | 1994-1997 | Stage recorder |
| | RM 0.28 | 1997-present | |
| USGS No. 12118300 Rock Creek near Ravensdale | RM 1.58 | 1956-1958 | Continuous recorder |
| USGS No. 12118400 Rock Creek at Kent-Kangley Road near Ravensdale | RM 1.82 | 1956-1962 | Continuous recorder |
| USGS No. 12118400 Rock Creek at Kent-Kangley Road near Ravensdale | RM 1.82 | May 2001-present | Continuous recorder at Parshall Flume |
| Clark Spring flume | RM 1.82 | 1969-April 2001 | Parshall flume |

[1]Note that USGS gage 12118000 Rock Creek diversion near Landsburg was located on a different Rock Creek located on the north side of the Cedar River.

Hydrologists use a variety of flow statistics to describe flow regimes. These can include peak flow, mean annual flow, 7-day average low flow, recurrence intervals, and exceedance flow values. Peak flow is the highest flow observed during a year. Mean annual flow is the average flow based upon the flow from each day during the year. Mean annual flow is an indicator of the annual water yield. The 7-day average low flow is the lowest 7-day running average of daily flows calculated over the year. A 7-day running average is used because it has been found to be more biologically relevant than the lowest single-day flow value to represent base flow levels.

Recurrence intervals and exceedance flow values are inter-related. Exceedance flow values are generally calculated from mean daily values and provide the probability that flows exceed a given amount during a specified time period. For example, an 80 percent exceedance value of 1.1 cfs for the first week of October means there is an 80 percent probability that flows would be higher than 1.1 cfs. Similarly a 50 percent exceedance value of 1.3 cfs means there is a 50 percent probability that flows would be higher than 1.3 cfs. A 50 percent exceedance value can also be considered the median flow. Recurrence intervals are calculated from the exceedance value and provide an indicator of the long-term statistical frequency of an event occurring. A 10 percent exceedance value would equate to a 1 in 10 year recurrence interval. Exceedance values are useful when data are not normally distributed (i.e., bell curve), which is generally the case with hydrologic data. When data are not normally distributed the mean value may not be a “typical” value because extreme events can have a large influence on the mean. In these circumstances the median is often more representative of the “typical” condition.

### *Peak Flows*

Stream flows in Rock Creek follow the same general pattern as other streams in Puget Sound Lowlands. Flows are highest in the late fall and winter (November through March), then gradually decline through the spring and summer and are lowest in September and October (Figure 3-5). High flows in Rock Creek are generally the result of heavy rainstorms during the months of October to February. The highest peak flow recorded in Rock Creek to date was 221 cfs on March 6, 1972. Floods with a recurrence interval of 50 and 100 years were

estimated to be 244 cfs and 276 cfs respectively (Sumioka et al. 1997). Although development has been noted to increase peak flows in other Puget Sound basins (May et al. 1997), modeling conducted for Appendix C suggests that existing development in the Rock Creek basin has not substantially affected peak flows. This is due in part to the relatively limited level of development (total impervious area < 5%) as compared to other Puget Lowland streams, and in part to the fact that surface runoff generated by impervious surfaces in the Rock Creek basin flows onto the highly permeable surrounding soils and infiltrates to recharge groundwater rather than being delivered to surface streams.

#### *Mean Annual Flow*

The mean annual flow of Rock Creek at USGS gage 12118500 is reported as 19.0 cfs based on available data collected for water years 1956 to 1972 and 2002 (USGS 2005). The USGS gage 12118500 was not in operation from October 1, 1973 to April 30, 2001. Analyses conducted for Appendix C tested the consistency of data at that site. The results of those analyses show a reduction in mean annual flow in around 1965 or 1966, from 21.0 cfs to 16.4 cfs. A similar reduction in basin water yield of around 6 cfs was also noted. The analysis concluded that the apparent reduction was not attributable to a reduction in precipitation. The reduction occurred around the time that a diversion channel that routed flow from Crow Marsh to the Green River was constructed (circa early 1960s), as well as the start of water withdrawals by the City of Kent.

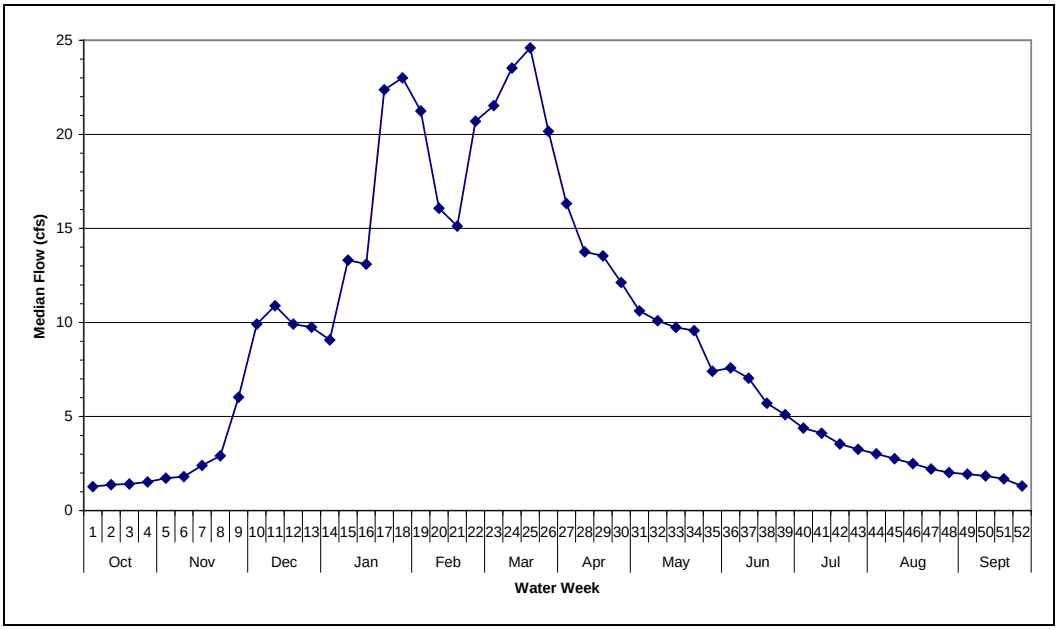



Figure 3-5. Median daily flow by water week at the Parshall Flume based upon data from 1986 to 1998.

### *Low Flows*

The lowest flows of the year typically occur from mid-September to early November just prior to the onset of the fall rains. The mean daily flow of approximately 6.0 cfs (median 5.7 cfs) in September and October is relatively stable based on a 37-years of record (water years 1946 to 1965, 1966 to 1973, and 2007 to 2009 from USGS gage 12118500). An analysis of low flows estimated that prior to 1966, a period when withdrawals at Clark Springs were 0.0 to 0.5 cfs, the mean annual seven-day low was 4.7 cfs (median 4.5 cfs), and ranged from 1.5 to 6.7 cfs (n=20). The 1966 to 1973 data, a period when withdrawals ranged from 3.6 to 8.0 cfs, exhibit a mean annual seven-day low of 1.6 cfs (median 1.3 cfs). During the most recent period, 2001 to 2009, the mean annual seven-day low flow was 1.6 cfs (median 1.5 cfs) and similar to the 1966 to 1973 period.

### *3.1.4.2 Ground Water*

As described in Section 3.1.2, the unique geologic features of the Rock Creek basin, primarily the large amount of glacial outwash above bedrock, have a major influence on the hydrology of Rock Creek. The highly permeable recessional outwash channels that extend

across the basin in a generally east to southeast direction form shallow surficial aquifers that serve as preferential groundwater flow paths. Rainfall and surface runoff across the permeable recessional outwash deposits rapidly infiltrates and recharges the aquifer. The less permeable underlying bedrock forms an effective base for the shallow aquifer system, providing a boundary that prevents deeper absorption of groundwater.

Groundwater generally flows north from the Crow Marsh area and southeastern portion of the basin eventually combining with groundwater flows from the east in the larger outwash channel that runs through the Ravensdale area (Figure 3-3). A substantial amount of groundwater flows (approximately 44 to 48%; Appendix D) down the Ravensdale outwash channel and out of the Rock Creek basin. Groundwater remaining in the aquifer continues to flow north then westward into the lower Rock Creek valley. The proportion of groundwater flowing into the lower Rock Creek valley varies seasonally with approximately 49 percent flowing that direction during the winter months and approximately 44 to 46 percent flowing that direction during the summer months.

In the upper basin, the water table in the highly permeable outwash is generally subsurface and thus many areas of the creek are dry during substantial portions of the year, except during extremely wet periods. As a result precipitation and surface flow in Rock Creek that originates in Lake 12 infiltrate to the aquifer. Near the eastern end of the Clark Springs watershed, the glacial outwash deposits are narrower and thinner due to the underlying bedrock geology, which also acts as a “pinch point,” forcing groundwater flow to the surface where the perennial flow of Rock Creek begins (Figure 3-6).

From the Clark Springs watershed, groundwater flows north along the lower Rock Creek valley and west towards Lake Wilderness. In this area the shape and topography of the underlying bedrock and the densely compacted glacial till deposits that pre-date the glacial outwash sediments control surface and groundwater flows. The glacial till captures the surface flow in this area while the groundwater levels are generally below the level of Rock

Creek as it becomes perched above the aquifer. Due to this geology, groundwater contributes little if any additional flow to lower Rock Creek below Clark Springs.

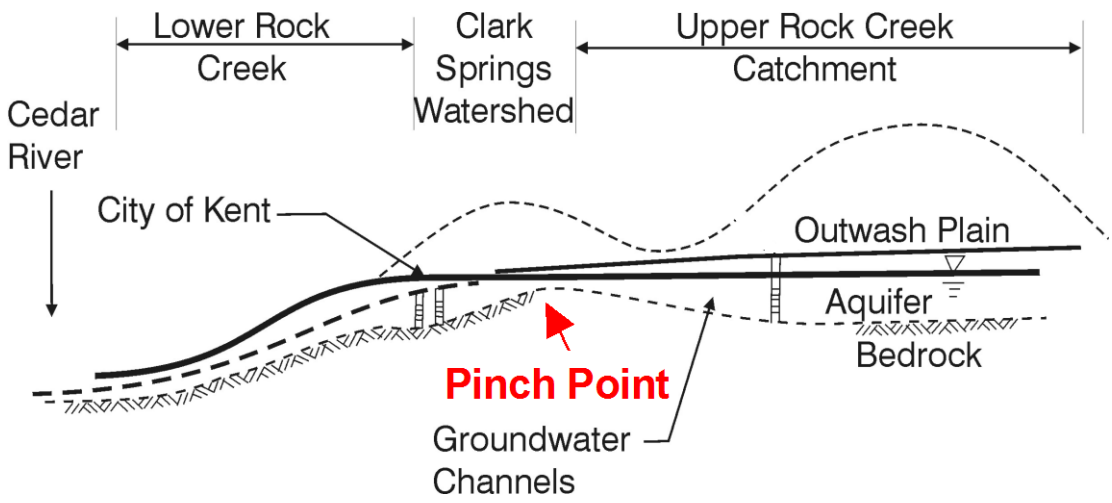



Figure 3-6. Schematic cross-section of the Rock Creek Basin.

Groundwater levels in local wells clearly reflect seasonal recharge. Recharge in the fall is fairly rapid, followed by a long period of recession as water stored in the fall and winter is released through the spring and summer. The general pattern of groundwater levels is similar to seasonal variations in stream flow, and seasonal groundwater levels reflect antecedent rainfall amounts: wet winters result in particularly high groundwater levels and dry winters result in reduced rates of groundwater recharge.

#### *3.1.4.3 Groundwater-Surface Water Interactions*

In stream systems associated with unconfined surficial aquifers (i.e., aquifers where surface water can percolate directly into the groundwater), two types of flow conditions are often observed (Figure SWM-8 from Dunne and Leopold). When the groundwater surface is equal to or higher than the streambed elevation, groundwater flows into the channel and the stream is said to be "gaining." When groundwater levels are lower than the streambed

elevation, water from the streams soaks into the ground, and the stream is considered to be "losing." Under some stream channel substrate conditions, surface water can become perched despite the fact that the groundwater level is lower than the streambed elevation. Under these substrate conditions, when groundwater levels are high water can seep into the stream laterally from the channel edges. However, when ground and surface water levels are low, the impermeable channel bottom prevents the surface waters from seeping vertically into the groundwater (Figure 3-7). Surface and groundwater interactions may change spatially (varying between stream reaches) as well as seasonally (varying over time).

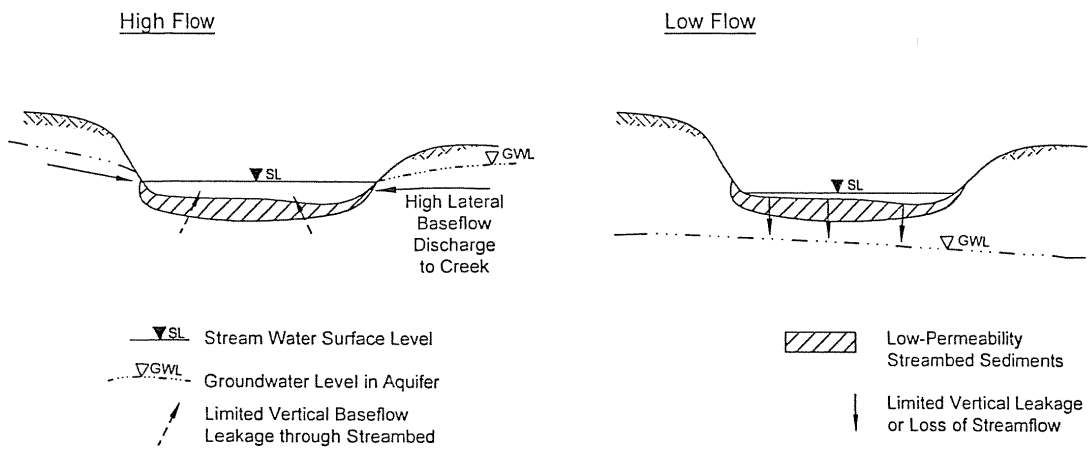



Figure 3-7. Conceptual model of Rock Creek downstream of Clark Springs during high and low flow periods.

Rock Creek exhibits three distinct hydrologic regimes that are the result of groundwater - surface water interactions. Stream flows in the intermittent upper Rock Creek depend primarily on groundwater levels. Overall, this section of Rock Creek is generally a "losing" stream, serving as a source of recharge to the underlying groundwater. However, there are areas that have perennial wetlands (e.g., Crow Marsh and near Brathvode property at approximately RM 4.8). In the winter, groundwater levels rise rapidly in response to heavy

fall rains. If precipitation is sufficient to raise groundwater levels to the level of the streambed, surface flows occur. Wetlands and other low spots are the first to exhibit surface flows, which may not be continuous along the stream course.

Because of changes in the aquifer characteristics and underlying bedrock described above, the section of Rock Creek below RM 2.8 is typically a "gaining" stream reach year-round. The natural springs east of the Clarks Springs watershed represent the headwaters of perennial flow. It is important to note that only a portion of the groundwater flow in the aquifer becomes baseflow in Rock Creek; the remainder continues to flow subsurface through the aquifer. In summer, when groundwater levels in the aquifer are low, perennial flow originates at the "pinch point" approximately 1 mile upstream (east) of the Clark Springs Supply system. In winter, when groundwater levels are higher, perennial flow in Rock Creek begins farther east.

Downstream of the Clark Springs System near RM 1.95, Rock Creek flows north through a slightly incised valley. Low gradient wetland reaches appear to be underlain by glacial till, which in turn lies above a layer of advance glacial outwash. In this area well logs suggest that the aquifer is contained mainly with the advance outwash and is separated from Rock Creek by a layer of glacial till. As a result, the lower section of Rock Creek neither gains nor loses substantial amounts of flow, although small seasonal gains or losses may occur as a result of local geologic variations.

Operation of the City of Kent's Clark Springs System does affect groundwater levels and surface flows in Rock Creek, however the interaction between surface water, groundwater, and water withdrawals is complex and highly variable depending on the aquifer levels and precipitation patterns that are occurring. The effects of these operations are discussed further in Appendix C and in Section 3.3.

### 3.1.5 Land Use

The Clark Springs Watershed, which is geographically separate from the City (Section 1.1), was annexed to the City of Kent in 1958 for municipal water supply purposes. The City of Kent has no control of land use regulations beyond the 320 acre Clark Springs property. King County controls most of the land use regulations in the Rock Creek Basin except for a small portion of the lower Rock Creek basin, which falls within the jurisdiction of Maple Valley (Figure 1-1). The Urban Growth Line is the western edge of the Clark Springs watershed and generally follows the municipal boundary of Maple Valley. Ravensdale, a small unincorporated, town is located within the basin approximately 1 mile east of the Clark Springs watershed boundary.

Existing land use within the Rock Creek basin is predominantly rural residential and forestry, with some mining, though some businesses such as Bremmeyer Logging Company and a small general store are located in Ravensdale. Some small pockets of medium residential development are present in the Ravensdale area. In the lower basin within the City of Maple Valley, medium and high-density residential areas, a small industrial area and a school are present. The lower portion of Rock Creek (RM 0.25 to RM 1.10) flows through the Rock Creek Natural Area, which was acquired by King County in 1995. In addition, a significant area was dedicated permanent open space through the King County 4:1 open space program with the development of the Maple Ridge Highlands subdivision located just south of the Clark Springs watershed.

The King County Comprehensive plan proposes little change keeping with the rural residential and forestry land use designations. As an example of this strategy, an agreement was reached in 2005 with the Plum Creek Timber Company to maintain 1,600 acres of forestland along Ravensdale Ridge in timber production, effectively restricting this area from future development (Welch 2005). In addition, the portions of the City of Maple Valley within the Rock Creek basin are nearly built out according to current zoning ordinances.

An evaluation by May et al. (1997) indicated that approximately 84 percent of the Rock Creek basin was undeveloped; the remainder consisted of developed areas (6%), low density rural residential development (7%), commercial and industrial areas (2%) and suburban (1%). The total impervious area in the Rock Creek basin was 3.2 percent (May et al. 1997). A more recent evaluation concluded that the Rock Creek basin had a total impervious area of 5.0 percent in 2001 (Simmonds et al. 2004).

## 3.2 Structural and Operational Setting

The Clark Springs System is located south of Kent-Kangley Road within the Clark Springs watershed. This 320-acre property is largely fenced on the south side of Kent-Kangley Road and is geographically separate from the City of Kent proper. It was annexed to the City of Kent in 1958 for municipal water supply purposes. The balance of the area falling outside of Kent's annexed property is bounded and regulated by the City of Maple Valley on the west, and unincorporated King County to the north, south, and east.

The Clark Springs System is used on a continuous basis throughout the year and is comprised of three (3) separate, but conjunctively managed primary sources and/or water rights: Clark Springs (Trench) Infiltration Gallery, Rock Creek Surface Water Diversion, and Clark Springs Wells. Among these three (3) water rights/sources, only the Clark Springs Wells/water rights – which are the most junior water rights, are subject to a state-based minimum flow limitation (i.e., Rock Creek). Each of these three (3) rights/sources draw upon the same shallow aquifer source (Qvr) and are in hydraulic continuity with each other.

Given the close hydraulic connections among these sources, Kent has found it most effective from a production and environmental protection standpoint, to operate these sources in a conjunctive manner. Put another way, the Clark Springs System sources are operated as a wellfield, whereby the instantaneous (Qi) and annual (Qa) withdrawals of the System are limited to the cumulative totals allowed under the combined Clark Springs System surface water, springs, and groundwater rights (i.e., 5,400 gpm - Qi, and 8,710 af/yr - Qa).

This section describes the major structural components that comprise the Clark Springs System and how the three water supply sources are conjunctively operated. The majority of materials contained in this section are excerpted from (Appendix C).

### 3.2.1 Structural Facilities

The major structural components of the Clark Springs System include an infiltration gallery that delivers water from the Clark Springs Trench and Rock Creek Surface Water diversion to a clear well that is then linked into the City of Kent's transmission main. Water pumped from the Clark Springs Wells bypasses the clear well and is directly transmitted to the transmission main immediately downstream of the clearwell. The City's 24-inch transmission pipeline follows Kent-Kangley Road down to a 6 million gallon (MG) reservoir in the City. The production rates from the infiltration gallery are between 2,200 and 3,400 gpm (4.9 to 7.6 cfs). Daily flow measurements have been recorded by the City since 1985. The long-term average production rate from Clark Springs, including flows from both the infiltration gallery and wells is approximately 2,800 gpm (6.2 cfs) (see Figure 1-6).

Structurally, the infiltration gallery consists of perforated pipes laid perpendicular to the main direction of flow through the aquifer (Figure 1-2). The pipework is laid with an invert level of approximately 548 feet MSL, which is approximately 18 feet below ground level. The infiltration gallery consists of 273 feet of 16-inch diameter and approximately 500 feet of 12-inch diameter perforated pipe (slotted well casing) laid in a bed of gravel. Although only limited construction details are available, it appears that the gallery pipework has ample open area for the amount of water intake under normal gravity. The system usually flows steadily under gravity at a rate of around 2,200 to 3,400 gpm (between 4.9 and 7.6 cfs). Changes in flow rate are driven by operational fluctuations in the transmission line backpressure and by changes in groundwater level. There is a seasonal change in groundwater level at the gallery of up to 5 feet. Higher gravity flows are typically recorded during the winter when a higher driving head is available at the gallery.

The transmission pipeline from the Clark Springs System has a capacity of about 3,700 gpm (8.2 cfs) under gravity flow (URS 1985) and a full storage reservoir (designated 6 MG #1 or the James Street Tank) in the City of Kent. During the summer months, additional downstream inputs to the transmission line (from other City of Kent sources - Seven Oaks and Armstrong Springs Wells) may reduce the gravity-flow capacity from the Clark Springs System to between 2,200 and 2,800 gpm (4.9 and 6.2 cfs).

Under pumping conditions, the transmission pipeline from the Clark Springs System has a capacity of about 5,400 gpm (12 cfs) with an applied head of around 170 feet (URS 1985). When the applied head of the well pumps exceeds that of the clear well, a check valve on the transmission main closes and all flow is then from the wells.

### 3.2.2 Clark Springs Trench

The Clark Springs Trench is a certificated (Certificate No. 3107-A: Supplemental), spring-based water source with an authorized instantaneous quantity (Qi) of 2,250 gpm and an annual quantity (Qa) of 1,350 af/yr, and is supplemental to Clark Springs Well Right Cert. No. 7660. The water right has a priority date of 1957. The water right's purpose of use is for "municipal purposes" and the designated place of use is the "Area served by the City of Kent." The right was initially issued as a primary right and perfected as such. In 1969, the authorized Qi and Qa became subject to the total Qi and Qa limitation established in Clark Springs Wells right (G1-7660-A) described below. This source of supply is not, however, subject to the instream flow limitations set for the Clark Springs Wells.

The Clark Springs Trench, which is located within the Clark Springs watershed, is a primary component of the Clark Springs System. The water intake facilities are located in the mid-westerly part of the watershed at an elevation of approximately 548 feet. Water is collected in the infiltration gallery that is constructed of approximately 773 feet of perforated steel pipe placed perpendicular to the aquifer flow, across a narrow valley of glacial till, and extending under the streambed.

The design of the Trench infiltration gallery allows the simultaneous withdrawal of water under the Trench water right as well as the Rock Creek surface water right. This design also allows Kent, when appropriate, to limit diversions allowed under its Rock Creek surface water right (although use of this right is not subject to minimum instream flow conditions). In such circumstances, the production of instantaneous and annual quantities authorized under the Rock Creek surface water right may be voluntarily reduced and shifted to the Trench source. This conjunctive management approach assists the City in meeting system demands in a reliable and continuous manner, while protecting instream flow conditions in Rock Creek.

The Clark Springs Trench collection system and transmission line were constructed in 1957 and allow the collection of water underground at an approximate depth of 10 to 20 feet. Water collected by the infiltration gallery system has been determined by the City of Kent's hydrogeologic studies (Appendix C) to come from the Qvr aquifer, which is the same aquifer source used by the City of Kent's Clark Springs Wells, as well as the Kent Springs Water System and Armstrong Springs Wells at a lower hydraulic gradient.

### 3.2.3 Rock Creek Surface Water Diversion

The City of Kent's Rock Creek Surface Water Diversion is a certificated (Certificate No. 7232-A-Supplemental), surface water source with an authorized primary Qi of 2,250 gpm (5 cfs). As a pre-1964 surface water right, no Qa limitation is assigned to the water right, although the City has established through beneficial use, a Qa for this right in the amount of 3,600 af/yr which is supplemental to Clark Springs Well Right Cert. No. 7660. The Rock Creek water right has a priority date of 1931. The right's purpose of use is for "domestic/municipal supply" and the designated place of use is the "City of Kent." The right was initially issued as a primary right and perfected as such. In 1969, the authorized Qi and Qa became subject to the total Qi and Qa limitation established in the Clark Springs Wells water right (G1-7660-A) described below. This source of supply is not, however, subject to the instream flow limitations set for the Clark Springs Wells.

Rock Creek is the City's only direct surface water source. The "intake structure" for this source is constructed as an extension of the 16-inch Clark Springs Trench infiltration gallery piping, and is a 12-inch diameter steel pipe that extends under the Rock Creek channel (Figure 1-2).

As noted earlier (see Rock Creek Resource Protection Program), the City of Kent monitors stream conditions to protect fish and related aquatic habitat and to substantially minimize/avoid potential adverse operational effects. During low flow events or seasonal conditions, the City may meet its current demand requirements by shifting its withdrawal of authorized quantities to its Clark Springs Trench infiltration gallery, which is required so as not to exceed water right limits.

As noted above, the Clark Springs Trench infiltration gallery and the Rock Creek Surface Water Diversion system are capable of withdrawing over 4,000 gpm. Through the conjunctive management of these two sources, the City is able to meet current demands within the combined authorized withdrawal limits of its Rock Creek and Clark Springs Trench infiltration gallery water rights.

### 3.2.4 Clark Springs Wells

Clark Springs (Wells) is a certificated (Certificate No. 7660-A), primary groundwater source with an authorized Qi of 5,400 gpm, and a Qa of 8,710 af/yr from three (3) wells (Figure 1-2). The Clark Springs Wells water right has a priority date of 1969. The right's purpose of use is for "municipal purposes" the designated place of use is the "area served by City of Kent." The limits identified for the Clark Springs Wells water right defines the total Clark Spring water supply available to the City of Kent for withdrawal.

The three Clark Springs Wells are located in close proximity to and within the same property as the City of Kent's Rock Creek and the Clark Springs Trench infiltration gallery source, as described above. Each of the three wells is drilled and screened to an approximate depth of 30 to 60 feet; the wells tap the same Qvr aquifer as the Clark Springs Trench infiltration

gallery source that discharges to Rock Creek. All of the wells have 16 to 18-inch diameter casings and screens, and a combined production capacity of 5,400 gpm. The individual wells (numbered #1, #2, and #3) have a capacity of 900, 1,800, and 2,700 gpm respectively.

Because of their hydraulic continuity with Rock Creek, the operation and beneficial use of the Clark Springs Wells is conditioned on ensuring the maintenance of the following instream flows: 15 cfs from January 1 - April 30; 15 cfs on May 1 decreasing arithmetically to 2 cfs by June 30, 2 cfs from July 1 through October 31, 15 cfs from November 1 through December 31. ***These minimum instream flows limitations only apply when the Clark Springs Wells are pumping.*** A Parshall Flume was installed in Rock Creek to measure flow conditions and with funding from Kent the USGS has recently installed a continuous monitoring station. Kent also has the means to discharge untreated water into Rock Creek from its pumping station to ensure minimum flows are maintained during periods of pumping.

As a result of minimum flow conditions associated with this right, and seasonal (summer) declines in the static water level of the source aquifer level, which Kent believes may involve development impacts upon the local recharge area, exempt wells, and upland degradation of riparian habitat, Kent has encountered difficulty in sustaining the pumping levels required to meet peak demands. The periodic inability of the Clark Springs Wells to sustain their authorized instantaneous withdrawal rates currently affects the City's ability to meet its reliability/emergency standby supply requirement, and, unless resolved, is expected to impair Kent's ability to meet existing and projected peaking demands.

### 3.2.5 Flow Augmentation System

In 1997, the City installed a streamflow augmentation system that allows the return of up to 900 gpm (2.0 cfs) to Rock Creek. This system operates by pumping water from the infiltration gallery Clearwell in the Clark Springs System facility to Rock Creek after aeration (Figure 1-3). The water available for discharge is subject to hydrologic conditions affecting the infiltration gallery. Consequently, the pumping capacity of the augmentation system is subject to the amount of flow from infiltration gallery and the depth of water in the

Clearwell. This system, which is authorized by the City's Clark Springs groundwater rights, has been operated periodically since September 1998 to voluntarily augment creek flows at or above 3 cfs. The City is proposing to continue its low flow augmentation program as one of the formal Habitat Conservation Measures (HCM) required under this HCP (see Chapter 4).

### 3.2.6 Operational Constraints

There are a number of operational constraints that the City of Kent must consider when evaluating existing and future water supply needs. These include long-term constraints, system-wide constraints, and constraints directly on the Clark Springs System.

#### *3.2.6.1 Long Term Constraints Based on Demand*

The City has evaluated 12 plus years of supply data from the recent past, with data from 1992 through present, to produce a history of reliable or proven water supply from the City of Kent Water system. By analyzing the 12 plus years of supply data, Kent has been able to develop a record of monthly variations in water supply, and estimate the reliability of those groundwater sources of supply. This period of time included cyclic weather patterns and variability in water system demand, as well as aquifer changes and response to withdrawals. It therefore forms the basis for a somewhat consistent water supply projection that is reasonable and as reliable as possible for the City of Kent.

The monthly and annual reliable supply estimate was then compared to the monthly and annual demand projections from the City of Kent's Comprehensive Water Supply Plan, beginning with demand projections for 2005 and progressing yearly through 2043 (Appendix G). This is the estimated date of build-out for the City's water system using a number of factors and estimates in the planning and projection of city growth. Importantly, demand and growth will not stop in 2043, but changing business demands and elevated construction/density of buildings will cause continued increases in demands, albeit at a slower rate than earlier projections up through 2043.

The comparison has shown that in 2005, the City of Kent water system supply was lagging behind projected demands by approximately 10 to 20 percent, spread evenly throughout the year. Re-occurring years of drought, declining aquifers, well failures, water right limitations, and other constraints have limited the system supply in the past five to ten years. Through aggressive conservation, mandatory watering restrictions, and careful management of existing water supplies, as well as an unanticipated downturn in the economy and the resultant commercial building vacancy rates, the City has been able to meet the system needs without the purchase of emergency water in all but the worst years of drought.

*Over-Pumping*

One concern with using the analytical approach cited above is that there have been years when deep aquifers have been over-pumped to meet the system demands. Often it is necessary to rest or lessen the pumping from these aquifers for one to several years to allow them to recover, shifting the demand to other sources. In other instances, wells have been historically pumped harder in the summer months and then allowed to recover through the winter and spring months to be recharged for the next summer months demands. To meet the future demand needs by shifting water supply timing and also to meet the proposed mitigation measures outlined in this HCP, it may be necessary to pump a well harder in the fall and winter months, and then again in the following spring season, thereby not allowing full recharge of the aquifer, with the resultant lessening of water supply reliability.

*Tacoma - Second Supply Project*

The City of Kent is planning for the completion of the Second Supply Project (SSP), which began construction in 2000, with the final installation of the associated transmission pipeline, water treatment; water storage and fish bypass components. Completion of all of these essential components is expected in 2008, at which time the SSP partners in the project will be able to store their share of project water in the reservoir behind the Howard Hansen Dam. The City of Kent's share of storage and transmission capacity is approximately 3,850 acre-feet, or 12.64 MGD in the period from June through September. An analysis of more than 20 years of historical turbidity levels in the Green River system by Tacoma has shown

that the months of July and August have not had turbidity events that would make this supply unusable because of turbidity levels above 3.5 Nephelometric Turbidity Units (NTU). The months of June and September are more marginal, with periodic instances of unusable water supplies because the turbidity levels are high enough to create uncertainty about the effectiveness of disinfection, or cause customer concerns due to turbidity levels.

For the benefit of Tacoma's direct end customers, the Tacoma Green River Supply System, under Tacoma's first diversion water right, is designed to mix highly turbid surface water from the Howard Hansen storage reservoir when it exceeds 3.5 NTU with groundwater from nearby wells at the Tacoma Headworks, which dilute the turbid surface water so that it remains below a turbidity of 3.5 NTU before it enters Tacoma's water distribution system. The Department of Health has set an MCL threshold of 5 NTU for water entering a distribution system, and the 3.5 NTU trigger that Tacoma uses allows a safety cushion for the water system to prevent them from becoming non-compliant and being required to issue a boil water notice to their customers. In contrast to the City of Tacoma's customers, the water supplied to Kent as part of the SSP does not have access to the water used for dilution and/or blending by Tacoma (under its first diversion water right), therefore Kent can only use water from the SSP and the second diversion water right system when turbidity levels stay below 3.5 NTU. The months of October through May are historically much more likely to have significant turbidity above 3.5 NTU, and that will preclude the use of SSP water by Kent as a reliable source of supply during those months.

When the SSP water supply was brought into the Kent supply/demand analysis for 2008, a portion of Kent's summer water demand was offset by the addition of the stored water from the SSP system. The water supply capacity from several of Kent's deep aquifer sources was then shifted forward in the year to meet the projected demands of the water system in 2008. Much of the supply deficit projected in 2007 was met by shifting this water supply to a time earlier in the year, and the projected deficit was also met in the month of October. There remained a deficit of approximately 32 million gallons in November and 17 million gallons in December 2008, which was unmet by any reliable supply available to Kent. As described

earlier, there is uncertainty associated with using wells, especially deep wells, during periods falling outside of historic past use, because of the effects on full aquifer recharge and reliability in the following season(s).

Continuing this evaluation for each year through 2016 and progressively shifting supplies forward more and more each year to meet growing demands of the system, creates more and more of a deficit in the months of October, November and December. In approximately 2017, the deficit begins to show in May as well. In 2019, the deficit appears in September, and as the years' projections progress, the deficit begins to appear in each month, finally appearing as a shortfall in every month but June during 2024. In the final analysis for 2043, the total deficit is approximately 6,500 acre-feet spread throughout the year, with the largest shortfalls occurring in October, November and December. This is primarily because all of the supply from the deep well sources has been moved to the first 6 months of the year to meet projected demands and SSP water provides the bulk of the supply in June, July, August and September, with only shallow aquifer supplies available for the months of October, November and December.

#### *3.2.6.2 System-wide Constraints – Timing Sources to Provide More Water at Clark Springs*

The City of Kent supply and demand projections are based on an annual yield projections from Kent sources based on historical supply quantities. All water rights and claims in the State of Washington are based on annual and instantaneous consumption, beginning with each new calendar year. As such, many of the City's sources are constrained by the annual yield of water up to the water right quantity of the individual source. As more of the source water is used to meet demands earlier in each year, less of the remaining water can be used for fall and winter demands, creating increasingly larger deficits in the fall and early winter months. In a similar fashion, sources with a limited quantity of water available, constrained by source capacity, would be used to meet the initial demands of the water system, and then be allowed to rest and recover their capacity for the following season. Without careful analysis and data gathering over a number of years to predict what the effects will be under adverse conditions, there is inherent risk with attempting to shift water withdrawals to

periods that are unproven and there is the potential to reduce reliability and yield of any given source.

#### *3.2.6.3 Clark Springs Constraints*

As described in Sections 3.1.2 and 3.1.4, the Clark Springs aquifer is dependent upon rainfall recharge during the late summer and early fall to increase the daily yield available for surface flows in Rock Creek and Kent's water supply. A unique characteristic of the Rock Creek aquifer that constrains the Clark Springs operations is the very high aquifer transmissivity that does not allow storage of groundwater. Peak annual precipitation leaves the basin in a matter of a few months, though Rock Creek is a perennial stream from approximately the eastern boundary of the Clark Springs property. Another constraint is the unique groundwater divide that shunts a significant portion of the groundwater out of the basin to drainages other than Rock Creek. Each of these reduces or constrains the quantity of water available in a reliable fashion for the operation of the Clark Springs System and amount of flow that can be dedicated to flow augmentation.

### 3.2.7 Potential Operational Deficit Solutions

Over the past twenty-five years, the City of Kent's population and land base have significantly expanded. Further growth is projected over the next forty years as population density increases within the City of Kent's existing water system boundaries, resulting in an approximate doubling of the city's current water service area population.

As a matter of law, the City has an on-going responsibility to plan for and develop the water supplies necessary to meet its projected population growth, as well as to maintain and protect the viability of its existing sources. Within recent years, however, meeting these responsibilities has become a significant challenge due to a combination of factors that include: the seasonal and development-based impacts on source aquifers, the increasingly stringent and dynamic regulatory environment governing water supply, water quality, and water rights; and the ESA listing of species in an urbanized setting. The State's Growth

Management Act also limits development by requiring cities to have adequate water supplies prior to additional development.

In its efforts to meet the challenges posed by both the natural and regulatory environment, the City of Kent has made, and will continue to make, significant investments in conservation, source rehabilitation, and the development of new sources of supply as summarized below. It is expected that the development of new sources will not change the City's reliance on the Clark Springs system for their water supply needs.

#### *3.2.7.1 Surface Water Rights*

The Green and Cedar rivers are subject to minimum instream flow rules and/or agreements that effectively preclude all new surface water withdrawals beyond those occurring during high flow winter months. Since the City of Tacoma secured a flow-restricted, seasonal water right on the Green River for its Second Supply/P-5 project in the 1980s, no further surface water applications have been approved by Ecology due to on-going concerns relating to flow levels, cumulative impacts, and tribal treaty rights. Moreover, because streams tributary to the Green and Cedar rivers have been closed by administrative rule to further appropriation, Ecology has not entertained the issuance of new primary rights for these surface waters for several years. Due to the foregoing factors, and the ESA, development of new surface water rights is not considered a reasonable or viable supply alternative.

#### *3.2.7.2 Acquisition of Existing Rights*

State water law allows the transfer of existing rights to new places of use and purposes of use if such actions do not impair existing rights and do not create new, adverse effects upon pre-existing aquatic habit, flow and water quality conditions. Given the difficulty in securing new ground and surface water sources within the Green River basin, the City of Kent has explored the potential of securing existing water rights within the vicinity of its service area that are still valid and could provide water of sufficient quality and quantity to be of value to the system.

With the exception of a defunct trout farm with a questionable water right, no water rights could be identified within a reasonable distance of the City's service area which were still active and/or not subject to relinquishment due to lack of use. This alternative is therefore not considered a reasonable or practicable alternative to the City's supply problems.

#### *3.2.7.3 Water Right Changes*

Water right changes include a variety of options, including changes in place of use, purpose of use, and to the point of diversion or withdrawal of water, as well as the addition of points of diversion or withdrawals.

There are three potential sites within the water system for which a water right change could be feasible. The first is a well located at the Blue Boy reservoir site. Water rights from smaller wells believed to tap the same aquifer, may be transferred to the Blue Boy Well. It is believed that the well is capable of producing up to 400 gpm. However, this is dependent on an aquifer analysis that would need to be performed to determine the long-term yield, as well as the total water rights for the site. The second site that may benefit from this option is the Armstrong Springs site. A portion of the water rights for the Kent Springs site, believed to be in the same aquifer, would be transferred to the Armstrong Springs site for an additional well(s). Currently, it is not known if additional well(s) are a feasible option at the Armstrong Springs site, or the volume that could be produced from these well(s). Therefore, additional testing is needed to validate this option.

The third site is a small existing well located at the City's Earthworks Park, approximately 200 gpm, with an uncertain annual yield amount without further testing. Because of the uncertainty remaining around these sites, at this time, this alternative is not considered a practicable solution to the City of Kent's supply problems. Furthermore, as indicated previously, these potential water sources would not reduce the City's reliance on the Clark Springs system for their water supply needs because of the projected increase in demand within their service area.

#### *3.2.7.4 Regional Supply Purchases*

Assessing the viability of acquiring water supply from adjacent and regional supply systems has been a constant feature of the City of Kent's water supply planning and system operations. The City has in the past acquired firm, annual supply, via existing interties, from the cities of Tukwila and Renton, and Highline Water District (Water District 75). However, because of demand occurring within the respective service areas of these cities/systems, the provision of supply has been suspended or limited to emergency supply.

Aside from the systems described above, Kent has examined opportunities with other regional purveyors to acquire new, firm, annual supply. That investigation has focused on the City of Auburn, City of Tacoma, City of Seattle (Seattle Public Utilities) and the Cascade Water Alliance.

*Seattle Public Utilities (SPU)*

SPU had approached the City of Kent to discuss the opportunity and terms under which the City could secure a bridge supply of water that could assist in meeting its summer peaking needs until the SSP/P-5 project is on-line and providing water to the City's system. Since that time, the City has drilled four replacement wells that have enhanced the reliability of its dependable supply. In addition, the City of Kent constructed an emergency intertie with Soos Creek Water and Sewer District that provides the opportunity to receive Seattle water via bridging across Soos Creek's distribution system.

*Cascade Water Alliance*

The Cascade Water Alliance (CWA) is a consortium of King County cities and water districts. Its members include the cities of Bellevue, Issaquah, Kirkland, Redmond, Tukwila, Covington Water District, Sammamish Plateau Water and Sewer District, and Skyway Water and Sewer District. The CWA was formed in response to SPU's notice that it would not renew its current agreement to existing customers in 2012. Shortly after its inception, the CWA commenced negotiations with SPU to assume responsibility for the distribution of

SPU water to the purveyor community post – 2012. In addition, CWA continues discussions with Tacoma Public Utilities and Seattle Public Utilities for additional supply purchases.

The CWA is pursuing the Lake Tapps water right currently held by Puget Sound Energy. This transfer of water right ownership and use is currently being challenged in the court system. Even if the CWA is successful in obtaining the water right, no domestic water is anticipated from this source until the mid 2020s. With the CWA's dependence on purchasing water from other utilities, it is not considered a potential source of supply.

### *City of Auburn*

The City of Auburn is located directly south of the City of Kent. Based on its Water System Plan (1995) Auburn has sufficient water supplies to meet projected demand until 2015. In 1996, Auburn executed interruptible supply agreements with two adjacent systems (i.e., Covington Water District and Water District 111) totaling 1-5 mgd. Under the terms of this agreement, should Auburn succeed in securing new primary water rights, the interruptible supplies may be converted to firm supply. If, however, Auburn fails to secure new rights, the water may be called back in 2006 or earlier to meet the City's projected municipal demand. Unfortunately Auburn's pursuit of acquiring those new, primary water rights in its Valley Production Aquifer has proved to be unsuccessful.

### *City of Renton*

The City of Kent has conducted negotiations with the City of Renton to acquire 1-2 mgd of interruptible "bridge" supplies. The need for such "bridge" supplies was necessary because the proposed SSP/P-5 Tacoma project was not expected to deliver supply on either an annual or seasonal basis until 2005 and now 2008 at the earliest. No agreement was reached and negotiations with the City of Renton are no longer underway.

### *City of Tukwila*

The City of Tukwila has recently contacted the City of Kent to discuss the possibility of the City of Kent supplying water to Tukwila with the potential to distribute some of the water to other CWA members. Therefore, water availability from Tukwila is not considered a viable option by the City of Kent.

### *Lakehaven Utility District*

The Lakehaven Utility District and City of Kent discussed a "bridge" supply through a potential intertie that would provide the City with an interim supply of up to 2 mgd. The supply would have remained interim until 2008 when flows from Tacoma's second supply pipeline would be available to the City. No action was taken as result of the discussions. However, Kent has submitted a letter of interest in participating in the development of its OASIS aquifer storage project over the next 20 years.

### *City of Tacoma: Second Supply Pipeline Project (P-5)*

The SSP/P-5 project would provide Tacoma a second supply pipeline and divert water from the Green River for local as well as regional benefit. The P-5 water right is subject to strict instream flow limitations set through negotiations with the state and the Muckleshoot Indian Tribe. Accordingly, even if the project was built today, it could not provide reliable, firm annual supply. To provide such supply, Tacoma must increase the storage capacity of Howard Hanson dam. The City completed necessary infrastructure improvements to receive TSSP water in 2008.

In 1985, the City of Kent contracted with Tacoma Public Utilities (TPU) to purchase 7.2 mgd of summer peaking water from the proposed SSP/P-5 project. This volume was increased to 12.64 mgd in 2002 when the City agreed to purchase one-fourth of Seattle's share after Seattle was no longer a participant in the project. The remaining portion of Seattle's share was purchased by other participants in the project. To this end, and in reliance on the Ecology-approved water right and place of use documents issued to Tacoma,

the City has expended substantial financial resources on the SSP/P-5 project. The SSP/P-5 source of supply is considered critical to Kent's ability to meet near and long-term demand needs.

Although Kent's share of the TSSP water has increased, this source remains subject to intermittent, seasonal precipitation, flow inputs, and flood management constraints which affect the quantity and quality of water available for storage behind Howard Hanson Dam. These limitations contribute to variability in the time of delivery to the City, which in turn affects the reliability of this source. For the City of Tacoma's water supply only, the North Fork Wellfield water supply system is used to begin to dilute highly turbid surface water from the Howard Hanson storage reservoir when it exceeds 3.5 Nephelometric Turbidity Units (NTU), and ramps up to fully dilute the turbid surface water to avoid exceeding the Washington Department of Health's (DOH) Maximum Contaminant Level (MCL) threshold for turbidity of 5 NTU's. The City, and the other junior project partners, do not have access to groundwater from the North Fork Well field at the Tacoma Headworks and so will not receive the water used for dilution; therefore, during periods of fall, winter, and spring turbidity, the TSSP becomes unavailable to Kent and the other project partners.

An analysis of more than 20 years of historical turbidity levels in the Green River system shows that turbidity levels during the months of June, July, and August have been reliably below MCL levels, with occasional exceedances of the normal turbidity levels following precipitation events. Turbidity levels in the Green River during the months of September through May have been shown to be more likely to be above MCL thresholds. Based on these historical turbidity levels, the City of Kent would not reliably expect to receive water supplied by the TSSP other than during the months of June through August, with some potential for interruption even during those months.

Although the City of Tacoma is now proposing to construct a facility to filter its TSSP surface water source to remove cryptosporidium and reduce algae, manganese, and turbidity, the proposed filtration plant has yet to be designed, permitted, or constructed. Once

constructed, in an effort to reduce costs, TSSP yield will be constrained by a filtration capacity that will be capable of filtering only a portion of the system capacity during turbidity events. As a result, the City's TSSP supply will still be subject to intermittent and/or variable flows, particularly during fall and winter months. Under any circumstance, filtration of the TSSP surface water will have little effect on the variability of the TSSP water that can be predictably stored and released by the Howard Hanson Dam for use by the City of Kent and other TSSP partners.

In addition, for authorized storage of the annual water supply for the TSSP partners behind the Howard Hanson Dam, the downstream fish passage improvements must be funded and built by the US Army Corps of Engineers. To date, Congress has only partially funded the downstream fish passage improvements.

For these reasons, water supplied to the City by the TSSP would not be able to meet the City's water demand needs for the months of September through May, thereby allowing the City to reduce its water withdrawals from Rock Creek during low-flow periods of October, November, and December.

### 3.2.8 Conservation Measures

The City of Kent has an ongoing Water Conservation Program that was initiated on June 1, 1993, with the passage of Resolution 1361. The City of Kent is proposing to continue and as necessary update its Conservation Program as one of the HCMs in this HCP, and therefore details of the plan are presented in Chapter 4.

## 3.3 Biological Setting

Fish species that are candidate, proposed, or listed under the ESA (Chinook salmon, bull trout, steelhead trout) and which could potentially be affected by the operation of the City of Kent's Clark Springs System as well as by certain Habitat Conservation Measures (proposed in this HCP), are covered in this HCP. Other species covered by the HCP (coho salmon, sockeye salmon, chum salmon, coastal cutthroat trout, Pacific lamprey, river lamprey) are

those considered to have the greatest likelihood of utilizing Rock Creek and of being listed under the ESA in the future.

This section provides a brief description of the nine fish species covered by this HCP, as well as a general description of other fish species found in the project area, and a general characterization of terrestrial wildlife and plant species that also are found or frequent the project area.

### 3.3.1 Fisheries

The historical fisheries habitat within the lower 2.8 miles of Rock Creek is presumed to have been excellent for anadromous salmon and trout, resident trout, and other coldwater species native to the area. However, specific documentation of historic conditions and the presence of fish and fauna are limited. Recently, native stocks of Chinook (episodic presence) and coho salmon, steelhead and cutthroat trout have been documented to utilize Rock Creek (MCS Environmental 2003; R2 Resource Consultants 2005a). A small kokanee (landlocked sockeye) population is believed to have been historically present in the Cedar River, which could be indicative of a historic anadromous population as well (Anderson 1997). The current sockeye salmon population was built through introduction of Baker River stock to the basin during the 1930s (City of Seattle et al. 1999). An electrofishing survey performed during August 2002 identified the presence of coho salmon, trout (cutthroat and unidentified cutthroat or rainbow trout), sculpin, and one unidentified lamprey (MCS Environmental, unpublished data). Although they have not been observed, it is possible that bull trout occasionally utilize Rock Creek. Bull trout are located in the upper Cedar River Watershed above Masonry Dam, located at RM 35.7, and outmigrants or juveniles may be occasionally flushed downstream. However, no populations of bull trout have become established below Masonry Dam and only one bull trout sighting has been documented in the reach downstream of Landsburg recently (City of Seattle et al. 1999). Bull trout have also been observed to migrate upstream through the Ballard Locks and utilize Lake Washington (designated as critical habitat by the USFWS), and perhaps the lower Cedar River for foraging, migration, and overwintering habitat (70 FR 56212). Consequently, the possibility

exists that bull trout may stray into Rock Creek. In addition to salmonids, warm water fish species also inhabit the project area. King County (1993) has indicated that unidentified warm-water fish have been observed in Hidden Lake (Figure 1-4). However, it is unclear if conditions are suitable for maintenance of a persistent warm-water fish community. Jones and Stokes (1993) reported the Washington Department of Fisheries had collected 3 crappie (*Pomoxis* spp.) in Rock Creek during surveys conducted in 1982, but the exact location of these surveys is not known. The Cedar River flows into Lake Washington, which contains a number of warmwater fish species including largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), yellow perch (*Perca flavescens*), sunfish (*Lepomis gibbosus*), black crappie (*Pomoxis nigromaculatus*), and brown bullhead (*Ameiurus nebulosus*), as well as a number of species of minnows (Cyprinidae) (Edmondson 1991).

Most of the nine species proposed for coverage (Table 1-1) under this HCP are anadromous, but several also exhibit resident freshwater life history phases. The anadromous salmonids include Chinook and coho salmon, steelhead, coastal cutthroat, and bull trout. Resident salmonids proposed for coverage include rainbow and cutthroat trout, and bull trout. Other anadromous species proposed for coverage are Pacific and river lamprey (*Lampetra tridentatus, L. ayresi*). More detailed information on the life history characteristics and stock status of each of the eight species are discussed in Appendix A, *Life Histories of Species of Concern*.

#### *3.3.1.1 Chinook Salmon (Oncorhynchus tshawytscha)*

Chinook, also referred to as king salmon, are the largest of the Pacific salmon species (Wydoski and Whitney 2003). They are differentiated into two juvenile behavioral forms, ocean-type and stream-type, based on their pattern of freshwater rearing. Juvenile ocean-type Chinook salmon migrate to the marine environment during the first year of life, generally within 3 to 4 months of emergence (Lister and Genoe 1970). Juvenile stream-type Chinook salmon rear in fresh water for a year or more before outmigrating to the ocean (Figure 3-8). Within these two migrant designations many subtype variations have been

Figure 3-8. Likely freshwater life history periodicity of sockeye salmon, coho salmon, and Chinook salmon, in the Cedar River Watershed, Washington. Source: City of Seattle et al. (1999) and Wydoski and Whitney (2003).

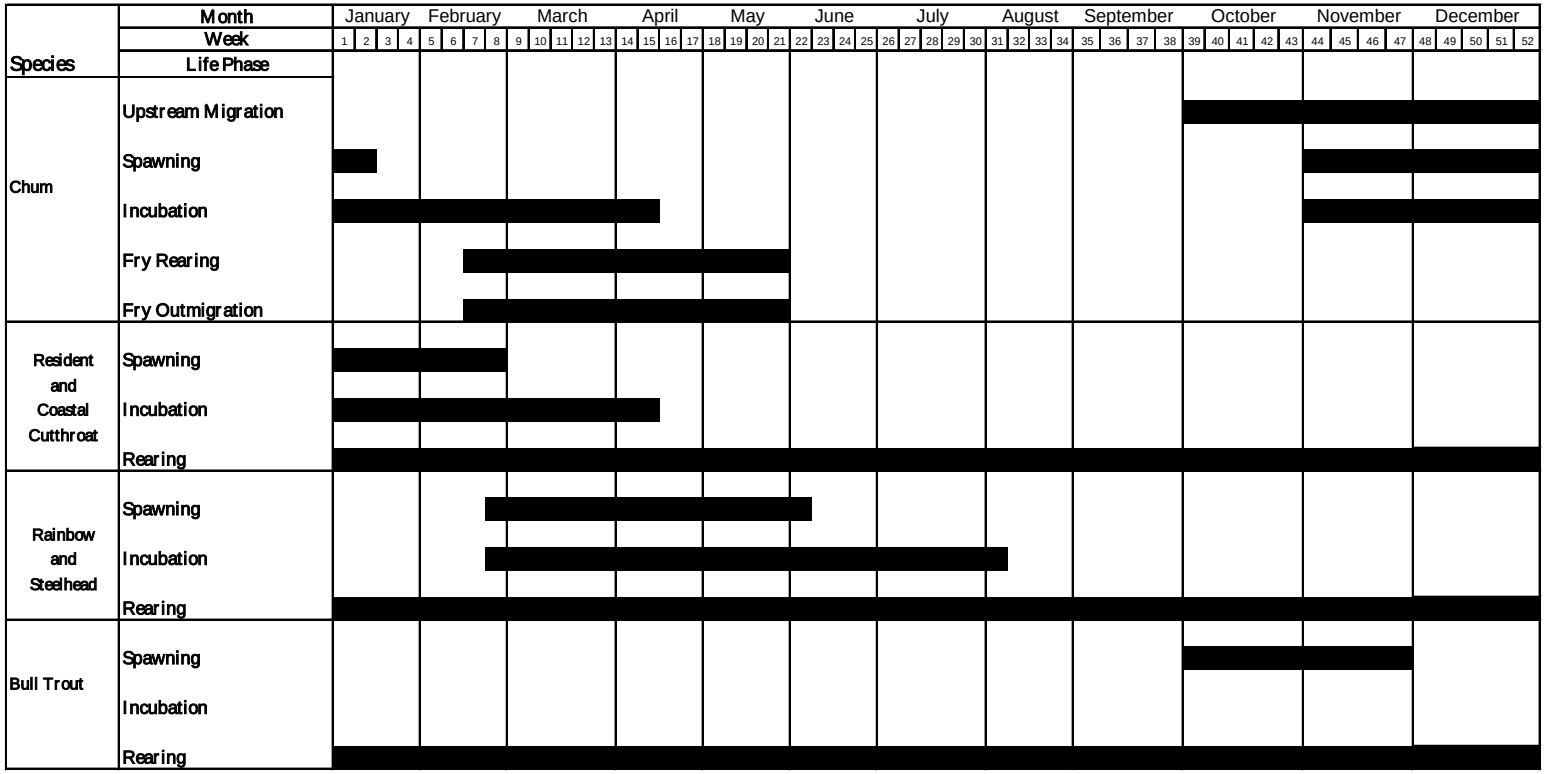



Figure 3-8. (cont.) Likely freshwater life history periodicity of chum salmon, cutthroat trout, rainbow and steelhead trout, and bull trout in the Cedar River Watershed, Washington. Source: City of Seattle et al. (1999) and Wydoski and Whitney (2003).

described (Reimers 1973). Differences between these life history patterns are accompanied by differences in morphological and genetic attributes (Myers et al. 1998). Chinook salmon classification is further divided by the timing of upstream migration (e.g., spring or fall/summer runs) (Beauchamp et al. 1983).

The principal race of Chinook salmon present in the Cedar River is summer/fall ocean-type Chinook (WDF et al. 1995). Adult summer/fall Chinook salmon enter freshwater at the Chittenden Locks between June and September with peak migration in mid-August (Warner and Fresh 1999). Spawning occurs from early to mid-September through mid- to late-November. Peak spawning occurs during early- to mid-October (CES 1995; WDF et al. 1995).

Cedar River (including Rock Creek) Chinook are considered part of the Puget Sound Evolutionarily Significant Unit (ESU). Overall, abundance of Chinook salmon in this ESU has declined substantially, and both long- and short-term abundance exhibit predominately downward trends. One factor negatively affecting the Chinook population in the Cedar River basin is land use practices. Lack of pool habitat, bank hardening features, loss of floodplain connectivity and a reduction in forest cover are all examples of factors affecting Chinook salmon populations (Kerwin 2001). Between 1998 and 2002 the mean number of Chinook salmon returning to the Cedar River has been 327 fish (NMFS BRT 2003). These factors have led to this ESU being listed as threatened under the ESA in March of 1999 (64 FR 11481:11520).

#### *3.3.1.2 Bull Trout (Salvelinus confluentus)*

Bull trout is a member of the char family. Within the Puget Sound region bull trout exhibit resident, anadromous, and adfluvial life history strategies (64 FR 58910). Bull trout spawn in cold, clear streams with complex channel characteristics. Juvenile rearing in streams occurs for 1 to 4 years. The two migratory forms then begin to move downstream to take up residence in lakes (adfluvial) or nearshore marine areas (anadromous). Maturity occurs at age 4 to 7 years with spawning migrations to the natal stream. Unlike Pacific salmon, bull trout are iteroparous and repeat spawn annually or in alternate years.

Bull trout are native to the upper Cedar River Watershed upstream of Chester Morse Lake and Masonry pool. However, bull trout have rarely been observed in Cedar River reaches downstream of Masonry Pool:

- One bull trout has been documented near the powerhouse at Cedar Falls during 1997 (City of Seattle et al. 1999);
- 3 adult bull trout were observed in the tailrace to the Cedar Falls powerhouse during July 2000 (USFWS 2004); and
- 3 adult char assumed to be bull trout in the tailrace to the Cedar Falls powerhouse during August 2003 (USFWS 2004).
- Bull trout in Lake Washington

There have been no reported observations of bull trout in Rock Creek. However, the USFWS believes conditions "may come close to suitable spawning temperatures and that may provide thermal refuge for rearing or foraging during warm summer periods" (USFWS 2004).

Five Distinct Population Segments (DPS) of bull trout (Klamath River, Columbia River, Jarbidge River, Coastal-Puget Sound, and St. Mary-Belly River) were listed as threatened under the ESA by the USFWS on October 28, 1999. These population segments are disjunct and geographically isolated from one another with no genetic interchange between them due to natural and man-made barriers. Bull trout populations in the Cedar River Watershed as well as all Pacific Coast drainages in western Washington are part of the Coastal-Puget Sound DPS.

The Washington Department of Fish and Wildlife includes bull trout as a State Candidate species. Candidate species include fish and wildlife species that the Department will review for possible listing as State Endangered, Threatened, or Sensitive.

Lake Washington, Lake Union, the lower Cedar River (downstream of Cedar Falls) and their associated tributaries are considered by the USFWS as part of the Lake Washington critical habitat subunit (69 FR 35768; June 25, 2004). This area is considered critical habitat because of its ability to support bull trout foraging, migration, and overwintering behavior. Core population areas such as the Stillaguamish, Snohomish, and Skykomish rivers are considered to be the most likely source of bull trout to utilize the Lake Washington critical habitat subunit. Bull trout have been captured and observed within and below the Ballard Locks and within the associated fish ladder (Goetz et al. 2004).

Bull trout in the Chester Morse critical habitat subunit utilize an adfluvial life history strategy meaning that the majority of rearing occurs in a lake with annual spawning migrations by mature fish to associated upstream rivers and streams. There are no upstream passage facilities at Chester Morse or Masonry Dams and Cedar Falls is considered a natural barrier to bull trout. Consequently, bull trout that actively migrate or are inadvertently washed downstream from the dams are considered lost to the Chester Morse population. In contrast to the Chester Morse population, bull trout that enter the Lake Washington Watershed by passing through the Ballard Locks utilize an amphidromous life history strategy. Amphidromous bull trout return to, and spawn in, natal freshwater streams and rivers, but migrate to estuarine and nearshore marine areas for rearing or feeding. Amphidromous bull trout may also enter non-natal freshwater systems, such as Lake Washington, to overwinter and rear. Reproducing populations of bull trout have not been confirmed in the lower Cedar River (Kerwin 2001).

#### *3.3.1.3 Coho Salmon (Oncorhynchus kisutch)*

Coho salmon populations exist as far south as the San Lorenzo River, California and north to Norton Sound, Alaska (Sandercock 1991). Coho salmon are one of the most popular and widespread sport fishes found in Pacific Northwest waters. Rock Creek coho salmon appear to be typical of Puget Sound stocks with regard to their life history, which includes approximately eighteen months spent in freshwater followed by approximately eighteen months in saltwater (or up to three years; Weitkamp et al. 1995).

Adult coho enter freshwater at the Ballard Locks during late August to mid-November (City of Seattle et al. 1999) and migration up the Cedar River occurs from early September through late January (Figure 3-8). River flow and temperature have been found to be important factors in the timing of river entry (Weitkamp et al. 1995). Spawning generally occurs in Rock Creek from late October to early March (WDF et al. 1994, R2 Resource Consultants 2004).

Rock Creek coho salmon are identified by the WDFW as part of the Lake Washington – Cedar coho stock. Although the status of Cedar River coho salmon was determined to be healthy in 1992 (WDF et al. 1994), due to recent downward population trends it is now classified as depressed (WDFW 2002a). NMFS includes Rock Creek coho salmon in the Puget Sound/Strait of Georgia ESU. Continued loss of habitat, extremely high harvest rates, and a severe recent decline in average spawner size are considered substantial threats to remaining native coho salmon populations in this ESU. Currently this ESU is not listed as threatened or endangered under the ESA, but is considered a candidate. Consequently, upon re-evaluation NMFS may reconsider and propose to list the Puget Sound/Strait of Georgia population as threatened or endangered in the future (60 FR 38011).

#### *3.3.1.4 Sockeye Salmon (Oncorhynchus nerka)*

Sockeye salmon exhibit a variety of life history habits and characteristically use lacustrine (lake) habitat more than other salmon species. The Cedar River, one of the most productive sockeye salmon streams in the Puget Sound region, is home to the largest wild sockeye run south of British Columbia. There is debate whether historically sockeye were present in Lake Washington prior to introduction of the Baker River stock in 1935. Currently a "temporary interim hatchery" has been operated at the base of the Landsburg Dam on the Cedar River since 1991 and the city of Seattle has plans to build a permanent hatchery facility as part of its Cedar River Watershed HCP. Sockeye fry releases from the temporary hatchery have averaged 9.7 million fish annually from 1995 to 2001 (WDFW 2003). There is debate as to whether increased sockeye production will negatively affect Chinook populations in the Cedar River basin; however, a recent analysis (SPU 2005 concluded that adverse effects were unlikely, even under a worst-case scenario.

Sockeye salmon begin to enter the Cedar River during late August or early September, continuing into January. Spawning takes place in mid-September to late December and occasionally through January. Peak spawning takes place in mid- to late October (Gustafson et al. 1997; R2 Resource Consultants 2005a).

The sockeye in Rock Creek are considered by the Washington Department of Fish and Wildlife (WDFW) to be part of the Cedar River sockeye run, a component of Lake Washington sockeye. The Lake Washington sockeye escapement goal (350,000 fish) has been sufficiently exceeded to allow a Lake Washington sport fishery seven times since the 1980s (1984, 1988, 1996, 2000, 2002, 2004, and 2006). Although adequate fish were counted at the Ballard Locks to allow a Lake Washington sport fishery during 2004, relatively low numbers of spawning sockeye were observed in the Cedar River and Rock Creek. NMFS does not consider the Cedar River sockeye stock to constitute an Evolutionarily Significant Unit (ESU) under the Endangered Species Act (ESA), and therefore it is not listed as threatened or endangered at this time.

#### *3.3.1.5 Chum Salmon (Oncorhynchus keta)*

Adult Chum salmon typically return to freshwater in October and November and spawn in the lower reaches of rivers from early December to early February (WDFW et al. 1994). Preferred spawning areas are in groundwater-fed streams or at the head of riffles (Grette and Salo 1986). In general, chum salmon are reported to spawn in shallower, low-velocity streams and side channels more frequently than other salmon species (Johnson et al. 1997). Similar to other salmonids, the length of incubation of the eggs is influenced primarily by water temperature.

Juvenile chum salmon, like ocean-type Chinook, have a short freshwater residence and an extended period of estuarine residence, which is the most critical phase of their life history and often determines the size of subsequent adult returns (Johnson et al. 1997; Grette and Salo 1986). Chum fry in the middle Green River, a nearby watershed, were found to be present starting from the middle of March and continued through the end of the study in June

(Jeanes and Hilgert 2000). Peak abundance was likely influenced by large hatchery releases and occurred during May. Chum populations are often limited in Puget Sound river systems by the quantity or quality of available estuarine habitat because of their dependency on estuaries as rearing habitat. Little suitable estuarine habitat remains in the Lake Washington drainage for rearing juvenile chum salmon (Kerwin 2001). Chum salmon mature at 2 to 6 years of age, most commonly at 3 or 4 (Salo 1991).

Chum salmon have occasionally been observed in the Cedar River drainage, however native populations were all but extirpated in 1917 by the diversion of the river into Lake Washington. Only seven chum fry were captured in the Cedar River screw trap during the 2004 season (Seiler et al. 2005). Adult chum salmon have been observed recently in Rock Creek and Mercer Slough, and possibly in Bear Creek and other tributaries, however the extent of any spawning is unknown (R2 Resource Consultants 2005a; KCWLD 2004). Cedar River (including Rock Creek) chum salmon are considered by NMFS as part of the Puget Sound/Strait of Georgia ESU. The National Marine Fisheries Service concluded that this ESU is not presently at risk of extinction, and is not likely to become endangered in the near future (63 FR 11778).

#### *3.3.1.6 Steelhead Trout (Oncorhynchus mykiss)*

Steelhead trout are rainbow trout that display an anadromous life history pattern. Their historic native distribution extended from northern Mexico to the Alaska Peninsula. Presently, spawning steelhead are found along the Pacific Coast from as far south as Malibu Creek, California (Busby et al. 1996). As with Chinook salmon, runs of steelhead trout are generally named for the season in which they occur or peak. There are two types of runs of Pacific Northwest steelhead. Winter run fish migrate into freshwater during the fall and winter, while summer run fish enter freshwater during the spring and summer (Pauley et al. 1986). Steelhead are further divided based on the state of sexual maturity when they enter freshwater. Stream-maturing steelhead (summer steelhead) enter freshwater in an immature life stage. Ocean maturing (winter steelhead) enter freshwater with well-developed reproductive tissues (Busby et al. 1996). In the Lake Washington system, no summer steelhead stocks and one winter steelhead stock have been identified (WDF et al. 1994).

Winter steelhead return to the Lake Washington drainage from mid-December to mid-May and spawn generally from early March to mid-June (WDF et al. 1994).

The Cedar River may be the only stream in the Lake Washington basin that is contributing natural steelhead production to the basin (City of Seattle et al. 1999). Cedar River steelhead spawn and rear in the mainstem and tributaries below Landsburg Diversion Dam. In particular, small perennial streams, like Rock Creek, contain good steelhead spawning habitat (City of Seattle et al. 1999). However no adult steelhead have been observed during fall spawning surveys (R2 Resource Consultants 2005a) and there have been no spawning surveys conducted during the spring months to document their use of Rock Creek. During 1984 to 1992 steelhead spawner escapement has only met the WDFW goal of 1,600 in one year, 1985. Escapement has ranged from 20 to 1,816 wild steelhead in the Lake Washington basin from 1986 to 2004 and escapements of less than 50 fish between 2000 and 2004 (WDFW 2002b).

Cedar River steelhead have been classified by NMFS as part of the Puget Sound ESU (1 of 15 west coast steelhead ESUs). Total run size for the major stocks of this ESU was estimated at 45,000; natural escapement was estimated at 22,000 steelhead (Busby et al. 1996). On May 8, 2007, NMFS listed the Puget Sound ESU of steelhead as threatened (72 FR 26722). In the proposed listing (71 FR 15666), NMFS listed forestry, urbanization, and water diversions for domestic purposes among the factors that have contributed to the decline of Puget Sound steelhead. This classification was made based on the short-term severe decline in spawner escapement and run size. Many other regional stream systems have also displayed a steady decrease in winter steelhead populations since the mid-1980s (Kerwin 2001).

#### *3.3.1.7 Coastal Cutthroat Trout (Oncorhynchus clarki clarki)*

Natural coastal cutthroat trout (*O. clarki clarki*) habitat ranges from the Eel River of northern California to Prince William Sound in southern Alaska, rarely penetrating more than 100 miles inland (Behnke 2002; Johnston 1982). It is a common native species in western Washington, often referred to as sea-run cutthroat. The coastal cutthroat trout exhibits four

life history variations: sea-run (anadromous), resident stream populations, fluvial populations and lake-adapted (adfluvial) populations (Behnke 2002). All variations may be exhibited within the same stream. While it is likely anadromous populations once existed historically in the Cedar River they are most likely not present in the Lake Washington watershed today. The cutthroat trout in Rock Creek are considered adfluvial fish from Lake Washington as there are no records of sea-run cutthroat use at the Ballard Locks (City of Seattle et al. 1999). These adfluvial cutthroat trout reside in Lake Washington and migrate in late winter into tributaries, including the Cedar River and Rock Creek, to spawn. Adult adfluvial cutthroat trout have been observed in Rock Creek as early as the third week in November through mid-February (R2 Resource Consultants 2005a); however, most observations tend to occur in late-December into January.

Considerable information exists for Puget Sound cutthroat trout, though little of that has been collected in a standardized manner and over a long enough time period to establish trends in populations (Leider 1997). However, the Lake Washington cutthroat trout is considered by USFWS to not warrant listing under the ESA at this time (64 FR 16397).

#### *3.3.1.8 Pacific Lamprey (Lampetra tridentatus)*

Pacific lamprey inhabit coastal streams from southern California north to Alaska (Wydoski and Whitney 2003). Pacific lamprey have been documented present in the Cedar River below Landsburg Dam (City of Seattle et al. 1999). One lamprey was captured during electrofishing surveys in Rock Creek during August 2002, but its species was not identified. Consequently, lamprey presence is considered likely.

In the Pacific Northwest, adult Pacific lamprey enter freshwater in July to October, and overwinter to spawn in May when water temperatures are between 10°C and 15°C (Close et al. 1995, Wydoski and Whitney 2003). They do not feed during the spawning migration, and will die shortly after spawning. The spawned out carcasses provide important nutrients to the stream system, as well as dietary items for other fish, such as white sturgeon (Close et

al. 1995). Pacific lamprey may reach a size of approximately 70-cm, or over 2 feet long, at maturity (Hart 1973).

#### *3.3.1.9 River Lamprey - (Lampetra ayresi)*

River lamprey exhibit life history characteristics similar to the Pacific lamprey. Furthermore, river lamprey juveniles are morphologically similar to Pacific lamprey, making positive distinction between the two species difficult (Wang 1986). The adult river lamprey is smaller than the Pacific lamprey, with a body length of only 30 cm, or slightly less than one foot (Hart 1973). River lamprey remain in the ocean for only about ten weeks (Kostow 2002). They remain very close to shore, near the rivers that produced them. The life span of river lamprey from metamorphosis to death after spawning is shorter than that of the Pacific lamprey, measuring approximately two years (Beamish 1980). No specific documentation has been found concerning river lamprey in the project area. However, similar to Pacific lamprey, it is likely the species may be present because of the capture of an unidentified lamprey during surveys in August 2002.

### 3.3.2 Plant Communities

#### *3.3.2.1 Terrestrial Plant Communities*

The Rock Creek basin is located within the Western Hemlock Forest Zone (Franklin and Dyrness 1987). The Western Hemlock Forest Zone is characterized by climax western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*) forests, and sub-climax Douglas-fir (*Pseudotsuga menziesii*) forests. Although western hemlock is the potential climax species in this zone, Douglas-fir forests cover large areas of the landscape. Douglas-fir-dominated forests develop following disturbance, such as fire and clearcut logging practices, and can persist for several centuries. Hardwood forests are commonly restricted to moist, early successional sites, where red alder (*Alnus rubra*) often dominates and big-leaf maple (*Acer macrophyllum*) is common. Topography, aspect, geology, soil, and available groundwater all influence plant community patterns at the local level, particularly for understory species. Common understory species include sword fern (*Polystichum munitum*) in moist sites, salal (*Gaultheria shallon*) in dry sites, and Oregon grape (*Berberis nervosa*) in

sites with intermediate moisture levels. Vine maple (*Acer circinatum*) is a common shrub in the middle understory.

Disturbance has had a major impact on forest patterns in the Rock Creek basin due primarily to extensive timber harvest. Timber harvest activities have resulted in the predominance of second-growth, even-aged coniferous stands. The City's property is currently mostly forested with second growth timber. Areas that are not forested include approximately 6.7 acres around the Clark Springs facility plus Kent-Kangley and Summit-Landsburg Roads, and slightly under 9 acres in a corridor below the Bonneville Power Administrations transmission lines which run across the property.

#### *3.3.2.2 Riparian and Wetland Plant Communities*

There are numerous wetlands in the Rock Creek basin. Wetlands consist of two main types: 1) riparian wetlands adjacent to and associated with the stream channel; and 2) isolated depressional wetlands believed to be associated with kettle holes or other closed depressions formed by glaciation, and generally located away from Rock Creek (Appendix C). Surveys of riparian communities downstream of the Clark Springs property were conducted in 1991; the most common tree species encountered were western hemlock and red alder (Jones and Stokes 1993). Douglas-fir, western redcedar, and bigleaf maple also occurred regularly. Black cottonwood was noted only near the downstream end of Rock Creek on the Cedar River floodplain. The average diameter and height of western hemlock were 15 inches and 58 feet respectively. Douglas-fir, western redcedar and big-leaf maple tended to be slightly larger, while red alder were slightly smaller (Jones and Stokes 1993).

Isolated, depressional wetlands and wetlands associated with small lakes or ponds consist of forested swamp, shrub swamp, emergent marsh, bog, and open water. The largest wetland in the Rock Creek basin is Crow Marsh, located in the southwest corner of the basin. Large wetlands are also mapped along Rock Creek between RM 6 and 7 (delineated by King County), and between RM 4 and RM 5 (undelineated). No depressional or non-riparian wetlands are mapped on the City's property.

### 3.3.3 Wildlife

The Rock Creek basin is home to many species of birds, mammals and other types of wildlife (Friends of Rock Creek Valley 2004). Common mammals include black bear (*Ursus americanus*) and cougar (*Felis concolor*) that inhabit more remote areas, and both have been sighted on the City's watershed property. River otter and beaver are common in wetlands and stream corridors. Deer (*Ococoileus* spp.), elk (*Cervus elaphus*), coyote (*Canis latrans*), raccoons (*Procyon lotor*), skunk (*Mephitis mephitis*) and other animals have adapted well to living near humans, and can be found throughout the basin.

Common birds include crows (*Corvus brachyrhynchos*), ravens (*C. corax*), hawks (*Accipiter* spp.), stellar jays (*Cyanocitta stelleri*) and several species of woodpecker. Cavity nesting birds such as owls inhabit forested areas. Great blue herons (*Ardea herodias*), bald eagles (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*) and many species of ducks rely on the stream, pond and wetland habitats distributed throughout the Rock Creek basin.

## 3.4 Factors Contributing to, or Reversing, the Decline of Fish Populations and Habitat

There have been extensive changes in the Rock Creek basin, the Cedar River, Lake Washington, and adjoining ecosystems since Euro American settlement began more than a century ago. Land and water use activities such as logging, urban and residential development, agriculture, transportation, and municipal and industrial water use have all influenced the processes regulating the flow of water, sediment and nutrients throughout the basin. These processes govern the underlying productivity of a system, and directly influence fish and other species that rely on aquatic habitats for some or all of their life cycle. Direct manipulation of fishery resources that utilize the Cedar River and Rock Creek systems, including the establishment and operation of hatcheries, and commercial, sport and Tribal fishing have directly influenced spawning population sizes. Indirect activities that alter habitat also impact fish populations. This section reviews historic influences on fish and their environment in the Rock Creek basin, and thus, sets the framework for

understanding the context of the City of Kent's Clark Springs System water withdrawals, and the overall effects of associated conservation and monitoring activities proposed in this HCP.

### 3.4.1 Physical Backdrop

Salmonid populations in Rock Creek are controlled in part by basin-scale characteristics of sediment sources, transport and deposition, surface and ground water hydrology and nutrient supply. Habitat conditions in the Rock Creek basin are naturally constrained by ongoing geomorphic processes (sediment transport, hydrology and wood recruitment) as well as anthropogenic disturbances.

Aquatic habitat characteristics are typically a function of channel type, which is a function of gradient and confinement. In the absence of anthropogenic influences, pool-riffle habitat sequences with a gravelly-bed would be expected to predominate in the lower reaches of Rock Creek, where the channel crosses the Cedar River floodplain. At around RM 0.2 the channel steepens and becomes more confined as it cuts across the valley wall formed by the Cedar River. The higher gradient and confinement increase the stream energy and constrain lateral channel migration, resulting in the formation of step-pool sequences and generally coarser substrates; with abundant wood, this portion of the channel would be expected to exhibit forced pool-riffle morphology. Upstream of RM 1.5, Rock Creek flows across a wide valley consisting of coarse sediments deposited by much larger glacial outwash streams under a very different climatic regime.

Under the current climatic regime, sediment inputs from headwater areas via mass wasting and surface erosion are naturally low. Erosion of glacial outwash deposits in the valley bottom is the primary mechanism for recruitment of gravels to Rock Creek. The largest particles within the glacial outwash deposit may be too big for Rock Creek to move under the current hydrologic regime, particularly in headwater reaches, thus the bed would be expected to consist of a heterogeneous mixture of sediment sizes with a pool-riffle to braided morphology.

The flow regime of Rock Creek is dominated by either surface flow or groundwater flow depending on the season, as described in Section 3.1.4. The contributing area and dominant water source determine the amount and quality of available aquatic habitat. Although groundwater flow may maintain higher summer base flows per unit area in the lower reaches of Rock Creek in comparison with other nearby non-groundwater fed tributaries, the relatively small contributing area of Rock Creek (groundwater and surface water) limit the overall amount of available aquatic habitat even under unmanaged conditions.

In small streams such as Rock Creek, large woody debris can be a primary factor controlling the quality of aquatic habitat. Under unmanaged conditions, most of the Rock Creek basin would be expected to support forest vegetation. Forest communities on the Cedar River floodplain would be influenced by floods and channel migration of the Cedar River, and would thus be expected to consist of a mosaic of tree species and ages. Wood would be recruited to lower Rock Creek through mortality, bank erosion and potentially by overbank flows in the Cedar River. Where Rock Creek crosses the Cedar River valley wall, riparian stands would have naturally consisted primarily of coniferous forest. Wood recruitment would occur from bank erosion and mass wasting. Upstream of RM 0.25, vegetation would most likely have consisted of conifer forests, except in naturally occurring wetlands where trees would have been uncommon. Windthrow and natural mortality would have been the primary LWD recruitment mechanisms. Trees and organic material falling into the stream provide habitat structure and food for aquatic insects, which in turn are eaten by salmonid fishes. During December 2005 an extreme windstorm added substantial amounts of large woody debris to Reaches 2 and 3 and initiated changes in the channel morphology and movement of channel substrate.

### 3.4.2 Anthropogenic Influences

A number of anthropogenic activities have combined to influence current habitat conditions in Rock Creek over the past 150 years or so (Kerwin 2001). Many physical changes to the hydrologic regime, sediment supply and transport and stream channel have both directly and

indirectly affected fish and their habitat. The changes are briefly described below, in no particular order of importance.

#### *3.4.2.1 Transportation*

The first road in King County was constructed in around 1854; railroad construction in the general area of Rock Creek began in 1867. Since then, construction of roads and railroads has affected aquatic habitats throughout the Rock Creek basin. Major roads in the Rock Creek basin include Kent-Kangley Road, Summit-Landsburg Road, Ravensdale Way, and Retreat-Kanaskat Road. In addition, a number of other County, local and private roads are located within the basin. Important road/stream crossings downstream of the Clark Springs Watershed include Summit-Landsburg Road and SE 248th Street.

Historically, an old railroad generally followed the Cedar River, crossing Rock Creek approximately 800 feet from its mouth. That railroad was abandoned, and the right of way has since been converted to a trail. The Burlington Northern Railroad continues to maintain an active rail line that crosses the center of the basin near Ravensdale, running generally parallel to Rock Creek for about a mile.

Other infrastructure located in the Rock Creek basin includes the City of Seattle's aqueduct, a water supply pipeline that runs east from the Landsburg diversion, crossing Rock Creek approximately one-quarter mile upstream of the confluence with the Cedar River. This crossing has been considered as at least a partial barrier or impediment to upstream passage of salmonids under some flow conditions and, as a result, it was replaced by the Seattle Public Utilities during the summer of 2007 (J. Harold, SPU, June 21, 2007, personal communication). The new crossing is a box culvert 26 feet wide with roughness elements one foot wide along each side. A low flow channel approximately 5 feet wide was built using 18 to 36 inch boulders in a step-pool configuration.

#### *3.4.2.2 Logging*

The earliest widespread human activity affecting the Rock Creek basin was forest harvest. Logging activities have been documented to result in increased fine sediment inputs and sediment loading, altered streamflows, and removal of riparian vegetation that provides shade, bank stability, leaf litter and large wood to the stream. Large-scale logging in the vicinity of the Rock Creek basin began circa 1880-1910 (Kerwin 2001). Logging has affected conditions throughout the basin; although the majority of the area is currently forested, those forests consist primarily of second growth timber stands. If harvested areas are allowed to become reforested the sediment inputs eventually return to natural levels. However, permanent conversion of forest to urban, residential or agricultural landuses may result in more permanent changes in sediment delivery and flow regime.

#### *3.4.2.3 Urban and Residential Development*

Urbanization involves conversion of land and wetlands into residential, commercial, and industrial uses. Primary effects of urbanization on river ecosystems, in addition to the related water withdrawal and land uses described in previous and successive paragraphs, include: water quality degradation through sewage discharge and septic tank leakage, spills of pollutants, runoff over contaminated and fertilized surfaces, groundwater contamination and subsequent non-point source inflow to the stream channel, and point source discharge; increased peak flows and reduced summer flows in association with increased impervious area and reduced floodplain storage; increased fishing pressure as the human population expands; filling of wetlands and drainage channels for development; and removal of riparian vegetation and increased summer water temperatures. Pollutants associated with urbanization that influence water quality include but are not limited to heavy metals, petrochemicals and related byproducts, herbicides and pesticides, other organic compounds, and nutrients.

As of 2004, approximately 72 percent of the Rock Creek valley was forested (Radford 2004). The remainder of the area has been cleared, primarily for urban/rural development and limited, small-scale agriculture and animal husbandry. Although there are some

developed and densely populated areas in the Rock Creek basin, the estimated total impervious area (3.2%) is below the threshold (5%) at which significant effects on the hydrologic regime and impacts on the overall biological integrity are observed (May et al. 1997).

Residential development along the stream banks of Rock Creek has resulted in channelization and some bank hardening. Modification of channel banks through placement of riprap or other materials reduces the quality of lateral margin habitat that has been shown to be important for juvenile salmonids (WDFW and Inter-Fluve 2003).

A number of roads cross Rock Creek upstream of Clark Springs and utilize culverts to pass stream flow when it is present. No detailed culvert surveys have been conducted to determine their condition or ability to meet state fish passage requirements.

#### *3.4.2.4 Consumptive Water Use*

Water use in the Rock Creek basin is described in detail in Appendix C. Unless specifically noted, the information presented below is derived from that document. Consumptive water use in the Rock Creek basin consists primarily of ground water withdrawal. Groundwater withdrawals generally fall into four categories:

- Municipal water supply;
- Private multi-dwelling water supply;
- Other wells with water rights; and
- Domestic wells (exempt from water rights).

The City of Kent holds the largest water right in the Rock Creek Basin. Available records indicate that the City of Kent began withdrawing water from the shallow aquifer at Clark Springs in 1957. The Clark Springs System is used on a continuous basis throughout the year.

The combined Clark Springs, surface water, wells and trench rights are 5,400 gallons per minute (gpm; instantaneous withdrawal) and 8,710 acre-feet per year (annual). Over the period from 1986 to 1998, annual withdrawals averaged 6.2 cfs. The Ravensdale well, operated by the Covington Water District, is another source of municipal water that is withdraws groundwater within the Rock Creek basin. Groundwater pumping from that well increased steadily between 1996 and 2000, but repairs and/or replacement of leaky pipes during mid-2000 resulted in decreases between 2001 and 2004; in 2001 pumpage was approximately 0.08 cfs/35 gpm (Appendix C).

In addition, several independent, privately operated water supply systems provide water to subdivisions at Evergreen Acres, Retreat Lake, Lake Twelve and a number of other locations throughout the basin. Total capacity for these systems within the Rock Creek basin is 9.4 cfs/4,231 gpm; information on actual water usage is lacking.

Other water rights that are all or partly within the Rock Creek basin total 1,230 acre-feet per year, which is equivalent to 1.7 cfs. In addition, there are a large number of wells withdrawing less than 5,000 gallons per day that provide water to individual landowners which are exempt from the water rights permitting process. The overall impact of private and individual water supply withdrawals is likely less than the stated water right amount because a portion of the water returns to the aquifer as infiltration or septic flow from drainfields.

One additional water diversion has been documented in the Rock Creek basin. For an unknown period of time, there was a 6 to 8 foot wide diversion channel that cut through from Crow Marsh to the Green River. Flow in this channel was observed to be approximately 5 cfs in 1993 (King County 1993). This diversion channel was eventually blocked off by King County in 1997.

#### *3.4.2.5 Hatchery and Supplementation Practices*

Hatchery and supplementation practices, often referred to as artificial propagation, have historically been used as partial or complete mitigation for urbanization, hydropower,

municipal and agricultural water supply, highway construction or other projects that affect stream habitats. Artificial propagation has also been used to sustain or increase available numbers of fish for recreational and commercial harvest. Under the ESA, artificial propagation is a potential recovery mechanism for some stocks of Pacific salmon (Hard et al. 1992). For instance, artificial propagation appears to have reversed the decline in abundance of spring-run Chinook salmon in the White River in western Washington (WDFW et al. 1996). However, artificial propagation appears to entail risks as well as opportunities for recovery of Pacific salmon populations. Steward and Bjornn (1990) noted that interactions between hatchery fish and natural fish may result in greater competition for food, habitat, or mates; an increase in predation or harvest pressure on natural fish; potential transmission of disease and deleterious genetic interaction between populations. In its status review of Chinook salmon, the NMFS noted that hatchery production may mask trends in natural populations and hinder the determination of whether runs are self-sustaining (Myers et al. 1998).

Three hatcheries are operated in the Lake Washington/Cedar River watershed: the Landsburg sockeye hatchery, the Issaquah hatchery, and the University of Washington hatchery. The City of Seattle has been operating an interim sockeye hatchery near Landsburg since 1991. A permanent hatchery as part of the Cedar River HCP is scheduled for completion in 2011 and is planned for producing up to 34 million sockeye fry annually; however, a recent analysis suggested the sockeye hatchery would be unlikely to adversely affect Chinook salmon recovery in the Cedar River (SPU 2005). The WDFW operates a Chinook and coho salmon hatchery in Issaquah that has an annual production of 2 million Chinook fingerlings and 450,000 coho yearlings (WDFW 2002a, WDFW 2003). Beginning in 1996 for coho salmon and 2000 for Chinook salmon all fish released from the Issaquah hatchery were marked with an adipose clip. The University of Washington's hatchery is a research and educational facility that releases approximately 90,000 yearling coho salmon and 180,000 fingerling Chinook salmon.

Recent observations since 2003 of adipose clipped Chinook salmon and identification of code wire tags from hatchery fish in Cedar River and its tributaries have led to concern about the straying of Issaquah hatchery fish into the Cedar River and elsewhere (Berge et al. 2006). While other hatcheries, including the University of Washington and Grover's Creek (located on the Kitsap Peninsula), and Soos Creek may also contribute to Chinook hatchery strays into the Cedar River, most of the hatchery strays are believed to derive from the Issaquah hatchery (Berge et al. 2006). It is also possible that straying could occur from naturally reproducing Chinook elsewhere in the Lake Washington Watershed such as Issaquah Creek, Bear Creek, North Creek, and Kelsey Creek. A large number of strays relative to wild Chinook spawning in the Cedar River could potentially result in a dilution of the Cedar River gene pool.

#### *3.4.2.6 Fishing Harvest*

Salmon originating from the Cedar River basin, including Rock Creek, are caught in both the United States and Canada sport and commercial saltwater fisheries. Hatchery production facilitates a higher harvest rate than wild-spawning populations are able to sustain. Sport angling and Tribal gill net fisheries for Chinook and coho salmon and steelhead trout have been active within the densely populated Elliott Bay area, near the mouth of the Duwamish River. In addition, limited sport fishing seasons for Lake Washington sockeye salmon have occurred in recent years when escapement is deemed high enough. Until recently the Cedar River has generally been closed to fishing. However, since 2004, portions of the Cedar River have been open for catch-and-release fishing of gamefish. Rock Creek continues to be closed to fishing.

### 3.4.3 Current Processes Affecting Fish Habitat and Populations

Under natural conditions, aquatic ecosystems in the Pacific Northwest, including Rock Creek, are dynamic in both space and time. The behavior of fluvial systems in the Pacific Northwest ecosystems is driven by four components:

1) climate, which varies over time and causes floods and associated erosional events to be punctuated in time;

2) a complex topography that causes the supply of sediment and wood to streams to vary spatially;
3) a branching channel network that juxtaposes different sediment delivery and transport regimes; and
4) basin history, which affects the timing, volume, and location of wood and sediment supplies (Benda et al. 1997).

The result is a mosaic of conditions within a basin at any time created as a result of disturbances. Natural ecosystems have a large capacity to absorb change without being dramatically altered (Reeves et al. 1995). In the context of these naturally variable ecosystems, disturbances may be described as “pulse” or "press" disturbances. Pulse disturbances alter conditions but allow the ecosystem to recover and remain within its normal bounds. Press disturbances force an ecosystem to a different set of equilibrium conditions, preventing or delaying recovery beyond the normal time frame (Yount and Niemi 1990; Bender et al. 1984).

Natural disturbances can be either “pulse” or “press” disturbances; glacial episodes or the eruption of Mount St. Helen’s are examples of a natural “press” disturbances; periodic floods or wildfires are “pulse” disturbances. However, many anthropogenic disturbances, such as flood control or urbanization, are considered “press” disturbances (Yount and Niemi 1990). The following text describes the effects of human activities on the variability of important ecosystem processes including sediment transport, flow regime, woody debris recruitment and low flows in the Rock Creek basin.

The Rock Creek basin is partitioned into lower and upper basins reflecting geographic differences in the system of both natural processes and human influences. Prior to development of the Clark Springs System, the upper Rock Creek basin was naturally distinguished from the lower Rock Creek basin by the flow regime and overall topography. Rock Creek generally flows across gentle, rolling topography in the upper basin, and streamflows tend to infiltrate into highly permeable glacial outwash deposits. Channel

morphology consists of a series of wetland areas distinguished by multiple small channels and intermittent stream reaches that carry water for only a portion of the year.

Perennial streamflow originates near Clark Springs at RM 2.8 (Appendix C Hart Crowser 2003). Because it is located nearly a mile downstream of the perennial headwaters of Rock Creek, the artificial geographic division imposed by water withdrawal at the Clark Springs System is generally coincidental with the natural drainage basin division and thus is useful in the context of evaluating City of Kent activities.

#### *3.4.3.1 Sediment Transport*

Because of the limited drainage area and gentle sideslopes of the basin headwaters, colluvial sediment inputs are low. The primary sources of coarse sediment in Rock Creek are the unconsolidated glacial outwash deposits, which are recruited through erosion of the channel bed and banks. Coarse, gravel-size sediment is transported downstream only during moderate to high flows, and is stored within the channel bed and banks during intervening low flow periods. There is no available information regarding known man-made structures that intercept coarse sediment in Rock Creek. Stream crossings occur at four locations within the perennial section of the stream: SE 248th Street, the Cedar River Pipeline, Summit–Landsburg Road, and Highway 516. The crossing at SE 248th Street was replaced in 2003 and was designed to better pass water, sediment, and fish compared to the old structure. To date no studies have been conducted to determine if any of the structures are affecting sediment transport. Because the majority of the drainage basin is forested, and peak flows are similar to those that would occur under unmanaged conditions, the coarse sediment transport regime is considered to be functioning properly.

Fine sediments generally move downstream suspended in the water column, and thus may be transported at all but the lowest flows. Fine sediment inputs from forested lands in the Pacific Northwest are generally negligible because instantaneous precipitation rates are usually low and a dense layer of organic debris and herbaceous vegetation usually protects the soil surface. Fine sediment inputs may increase substantially when forest vegetation is removed. Development of agricultural, commercial and residential buildings and lands; and

a transportation network, in particular unpaved forest roads, may also substantially increase fine sediment delivery to a stream system. Although development, roads and forest harvest may have increased the fine sediment inputs to Rock Creek, data presented in May et al. (1997) do not indicate that substrate in Rock Creek has experienced a shift towards increased fines.

#### *3.4.3.2 Woody Debris Transport*

Woody debris is an important component of salmonid habitat because it provides habitat space (pools) and structure (cover), provides habitat and food for aquatic invertebrates, helps retain local deposits of spawning gravel in reaches where the sediment transport capacity exceeds the rate of supply, contributes to bank stability, and can be integral to channel migration processes in alluvial reaches. Removal of in-channel LWD may have occurred in the Rock Creek basin as a result of timber harvest practices prior to implementation of the Forest Practices Act enacted in 1974, road maintenance, and from clearing by private individuals to reduce localized flooding or bank erosion. Habitat surveys conducted in 2000 indicate that LWD loading downstream of the Clark Springs System is classified as "good" (i.e., > 2 pieces per channel width) according to criteria established by WFPB (1997) for all but the first 535 feet of stream. Most of the LWD was less than 24 inches in diameter; however, because of the relatively small channel width, the frequency of "key" size pieces was generally rated "good" (Pentec 2001; Appendix B).

Logging and development have reduced LWD recruitment in parts of the Rock Creek basin, although not to the extent that has been observed in many other Puget Sound streams (May et al. 1997). Water withdrawals by the City of Kent and others have had little effect on LWD recruitment and redistribution since wood, like sediment, is recruited and transported by high flows. Existing water withdrawals represents only a small fraction of the volume of high flows.

#### *3.4.3.3 Drought and Low Flow Conditions*

Anadromous fish migrating upstream must pass through Lake Washington and the Cedar River. Some species, such as Chinook salmon, begin this upstream migration in the late

summer, when flows are often naturally at their lowest, particularly in drought years, before fall rains arrive. Low flows in Rock Creek are naturally sustained by the slow release of water stored in the shallow glacial outwash aquifers connected to the stream. Under conditions prior to substantial withdrawals at Clark Springs (USGS gage 12118500 data from 1945 to 1967), mean flows during October and November, when Chinook salmon are spawning, were 6.6 and 13.8 cfs, respectively. Groundwater withdrawal by the City of Kent and others plus the diversion of flow from Crow Marsh prior to 1997, contributed to reduced flows in Rock Creek. In 1997, the Crow Marsh diversion was blocked. Around the same time, the City of Kent voluntarily installed a streamflow augmentation system that allowed the return of up to 2.0 cfs/900 gpm to Rock Creek. Over the past five years, the system has been used periodically to augment flows in Rock Creek.

#### *3.4.3.4 Effects of Changes in the Flow and Sediment Regimes on Water Quality*

In general, water quality problems that potentially contribute to the decline of salmonids in the Puget Sound region are lowest in less developed headwater areas and increase in severity as the water flows downstream. In tributaries such as Rock Creek, the primary factors affecting water quality and fish production are increased turbidity and fine-sediment loading associated with land clearing and timber harvest and increased temperature due to loss of streamside shade. Summer low flows also influence water quality, in particular water temperature. Rock Creek generally exhibits lower temperatures than other regional streams (e.g., the Cedar River) because of the high proportion of groundwater contributions in the summer. If appropriate best management practices are not utilized, agricultural land uses such as the livestock reared on the small farms in the Rock Creek basin can also affect water quality by contributing to sediment and nutrient loading as well as coliform bacteria.

#### *3.4.3.5 Salmonid Limiting Factors in Rock Creek*

Several investigations have recently assessed factors that currently limit Chinook salmon populations in the Cedar River basin (including Rock Creek). Kerwin (2001) described physical habitat conditions in Rock Creek as excellent, with high volumes of LWD, frequent pools and good spawning gravel. He noted that low flows in lower Rock Creek likely impaired Chinook access and holding habitat during the low flow season. Other limiting

factors included wetland and riparian zone disturbance, and potential water quality impacts (i.e., oil and gas spills) from recreational boating on Lake No. 12 (Kerwin 2001).

The proposed WRIA 8 Conservation Plan (WRIA 8 Steering Committee 2005) suggested that habitat degradation and loss of life history diversity were two freshwater factors contributing to the steep decline in Cedar River Chinook abundance. WRIA 8 grouped streams into three groups: core, satellite, and episodic, based upon recent observations of spawning Chinook salmon. Similar to other Cedar River tributaries except Taylor/Downs, Rock Creek was considered to be episodic because Chinook salmon have been infrequently observed in Rock Creek in recent years.

The low frequency of Chinook salmon utilization in Rock Creek over at least the last 20 to 30 years may be a function of numerous factors including:

- Low and declining overall Cedar River Chinook population abundance;
- Historic partial barriers at the SE 248th Street culvert and Seattle pipeline culvert (both currently meet WDFW passage criteria);
- Potential competition from sockeye salmon;
- Unsuitable spawning habitat for Chinook salmon;
- Realignment and channelization of the lower Rock Creek reaches (channelization primarily Reach 1; some limited bank hardening in both Reaches 1 and 2);
- Reduced flows in Rock Creek as a result of groundwater withdrawals in the watershed;
- Water withdrawals from the Cedar River affecting tributary access; and
- Fishing (both commercial and sport).

These factors are not mutually exclusive and information to discern the relative importance of each factor is variable. For example there is some evidence that the Seattle Pipeline culvert was a partial barrier (Chinook Engineering 2002), yet adult sockeye salmon, which have a spawning period that overlaps that of Chinook salmon but peaks later, do not appear

to be substantially affected by the culvert. There is also evidence from a GIS-based model that Rock Creek has a very low potential for Chinook spawning habitat (Sanderson et al. 2004). The sockeye salmon spawning run into Rock Creek appears to be relatively robust (e.g., 2003 had an estimated 3,600 fish [R2 Resource Consultants 2004]). The degree to which redd superimposition might have adversely affected past Chinook reproduction in Rock Creek is unknown. Recent redd surveys on the Cedar River have demonstrated significant superimposition of sockeye redds on Chinook redds (Burton et al. 2004). High levels of superimposition provide some evidence that the hypothesis may have merit. Overall, the available evidence suggests that under historic conditions Rock Creek had the potential to support some limited Chinook salmon reproduction, but the magnitude of this reproduction is unknown.

WRIA 8 sponsored an implementation of the Ecosystem Diagnosis and Treatment (EDT) model to aid in understanding the limiting factors affecting Chinook populations and prioritizing recovery actions. The EDT model estimates population performance by estimating population abundance, productivity, and life history diversity, attributes that are consistent with the parameters are known as the viable salmonid population (VSP) parameters (WRIA 8 Steering Committee 2005, McElhany et al. 2000). For the Cedar River population, the model included 28 mainstem river segments, the dam at Landsburg, and four tributaries, including lower Rock Creek up to RM 0.65 (MBI 2003a).

One EDT analysis examined the relative importance of implementing protection and restoration actions within individual river segments or tributaries. In the EDT model, “restoration” was examined by restoring all attributes in a given reach from current to “template” conditions. Template conditions are an approximation of the maximum, or best, potential conditions in the reach. The model is then re-run to determine how the population performance measures would change from current conditions. In an analogous process, “protection” was examined by degrading all attributes in a given reach from current conditions to a minimum condition.

Relative to abundance, productivity, and life history diversity, the EDT model suggested that Rock Creek is a minor contributor within the Cedar River population (MBI 2003a). Under the restoration scenario, the Cedar River population increased about 0.1 percent in abundance and productivity relative to current conditions and had no effect on life history diversity. Similarly, under the protection scenario, the Cedar River population increased about 0.6 percent in abundance and productivity relative to current conditions, and about 0.7 percent in life history diversity. Of the 33 Cedar River segments considered, Rock Creek ranked 30 in relative importance under the restoration scenario and 32 under the protection scenario (MBI 2003a).

The WRIA 8 plan did not rely solely on the EDT model results in the development of its Chinook recovery strategy (WRIA 8 Steering Committee 2005). WRIA 8 also considered current watershed conditions (e.g., amount of total impervious area, stream crossings, forest cover, wetlands, etc) when stratifying stream segments into three tiers to help in prioritizing Chinook recovery actions (Table 3-4). Rock Creek was considered a Tier 2 subbasin because watershed quality was relatively high, but recent Chinook salmon utilization was infrequent. Strategically, WRIA 8 would like to implement restoration and protection measures that tend to move subbasins towards the upper left in the table (i.e., increased fish utilization and higher watershed function) while avoiding any movement of subbasins towards the lower right (WRIA 8 Steering Committee 2005).

In addition to providing some guidance in prioritizing land use and instream protection and restoration actions, the tier system also allowed for the development of broad strategies to address watershed conditions. For example, protection activities are important in subbasins with higher watershed functions while restoration becomes more important in subbasins with moderate and lower function. In areas where satellite or episodic fish utilization may be the result of passage barriers, recovery actions that improve passage are important.

The WRIA 8 Chinook Conservation Plan (WRIA 8 Steering Committee 2005) recognizes that Tier 2 subbasins in the Cedar River, including lower Rock Creek, " have played a relatively small role in the spatial distribution and overall abundance of the population." The

plan views these subbasins as a hedge against natural disturbances in the mainstem, such as landslides or flood (scour) events. The reasoning is that reproduction in tributaries could be a source for recolonization of the mainstem if such a catastrophic event should occur.

Table 3-4. Subbasin tier system for prioritizing subbasins in WRIA 8 and assignment of subbasins for the Cedar River population (WRIA 8 Steering Committee 2005).

| | Watershed Quality | | |
|---|---|---|---|
| **Fish Utilization** | **Higher Function** | **Moderate Function** | **Lower Function** |
| **Core/Migratory** | **Tier 1:** Cedar Mainstem Rural | **Tier 1:** Cedar Mainstem Urban | **Tier 1:** Lake Washington, Lake Union, Ship Canal, Nearshore and Estuary |
| **Satellite** | **Tier 2:** Upper Cedar, Taylor/Downs Creek | **Tier 2:** None | **Tier 3:** None |
| **Episodic/None** | **Tier 2:** Lower Rock Creek, Peterson Creek, Walsh Lake Diversion | **Tier 3:** None | **Tier 3:** Madsen Creek, Molasses Creek |

The conservation plan suggested that in areas of high watershed function, such as Rock Creek, recovery actions should concentrate on protecting habitat attributes and habitat forming processes. Within the Rock Creek basin, the EDT model suggested that habitat protection should focus on Reaches 1, 3 and 5 (see Figure 1-5), and that reducing channel confinement caused by human modifications and increasing the number of pools in Reaches 1 and 2 would be beneficial. Restoration of seasonal low flows in lower Rock Creek was also advocated. Compared with other Tier 2 tributaries, only Reach 1 of Rock Creek (RM 0 to RM 0.06) had a high restoration potential.

### 3.4.4 Restoration Activities (parties other than City of Kent)

There are a number of groups and institutions involved in a wide range of active, planned, or conceptual restoration projects that are intended to reverse the losses in habitat quantity and quality that have occurred in the Cedar River system within the last 100 years. Local governments, businesses, environmental groups, and state agencies are working to develop a

science-based salmon conservation plan for WRIA 8. The plan was issued on February 25, 2005. The City of Kent has been and will continue to participate in the WRIA 8 planning process.

In addition to WRIA 8 planning, the Friends of Rock Creek Valley (FORCV), a community based non-governmental organization, developed the Rock Creek Valley Conservation Plan using a grant from the National Park Service. The plan was developed as a roadmap to achieve the Rock Creek Valley Vision that includes:

- Protect and enhance water, fish, and wildlife resources;
- Maintain forest cover for water and wildlife protection, aesthetics, recreation, and commercial forestry opportunities;
- Preserve and promote local historic and cultural sites; and
- Establish a working alliance between King County and private entities in valley to implement vision.

In partnership with King County, Washington State, and the Cascade Land Conservancy, the FORCV have protected almost 80 percent of the stream-side habitat along Rock Creek (Burlingame 2006).

The WRIA 8 collaborative planning process influences three primary funding sources: the Salmon Recovery Funding Board; King County Conservation District grants; and the WaterWorks Forum Initiative. King County is a major proponent of projects within the Rock Creek basin having purchased land or easements to 466.3 acres and 33 parcels between 1995 and 2003 using county funds and other grant sources (King County data provided by D. St. John, August 4, 2006). A description of projects funded to date through these sources is provided below. Unless otherwise noted, information presented below was obtained from King County's Salmon Recovery web site (King County 2005).

Together, the projects described below are intended to protect water quality in Rock Creek as well as the larger Cedar River basin.

#### *3.4.4.1 Salmon Recovery Funding Board Grants*

In 1999 the Washington State Legislature created and authorized the Salmon Recovery Funding Board to guide spending of funds targeted for salmon recovery activities and projects. Since that time, a number of projects have been funded and implemented that both directly and indirectly affect salmonid populations and habitat in Rock Creek. Major projects funded to date include:

- **Rock Creek/Ravensdale-Retreat** project (2001) which authorized funds to purchase approximately 135 acres of land along a one-mile stretch of Rock Creek, resulting in the protection of forested and scrub-shrub wetlands, pond habitats and second growth coniferous forest.
- **Cedar Rapids Floodplain Restoration** project (2004) will restore 1,850 of shoreline and floodplain habitat along the mainstem Cedar River east of Renton.
- **Acquisition (**2001-2004**)** of 71 acres of land within the Cedar River floodplain in the vicinity of Taylor Creek, Ricardi Reach, Dorre Don meanders and Cedar Rapids areas that will protect floodplain and spawning habitat.

#### *3.4.4.2 King County Conservation District*

Elected officials representing local governments participating in the WRIA 8 salmon conservation process comprise the Lake Washington/Cedar/Sammamish Forum. This group allocates approximately $634,000 in King Conservation District funds annually to local governments within King County to support habitat protection and restoration projects in the Lake Washington, Cedar River and Lake Sammamish basins.

One of the projects funded is the Rock Creek RM 0.3 Acquisition project (2001) which resulted in the purchase of 2.1 acres of riparian forest along 250-feet of lower Rock Creek to preserve an area of high quality forest habitat.

#### *3.4.4.3 Waterworks Forum Initiatives*

The King County WaterWorks grant program annually funds grants of up to $50,000 for community projects that protect or improve watersheds, streams, rivers, lakes, wetlands and tidewater area. The WRIA 8 Forum requests proposals for consideration for the

WaterWorks Forum Initiative each spring. Projects funded to date in the Rock Creek basin include:

- **Rock Creek/Crow Marsh conservation easement** (2002) that secured conservation easements to protect 28 acres of Crow Marsh.
- **Horses for Cleanwater** (2004) received a $15,000 grant for stream restoration projects along Rock Creek (King County Journal 2004).

Typical projects funded through the grant include fencing to keep animals away from surface water and replanting of streambanks.

#### *3.4.4.4 Huckleberry Land Exchange*

In addition to conservation easements near Crow Marsh secured through a Waterworks grant (Section 3.5.4.3), approximately 100 acres of wetlands and mature forest near Crow Marsh at the headwaters of Rock Creek were obtained from the Weyerhaeuser Company in 2002 as part of the Huckleberry Land Exchange and placed under the ownership of the Cascade Land Conservancy (Pilchuck Audubon Society et al. 2002).

#### *3.4.4.5 Other Efforts*

In 2003, King County replaced a 100-year old wooden culvert associated with 248th Street, with a new three-sided concrete box culvert (King County 2003b). A streambed consisting of gravel and boulders was constructed through the culvert and designed to maintain low velocity and resting areas for fish across a range of flows, improving upstream passage at the site. As part of this project, the Cedar River Trail trestle was replaced with a longer span concrete and steel structure. The longer span was needed in order to place the wider culvert under the road. Downstream from the culvert where the banks were eroding, streambanks were stabilized using boulders and trees with root wads. Railroad ties and sand bags were removed along the eroded stream bank adjacent to two houses downstream of the culvert. These were replaced with logs and boulders to provide habitat complexity and stream flow variation.

# 4. HABITAT CONSERVATION MEASURES TO BE IMPLEMENTED UNDER THE HCP

This chapter describes specific Habitat Conservation Measures (HCM) that the City of Kent is financially committed to implement as part of this Habitat Conservation Plan (HCP). These measures would collectively and substantially contribute to other ongoing local and regional efforts focused on the protection and restoration of the covered species. These measures are intended to meet the standards set forth in the ESA for HCPs, which requires that the take of covered species be minimized and mitigated to the maximum extent practicable, and that the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild (16 U.S.C. § 1539 [a][2]).

The HCMs that the City has committed to are summarized in Table 4-1 and include: 1) flow enhancement measures that directly benefit Rock Creek; 2) habitat enhancement measures that directly benefit Rock Creek; and 3) conservation measures of a basin-wide nature that may provide both direct and indirect benefits to aquatic ecosystems generally, and specifically to the covered species. The purpose of the HCMs is to provide both direct and indirect mitigation for covered activities included in the ITP and described in Chapter 1. Four of the habitat enhancement measures were mentioned in the recently released Lake Washington/Cedar/Sammamish Watershed (Water Resource Inventory Area or WRIA 8) Steering Committee Chinook Salmon Conservation Plan (2005). The HCMs providing the most direct benefits to the covered species will occur within 10 years after issuance of the ITP. Others, such as those related to easements or land acquisitions would occur as opportunities arise within 6-15 years after issuance of the ITP. Some of the HCMs were developed to address specific issues raised by the Services. The measures have been given an identification number consisting of the letters HCM (Habitat Conservation Measure) followed by a number (e.g., HCM-X). Details of monitoring and adaptive management components are presented in Chapter 5. The effects on and benefits of these measures to the nine fish species covered in this HCP are discussed in Chapter 6.

Table 4-1. Habitat Conservation Measures (HCM) to be implemented by the City of Kent under the Clark Springs System HCP.

| Habitat Conservation Measure | Title | Summary |
|---|---|---|
| HCM-1 | Flow Augmentation Plan | Augment flows in Rock Creek downstream of the Clarks Springs System from October 1 through December 31, with variations in the amount of augmentation required based on a wet, normal, dry or drought year basis (see description in text); Estimated Range of Costs - $0 to $387,504 per year |
| HCM-2 | Passage improvements at mouth of Rock Creek – Reach 1 | Modify Rock Creek channel at the mouth of Rock Creek to provide increased water depth during low flows; Estimated Costs - $55,000 |
| HCM-3 | Wetland Improvement and Juvenile Salmonid Habitat Enhancement – Reach 1 | Connect existing pond and improve off-channel habitat conditions pond adjacent to Reach 1 of Rock Creek; Estimated Costs - $40,000 |
| HCM-4 | Wetland Improvement and Juvenile Salmonid Habitat Enhancement -Reach 2 | Improve connectivity and habitat conditions in the existing off channel wetland in Reach 2 of Rock Creek; Estimated Costs - $69,000 |
| HCM-5 | Summit-Landsburg Road culvert replacement-Reach 8/9 | Replace the culvert at the Summit-Landsburg Road crossing with a structure that meets existing WDFW fish passage criteria; Estimated Costs - $680,000 |

Table 4-1. Habitat Conservation Measures (HCM) to be implemented by the City of Kent under the Clark Springs System HCP.

| Habitat Conservation Measure | Title | Summary |
|---|---|---|
| HCM-6 | LWD Placement – Reach 10 and 12 | Place large woody debris (LWD) in Reach 10 and Reach 12 of Rock Creek within the City of Kent watershed property to increase hydraulic complexity; Estimated Costs - $62,000 |
| HCM-7 | Water conservation program | City of Kent's on-going water conservation program |
| HCM-8 | Riparian Acquisition, Easement, and Enhancement Fund in Rock Creek Basin | Establish a $1.6 million Habitat Fund to mitigate for impacts associated with operations of the Clark Springs Water Supply System. |

## 4.1 HCM-1: Rock Creek Flow Augmentation

**HCM-1**

**Rock Creek Flow Augmentation**

The City of Kent is proposing to augment Rock Creek during the months of October, November, and December, periods that are biologically important for adult migration and spawning by a number of the covered species. The maximum flow augmentation and Rock Creek flow target will be based on two-month antecedent precipitation as measured at Landsburg. The City will commit to augmenting up to the stream flow target, but not more than the maximum augmentation amount defined in Table 4-2. When instream flows meet or exceed the target flows at the Parshall flume during October, November, and December,

*HCM-1 (continued on next page)*

*HCM-1 (continued)*

then no augmentation would occur. When instream flows are below target flows, water up to the maximum amount would be allocated to increase instream flows to the target flow. As part of HCM-1, the City will move the current location of the augmentation outfall to a location closer to USGS gage 12118400. The initiation of augmentation will be adaptively managed based upon Chinook salmon spawn timing in the Cedar River.

Table 4-2. Rock Creek flow targets and the maximum augmentation flows to be provided by the City of Kent to meet those targets as determined by seasonal water year type.

| Seasonal Water Year Type[1] | Maximum Augmentation | Rock Creek Flow Target[2] |
|---|---|---|
| Wet | 2.5 cfs | 3.5 cfs |
| Normal | 2.0 cfs | 3.0 cfs |
| Dry | 1.75 cfs | 2.75 cfs |
| Drought | 1.50 cfs | 2.50 cfs |

[1]See Appendix H for a description of the rationale for and process used for categorizing seasonal water year types.

[2] Minimum stream flow target to be measured at USGS gage 12118400 on the Clark Springs property with augmentation occurring during the months of October through December only. The augmentation flow rate shall be measured at the flow meter on the augmentation pipe from the City's clear well

### *Rationale and Benefits*

Rock Creek represents a regionally important aquatic ecosystem that supports or potentially could support a number of salmonid fish populations that are described in Section 3.4. The City of Kent is aware of potential resource conflicts relative to balancing its primary obligation of providing its citizens with a sustainable water supply to meet their domestic, fire, and life safety requirements, and its environmental stewardship ethic of protecting and promoting important aquatic resources. In 1997, the City voluntarily installed a streamflow augmentation system that was designed to pump as much as 900 gpm (2.0 cfs) to Rock Creek (see Section 3.2). This system operates by pumping water from the clearwell and

discharging it to Rock Creek after aeration. The City has voluntarily operated this system periodically since 1998, especially when stream flows have fallen below 2 cfs. As stated, operation of this system has been on a purely voluntary basis by the City as a means to provide some supplemental flows into Rock Creek during periods of low flow that coincide with adult salmonid migration and spawning. The City is now proposing, as part of this HCP to guarantee at certain times and under certain conditions to supplement the flow in Rock Creek to benefit fish and fish habitat. The City is also proposing to move the current location of the augmentation outfall to a location closer to USGS gage 12118400 in order to minimize augmentation flow losses to the groundwater that occurs in the reach adjacent to the water supply facility (see Chapter 6 for a detailed discussion of this effect).

USGS gage 12118400 will be the compliance point for HCM-1 because it is in a secure location within the Clark Springs watershed. The gage is also close to the augmentation source, which reduces the likelihood that other factors, such as losses and gains to the creek, will confound measurements used to determine compliance. Gage 12118400 also has a relatively long record of use by the USGS and City of Kent.

The beginning of the augmentation period under HCM-1 will be managed adaptively based upon an assessment of the timing of Chinook salmon spawning in the Cedar River Basin. The available spawning periodicity information currently suggests that October 1 is an appropriate time to begin augmentation and corresponds with the October 1 flow increase in the Cedar River required under the City of Seattle's HCP. On a five-year interval, the City of Kent and Services will evaluate whether a significant shift in Chinook salmon spawn timing has occurred based upon the available spawning survey information from the Cedar River mainstem and its tributaries. If a significant shift has occurred, the beginning of augmentation may occur as early as September 17 or as late as October 15.

The proposed augmentation flow amounts were based on a careful evaluation by the City of Kent regarding its existing and future water demands (see Section 3.2.6 – Operational Constraints). The City has constraints with regards to water supply and operations, as stated

in Appendix G, including a limited time when the City is able to augment flows. In an effort to provide the proposed stream flow augmentation during the critical period of October, November, and December when most salmonids are spawning, and flows tend to be the lowest, the City must rely on other sources of supply to replace water that would otherwise be available at Clark Springs. The productivity of these sources are sensitive to necessary "resting" or "recharge" periods to be available during the proposed augmentation period. If these other sources were utilized to offset augmentation during other portions of the year (January-September), it would inhibit the City's ability to use these sources during the proposed low flow augmentation period when most salmonids are entering Rock Creek and potentially create a situation where the City is unable to provide the water required for meeting the public health, economic, and life safety needs of the citizens and businesses of Kent. The proposed augmentation represents flows the City is committed to providing (when needed to meet specific flow targets) throughout the duration of the HCP.

As a further step, the City commissioned a detailed study to establish and assess the relationship of fish habitat versus flows in Rock Creek, so that the biological benefits of its flow proposal could be quantified and compared with current (baseline) conditions in which no supplementation occurs. These studies utilized the USFWS Physical Habitat Simulation System (PHABSIM) (Bovee and Milhous 1978; Bovee 1982) and involved the establishment of a series of 37 cross-channel transects at selected locations representative of different habitat types in Rock Creek, and the collection of depth, velocity and substrate data under three different flows (see Appendix F). These data were used to develop a hydraulic model of the system that was linked with a habitat model to derive species and life stage specific habitat versus flow relationships. The habitat in this case is termed "Weighted Usable Area" (WUA) because it is weighted by a fish's preference for certain depths, velocities and substrates.

The PHABSIM output was then linked with a Hydrological Simulation Program – Fortran (HSPF) model (see Appendix C; MGS Engineering 2005) and an operations analysis tool developed (termed PHLOAT – PHABSIM/HSPF Linked Operations Analysis Tool) that

provided estimates of mean daily flow under three operational scenarios: Scenario 1 – current conditions (baseline-no augmentation); Scenario 2 – no withdrawals or augmentation; and Scenario 3 – with the City of Kent's operation and flow augmentation program. The analysis under Scenario 1 provided an estimate of flow conditions that would occur if the City of Kent continued its current operations of the Clark Springs System, but without any flow augmentation. The analysis under Scenario 2 provided an estimate of flows that would occur if the City ceased its operations. The Scenario 3 analysis estimated the flow conditions that would occur in Rock Creek with the City of Kent's proposed flow augmentation under the HCP. Through this analysis, it was possible to compare the amount of habitat (for different species and life stages) that would be provided under each of the three scenarios at different times of the year, and to quantify impacts and benefits resulting from the City's operations and benefits and effects resulting from HCM-1. The following discussion focuses on a comparison of Scenarios 1 and 3 to demonstrate the benefits of HCM-1 to covered fish species in Rock Creek. A detailed description of all the scenarios is included in the PHLOAT analysis completed on Rock Creek is contained in Appendix F and the effects analysis in Chapter 6. Selected sections, figures and tables are excerpted and presented here to depict major findings of the analysis.

As noted above, WUA-flow relationships were developed for specific species and life-history stages of concern for which default habitat suitability curves were available from WDFW and Ecology (2003). These species and life-history stages were:

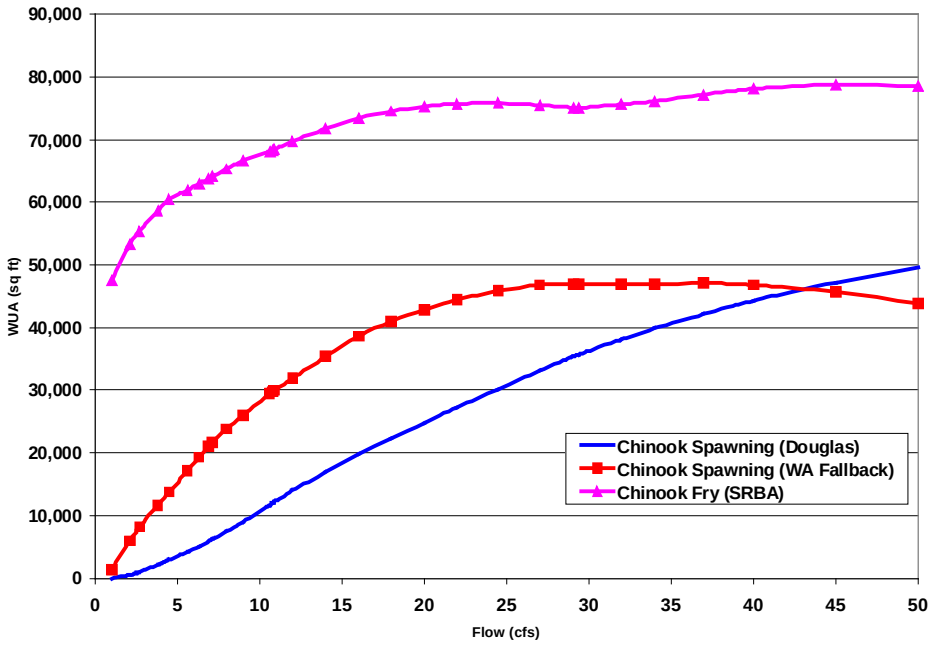
- Chinook salmon spawning, fry, and juvenile;
- Sockeye salmon spawning;
- Chum salmon spawning;
- Coho salmon spawning and juvenile;
- Cutthroat spawning, juvenile, and adult;
- Bull trout spawning, juvenile, and adult;
- Steelhead spawning, juvenile; and
- Rainbow trout spawning, juvenile, over-wintering, and adult.

The PHABSIM system allows for the calculation of a species and life-stage specific WUA versus flow relationship for each transect or each site, which is a composite of each transect within the site. In addition, composite WUA versus flow curves were developed by habitat type (run, riffle, pool). The result was a single WUA versus flow curve that represented the entire amount of habitat for a species and life history stage in a stream segment of interest. With this approach, each WUA versus flow curve was weighted by the proportion of stream habitat the transect represents. For example, Site B Transect 3 represented 20 feet of a pool and the total pool habitat represented by transects was 111.9 feet. Consequently, the WUA versus flow curve from this transect had a weight of 0.18. These curves were subsequently blended together into composite curves that represented the overall habitat-flow relationships for the reach of Rock Creek extending downstream of the Parshall Flume, which will be the compliance point for flows under HCM-1. Therefore, only Reaches 1 through 9b downstream of the flume were considered when developing composite WUA versus flow curves for each species and life history stage of interest. A total WUA versus flow curve was calculated by multiplying the composite curve (in square feet of WUA per 1000 feet of stream) by the length of stream (10,192 feet) divided by 1000 (see Appendix F).

Figures 4-1 to 4-3 provide total WUA versus flow curves for species and life history stages of interest. The WUA versus flow curves were generated for flows up to 50 cfs (a value chosen for modeling purposes that covers all but the highest winter flows likely to be experienced in the creek).[1] Some life stages of the species of interest may never experience this range of flows.

The HSPF model allowed the simulation of mean daily stream flows over a 45-year period under the three operational scenarios noted above. Exceedance flow values for these three scenarios are provided in Figure 4-4.

[1] Based upon HSPF modeling results under Scenario 1.



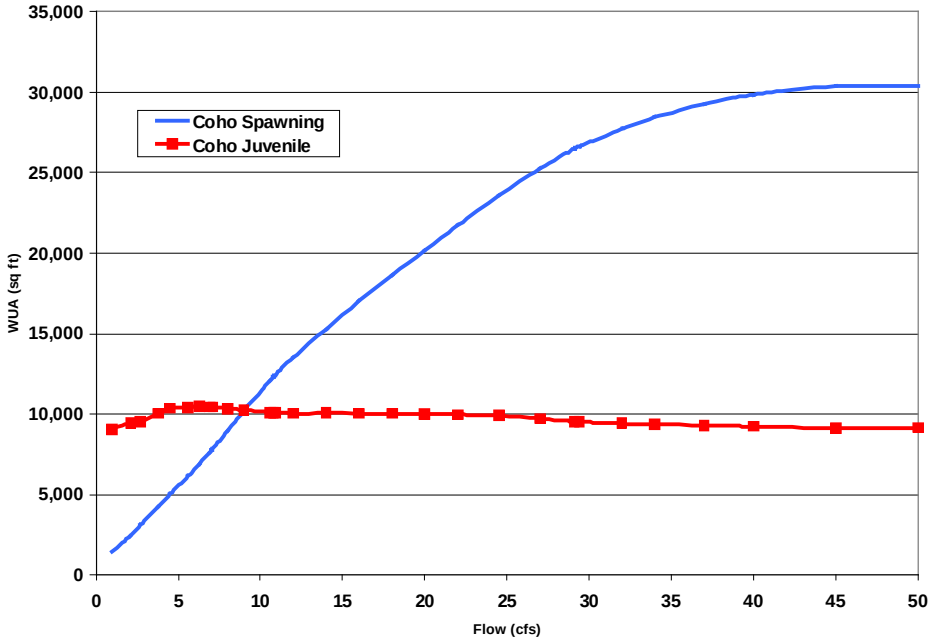
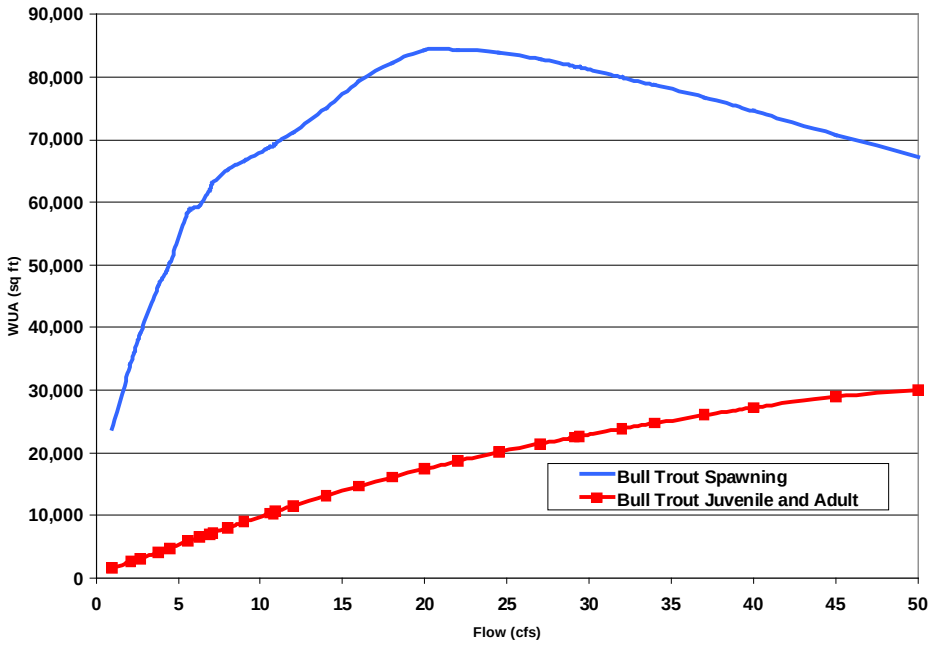




Figure 4-1. Total weighted useable area versus flow in Reaches 1 through 9b downstream of the Parshall Flume in Rock Creek for Chinook salmon (top) and coho salmon (bottom).



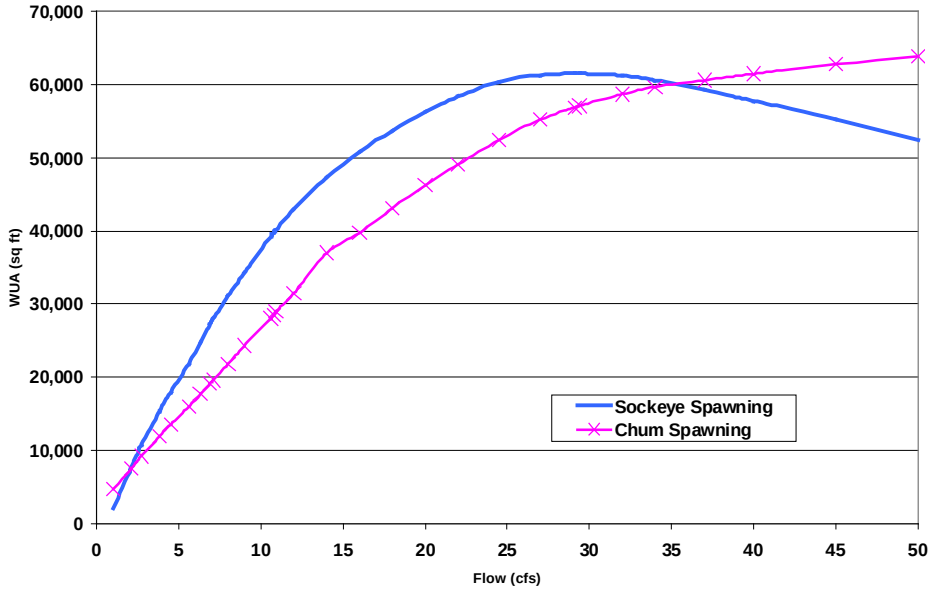




Figure 4-2. Total weighted useable area versus flow in Reaches 1 through 9b downstream of the Parshall Flume in Rock Creek for bull trout (top) and sockeye and chum salmon (bottom).

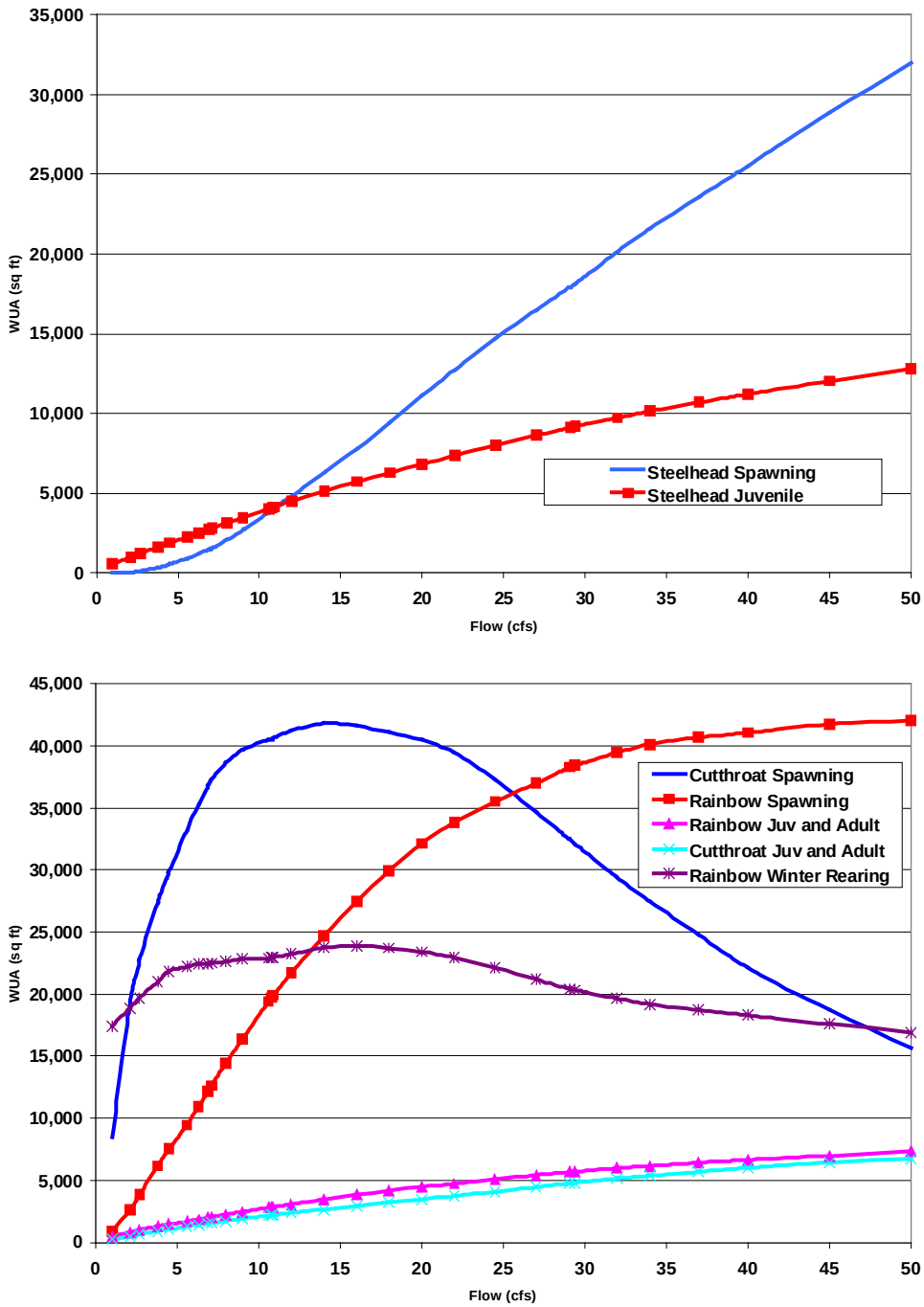



Figure 4-3. Total weighted useable area versus flow in Reaches 1 through 9b downstream of the Parshall Flume in Rock Creek for steelhead trout (top) and rainbow and cutthroat trout (bottom).

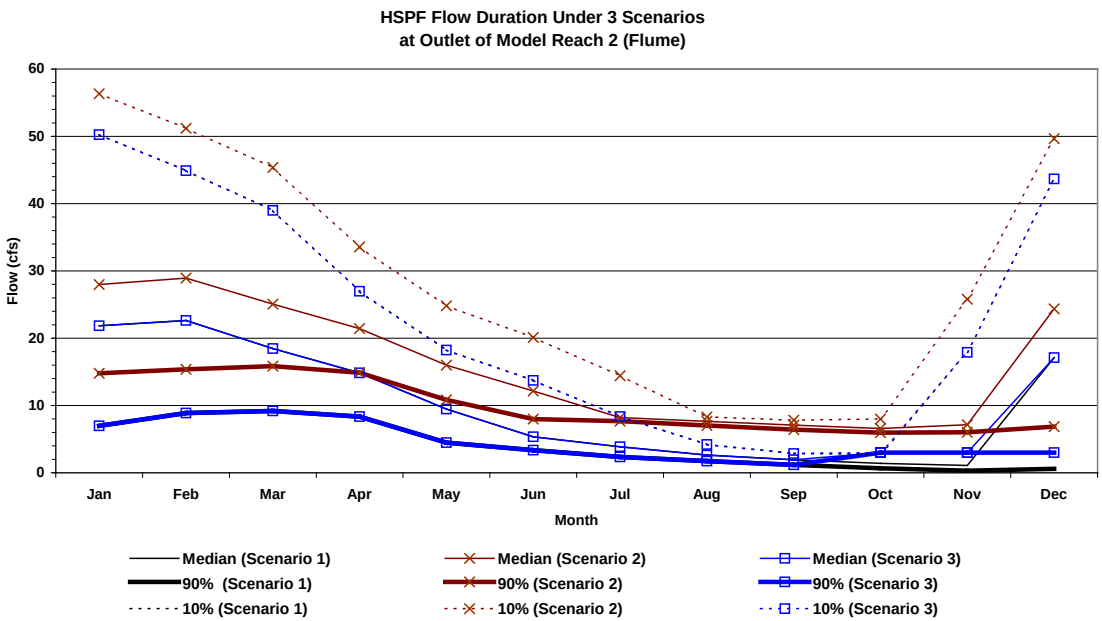



Figure 4-4. Median (50%), 10%, and 90% exceedance flow values at the outlet of model Reach 2 (Flume) from the HSPF model for Scenario 1 (current operations), Scenario 2 (no withdrawals or augmentation), and Scenario 3 (operations under HCM-1).

Using the total WUA versus flow curves, a daily WUA value was calculated from the simulated daily flow, which in turn allowed the calculation of habitat duration (exceedance) curves on a monthly basis for each species and life history stage. Approximately 4 percent of the simulated daily records exceeded 50 cfs. Under these circumstances, the WUA value at 50 cfs was used. Knowledge of the periodicity for the different life stages (Figure 3-8) was used to focus the analysis on critical months. For species with life history stages that may be found in Rock Creek throughout the year, four representative months (October, January, April, and July) were chosen for analysis. The month of October was selected since it represents a time when several salmonid species including Chinook, coho and sockeye are actively migrating into the Cedar River system and have the potential of spawning in Rock Creek. October is also representative of low flow conditions in Rock Creek. January was selected to represent winter conditions when juvenile coho and steelhead as well as resident rainbow and cutthroat trout would be present; some late sockeye and early steelhead

spawning can also occur in January. April was selected for analysis since it represents a period when steelhead as well as resident rainbow and cutthroat trout spawning occurs. July represents summer-time conditions when resident rainbow and cutthroat trout would be present in Rock Creek.

The following describes the results of the analysis under two of the three scenarios noted above: Scenario 1 – current conditions (baseline-Kent's operations without augmentation); and Scenario 3 – with the City of Kent's operations and flow augmentation. A comparison of all Scenarios is provided in Chapter 6 and Appendix F. With respect to this analysis it is important to note that the City of Kent's proposed flow augmentation program targets a 3 cfs flow (provided by up to 2 cfs of flow augmentation) during October, November, and December under conditions with normal precipitation patterns. The City of Kent's flow augmentation plan has operational provisions and flow targets that vary by wet, normal, dry and drought precipitation conditions (see Table 4-2). These four water year types were determined from analyses completed by the City of Kent and based upon the two-month antecedent precipitation for each 15-day augmentation period. That analysis is presented in Appendix H.

## Chinook

Chinook salmon spawning in the Cedar River system primarily occurs during the months of October and November (WDFW 1995). Chinook salmon fry typically begin emergence from the gravel as soon as late January. Chinook fry have generally completed outmigration from the Cedar River by mid-May, while most fingerlings are usually out of the Cedar River by early July (Volkhardt et al. 2006). The historic distribution of Chinook salmon in Rock Creek is uncertain and not based upon documented historical stream surveys. Different sources have placed the upper extent of Chinook spawning at RM 1.3, RM 0.65, RM 0.27, and RM 0.20, although documentation for these locations is limited (SASSI, SSHIAP, Streamnet, and WRIA 8 Conservation Plan); see Appendix B.

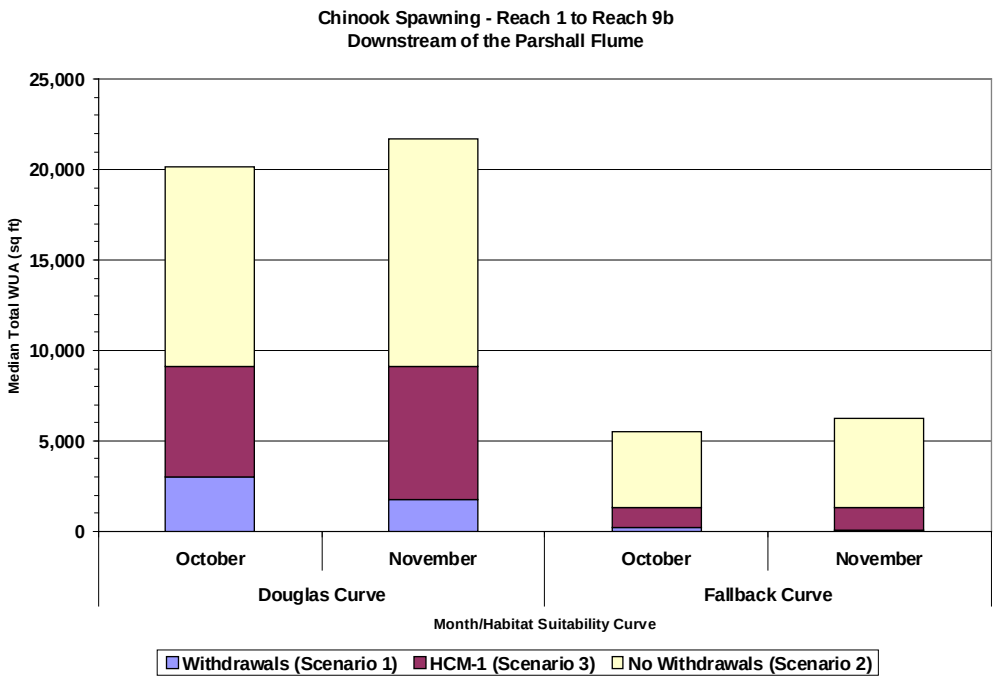
Habitat duration curves for two Chinook salmon life stages (spawning and fry), two alternative spawning Habitat Suitability Index (HSI) curves (Washington "Fallback" and

Douglas spawning curve)[2], and four alternative distributions corresponding to different segments of stream (based on historical reports of Chinook use in Rock Creek) were modeled. Stream segments included from the mouth up through Reach 3 (RM 0.28), Reach 5 (RM 0.67), Reach 8 (RM 1.58), and Reach 9b (RM 1.85). The end of Reach 8 was chosen as the end of one alternative distribution because RM 1.3 occurs in the middle of Reach 8.

The analysis indicated that under current operations (Scenario 1; baseline – without augmentation) the median amount of Chinook salmon spawning habitat through Reach 9b would only be approximately 168 $ft^2$ of habitat (WUA) during October and 47 $ft^2$ of WUA during November based on the Washington fallback HSI curves (Figure 4-5 top). Under the Douglas curves, the median amount of habitat would be 2,977 $ft^2$ of WUA during October and 1,756 $ft^2$ during November. Under HCM-1 (Scenario 3; Normal conditions), Chinook spawning habitat would increase to 1,301 $ft^2$ during October and November based on the fallback curves and 9,139 $ft^2$ using the Douglas curves. These represent a 7.8 to 27.7-fold increase over current conditions (Scenario 1; baseline – without augmentation) using the fallback curves, and 3.1 to 5.2-fold increase based on the Douglas curves.

An analogous analysis for the three other alternative Chinook distributions (i.e., up through Reach 3, 5, and 8) indicated the primary difference is scalar (i.e., the shorter alternative reach lengths have less total WUA) (Figures 4-5 bottom and Figure 4-6). Under HCM-1, the amount of total WUA would increase on a proportional basis in a similar fashion for each alternative distribution. Compared to current conditions (Scenario 1; baseline – without augmentation), under the fallback curve the proposed flow mitigation would increase total WUA 7.8 to 8.2-fold during October and 27.7 to 30.8-fold during November depending upon which stream segment is used to define the distribution of Chinook in Rock Creek. Under the Douglas curve, the WUA increase would be 2.9 to 3.1-fold during October and 4.7 to 5.2-fold during November.

[2] Two HSI curves were used to depict spawning habitats-flow relationships, the Washington "Fallback" curve which the state of Washington indicates should be used in instream flow studies if no site specific data are available, and a "Douglas" curve which was developed for Chinook spawning in streams of similar size to Rock Creek.



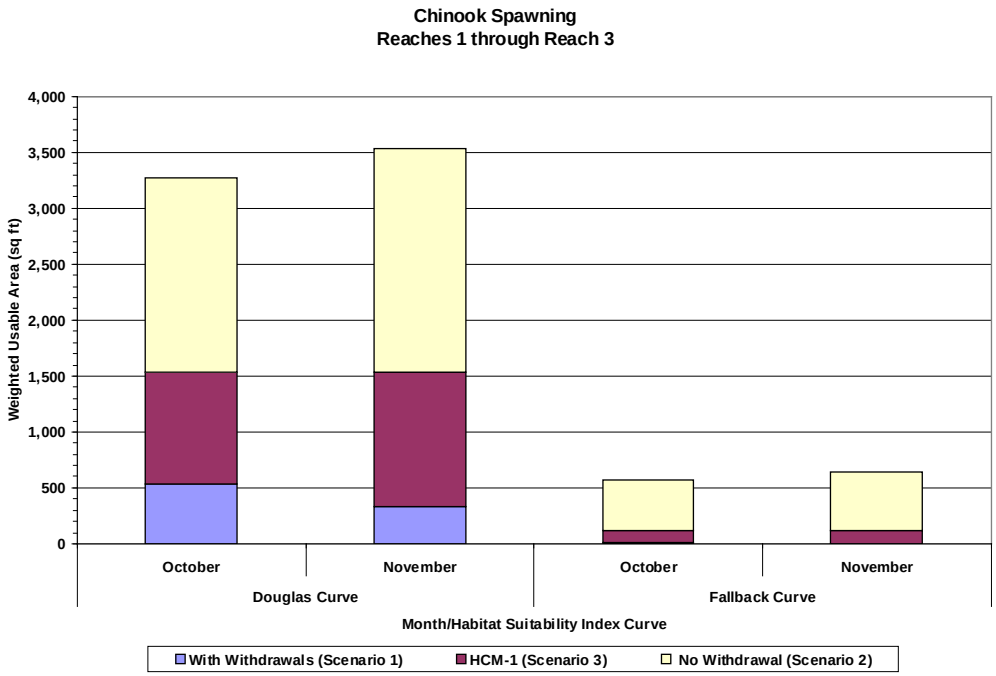
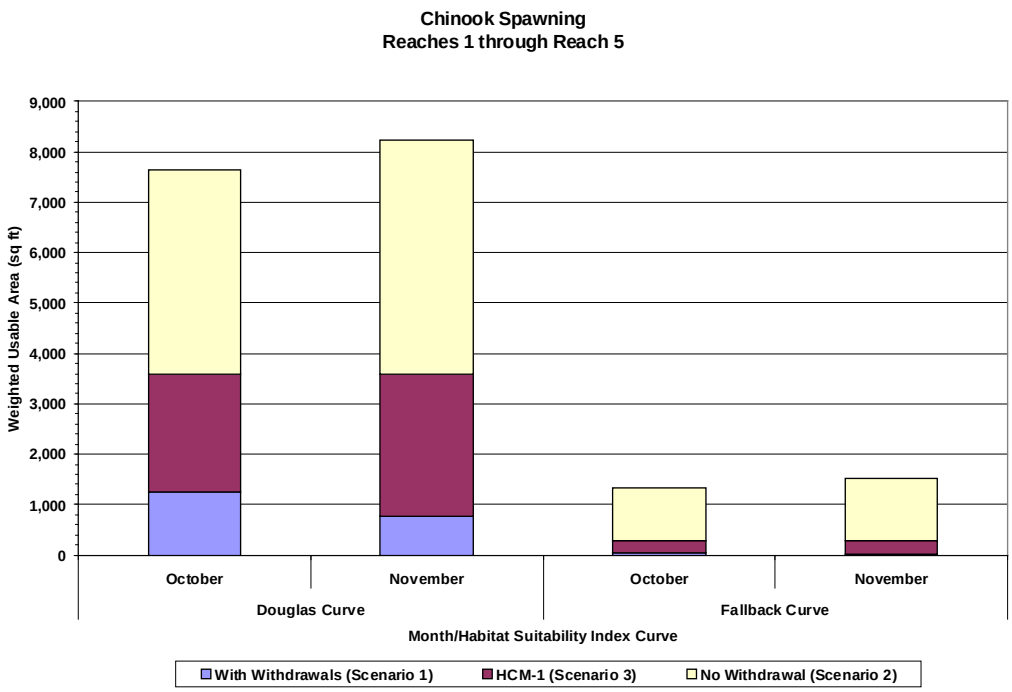




Figure 4-5. Median spawning WUA for Chinook salmon from Reach 1 through Reach 9b downstream of the Parshall Flume (top) and from Reach 1 through Reach 3 (bottom).



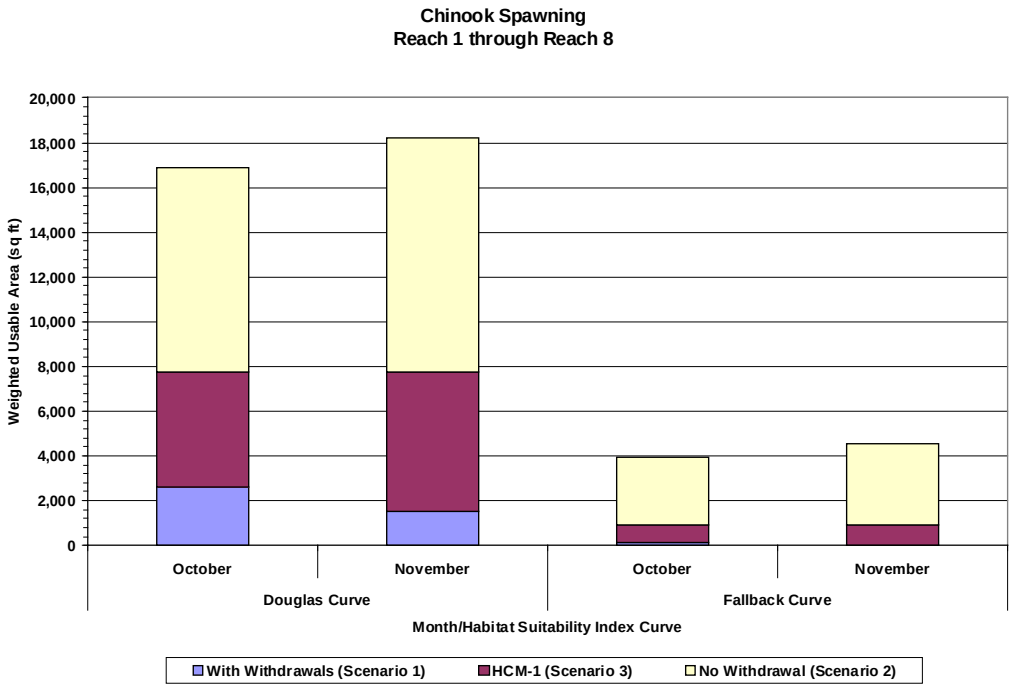



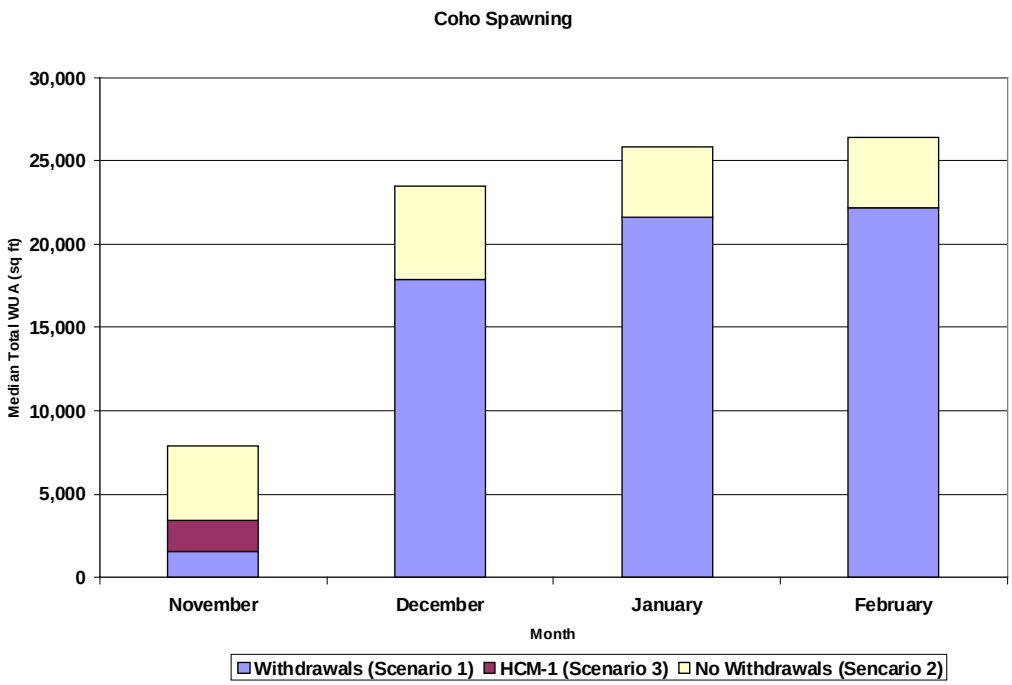

Figure 4-6. Median spawning WUA for Chinook salmon from Reach 1 through Reach 5 (top) and from Reach 1 through Reach 8 (bottom).

For current (Scenario 1; baseline – without augmentation) operations, the analysis indicated that under median flow conditions Chinook fry habitat ranges from approximately 71,143 $ft^2$ of WUA during May to about 80,356 $ft^2$ of WUA during February (see Appendix B Figure 10). These amounts represent 90.7 (May) to 99.5 (February) percent of the available habitat under the no-withdrawal scenario and indicate current project operations and those proposed in HCM-1 have a relatively small effect on fry habitat. The proposed flows during October, November, and December will not affect Chinook fry because they are not present in the system during that time period.

## Coho Salmon

Coho salmon are present in Rock Creek throughout the year. Adult salmon may enter Rock Creek in late-October, but more generally the spawning migration begins in mid- to late-November with peak spawning from the second week in December through mid-January (R2 2003, R2 2004) (see Appendix A). Juvenile coho salmon may rear in Rock Creek for about a year, migrating as smolts during the spring following their emergence from the gravel. Some coho juveniles may also emigrate over the year and undergo smoltification within the Cedar River. Because they are similar in size, the availability of coho salmon fry habitat is likely similar to that of Chinook salmon fry.

The PHLOAT analysis indicated that under current conditions (Scenario 1; baseline – no augmentation), the median amounts of coho spawning habitat would be 1,677 $ft^2$ of WUA during November and 18,977 to 23,490 $ft^2$ of WUA during December to February (Figure 4-7). Under HCM-1 (Scenario 3; normal year type), the median amount of coho salmon habitat would increase to 3,704 $ft^2$ of WUA during November, but no changes would occur in the median amount of WUA during December through February. These represent a 2.2-fold increase over current conditions (baseline – no augmentation) during November. During low flow years (1 in 5 years or 80 percent exceedance values or greater), the proposed minimum flows during December would increase the amount of spawning habitat from 1,508 $ft^2$ of WUA to 3,704 $ft^2$ of WUA or about a 2.3-fold increase over current conditions (Scenario 1; baseline – without augmentation).



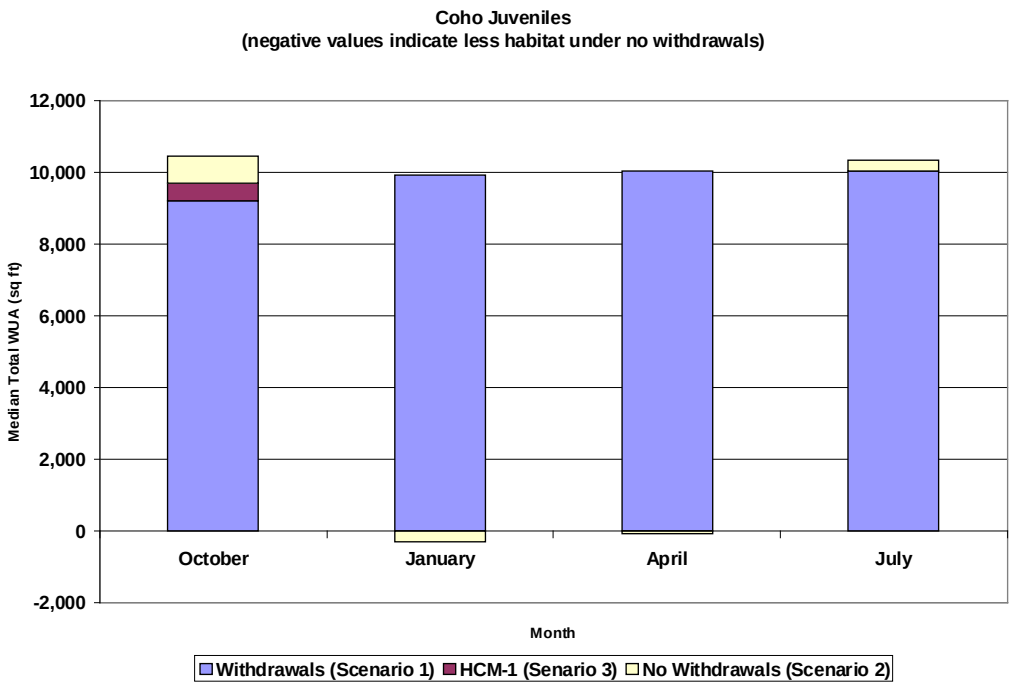




Figure 4-7. Coho salmon spawning (top) and juvenile (bottom) median total weighted usable area for from Reach 1 through Reach 9b downstream of the Parshall Flume.

The amount of habitat for juvenile coho salmon is relatively stable throughout the year (see Appendix F, Figure 13), regardless of the withdrawal scenario. During the high flow winter months, water supply withdrawals result in a small increase (e.g., about 350 $ft^2$ during January) in median coho juvenile habitat relative to the no withdrawals scenario. This is a case where reduced flow provides slightly more habitat as a result of reduced velocities making the habitat more suitable for juvenile fish according to the PHLOAT analysis. With HCM-1, there would be a small increase in WUA (e.g., about 462 $ft^2$ during October) compared to the current conditions (Scenario 1; baseline – without augmentation). It should be noted, however, that several studies (e.g., Seiler 2005; Smoker 1953) have documented a correlation between increasing flow and increasing coho production for other streams or on a regional basis.

## Sockeye

Sockeye salmon spawn in Rock Creek from October through December (R2 2003, 2004). Spawning has been observed up through Reach 12, but the majority occurs in Reaches 1 through 4. Fry emergence begins in late January and continues through May. Sockeye fry begin their downstream movement to Lake Washington shortly after emergence.

The PHLOAT analysis indicated that under current conditions (Scenario 1; baseline – without augmentation) the median amount of sockeye spawning habitat during October is 4,284 $ft^2$ of WUA, while November has 2,786 $ft^2$, and December 53,252 $ft^2$ (Figure 4-8). Under HCM –1, the median amount of sockeye salmon habitat would increase to 12,645 $ft^2$ of WUA during October and November, but no changes would occur in the median amount of WUA during December. These represent a 3.0-fold increase over current conditions (Scenario 1; baseline – without augmentation) during October and a 4.6-fold increase during November. Like coho, during low flow years (1 in 5 years: 80 percent exceedance value or greater), the flows provided under HCM-1 during December would increase the amount of sockeye spawning habitat from approximately 2,728 $ft^2$ of WUA to about 9,917 $ft^2$ of WUA or about a 4.6-fold increase over current conditions (baseline – without augmentation).

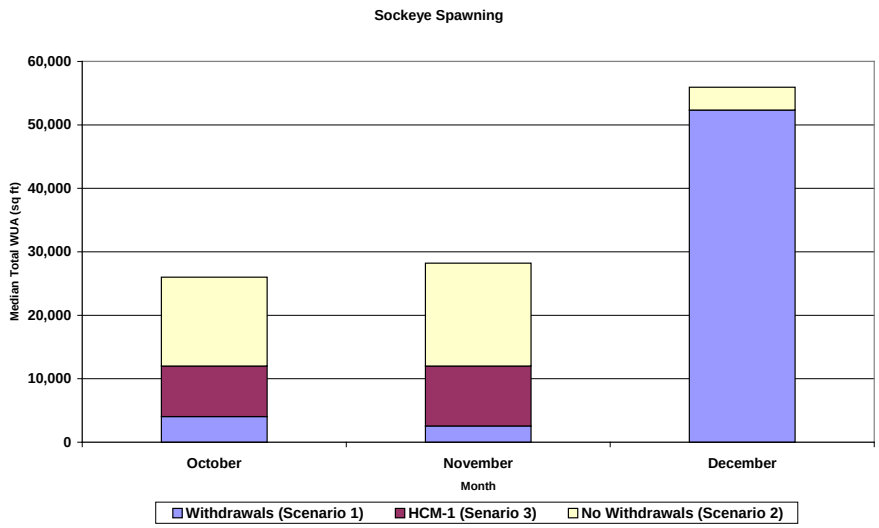



Figure 4-8. Sockeye salmon spawning median total weighted usable area for from Reach 1 through Reach 9b downstream of the Parshall Flume.

## Chum Salmon

Neither the Cedar River nor Rock Creek have a self-reproducing population of chum salmon, although strays may occasionally be observed. The freshwater migration period of chum salmon spans a three-month period from October through December and spawning occurs from mid-November through December. Chum fry tend to outmigrate to estuarine areas shortly after emergence from the gravel (Salo 1991), so it is not expected that chum fry would extensively use Rock Creek for rearing if any successfully spawn in the creek.

The PHLOAT suggests that under baseline conditions the median amount of chum salmon spawning habitat during November has approximately 4,985 $ft^2$, while December has approximately 41,657 $ft^2$ (Figure 4-9). Under HCM-1, the median amount of chum salmon habitat would increase to 9,985 $ft^2$ of WUA during November, but no changes would occur in the median amount of WUA during December. These represent a 2.0-fold increase during November.

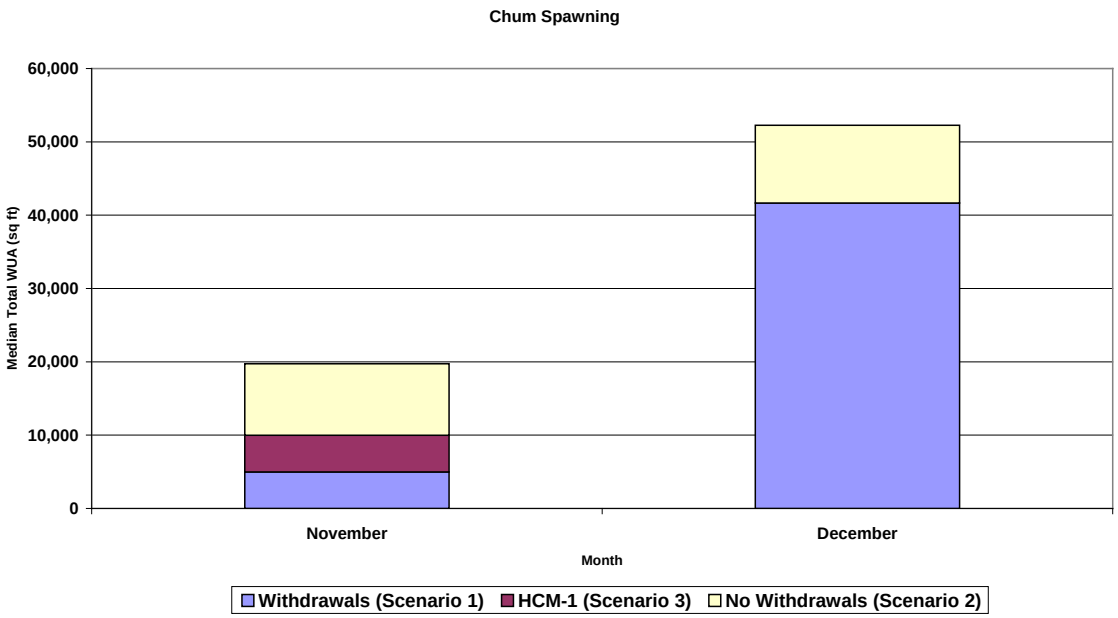



Figure 4-9. Chum salmon spawning median total weighted usable area for from Reach 1 through Reach 9b downstream of the Parshall Flume.

# Steelhead Trout

Steelhead trout were historically present in Rock Creek, but the current level of utilization is uncertain. Rainbow trout, the resident life history form of *O. mykiss*, is present throughout Rock Creek where suitable habitat is available. The WDFW and Western Washington Tribes (2005) listed the Lake Washington steelhead as critical because of a sharp decline following the 1999 run and an average escapement of 38.4 fish between 2000 ad 2004. Puget Sound steelhead trout were listed as threatened under ESA in May 2007. Steelhead trout in the Cedar River Watershed spawn from late-January through early-June. Juvenile rearing occurs throughout the year. Because of their similarity of size, the availability of steelhead fry habitat in Rock Creek would likely be similar to that of Chinook salmon.

Steelhead spawning habitat was modeled during April, May, and June. During this period the amount of spawning habitat declines as flows decline (Figure 4-10). Under current

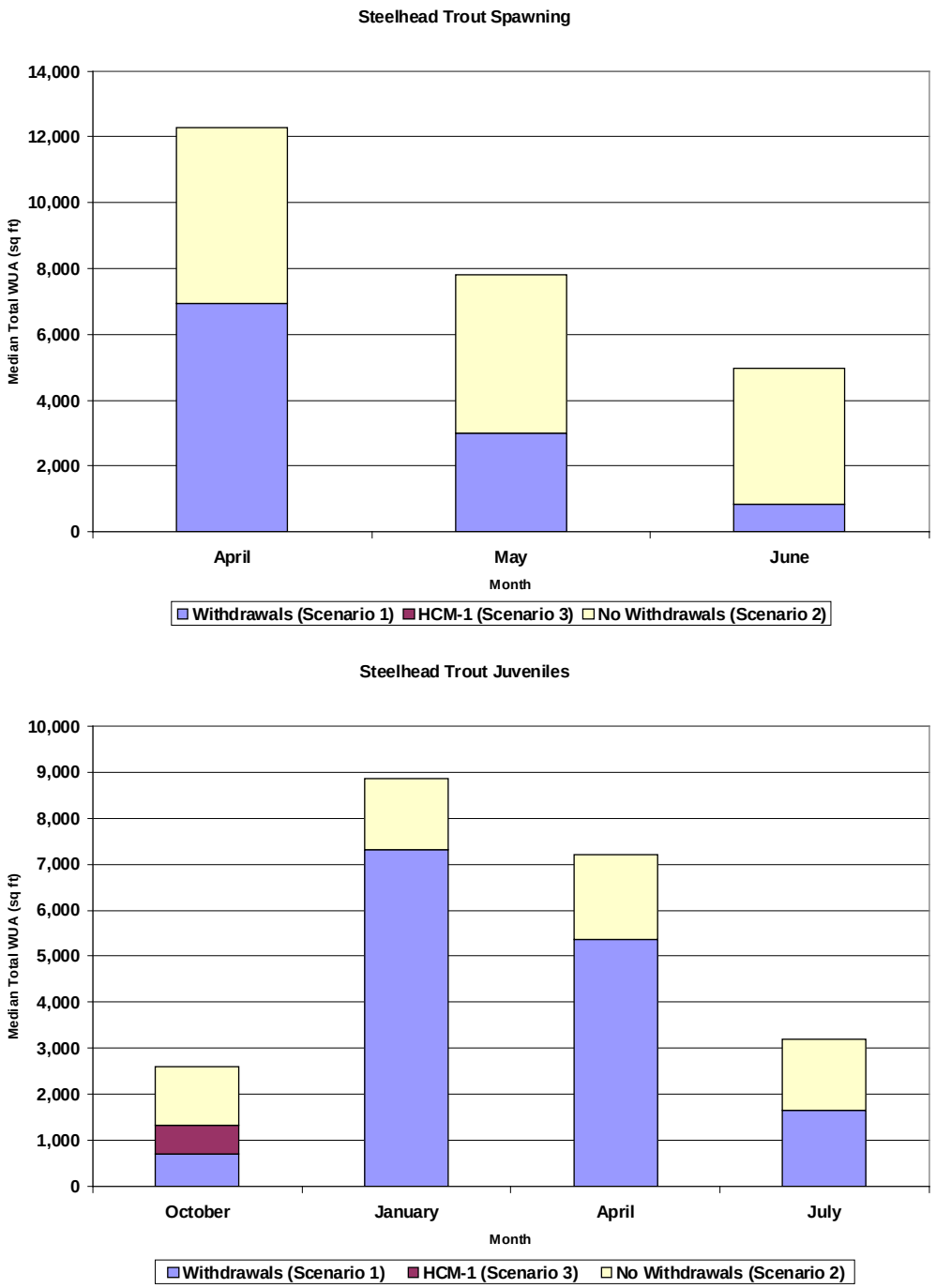



Figure 4-10. Steelhead trout spawning (top) and juvenile (bottom) median total weighted usable area for from Reach 1 through Reach 9b downstream of the Parshall Flume.

conditions (Scenario 1; baseline – no augmentation) the median amount of WUA was estimated at 7,461 $ft^2$ for April, 3,271 $ft^2$ for May, and 878 $ft^2$ for June. The flows proposed in HCM-1 (Scenario 3; Kent Operations with augmentation, normal year type) will not affect the amount of steelhead spawning habitat.

Under current conditions (Scenario 1; baseline - without augmentation) the median amount of juvenile steelhead WUA was estimated to be 763 $ft^2$ for October, 7,711 $ft^2$ for January, 5,630 $ft^2$ for April, and 1,760 $ft^2$ for June (see Appendix F, Figure 16). Under HCM-1 (Scenario 3; Kent Operations with augmentation, normal year type), a moderate increase over current conditions would be expected during October and November (e.g., an additional 650 $ft^2$ of WUA during October); however the benefits of HCM-1 to juvenile steelhead would generally decline between October and December. Benefits decrease in part because of decreases in the need for augmentation during most years and also because decreases in temperature and changes in behavior can result in changes in how juvenile salmonids use the available habitat. As temperatures decline during the fall fish becoming less territorial, may be found in schools, and may seek cover among coarse substrate (Bjornn and Reiser 1991).

HCMs proposed in Chapter 4 will provide benefits to steelhead specifically with improved habitat conditions in the Creek. The City is proposing to provide augmentation (HCM-1) to the Creek during the critical low flow period of October, November, and December when the greatest amount of adult salmonids are present, thus providing the greatest benefit to salmonids during this period. Augmentation of flows during this time will also be beneficial to rearing juvenile salmonids, including steelhead, which may rear in a small tributary like Rock Creek for up to 2 years after emerging (Wydoski and Whitney 2003). HCM-2 will improve adult passage at the mouth of Rock Creek for all salmonids. HCM-3, 4 and 6 will provide improved habitat conditions within the creek by connecting riparian wetlands to the stream and adding large woody debris which are important for rearing juvenile steelhead. HCM-5 will replace culverts at Summit Landsburg Road thus improving passage for adult steelhead to spawning areas in upper Rock Creek. In addition, the habitat fund identified as HCM-8 provides funds for projects, easements, or acquisition of property that may have a direct benefit to steelhead.

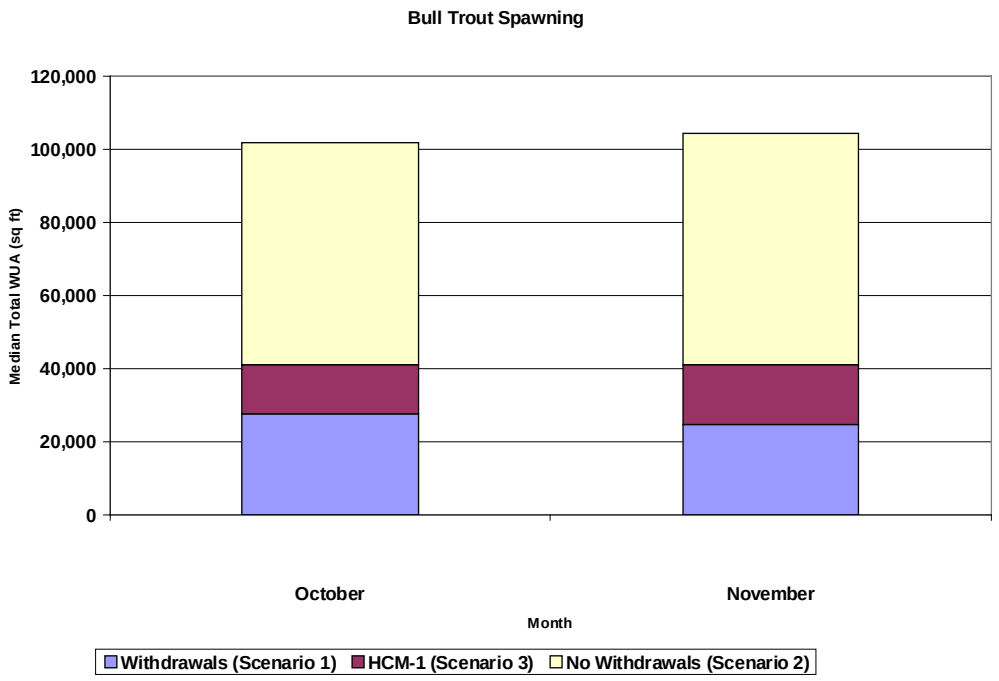
Due the operational constraints as outlined in Appendix G, the City is limited with the amount of water it is able to provide on an annual basis, as well as the specific times of the year. Steelhead, if present, would spawn from late March to early June, with a peak sometime in mid-May (City of Seattle 1999). At flows typical of March through June based upon the HSPF modeling, the average wetted perimeter from IFIM transects (Figure 6-13) would decline about 6 percent (about 33.5 to 31.5 feet) under Scenario 2 (no withdrawals) compared to about 13 percent (about 32.8 to 28.6 feet) under Scenario 1 (baseline conditions). Furthermore, the maximum change in water depth at these transects over these flows would be approximately 2.7 inches under Scenario 2 and approximately 4.0 inches under Scenario 1. Minimum spawning depth for steelhead under Washington Fallback habitat suitability curves is 7.8 inches (WDFW and Ecology 2003), which is nearly twice the maximum change in water depth under Scenario 1. Consequently, the risk of incubating eggs becoming dewatered as a result of water supply withdrawals would be low.

## Bull Trout

There are no documented observations of bull trout utilizing Rock Creek. However, rare observations of bull trout have occurred in the Cedar River; a viable population of bull trout occurs in the upper Cedar Watershed associated with Chester Morse Lake. In the upper Cedar River, bull trout spawn during October and November and rearing occurs year-round. The median amount of bull trout spawning WUA was estimated at 29,098 $ft^2$ during October and 26,284 $ft^2$ during November under current conditions (baseline – no augmentation).

Under HCM-1 (Scenario 3; Kent Operations with augmentation, normal year type), spawning habitat would increase to 43,057 $ft^2$ of WUA during both October and November (Figure 4-11).

Juvenile bull trout habitat was assessed during four representative months over the year (October, January, April, and July). Under current conditions (Scenario 1; baseline- without augmentation) the median amount of bull trout juvenile and adult WUA was estimated at 2,074 $ft^2$ for October, 19,738 $ft^2$ for January, 14,635 $ft^2$ for April, and 4,537 $ft^2$ for June (see Appendix B; Figure 18). With HCM-1 (Scenario 3; Kent Operations with augmentation,



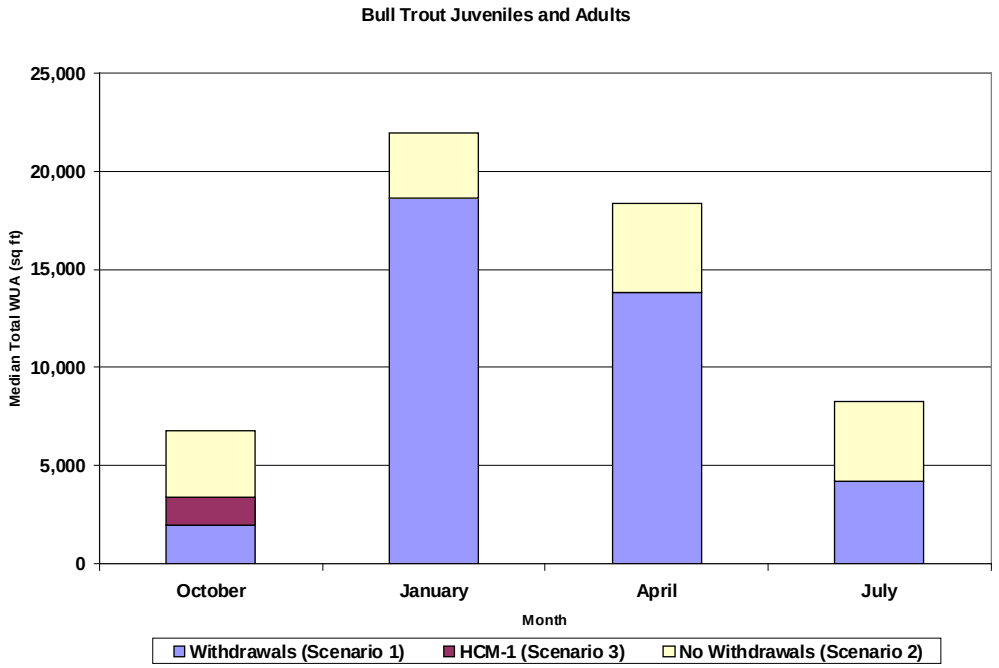



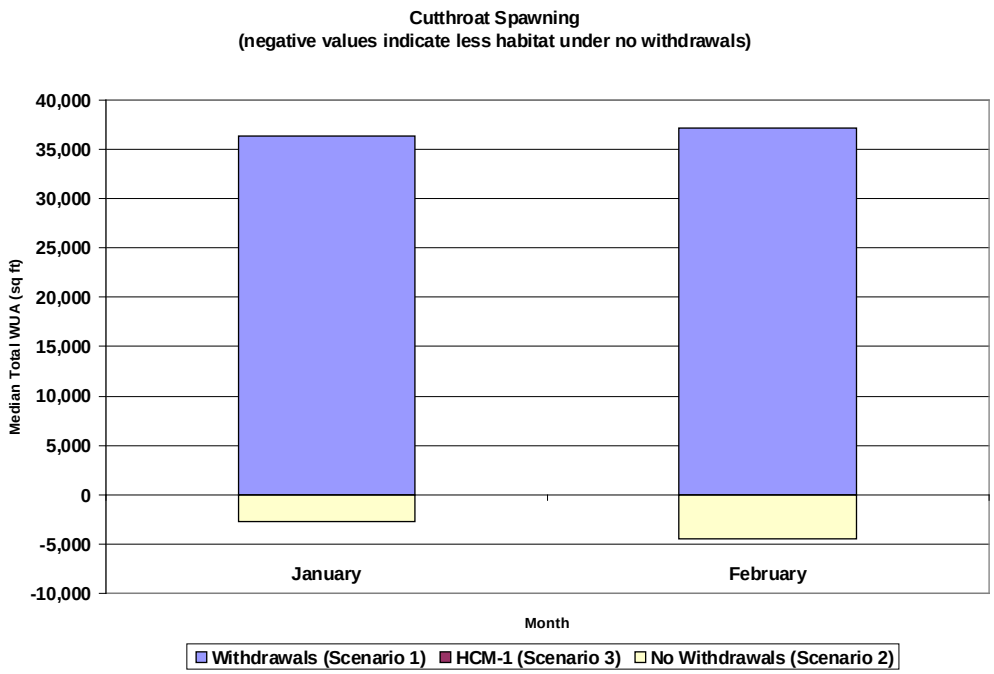

Figure 4-11. Bull trout spawning (top) and juvenile (bottom) median total weighted usable area for from Reach 1 through Reach 9b downstream of the Parshall Flume.

normal year type), a moderate increase in juvenile bull trout habitat over the current conditions would be expected during October and November (e.g., an additional 1,596 $ft^2$ of WUA during October).

## Cutthroat Trout

Adfluvial and/or fluvial cutthroat trout are known to utilize Rock Creek. Cutthroat trout spawn in Rock Creek during January and February, while juveniles and adults may be present year-round. The PHABSIM analysis estimated the median amount of cutthroat spawning WUA was 36,684 $ft^2$ during January and 37,305 $ft^2$ during February under current conditions (Scenario 1; baseline-without augmentation) (Figure 4-12). Because cutthroat spawn in the spring, the proposed flows under HCM-1 (Scenario 3; Kent Operations with augmentation, normal year type) are not expected to affect cutthroat spawning habitat.

Like other year-round residing salmonids in Rock Creek, juvenile habitat was assessed during four representative months over the year (October, January, April, and July). Under current conditions (Scenario 1; baseline-no augmentation) the median amount of cutthroat juvenile and adult WUA was estimated at 345 $ft^2$ for October, 3,960 $ft^2$ for January, 2,892 $ft^2$ for April, and 1,007 $ft^2$ for June (see Appendix B; Figure 20). During the proposed flow mitigation period under HCM-1 (Scenario 3; Kent Operations with augmentation, normal year type), the available juvenile cutthroat habitat is expected to more than double over current conditions during October and November (e.g., an additional 439 $ft^2$ of WUA during October). However, similar to steelhead, decreases in temperature and changes in behavior patterns would likely affect how cutthroat trout juveniles utilize the available habitat. Nevertheless, HCM-1 is anticipated to provide benefits to juvenile cutthroat trout during periods when augmentation occurs.



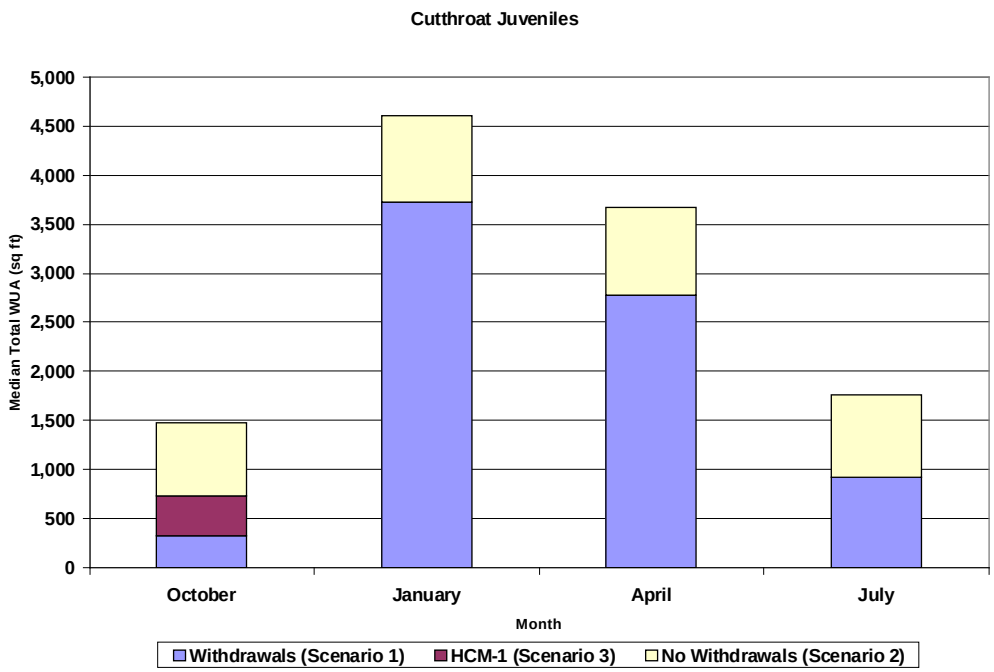




Figure 4-12. Cutthroat trout spawning (top) and juvenile (bottom) median total weighted usable area for from Reach 1 through Reach 9b downstream of the Parshall Flume.

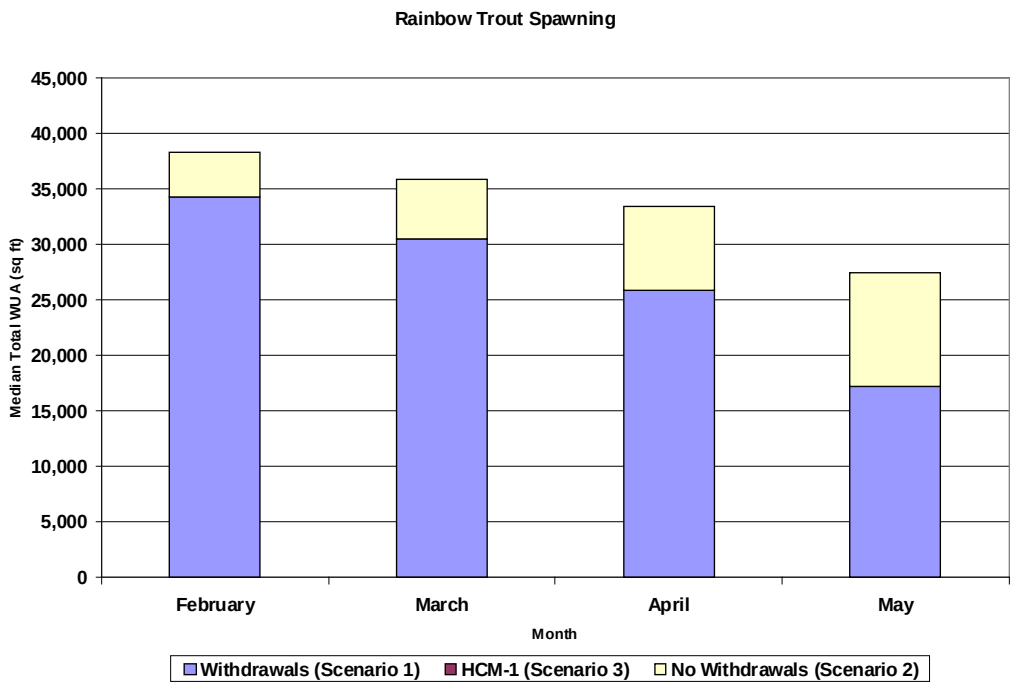
## Rainbow Trout

Resident rainbow trout are present in Rock Creek year-round; spawning occurs during late-February to early-June. Rainbow spawning habitat was modeled during February, March, April, and May. During this period, the amount of spawning habitat declines concurrently with declines in flow. Under current conditions (Scenario 1; baseline-no augmentation) conditions, the median amount of WUA was estimated at 35,349 $ft^2$ for February, 31,581 $ft^2$ for March, 26,938 $ft^2$ for April, and 18,084 $ft^2$ for May (Figure 4-13). The proposed flows under HCM-1 (Scenario 3; Kent Operations with augmentation, normal year type) are not expected to affect the amount of habitat available to spawning rainbow trout.

Similar to other salmonids that might reside year-round in Rock Creek, rainbow trout juvenile habitat is depicted graphically during four representative months over the year (October, January, April, and July). Under current conditions (Scenario 1; baseline-without augmentation) the median amount of WUA was estimated at 638 $ft^2$ for October, 5,016 $ft^2$ for January, 3,806 $ft^2$ for April, and 1,436 $ft^2$ for June (see Appendix B; Figure 22). During the proposed flow mitigation period in HCM-1 (Scenario 3; Kent Operations with augmentation, normal year type), a moderate increase in habitat over current conditions is expected during October and November (e.g., an additional 525 $ft^2$ of WUA during October). However, similar to steelhead and cutthroat trout, decreases in temperature and changes in behavior patterns would likely affect how rainbow trout utilize the available habitat. Nevertheless, HCM-1 is anticipated to benefit rainbow trout juveniles during periods when augmentation occurs.

### *Summary*

HCM-1 targets the months of October, November and December, a period of time when fall spawning fish are actively using Rock Creek. The PHLOAT analysis demonstrates that the implementation of HCM-1 (Scenario 3; Kent Operations with augmentation, normal year type) can substantially increase the amount of spawning habitats available for Chinook, coho, sockeye and chum salmon over that which would otherwise occur under current



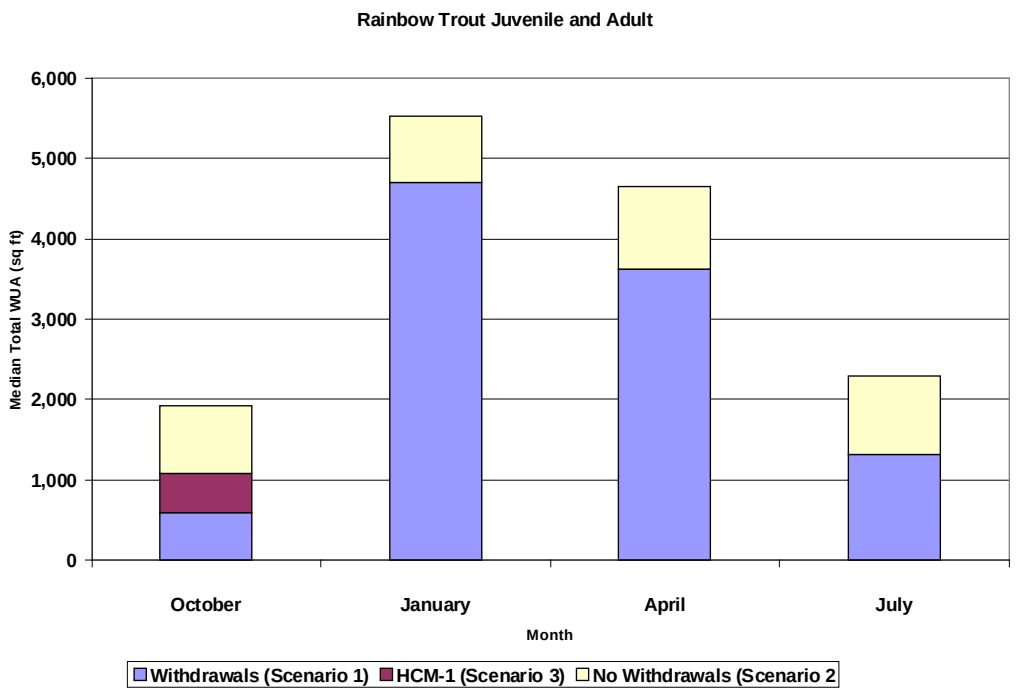




Figure 4-13. Rainbow trout spawning (top) and juvenile (bottom) median total weighted usable area for from Reach 1 through Reach 9b downstream of the Parshall Flume.

conditions (Scenario 1; baseline – without augmentation). The habitat gains by species range from a 7.7 to 27.4-fold increase over current conditions using the fallback curves, to a 3.1 to 5.3-fold increase based on the Douglas curves for Chinook. For coho, gains in spawning habitat provided by HCM-1 represent a 2.2-fold increase over current conditions during November. For sockeye, the spawning habitat gains represent a 3.0-fold increase over current conditions during October and a 4.6-fold increase during November. The provision of improved flows in October, coupled with the habitat modifications proposed at the mouth (see HCM-2), would be especially beneficial for facilitating adult fish passage from the Cedar River into lower Rock Creek. In addition, the augmentation of flows during this period will likely provide some temperature benefits to Rock Creek and may also create some localized thermal refugia along the left margins (looking downstream) of the Cedar River just below the mouth of Rock Creek.

## 4.2 HCM-2: Passage Improvement at Mouth of Rock Creek- Reach 1

**HCM-2**

**Passage Improvement at Mouth of Rock Creek – Reach 1**

The City of Kent has estimated $55,000 to complete permitting, final project design and construction of a habitat enhancement project intended to improve upstream passage at the mouth of Rock Creek during low flow periods throughout the term of the HCP. Passage improvements will consist of channel reconfiguration to concentrate flows using boulders and/or LWD. To ensure natural geomorphic function and reduce the risk of property damage during floods, improvement structures will not be designed to withstand major flood events (greater than a 100-year event) in Rock Creek or the Cedar River. Thus this measure includes funding for maintenance for the life of the project equal to the replacement cost unit or reconstruction over the course of the 50-year ITP. If a major failure of the structure occurs, the City and Services will meet to evaluate possible fixes and alternative mitigation. A final design package for HCM-2 will be

*HCM-2 (continued on next page)*

*HCM-2 (continued)*

submitted to the Services for review and the project will be permitted and constructed within 5 years of ITP issuance.

The confluence of Rock Creek with the Cedar River is bordered by land owned by King County to the west (parcel 2222069036) and a private homeowner to the east (King County 2005). Sponsorship and implementation of HCM-2 does not include purchase of property on either side of the project site. Moreover, if the landowner(s) or other entities determine that expansion of the project to incorporate additional project elements (e.g., recreational facilities) or land areas beyond those described in this HCM is desirable, the City of Kent is not committing additional funds to support objectives outside the HCP. If additional data collection indicates that the proposed project is not feasible or will not benefit species covered by the ITP, the City of Kent will likewise make the $55,000 allocated for HCM-2 available to other projects aimed at improving habitat in the Rock Creek basin. If transfer of funds to other projects is proposed, the City of Kent will notify the Services and obtain their approval of the suggested alternative prior to reallocation of funds.

Repair/reconstruction costs are anticipated to be comparable to original construction costs. Post-construction monitoring will be conducted annually to ensure the passage weir is functional. This will consist of directly observing the passage structure at the end of the run-off period (e.g., late May through June) to make sure it is functionally and structurally sound, and as part of MEM-4, conducting periodic spawning surveys that document successful adult passage from the Cedar River (see Section 5-1). The structure will also be monitored following any flow events greater than 50 cfs.

*Rationale and Benefits*

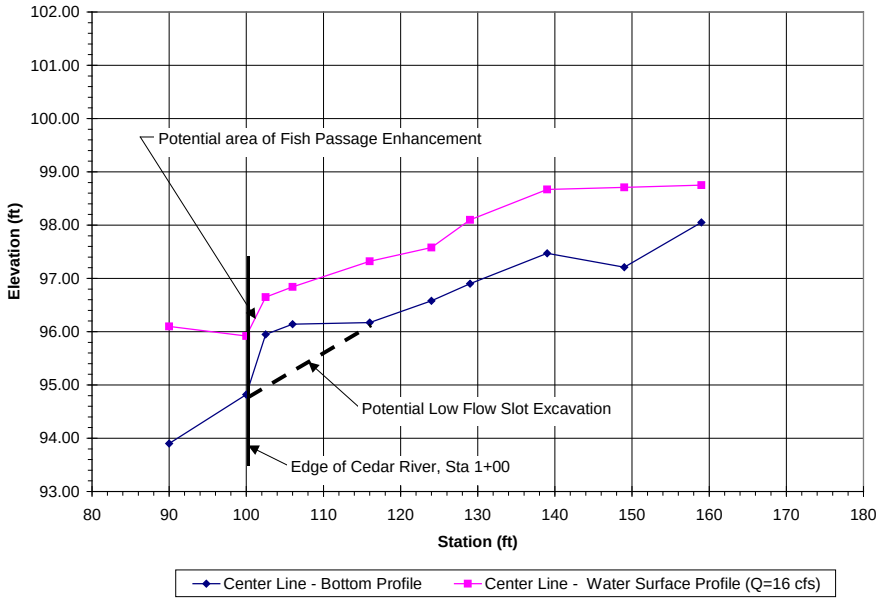
When flows in both the Cedar River and Rock Creek are low (i.e., Cedar River flows <200 cfs and Rock Creek flows are less than about 4 cfs), the mouth of Rock Creek becomes perched approximately 3 feet above the confluence with the Cedar River resulting in a 40-

foot long section composed of large cobble and boulders that has a gradient of 7 percent. At its juncture with the Cedar River, the mouth of Rock Creek is over 20 ft wide. This creates a condition in which low flows become quite shallow and diffuse as they enter the Cedar River. Although the area is readily passable at moderate to high flows (flows > 6-7 cfs), as flows decline, they become spread out so that water depths become increasingly shallower. Although successful adult salmonid passage has been documented at flows as low as 1.5 cfs as evidenced by spawning survey data (R2 2003, 2004), the prevailing conditions at these low flows are clearly sub-optimal for adult passage.

The adult passage improvement project (HCM-2) committed to by the City of Kent would be accomplished by constructing a series of low rock or LWD weirs with a center slot that concentrates flow. Concentrated flow would provide sufficient depth for fish to move upstream, while the weirs will act to slightly pond water. Swift velocity in the concentrated flow path is not anticipated to be a concern because of the relatively short length of the section. HCM-2 would be implemented according to the conceptual design depicted in Figure 4-14 (see Appendix I). Boulder placement would be accomplished using a small rubber-tired track hoe and hand adjustment. Access to the site is available on the King County property on the west bank of Rock Creek via a footpath from SE 246th Street. Minimal vegetation clearing would be required for access and construction. Cleared areas (if any) would be restored with native vegetation.

The weirs will be checked annually prior to the time when fish movement into Rock Creek generally commences to ensure that the center slots are clear and functioning to concentrate flow. The weir configuration could be affected by high flow events in either Rock Creek or the Cedar River, thus it is anticipated that maintenance will be required. Constructing weirs to sustain higher flow events could reduce potential maintenance costs. However, use of these techniques could increase permitting and construction costs.

An alternative to the use of rock weirs would be to construct similar structures using notched logs. Notched logs would need to be anchored and at least partly buried in the bank, thus this approach would require increased site disturbance, as well as access to the east bank



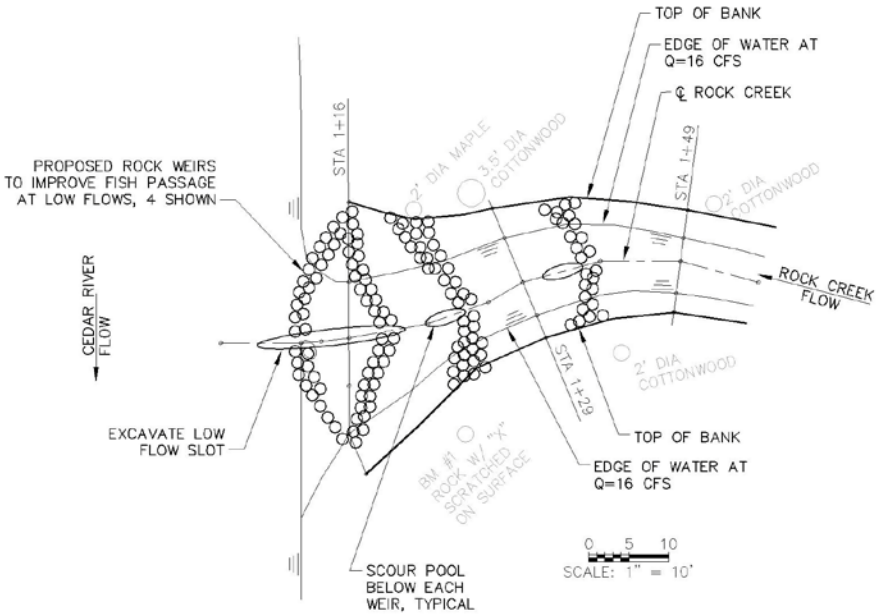




Figure 4-14. Profile of Rock Creek bed and water surface elevation at the confluence with the Cedar River on February 3, 2005 (top). Rock Creek flow of 16 cfs; Cedar River flow of 382 cfs. Conceptual plan view design sketch of a series of Rock weirs that could be constructed at the mouth of Rock Creek to improve low flow fish passage (bottom).

property. The City of Kent will support use of notched logs in lieu of boulder placement if requested by permitting agencies as long as: 1) the revised approach is supported by landowners on both sides of Rock Creek; and 2) the use of notched logs does not increase the total project cost (including, but not limited to, design and permitting).

Improvement of low flow fish passage at the mouth of Rock Creek would benefit all species that use or potentially use Rock Creek for spawning. Passage improvement would be particularly beneficial for Chinook salmon, which are large bodied fish that migrate upstream in the Cedar River basin to spawn during August and September when flows are typically low. Sockeye salmon also begin spawning in the late summer and are known to heavily utilize the entire perennial length of Rock Creek.

The development of HCM-2 was preceded by an analysis of passage conditions that would occur under varying flow conditions in lower Rock Creek (see Appendix J). For this, nine cross-channel transects used in the PHABSIM analysis were selected that were representative of riffle habitat types in lower Rock Creek. The analysis revealed that even under Scenario 2 (no Kent withdrawals) typical flow conditions during the late summer and early fall (estimated flows of about 7 cfs), maximum water depths at six of the nine locations were less than 1 ft (12 in.) deep, a depth considered by Bell (1991) as the minimum depth for providing adult fish passage in streams the maximum water depths (under no Kent withdrawal conditions) at the three transects where water depths were greater or equal to 1 ft were 12, 18.7, and 23.7 inches (Appendix J). The analysis also revealed that the channel configurations associated with the lower segment of Rock Creek were generally insensitive to changes in flow over the range of flows experienced under all three withdrawal scenarios. Maximum depths at the same three transects noted above, but under current conditions (i.e., baseline-no augmentation; flow of about 1.5 cfs) would be 9.2, 16.1, and 20.1 inches. Thus, an approximate 5.5 cfs flow difference (i.e., difference between 7 cfs natural flow and 1.5 cfs current conditions flow) translated into water depth differences of 2.8, 2.6, and 3.6 inches, respectively. Under normal (i.e., normal water year type with flow target of 3 cfs) flow conditions provided by HCM-1, the maximum depths at these same locations would be

10.4, 17.4, and 21.6 inches, or only 1.6, 1.3, and 2.1 inches shallower than what would occur under no Kent withdrawal flow conditions.

The construction of a series of weirs at the mouth of Rock Creek would facilitate adult fish passage under low flow conditions by concentrating flows that would normally be diffuse and widely distributed at the stream mouth, toward the center of the weir. This should provide a more direct passage portal for fish migrating from the Cedar River into Rock Creek. In addition, the weirs will create some deeper water areas above each of the structures that can be used as adult holding habitats.

## 4.3 HCM-3: Wetland Improvement and Juvenile Salmonid Habitat Enhancement – Reach 1

**HCM-3**

**Wetland Improvement and Juvenile Salmonid Habitat Enhancement – Reach 1**

The City of Kent will act as sponsor and provide funding (estimated cost $40,000) for a habitat enhancement project intended to connect a small wetland and pond located immediately west of Reach 1 of Rock Creek to the main creek channel. The connection of the wetland with Rock Creek will create and make available off-channel rearing and flood refuge habitat that can be used by juvenile salmonid species covered under the ITP. Existing pond habitat would be improved by placement of LWD in the pond to provide hiding cover for juvenile salmonids. HCM-3 would be implemented in accordance with the conceptual design and recommendations for additional survey and monitoring depicted in Figure 4-15 and further described in Appendix I.

The wetland is located on parcel 2222069036, which is currently owned by King County (King County 2005). The City of Kent will work with King County to develop a Memorandum of Understanding regarding the details and funding commitment related to this project. Development of final project designs will

*HCM-3 (continued on next page)*

*HCM-3 (continued)*

require a detailed topographic survey and at least one year of pre-construction temperature and water level monitoring. Pre-project monitoring will be implemented within two years of ITP issuance. A final design package for HCM-3 will be submitted to the Services for review within 5-years of ITP issuance. The City of Kent's estimated costs for HCM-3 are $40,000 to complete pre-project monitoring, permitting, final project design and construction as recommended in Appendix G. Post-construction monitoring will be conducted as part of this HCM. Sponsorship and implementation of HCM-3 does not include purchase of the subject property. If the landowner or other entities determine that expansion of the project to incorporate additional project elements (e.g., recreational facilities, waterfowl habitat) or land areas beyond those described in this HCM is desirable, the City of Kent is not committing additional funds to support objectives outside the HCP. If additional data collection indicates that the proposed project is not feasible or will not benefit species covered by the ITP, the City of Kent will make the $40,000 allocated for HCM-3 available to other projects aimed at improving habitat in the Rock Creek basin. If transfer of funds to other projects is proposed, the City of Kent will notify the Services and obtain their approval of the suggested alternative.

*Rationale and Benefits*

Side channels and off channel ponds have been shown to provide important habitat for juvenile and smoltified salmon and steelhead (Sedell et al. 1984; Murphy et al. 1989; Marshall and Britton 1990; Sheng et al. 1990; Bonnell 1991; Cowan 1991). Establishing direct hydrologic connectivity between the wetlands and pond and Rock Creek would provide approximately 0.3 acres of off-channel habitat, approximately doubling the amount of this type of habitat associated with lower Rock Creek.

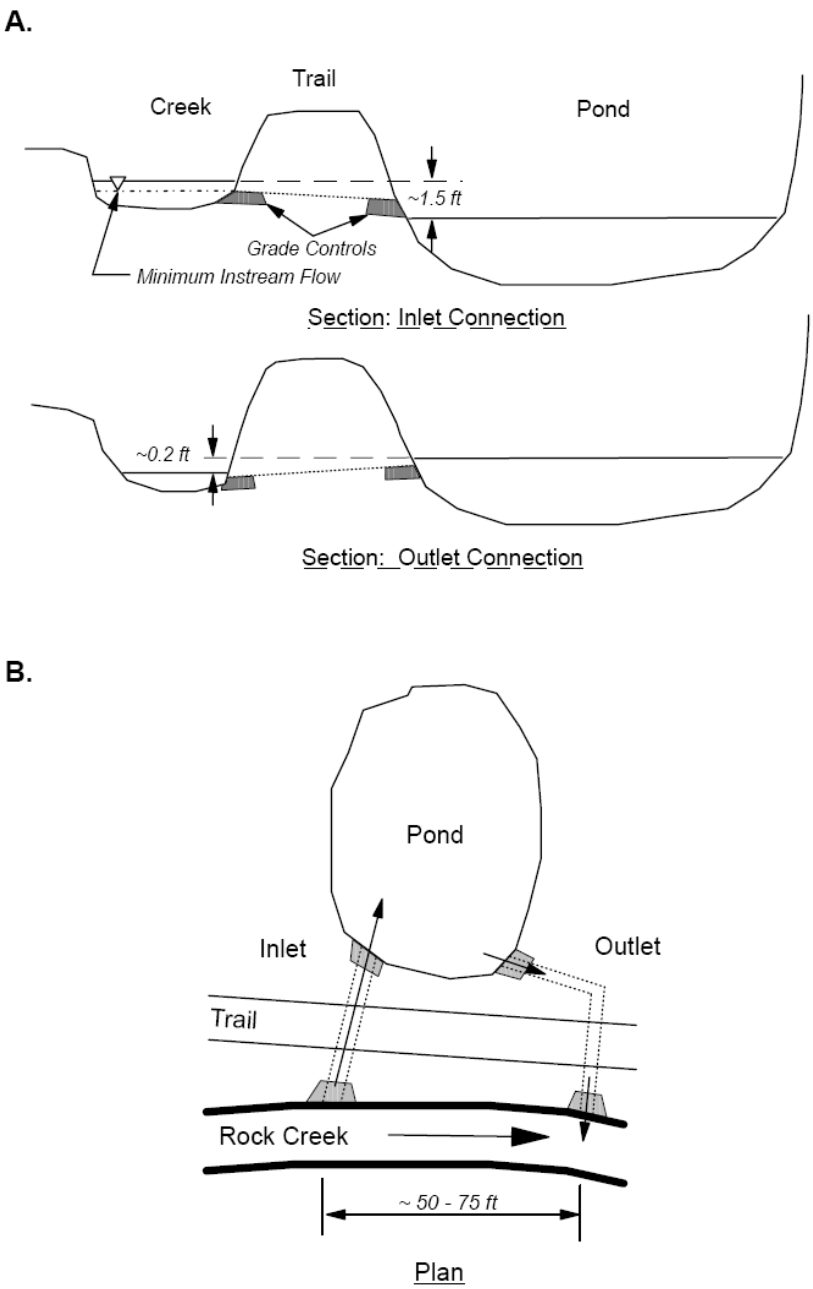



Figure 4-15. Section (a) and plan view (b) sketches of the HCM-3 Rock Creek Reach 1 pond connection project.

Off-channel habitat is particularly useful for: 1) adult coho salmon and steelhead; and 2) juvenile Chinook, coho salmon, and steelhead. The Reach 1 wetland and pond are currently not connected to Rock Creek, and represents the lowermost, potentially available off-channel rearing and holding habitat of any significance associated with lower Rock Creek. Because the wetland and pond are located less than 200-feet upstream from the Cedar River, it could also benefit fish attempting to avoid high velocity flows in the mainstem Cedar River. These types of off-channel habitats represent important winter rearing habitat for juvenile salmonids such as coho salmon, and as well, nursery areas and feeding stations for newly emerged fry.

## 4.4 HCM-4: Wetland Improvement and Juvenile Salmonid Habitat Enhancement – Reach 2

**HCM-4**

**Wetland Improvement and Juvenile Salmonid Habitat Enhancement – Reach 2**

The City of Kent will act as sponsor and provide funding (estimated costs $69,000) for a habitat enhancement project intended to enhance the quality of the existing wetland habitat and create additional off-channel habitat within a small wetland and pond located just upstream of an existing foot-bridge. The wetland and pond would be improved by excavating the organic material to a depth of around 2-4 feet, constructing an island in the center of the pond that would support trees and shrubs and provide increased shade, and by placing LWD in the excavated pond to provide cover for juvenile salmonids. These improvements will serve to enhance existing habitat and create some additional juvenile salmonid rearing habitat that can be used by species covered under the ITP. The wetland is located on, parcel 2222069006, which is currently owned by King County (King County 2005). The City of Kent will work with King County to develop a Memorandum of Understanding regarding the details and funding

*HCM-4 (continued on next page)*

*HCM-4 (continued)*

commitment related to this project. Development of final project designs will require a detailed topographic survey and at least one year of pre-construction temperature monitoring. Pre-project monitoring will be implemented within two years of ITP issuance. A final design package for HCM-4 will be submitted to the Services for review within 5-years of ITP issuance. Implementation of HCM-4 would be in accordance with conceptual design and recommendations for additional survey and monitoring described in Appendix G.

The City of Kent will commit up to $69,000 to complete pre-project monitoring, permitting, final project design and construction. Post-construction monitoring of pond habitat will be conducted as part of this HCM.

Sponsorship and implementation of HCM-4 does not include purchase of the subject property. If the landowner or other entities determine that expansion of the project to incorporate additional project elements (e.g., recreational facilities, waterfowl habitat) or land areas beyond those described in this HCM is desirable, the City of Kent is not committing additional funds to support objectives outside the HCP. If additional data collection indicates that the proposed project is not feasible or will not benefit species covered by the ITP, the City of Kent will make the $69,000 allocated for HCM-4 available to other projects aimed at improving habitat in the Rock Creek basin. If transfer of funds to other projects is proposed, the City of Kent will notify the Services and obtain their approval of the suggested alternative.

*Rationale and Benefits*

Side channels and off channel ponds have been shown to provide important habitat for juvenile and smoltified salmon and steelhead (Sedell et al. 1984; Murphy et al. 1989; Marshall and Britton 1990; Sheng et al. 1990; Bonnell 1991; Cowan 1991). Improvement of habitat in the Reach 2 wetland and pond would add to the overall quantity and quality of off

channel habitat available to fish in Rock Creek and seasonally to fish from the mainstem Cedar River that may be seeking velocity refuge habitat.

As noted for HCM-3, off-channel habitat is particularly useful for: 1) adult coho salmon and steelhead; and 2) juvenile Chinook, coho salmon, and steelhead. The Reach 2 wetland and pond are currently the only available off-channel juvenile rearing habitat of any significance associated with lower Rock Creek. Juvenile coho have been observed using this wetland and pond during spawning surveys (R2 2005a). In addition, because the wetland is located less than 500-feet upstream from the Cedar River, it could also benefit fish attempting to avoid high velocity flows in the mainstem Cedar River. Enhancement of the Reach 2 wetland and pond would provide approximately 0.25 acres of important winter rearing habitat for juvenile salmonids, and as well, nursery areas and feeding stations for newly emerged fry.

## 4.5 HCM-5: Summit-Landsburg Road Culvert Replacement – Reach 8/9

**HCM-5**

**Summit-Landsburg Road Culvert Replacement – Reach 8/9**

The City of Kent will act as sponsor and provide funding (estimated costs up to $680,000) to upgrade the existing Summit Landsburg Road stream crossing structure to a condition that meets WDFW fish passage criteria as described in WAC 220-110-070.

The existing culverts at the Summit Landsburg Road do not meet current WDFW fish passage criteria, which are intended to provide free and unimpeded passage for adult and juvenile fishes, including resident trout and juvenile salmonids (WDFW 2003). Within 10 years of issuance of the ITP, the City of Kent will upgrade these culverts to meet WDFW fish passage criteria.

### *Rationale and Benefits*

Culverts can substantially impede the ability of adult or juvenile fish to move upstream or downstream to fulfill specific species life history requirements (e.g., return to spawning

grounds in timely manner, access low velocity habitats during high flows). Conditions that impede fish passage include excessive water velocity, insufficient flow depth, absence of pools that provide resting or jumping space, or culvert outlets that are perched above the streambed (Furniss et al. 1999). Fish passage criteria developed by WDFW require that new or replacement water crossing structures installed on fish bearing waters "provide free and unimpeded passage for adult and juvenile fishes" (WAC 220-110-070). Installation standards for permanent culverts on a stream with the physical characteristics of Rock Creek (and that is inhabited by resident trout and anadromous salmonids) require that the culvert be placed at the same gradient as the stream channel with the bottom below the level of the streambed or that the structure be designed to maintain a water depth of at least 0.8 ft, maximum velocity of 4 fps, and a hydraulic drop of no more than 9.6 inches over the complete design flow range (WAC 220-110-070).

The existing culverts at the Summit Landsburg Road do not meet current WDFW fish passage criteria at all flows. Although there is no statutory timeline regarding the replacement of barrier culverts on public roads, accelerating the upgrade of the existing passage structure under the HCP will improve upstream passage of both adult and juvenile salmonids in Rock Creek, and improve access to approximately one mile of perennial stream habitat. Project plans will include a description of procedures to be used for removing fish from the area prior to construction and for maintaining flow and fish passage through the site during construction. Plans for fish handling, water management and proposed mitigation or enhancement measures (if any) will be provided to the Services and other appropriate regulatory agencies for review prior to initiating construction.

Access to spawning habitats within the City of Kent watershed property at all flows would benefit adult salmonids by increasing potential spawning areas in the late summer and early fall. Juvenile salmonids would benefit from increased accessibility to low gradient complex wetland habitats of Reaches 9 and 10 (above the culvert). These areas may be particularly important refuge sites during periods of high flows.

## 4.6 HCM-6: Large Woody Debris Placement – Reach 10 and 12

**HCM-6**

**Large Woody Debris Placement – Reach 10 and 12**

The City of Kent will act as sponsor and provide funding (estimated cost $62,000) for a habitat enhancement project intended to increase the quantity of salmonid holding, rearing and spawning habitat in the upper segments of Rock Creek via selective placement of large woody debris (LWD). The LWD will be placed in Reach 10 and Reach 12 of Rock Creek, which are both located on the City of Kent Clark Springs Watershed property. The LWD will be placed in a manner that concentrates moderate to high flows, enhancing local scour of fine sediment from the channel bed thereby promoting pool formation and spawning gravel deposition in proximal areas.

If possible, the LWD will be obtained from the City's Clark Springs Watershed property outside of the riparian zone, and will meet key piece criteria for a 25-ft wide stream (i.e., total volume 2.5 $m^3$; 18-30 inches dbh; 20-42 feet long) as defined by Fox (2001) or comparable criteria approved by the Services. Between three and six pieces of LWD will be placed at each site, depending on the results of channel surveys and analysis conducted during the final design phase.

*Rationale and Benefits*

The section of Rock Creek that flows through the City of Kent Clark Springs Watershed property is a low gradient channel with a stable flow regime that is dominated by groundwater inflows originating approximately 1-mile upstream. The Rock Creek valley in the vicinity of the watershed property consists of a wide valley filled with glacial outwash dating from the last major glacial episode (Appendix C). Material originating from those outwash deposits represents the primary source of sediment to the upper stream reaches, thus the channel naturally contains an abundance of fine sediment. Land-use activities in the upper watershed that increase surface erosion or disturb channel banks add to the naturally high fine sediment levels in these reaches.

Sockeye and coho salmon have been observed spawning in Reaches 10 and 12. Much of the habitat in these reaches consists of shrub-scrub wetlands with multi-threaded channels and abundant LWD and flow obstructions. However, two areas with a relatively uniform channel and little LWD were observed during field surveys conducted in February 2005 (Appendix I). These segments were approximately 100 to 200 feet long, and contained loose, unconsolidated bed surface material that consisted of a high percentage of fines. Placement of individual pieces of LWD within these segments that would be designed to concentrate flows should result in localized scour of fine sediments, improving available spawning habitat and as well create local cover and pool areas useful for adult holding and potentially juvenile rearing habitat. It should be recognized that the work proposed is not anticipated to impair or threaten the City water supply due to flooding or alteration/diversion of the streamflows at **any** time. Should the proposed work in its entirety, or any portion thereof, have a negative impact on the City's water supply, the LWD improvements will be removed. If the LWD improvements are removed, the City shall make an equitable amount of the $62,000 allocated for this HCM-6 of the removed LWD improvements available to other projects aimed at improving habitat in the Rock Creek basin. If transfer of funds to other projects is proposed, the City of Kent will notify the Services and obtain their approval of the suggested alternative.

## 4.7 HCM-7: Water Conservation Program

**HCM-7**

**Water Conservation Program**

In the past the City of Kent, as a part of the water conservation program, has voluntarily:

- provided rebates for low flow toilets
- provided rebates for low use washing machines
- offered businesses rebates to replace old equipment with water saving equipment

*HCM-7 (continued on next page)*

*HCM-7 (continued)*

- ► distributed low flow shower heads, sink aerators, irrigation measurement devices and shower timers
- ► completed water audits of city facilities
- ► retrofitted city facilities with low consumptive devices
- ► provided numerous education materials
- ► reduced unaccounted for water much better than industry standards within the City's water system

The City of Kent's current water conservation practices typically exceed State of Washington requirements, and will continue to meet or exceed the minimum state requirements as they change throughout the life of the HCP.

*Rationale and Benefits*

The City of Kent has long encouraged customers to use water efficiently, but increased its focus on conservation dramatically in the 1970s. The City began its formally adopted conservation program in 1993, with an original goal of reducing water use by 8 percent between 1993 and 2000. As a result of the program, water use per connection decreased by 12 percent between 1993 and 2000 (City of Kent 2002).

An assessment of future potential water conservation actions completed in 2003 identified 28 opportunities for cost-effective future water conservation (EES 2003). The greatest potential water savings would be realized by general residential and commercial conservation measures, including use of efficient household appliances and water saving fixtures, and reduced water use to maintain landscaping. Additional water savings can be realized through measures associated with industrial water processes. The current City Conservation Program includes activities and incentives designed to address those items.

Conservation is especially important in the summer when stream flows are at their lowest and water use is at its highest. As a part of this HCP, the City will make a firm commitment to invest resources and educate its customers about the importance of conserving water. Inclusion of the conservation program as an HCP measure will ensure that it is continued for the duration of the ITP. The overall objective of the City of Kent's Water Conservation Program is to maximize efficiency of existing water supply systems and minimize future increases in water use as a result of population growth. Further, the program is designed to educate the public on the value of water conservation and how it promotes watershed protection and health.

## 4.8 HCM-8: Riparian Acquisition, Easement, and Enhancement Fund in Rock Creek Watershed

**HCM-8**

**Riparian Acquisition, Easement, and Enhancement Fund in Rock Creek Watershed**

- The City of Kent will establish a $1.6 million Habitat Fund. The Habitat Fund will dedicate $1,600,000 in years 6-15 of the HCP with a minimum annual payment of $210,000 per year. The remaining balance shall be adjusted 3% per year from the year in which the ITP is signed. The balance of the Habitat Fund, if any, shall be paid in year 15. This will provide funding for various types of habitat conservation projects that may include but not be limited to:
- Acquisition of lands/property adjoining or influencing the Rock Creek system
- Securing a conservation easement on properties adjoining or influencing the Rock Creek system
- Enhancement projects within the Rock Creek basin that serve to protect and/or enhance existing riparian habitats and adjoining flood-plain function and integrity;

*HCM-8 (continued on next page)*

*HCM-8 (continued)*

- Other habitat projects within the Rock Creek basin that function to protect and/or enhance the populations of salmonids that utilize Rock Creek that are covered under the ITP.

The Habitat Fund must be spent on mitigation/restoration projects that benefit the covered species in the HCP and improve water quality within the Rock Creek basin. Funds can be spent on land acquisition, conservation easements, and the purchase of water rights. The City of Kent will establish a Rock Creek HCP Habitat Fund Committee which will consist of the City of Kent, the United States Fish and Wildlife Service (USFWS) and NMFS, which will meet twice a year to review progress of the identified projects above and make a determination of future HCP Mitigation/Restoration projects. The City of Kent will make recommendations to USFWS and NMFS on the use of the $1,600,000 Habitat Fund will be expended in 6-15 years. However, USFWS/NMFS will make the final determination on the mitigation/restoration projects and the expenditure of funds. In the event a mitigation/restoration project is recommended by the City of Kent and approved by the USFWS and NMFS but then deemed not feasible, the City of Kent, USFWS and NMFS shall consult and select another project as a substitute. Upon spending all of the $1.6 million (adjusted for inflation) in the Rock Creek Habitat Fund, the City of Kent's obligations to the Habitat Fund shall be complete.

*Rationale and Benefits*

The City of Kent has committed substantial resources toward the protection, enhancement and restoration of the Rock Creek Watershed. Through the City's participation in local and regional salmon recovery efforts, such as the WRIA 8 activities which have most recently resulted in publication of the Lake Washington/Cedar/Sammamish Watershed Chinook Conservation Plan (WRIA 8 Steering Committee 2005), the City is aware of actions and projects that relate directly and indirectly to Rock Creek. That plan lists eight "Restoration" projects in Rock Creek, four of which the City has specifically outlined and committed to

complete as part of this HCP. These include projects (with their respective WRIA 8 project numbers and cross-referenced to HCM number) that relate to flow enhancement (C351; HCM-1), increasing off-channel habitat in Reach 1 (C342; HCM-3), improvement of fish passage at mouth of Rock Creek (C343; HCM-2), and increasing off-channel habitat in Reach 2 (C344; HCM-4). Of the remaining four, one relates to fish passage under the Cedar River pipeline which falls under the jurisdiction of the City of Seattle, one pertains to replanting of conifers lost in the 2004 windstorm, one relates to a property acquisition, and one pertains to bank restoration on private property. Four other projects classified as "Protection" measures by the WRIA committee involve working with adjacent landowners to decrease encroachment into the Rock Creek Natural Area and increase stewardship.

The City of Kent also recently contracted with a consultant to complete a feasibility study that specifically identified potential habitat enhancement and restoration opportunities in Rock Creek (Appendix I). The City used the results of that study to identify and commit to fund (as part of this HCP) those projects (HCMs 1 through 5) having the highest potential benefit to the covered species and that were implementable. As noted above, four of the projects had also been identified by the WRIA 8 Steering Committee. However, the City is aware that some of the potentially best stream and watershed protection measures rest with land acquisitions (particularly lands adjoining Rock Creek) or involve working with private landowners (e.g., to restore riparian vegetation, etc.). These types of projects must be approached on an opportunistic basis and are very much contingent on the willingness of landowners to sell their property, enter into a conservation easement, or otherwise work cooperatively with City or other stakeholders on projects that may involve their property. As a result, the City has committed to establishing and contributing $1.6 million to a Rock Creek HCP Habitat Fund that can be used for these types of projects, as they become tangible. This fund would be administered as described above.

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# 5. MONITORING AND REPORTING

Monitoring and evaluation of the Habitat Conservation Measures described in Chapter 4 is integral to the success of the City of Kent's HCP. Monitoring and evaluation of these measures will provide the Services with certainty that the HCMs identified and described in Chapter 4 are implemented and maintained as agreed to under the IA. In addition, the measures allow for an adaptive management approach for certain HCMs whereby modifications can and will be made based on results of the monitoring measures. This chapter describes the Monitoring and Evaluation Measures (MEM) that the City of Kent has agreed to fund as part of the HCP; these are summarized in Table 5-1. As in Chapter 4, the measures are given a specific number to facilitate cross-referencing to other chapters in the HCP. The overall objectives of the MEMs are to:

- Ensure that the HCP conservation measures comply with appropriate design standards.
- Ensure that measures implemented under the HCP are effective in achieving their anticipated benefits as described in Chapter 4.
- Provide information useful for making adjustments in selected measures within an adaptive management framework.

The MEMs were developed within an adaptive management framework that recognizes uncertainty exists in managing biological systems and that adjustments to mitigation measures may occasionally be needed to maintain and maximize their effectiveness throughout the duration of the ITP. Key elements of adaptive management include monitoring, analysis, and as needed, modification of specific measures to increase their effectiveness and benefits, while meeting overall project goals.

There are four primary MEMs that would be implemented as part of the ITP. These are associated with flow monitoring in Rock Creek to document compliance with HCM-1, precipitation monitoring to allow refinements in determining water year types, spawning surveys to document effectiveness of HCM-2 and to track escapement trends of adult

Table 5-1. Monitoring and Evaluation Measures (MEM) to be implemented by the City of Kent under the Clark Springs System HCP.

| Monitoring and Evaluation Measure | Title | Summary of Measure |
|---|---|---|
| | **Compliance/Implementation Monitoring** | |
| MEM-1 | Rock Creek and Augmentation Flow Monitoring | Provide funding to maintain USGS gage 12118400 Rock Creek at Highway 516 near Ravensdale and monitor precipitation at the Clark Springs watershed to assist in refining classifications of Wet, Normal, Dry, and Drought conditions. Estimated Costs: $1.86 million |
| MEM-2 | Precipitation Monitoring at Landsburg | Provide funding to the USGS to work cooperatively with Seattle Public Utilities to monitor precipitation at Landsburg, to assist in classifications of Wet, Normal, Dry, and Drought conditions. Estimated Costs: $132,000 |
| MEM-3 | Spawning Surveys in Rock Creek | Conduct spawning surveys every fourth year over Index Reaches through the duration of the ITP. Estimated Costs: $410,000 |
| MEM-4 | Rock Creek mouth-passage improvements | Document successful project completion and annually check on project functionality. Estimated Costs: $104,000 |
| MEM-5 | Wetland fish use monitoring | Document if fish are utilizing the wetlands. Estimated Costs: $3,000 |

salmonids over the duration of the ITP, and monitoring of the fish passage low-flow weirs near the mouth of Rock Creek to document functionality. Details of these MEMs are provided below and summarized in Table 5-1.

In addition, there are four other compliance-related monitoring measures that are essentially embedded in certain HCMs. That is, as part of the actual HCM, there will be a reporting procedure that provides documentation to the Services that the measures were implemented in accordance with prior approved specifications. Details of these measures are not presented in this section but are noted under each of the respective HCMs in Chapter 4. Briefly, the HCMs that include embedded monitoring elements include:

- HCM-3 – Wetland Improvement and Juvenile Salmonid Habitat Enhancement – Reach 1: Compliance Monitoring will consist of documentation that construction was completed in accordance with design specifications.
- HCM-4 – Wetland Improvement and Juvenile Salmonid Habitat Enhancement – Reach 2: Compliance Monitoring will consist of documentation that construction was completed in accordance with design specifications.
- HCM-5 – Summit-Landsburg Road culvert replacement-Reach 8/9: Compliance Monitoring will consist of documentation that construction was completed in accordance with design specifications.
- HCM-6 – LWD Placement – Reach 10 and 12: Compliance Monitoring will consist of documentation that construction was completed in accordance with design specifications.

In general, documentation of construction of the above HCMs to design specifications will be provided to the Services within three months following completion of each of the projects. The time period of monitoring will vary depending on the intent of each measure, but some form of monitoring will continue for the duration of the ITP. The general timing

and duration of monitoring associated with each measure is specified in the following sections. A summary implementation schedule is provided in Chapter 7.

Short letter type reports describing the results of all compliance-monitoring efforts will be submitted to the Services on an annual basis. Although the specific measures described below do not explicitly identify other stakeholders as report recipients, it is expected that the City or the Services will provide copies of all reports to other federal, state and local government agencies, Indian Tribes, and non-governmental organizations who will participate in coordination activities or who could provide meaningful comments and review.

The results of all monitoring activities will be summarized and reported on an annual basis. Meetings will be convened at 5-year intervals (5-year reviews) to provide an opportunity to discuss the annual reports and any potential adjustments to conservation or monitoring measures. Additional reports and data will be produced or archived according to the specific schedule described for each monitoring measure. Copies of relevant materials will also be provided to state or local agencies with regulatory control over actions undertaken as part of monitoring (e.g., WDFW, as the agency in charge of issuing Hydraulic Project Approvals [HPA], will receive copies of all reports or design materials describing proposed or completed instream habitat restoration projects).

The potential to make adjustments to mitigation measures that fail to achieve their anticipated benefits is an important part of adaptive management. Any deficiencies identified from monitoring will be identified and reported to the Services immediately. The City will make themselves available to discuss any such issues at the Services discretion. Potential remedies developed by the City of Kent would be dependent upon the specific type of deficiency observed. Proposed remedies would be discussed with the Services prior to implementation. Examples of potential remedies could include, but are not limited to, modifications or reconstruction to the passage weirs at the mouth of Rock Creek if passage conditions fail to meet criteria (HCM 2); replanting vegetation with new or different plants if

initial plantings fail (HCM-3 and HCM-4); modifying entrance or exit channel hydraulic conditions if they exceed juvenile salmonid swimming capacity (HCM-3), or modifying LWD anchoring if initial anchoring methods fail (HCM-6). Adaptive management will also occur to potentially adjust the beginning of augmentation under HCM-1 based upon information on Chinook salmon spawn timing in the Cedar River. It is anticipated that any needed adjustments that result from monitoring and adaptive management will ultimately result in the success of all of the Habitat Conservation Measures proposed in this HCP.

## 5.1 Monitoring and Evaluation Measure MEM-1: Rock Creek and Augmentation Flow Monitoring

**Rock Creek and Augmentation Flow Monitoring**

**MEM-1**

The City of Kent will ensure that streamflow in Rock Creek downstream of the Clark Springs System is measured on a real-time basis for the duration of the ITP. The City will fund the continued operation of USGS gage 12118400 "Rock Creek at Highway 516 near Ravensdale," or a suitable alternate, as a real-time station. Data with a minimum unit interval of 15-minutes will be transmitted by the USGS via satellite telemetry and posted on the USGS NWIS web site. If the USGS web-site is discontinued in the future for any reason, the City will ensure that federal, state and local resource agencies have access to the data on a real-time basis by posting the data on the City of Kent web-site or an equivalent source.

Also as part of MEM-1, augmentation flow levels will be recorded by the City of Kent on a unit interval of 15-minutes from October 1 through December 31, but will not be posted realtime. The system of stream and augmentation flow monitoring data collection and data posting will be updated consistent with future advances in data transfer technology, as agreed upon by federal, state and local resource agencies. As part of a report describing flow patterns presented to the

*MEM-1 (continued on next page)*

*MEM-1 (continued)*

Services annually and reviewed at 5-year meetings, the City will provide summary plots of daily mean streamflow for each month during the period the City may provide flow augmentation (October, November and December). The report will also include tables summarizing daily mean, minimum, and maximum augmentation and stream flow, the two-month antecedent accumulated precipitation, the water year classification (wet, normal, dry, drought), and the maximum augmentation level and minimum instream flow target from the HCM-1 mitigation schedule.

### 5.1.1 Objective

The objective of this MEM is to ensure that data are available to independently track and document the City's compliance with all facets of HCM-1, which governs flow augmentation at the USGS gage 12118400 "Rock Creek at Highway 516 near Ravensdale."

### 5.1.2 Rationale

Ensuring that real-time data on flows in Rock Creek are available in a public access database that is updated on a daily or more frequent basis will facilitate and support monitoring other HCMs or monitoring activities that are dependent on knowing streamflows at the time specific actions are conducted. Access to real-time flow data will allow the Services and other agencies or interested parties to independently monitor flows in Rock Creek.

Data quality at the USGS gage 12118400 "Rock Creek at Highway 516 near Ravensdale" gage site is rated "fair." According to USGS data standards, "good" data have an error of 10 percent and "fair" data are associated with an error of 15 percent (USGS 2005). Data quality should be considered when making determinations of compliance or non-compliance.

## 5.2 Monitoring and Evaluation Measure MEM-2: Precipitation Monitoring at Landsburg

**Precipitation Monitoring at Landsburg**

**MEM-2**

The City of Kent's flow augmentation proposal (HCM-1) has certain target flows and augmentation amounts that depend on seasonal water year classifications corresponding to wet, normal, dry, and drought. These categories were established via an analysis of 74 years of precipitation data from the WA Climate Data Center collected at Landsburg (1931-2004). Precipitation data are also currently being collected at the Clark Springs watershed and are available in real time (15-minute increments) concurrent with USGS gage 12118400 also located within the Clark Springs watershed. However, these precipitation data have only been collected since 2003. The City is therefore proposing to continue to collect precipitation data at the Clark Springs watershed and compare those data with data collected by SPU at Landsburg. With these additional data, the City may, in the future, as a part of the adaptive management and monitoring element of the HCP, alter the location of the precipitation monitoring point used in defining the seasonal water year classifications from Landsburg to the Clark Springs watershed. For the first ten years of the HCP, the source for precipitation data will be the gage at Landsburg. After that and after the City has evaluated the additional data available from the USGS precipitation gage at the Clark Springs watershed, the City may propose to change the location for the collection of precipitation information to be the Clark Springs watershed. The City may also propose changes to methodology of determining wet/normal/dry/drought antecedent precipitation periods based on additional aquifer level and/or precipitation data.

*MEM-2 (continued on next page)*

*MEM-2 (continued)*

Prior to making this change, the City will prepare and submit to the Services a written report that describes the technical basis and rationale for the requested change. A meeting with the Services to discuss the proposed change will follow this. The change in precipitation monitoring points will only be made with written concurrence from the Services. As an alternative, the City may elect to work cooperatively with SPU in the monitoring of precipitation at the Landsburg site. In either case, the City has committed to support the continued monitoring of precipitation data for use in refining the seasonal water year classifications that will be used as part of HCM-1.

### 5.2.1 Objective

The objective of this monitoring measure is to collect precipitation data that will be used to determine current water year classifications and will be useful for refining the seasonal water year classifications that the City will use in determining flow targets and augmentation amounts as part of HCM-1.

### 5.2.2 Rationale

The classification of the seasonal water year types specified in HCM-1 is based on precipitation data collected at Landsburg. The accuracy of the classification is therefore related to the accuracy of the precipitation data. Although precipitation data are also being collected at the Clark Springs watershed, the data have only been collected since 2003. Because the Clark Springs watershed precipitation data monitoring station is closer to the Clark Spring System than data collected from Landsburg, those data may provide a more accurate depiction of precipitation patterns within the Rock Creek basin. The City of Kent is therefore proposing to continue collecting precipitation data at the Clark Springs watershed and will subsequently compare data to the Landsburg data set to see if refinements are warranted.

## 5.3 Monitoring and Evaluation Measure MEM-3: Spawning Surveys

**Spawning Surveys**

**MEM-3**

The City of Kent will conduct weekly spawning surveys for Chinook salmon, sockeye salmon, coho salmon, and adfluvial cutthroat trout within selected index reaches of Rock Creek every fourth year. Monitoring will occur beginning during the week of September 21 and extend through the end of February. The four-year period is selected based on a typical four-year life cycle of sockeye and coho salmon, the species with the longest life cycle that routinely uses Rock Creek. Hence, monitoring a four-year period would encompass one complete life cycle and should provide sufficient information from which to formulate population trends. It would also serve to monitor potential use by Chinook salmon. Index reaches for Chinook and sockeye salmon would include Reach 1 through Reach 7 from September 21 to December 31. Index reaches for coho salmon would include Reaches 8, 9, 10, and 11 from November 15 to February 28. The City is committing up to $15,000 every year that surveys are completed. A tentative schedule for conducting the spawning surveys is depicted in Table 5-2. The spawning surveys will be useful to document fish utilization both before and after construction of habitat enhancement projects (i.e., effectiveness monitoring), as well as to periodically monitor spawning escapement throughout the life of the ITP as a means to evaluate and compare trends in Rock Creek escapement with other Cedar River and Puget Sound stocks.

Table 5-2. Preliminary schedule of years in which spawning surveys will be conducted in Rock Creek. Surveys will be conducted in specified Index Reaches.

| HCP Year \ | Activity | Monitoring | Cumulative Years of Monitoring |
|---|---|---|---|
| 1 | Spawning Survey | Y | 1 |
| 2-4 | | N | |
| 5 | Spawning Survey | Y | 2 |
| 6-8 | | N | |
| 9 | Spawning Survey | Y | 3 |
| 10-12 | | N | |
| 13 | Spawning Survey | Y | 4 |
| 14-16 | | N | |
| 17 | Spawning Survey | Y | 5 |
| 18-20 | | N | |
| 21 | Spawning Survey | Y | 6 |
| 22-24 | | N | |
| 25 | Spawning Survey | Y | 7 |
| 26-28 | | N | |
| 29 | Spawning Survey | Y | 8 |
| 30-32 | | N | |
| 33 | Spawning Survey | Y | 9 |
| 34-36 | | N | |
| 37 | Spawning Survey | Y | 10 |
| 38-40 | | N | |
| 41 | Spawning Survey | Y | 11 |
| 42-44 | | N | |
| 45 | Spawning Survey | Y | 12 |
| 46-48 | | N | |
| 49 | Spawning Survey | Y | 13 |

### 5.3.1 Objective

The objective of the spawning surveys is to document salmon spawning utilization of Rock Creek and provide indices suitable for tracking trends in salmon population abundance in Rock Creek throughout the duration of the ITP.

### 5.3.2 Rationale

For the fall/winter periods from 2001/2002 to 2004/2005, the City of Kent funded the completion of spawning surveys in Rock Creek. These surveys have provided the City with adult escapement counts of anadromous fish into the Rock Creek system. These counts have been useful in determining the species composition and abundance of adult fish utilization in Rock Creek, and also importantly, the non-use by ESA listed species (e.g., Chinook salmon). The counts have provided a useful "baseline" data set with which to compare future trends in spawning escapement as they occur throughout the term of the ITP (i.e., 50 years). However, detecting trends in abundance does not require that spawning surveys be completed every year.

Assuming that construction and operation of most habitat enhancement projects will occur within the first 2-3 years from receipt of the ITP, a reasonable spawning survey monitoring period is every fourth year. The four-year period is selected based on a typical four-year life cycle of sockeye and coho salmon, the species with the longest life cycle that routinely use Rock Creek. Hence, monitoring a four-year period would encompass one complete life cycle and should provide sufficient information from which to formulate population trends. It would also serve to monitor potential use by Chinook salmon.

The City of Kent has committed to three mitigation measures (HCM-1, HCM-2, and HCM-5) designed to improve access to (HCM-2 and HCM-5) and the amount of (HCM-1) spawning habitat for covered species. HCM-2 modifies the Rock Creek channel at its mouth to improve access to Rock Creek under low flow conditions. HCM-5 replaces the culvert under the Kent-Kangley Road and will improve passage of adults to upstream spawning

areas. HCM-1 improves both access to and the amount of spawning habitat by providing flow augmentation during October through December that can result in higher flows under some conditions than would occur without the HCP. While these conservation measures are expected to improve spawning conditions, they cannot guarantee increased utilization by covered species because numerous other factors (e.g., commercial harvest; natural conditions; ocean conditions etc.) can affect the population numbers and potential utilization by covered species. Nevertheless, the City of Kent believes it is useful to monitor fish populations for trends in abundance, particularly before and after the implementation of mitigation or enhancement measures. While spawning surveys may not definitively demonstrate the success or failure of the proposed conservation measures, the surveys will be useful for contributing to monitoring the overall trend of fish populations within the WRIA 8 watershed.

## 5.4 Monitoring and Evaluation Measure MEM-4: Passage Improvement at Mouth of Rock Creek

**Monitoring of Passage Improvement at the Mouth of Rock Creek**

**MEM-4**

The City of Kent will act as lead sponsor and provide funding for a project designed to improve upstream fish passage at the mouth of Rock Creek during periods of low flow. Post-construction monitoring will be conducted to document compliance with the terms of HCM-2 and to ensure that the improvements remain viable over the term of the ITP. The City of Kent has committed up to $2,000 per year to conduct this monitoring.

Post-construction monitoring of HCM-2 will include the following:

- Project completion report including post-construction as-built drawings.
- Installation of photo point.

*MEM-4 (continued on next page)*

*MEM-4 (continued)*

- Annual inspection to assess stability and condition of improvement structures prior to the fall spawning season.
- Inspection following any flow events greater than 50 cfs.

The project completion report, including the as-built channel configuration, will be submitted to the Services within 6-months after construction has been completed. Project inspection reports will be archived and made available to the Services on request. The results of project inspections will be summarized at each five-year review meeting following completion of construction. Project inspection reports will consist of repeat photo pairs and a checklist describing:

- Flow depth and velocity in the center slot of each weir
- Proportion of the slot clear of debris or blockages
- Condition of the weirs (number, % intact, decay class if LWD)
- Assessment of the need to make minor modification, i.e., replacement of rock by hand to improve passage
- Time of survey and flow at closest USGS gage site on Rock Creek

The weirs will be considered functional if:

- Flow depth in the center slot is at least 8 inches
- Flow velocity through the center slot is <4 fps
- More than 90% of the original center slot area is clear
- If applicable, LWD is sound, with limited rot or decay
- Material size is similar to installed (no fragmentation)

Structures constructed at the mouth of Rock Creek are anticipated to be vulnerable to rearrangement by high flows in either Rock Creek or the Cedar River. Weirs constructed to improve passage at the mouth of Rock Creek will be reconstructed as needed, with up to the equivalent of one complete

*MEM-4 (continued on next page)*

*MEM-4 (continued)*

reconstruction effort funded over the term of the HCP. If substantial changes to the weirs are noted within the first 5-years of construction or a series of large annual peak flows (i.e., none less than the estimated 10-year return interval flow) at USGS gage 12118400 "Rock Creek at Highway 516 near Ravensdale," the design may be adjusted to reduce periodic maintenance costs. If adaptation of the design is deemed necessary, proposed changes will be submitted to the Services and appropriate regulatory agencies for review prior to implementation.

If the scope of the project is changed to incorporate additional project elements (e.g., recreational facilities) or lands areas beyond those described in HCM-2, the City of Kent will contribute up to but not more than the cost of monitoring as described above to overall project monitoring efforts.

### 5.4.1 Objective

Document that HCM-2 is implemented as specified and that modifications to the mouth of Rock Creek create conditions suitable for upstream passage of salmonids at low flows.

### 5.4.2 Rationale

The goal of modifying channel morphology at the mouth of Rock Creek is to improve upstream passage conditions for fall spawning salmonid species during low flow periods. Upstream passage requirements for most species are well documented, thus if the project as constructed provides suitable hydraulic conditions (i.e., depth of at least 8 inches and velocity <4 fps) the project will be assumed to be effective. Information gathered under spawning surveys conducted as part of MEM-3 will also help confirm the ability of salmonids to access Rock Creek. However, since a myriad of factors other than flow conditions may affect the number and timing of salmonid returns to Rock Creek, fish numbers or the absence of specific species will not be used exclusively to evaluate the effectiveness of HCM-2.

Monitoring conducted under MEM-4 is intended to document implementation of HCM-2 and to confirm that the project as built provides suitable conditions for upstream passage at low flows. Annual inspections will ensure that the project continues to function over the term of the ITP.

## 5.5 Monitoring and Evaluation Measure MEM-5: Presence/Absence of Fish Utilization

**Salmonid Presence/Absence Surveys**

**MEM-5**

The City of Kent will conduct snorkel surveys for juvenile Chinook salmon, sockeye salmon, coho salmon, steelhead trout, and cutthroat trout in the off-channel wetland areas enhanced under HCM-3 and HCM-4. Monitoring will occur during the spring of the first three years following the completion of the two projects. The City is committing up to $1,000 every year the City completes a survey. The snorkel surveyors will count the number of salmonids as well as other species observed, which will document fish utilization after construction of habitat enhancement projects (i.e., effectiveness monitoring). If no salmonids are observed within the wetland areas, the mainstem of Rock Creek will be snorkeled for a minimum of 300 feet immediately upstream of the wetland access point. Results of the surveys will be presented in letter reports submitted to the Services.

### 5.5.1 Objective

Document salmonid utilization of wetlands enhanced as part of HCM-3 and HCM-4.

### 5.5.2 Rationale

The goal of HCM-3 and HCM-4 is to increase the quantity and quality of off-channel habitat available to salmonids in lower Rock Creek. Implementation monitoring will be conducted

as part of these two conservation measures to ensure design specifications are met, which will indicate successful completion of the measures. Similar to adult spawner abundance previously discussed, a myriad of factors may affect the number and timing of actual juvenile salmonid use of the enhanced wetlands. Nevertheless, biological monitoring can be useful for learning about the effectiveness of the conservation measures. Consequently, the City of Kent proposes to monitor juvenile salmonid use in the enhanced wetlands for a three-year period following completion of the projects. If no salmonids are observed within the wetlands, the mainstem of Rock Creek will also be surveyed to determine if fish are present. If salmonids are relatively common in the creek, but not observed in the wetlands, the City will discuss with the Services options for improving access and use of the wetlands by salmonids.

# 6. EFFECTS OF CITY OF KENT WATER WITHDRAWAL AND CONSERVATION MEASURES

Changes in the flow regime and habitat characteristics within streams have the potential to alter physical and ecological processes. This chapter discusses the direct and indirect effects of the covered activities and HCMs proposed under this HCP on each of the covered species. The effects include those related to the three operational scenarios as described in Chapter 4 that pertain to HCM-1, the City's Flow Augmentation Plan, as well as measures designed to improve passage (HCM-2 and HCM-5) and create/enhance salmonid habitat (HCM-3, 4 and 6). The three flow-related operational scenarios include Scenario 1 – current operations without flow augmentation (i.e., baseline conditions); Scenario 2 – no withdrawals or augmentation; and Scenario 3 – conditions that would occur under HCM-1 (see Chapter 4). In general, the potential effects on flow, and habitat quality and quantity that could occur as a result of the implementation of the HCMs include the following:

- Increases in flow in Rock Creek during October, November, and December.
- Maintain existing high water quality, primarily temperature, as a result of flow increases during October, November, and December.
- Increases in the quantity of suitable fish (salmonid) spawning and rearing habitat as a result of flow increases during October, November, and December.
- Increases in the quantity and quality of fish (salmonid) rearing habitat as a result of large woody debris and off-channel enhancement projects.
- Improved fish passage at the mouth of Rock Creek and at the Summit-Landsburg Road stream crossing.
- Protection of existing excellent water quality in lower Rock Creek by continued implementation of Best Management Practices when handling chemicals within the Clark Springs Watershed.
- Protection of existing excellent water quality and riparian conditions by continued implementation of Best Management Practices during maintenance of facility structures, access roads, and fence lines.
- Habitat protection and improvements in the Rock Creek basin through beneficial habitat projects and acquisition of conservation easements, adjacent property, or corridors adjacent to Rock Creek.
- Temporary increases in suspended sediment during construction activities associated with passage and habitat enhancement projects.

All of the Habitat Conservation Measures are anticipated to provide net beneficial effects to covered species. In addition, most of the covered activities implemented with accompanying mitigation measures, are anticipated to have a minor to low level of risk that adverse effects would occur to covered species. Table 6-1 summarizes the possible effects to covered species for each covered activity described in Chapter 1 and any proposed mitigation designed to avoid or minimize these effects. Covered activities anticipated to have more than a low risk of adverse effects to covered species are also discussed in more detail within this section of the HCP. Many of the Habitat Conservation Measures will require federal, state, county, or local permits prior to implementing the measure. It is anticipated that specific Best Management Practices and mitigation measures will be developed in collaboration with the Services and the appropriate permitting agency as part of the permitting process. It is also anticipated that BMPs may improve over the term of the HCP and that these changes will be incorporated into the project design, as appropriate.

## IMPACT ANALYSIS PROCEDURES

The effects on fish and aquatic ecosystem are defined as those resulting from the water withdrawals, maintenance activities at the Clark Springs System and watershed, and the conservation measures to be implemented under this HCP. Effects vary depending on the species and lifestage considered and the following sections in this chapter are organized to discuss specific effects on each covered species by lifestage. The analysis begins with discussions of the effects in terms of the impacts to four major habitat components: 1) groundwater flow, 2) surface water quality and quantity, 3) instream habitat, and 4) off-channel habitat. Where appropriate, the effects on habitat are discussed in relation to NMFS and USFWS guidelines on properly functioning conditions (NMFS 1996; USFWS 1998a).

The effects of the Clark Springs System water withdrawals and habitat conservation measures on the hydrology and fish habitat in lower Rock Creek are based upon:

Table 6-1. Clark Springs System HCP covered activities, possible effects to covered species and their habitat, and proposed management practices to avoid and/or minimize effects.

| Covered Activity | Possible Effects to Covered Species and Their Habitat | Proposed Mitigation / Management Practices |
|---|---|---|
| Water supply withdrawals from the Clark Springs System pursuant to the City's water rights. | ▪ Refer to Section 6.1 of the HCP | ▪ HCM-1 through HCM-8: see Chapter 4 for complete descriptions |
| Augmentation flows released from the Clark Springs Water Supply Facility into Rock Creek. | ▪ Refer to Section 6.1 of the HCP<br>▪ Augmented flows will increase habitat during the critical low flow period | |
| Operations, maintenance, replacement, monitoring, and improvements to the augmentation system. This includes relocating the augmentation system; maintaining, additions to, and/or replacing all augmentation infrastructure as needed. | ▪ Minor to low level of localized riparian disturbance, depending upon the location of the augmentation pipe and amount of clearing required<br>▪ Minor localized stream bank disturbance | ▪ Best Management Practices described in Appendix K, such as:<br>▪ Sediment control (silt fencing, mulch, or straw, etc.)<br>▪ Reseeding, stabilization of riparian zone and stream bank as needed<br>▪ Timing restrictions for stream bank modifications at the discharge point |

Table 6-1. Clark Springs System HCP covered activities, possible effects to covered species and their habitat, and proposed management practices to avoid and/or minimize effects.

| Covered Activity | Possible Effects to Covered Species and Their Habitat | Proposed Mitigation / Management Practices |
|---|---|---|
| Operations, maintenance, and improvements to the water supply facilities located in the Clark Springs Watershed such as the buildings, wells, access roads, fences and security infrastructure, infiltration gallery, and water transmission main, except for portions within the ordinary high water boundaries of Rock Creek. This includes replacement of the facilities and infrastructure as needed in the future. | ▪ Adverse effects, such as the following, are anticipated to be minor:<br>▪ Soil disturbance resulting in increased potential for sediment delivery to stream<br>▪ Minor increase in impervious area | ▪ Best Management Practices described in Appendix K, such as:<br>▪ Sediment control BMPs (silt fencing, mulch, or straw, etc.)<br>▪ Reseeding, stabilization of riparian zone as needed |
| Vegetation management as needed by the City to maintain its facilities. This includes, but is not limited to, maintaining open areas, service roads, and clearing/trimming fence lines and power line/telephone line areas associated with the facilities. All vegetation management on the Clark Springs property will be via mechanical methods; chemical applications will not be used. | ▪ No significant adverse effects anticipated from normal vegetation management outside of riparian zones<br>▪ Only minor effects are anticipated from normal vegetation management within riparian zones because only minor levels of activity are anticipated | ▪ No chemicals used for vegetation management |

Table 6-1. Clark Springs System HCP covered activities, possible effects to covered species and their habitat, and proposed management practices to avoid and/or minimize effects.

| Covered Activity | Possible Effects to Covered Species and Their Habitat | Proposed Mitigation / Management Practices |
|---|---|---|
| Operation and maintenance of the Parshall Flume and USGS gaging station (No. 12118400). This includes cleaning the flume to remove algae, minor repairs, and repositioning of coarse substrate (primarily boulders and cobbles) or woody debris upstream or downstream of the flume, if needed to maintain its accuracy and integrity. | For normal maintenance activities (e.g., cleaning, movement of woody debris or coarse substrate):<br>▪ Only minor adverse effects anticipated such as:<br>▪ Short-term and localized dispersion of algae and periphyton community during cleaning<br>▪ Short term and localized instream disturbance and redistribution of fine sediment | ▪ Best Management Practices such as:<br>▪ Reseeding, stabilization of riparian zone and stream bank as needed<br>▪ Timing restrictions for instream work<br>▪ No substrate or wood will be removed from the stream<br>▪ Hazardous instream woody debris will be replaced downstream of the Kent-Kangley stream crossing. |

Table 6-1. Clark Springs System HCP covered activities, possible effects to covered species and their habitat, and proposed management practices to avoid and/or minimize effects.

| Covered Activity | Possible Effects to Covered Species and Their Habitat | Proposed Mitigation / Management Practices |
|---|---|---|
| Wildlife management within the Clark Springs Watershed for the purpose of protecting and enhancing the quality of the water supply. This includes trapping beavers to ensure a healthy municipal water source and removal of beaver dams to prevent stream relocation and damage to the City's infrastructure or the quality of the water supply. | ▪ A minor to low level of risk for adverse effects to covered species is anticipated such as:<br>▪ Prevents the increase in juvenile rearing habitat created by beaver dams<br>▪ Minor pulse flow increases during beaver dam removal<br>▪ Minor increases in suspended sediments during beaver dam removal<br>▪ Improved upstream passage of adult anadromous fish into reaches potentially blocked by beaver dams | ▪ HCM-3 and HCM-4: Wetland Improvement and Juvenile Salmonid Habitat Enhancement<br>▪ HCM-6: LWD Placement<br>▪ Mitigation identified in the HPA for this activity (Appendix M) will be followed |
| Habitat Conservation Measures HCM-1 to HCM-6 as described in Chapter 4 of this HCP. | ▪ Overall effects are anticipated to be beneficial for covered species.<br>▪ Minor short-term soil disturbance resulting in increased potential for sediment delivery to stream when implementing habitat conservation measures HCM-2 to HCM 6),<br>▪ See details provided in this chapter | ▪ Specific Best Management Practices will be developed as part of the permitting process |

Table 6-1. Clark Springs System HCP covered activities, possible effects to covered species and their habitat, and proposed management practices to avoid and/or minimize effects.

| Covered Activity | Possible Effects to Covered Species and Their Habitat | Proposed Mitigation / Management Practices |
|---|---|---|
| Electrical, control, and telemetry operations, maintenance, improvements and replacements to meet the needs of the water supply facilities within the Clark Springs Watershed. | ▪ No significant adverse effects anticipated with implementation of mitigation measures<br>▪ Temporary, localized soil disturbance resulting in increased potential for sediment delivery to stream | ▪ Best Management Practices described in Appendix K, such as:<br>▪ Sediment control BMPs (silt fencing, mulch, or straw, etc.)<br>▪ Reseeding, stabilization of disturbed soil, as needed |
| The delivery and storage of chemicals, the chemical treatment processes and the operation and maintenance of equipment, conduit, piping and sampling infrastructure required to monitor and to treat the City's water supply. This will include chemicals for existing treatment (chlorine and fluoride) and chemicals needed for potential future treatment as required by state and federal drinking water regulations. | ▪ Overall risk of adverse effects to covered species is considered low<br>▪ Low potential for accidental spillage or release of chemicals into Rock Creek because chemicals are stored within the facility and deliveries are infrequent (sodium fluoride approximately once per year; chlorine approximately six times per year)<br>▪ Potential adverse effects are high if a spill reaches Rock Creek, and include acute toxicity and sub-lethal effects such as inhibition of upstream migration (e.g., Damkaer and Dey 1989) | ▪ Best Management Practices identified on Material Safety Data Sheets (Appendix N)<br>▪ Emergency hazardous materials containment and recovery plan (Appendix N)<br>▪ On-site monitoring and alarm systems<br>▪ Sodium fluoride stored in a stable powder form |

Table 6-1. Clark Springs System HCP covered activities, possible effects to covered species and their habitat, and proposed management practices to avoid and/or minimize effects.

| Covered Activity | Possible Effects to Covered Species and Their Habitat | Proposed Mitigation / Management Practices |
|---|---|---|
| The maintenance and replacement of storm water conveyance, control, and distribution facilities. | ▪ Risk of adverse effects considered low because of mitigation measures<br>▪ Short-term and localized stream and stream bank disturbance resulting in increased potential for sediment delivery to stream<br>▪ Soil disturbance and increased potential for delivery to stream | ▪ Best Management Practices identified in Appendix K, such as:<br>▪ Sediment control BMPs (silt fencing, mulch, or straw, etc.)<br>▪ Reseeding, stabilization of riparian zone and stream bank as needed<br>▪ Timing restrictions for instream work<br>▪ Normal maintenance of roadway culverts and ditches will follow guidelines identified in the Regional Road Maintenance Endangered Species Act Program Guidelines (Regional Road Maintenance Working Group 2002) |

Table 6-1. Clark Springs System HCP covered activities, possible effects to covered species and their habitat, and proposed management practices to avoid and/or minimize effects.

| Covered Activity | Possible Effects to Covered Species and Their Habitat | Proposed Mitigation / Management Practices |
|---|---|---|
| Installation, operation, and maintenance of monitoring wells along the eastern boundary of the Clark Springs property to monitor groundwater quality and provide a network of wells to help detect any contamination that may come from Landsburg Mine, the residential and semi-commercial properties along the eastern boundary of the Clark Springs property, or other contaminant sources in the watershed. This includes construction of any access roads needed for these monitoring wells. | ▪ A minor to low level of adverse effects are anticipated, depending upon the number and location of wells needed<br>▪ Potential adverse effects to covered species from:<br>▪ Soil disturbance resulting in increased potential for sediment delivery to stream during road construction and well drilling<br>▪ Loss of riparian function if built within the riparian zone<br>▪ Fine sediment and water runoff from road surfaces<br>▪ Monitoring data may result in avoiding or reducing potential adverse effects of Landsburg Mine | ▪ Best Management Practices identified in Appendix K will be followed<br>▪ All roads to be at least 50 feet from all streams and wetlands<br>▪ No stream crossings<br>▪ Sediment control BMPs (silt fencing, mulch, or straw, etc.)<br>▪ Reseeding, stabilization of riparian zone and disturbed soils as needed |

- Operations tests that were used to determine how instream flows respond to changes in water withdrawals and augmentation;
- Hydrologic analysis of withdrawal, augmentation, and instream flow data from 1986 to 2004; and
- PHABSIM/HSPF Linked Operations Analysis Tool (or PHLOAT).

The methods utilized in these analyses are described in more detail within Section 6.1. As described in Chapter 4, the effects of HCM-1 on instream habitat were assessed using the PHLOAT. The PHLOAT methods and results are described in detail within Appendix F. Briefly, the Physical Habitat Simulation (PHABSIM) System is a modeling approach that was developed by the USFWS that relates fish habitat to water flow levels (Milhous et al. 1984). An operations analysis tool that combines the output from the Hydrologic Simulation Program Fortran (HSPF) model (MGS Engineering 2005) and the PHABSIM system was chosen as the method for assessing the effects of the City of Kent's withdrawals on fish habitat and as a tool for comparing the potential effects of alternative flow mitigation measures.

The PHABSIM system is based upon species and lifestage specific utilization of three habitat features: water depth, water velocity, and substrate type, which are defined in Habitat Suitability Curves (HSC). PHABSIM utilizes three models: the Water Surface Profile Program (WSP), the Q-V (Flow-Velocity) Hydraulic Simulation Program (IFG-4), and Physical Habitat (HABTAT) model. WSP provides detailed information on depth and transverse velocity across a stream cross-section. It predicts the horizontal distribution of depth and mean column velocity over a range of stream flows with one set of field data. The IFG-4 model develops the depth and velocity data required by the HABTAT program. The HABTAT program utilizes the species and life stage specific HSCs. Output from the model provides an index of the amount of suitable habitat, called weighted useable area (WUA) that is provided at different flows. The units for WUA are usually reported in square feet per 1000 feet of stream length, but may also be reported as the total WUA for a given stream reach.

The PHLOAT utilizes the daily mean flow output from the HSPF model to calculate flow statistics. As described in MGS Engineering (2005; Appendix E), the HSPF model allows

the simulation of mean daily stream flows over a 45-year period under different operational scenarios including current conditions (baseline) and the minimum flow target/maximum augmentation levels described under HCM-1 for a normal precipitation year type (i.e., 3 cfs as a minimum flow target during October, November, and December that utilizes flow augmentation up to 2 cfs to meet the target). The baseline scenario utilized the average monthly withdrawal amounts in the simulation. In turn, the simulated flow statistics allow the calculation of a WUA time-series for each species and lifestage of interest under each flow scenario. An overview of the PHABSIM/HSPF operations analysis tool is depicted in Figure 6-1.

The PHABSIM system allows for the calculation of a species and life-stage specific WUA versus flow relationship for each transect and for each site, which is a composite of all transects within the site. In addition, composite WUA versus flow curves were developed by habitat type (run, riffle, pool). The result is a single WUA versus flow curve that represents the entire amount of habitat for a species and life history stage by stream segment. With this approach, each WUA versus flow curve is weighted by the proportion of stream habitat the transect represents. To complete the composite WUA versus flow curve, the proportion of each habitat type in the stream segment of interest based upon a habitat survey was used to weight each composite habitat WUA versus flow curve. Those portions of Rock Creek downstream of the Parshall Flume, which will be the compliance point for HCM-1 were considered the most critical for the analysis. Therefore, only Reaches 1 through Reach 9b downstream of the Parshall Flume (see Figure 1-5) were considered when developing the composite WUA versus flow curve for each species and life history stage of interest. A total WUA versus flow curve was calculated by multiplying the composite curve (in square feet of WUA per 1000 feet of stream) by the length of Rock Creek through Reach 9b (9,697 feet) divided by 1000.

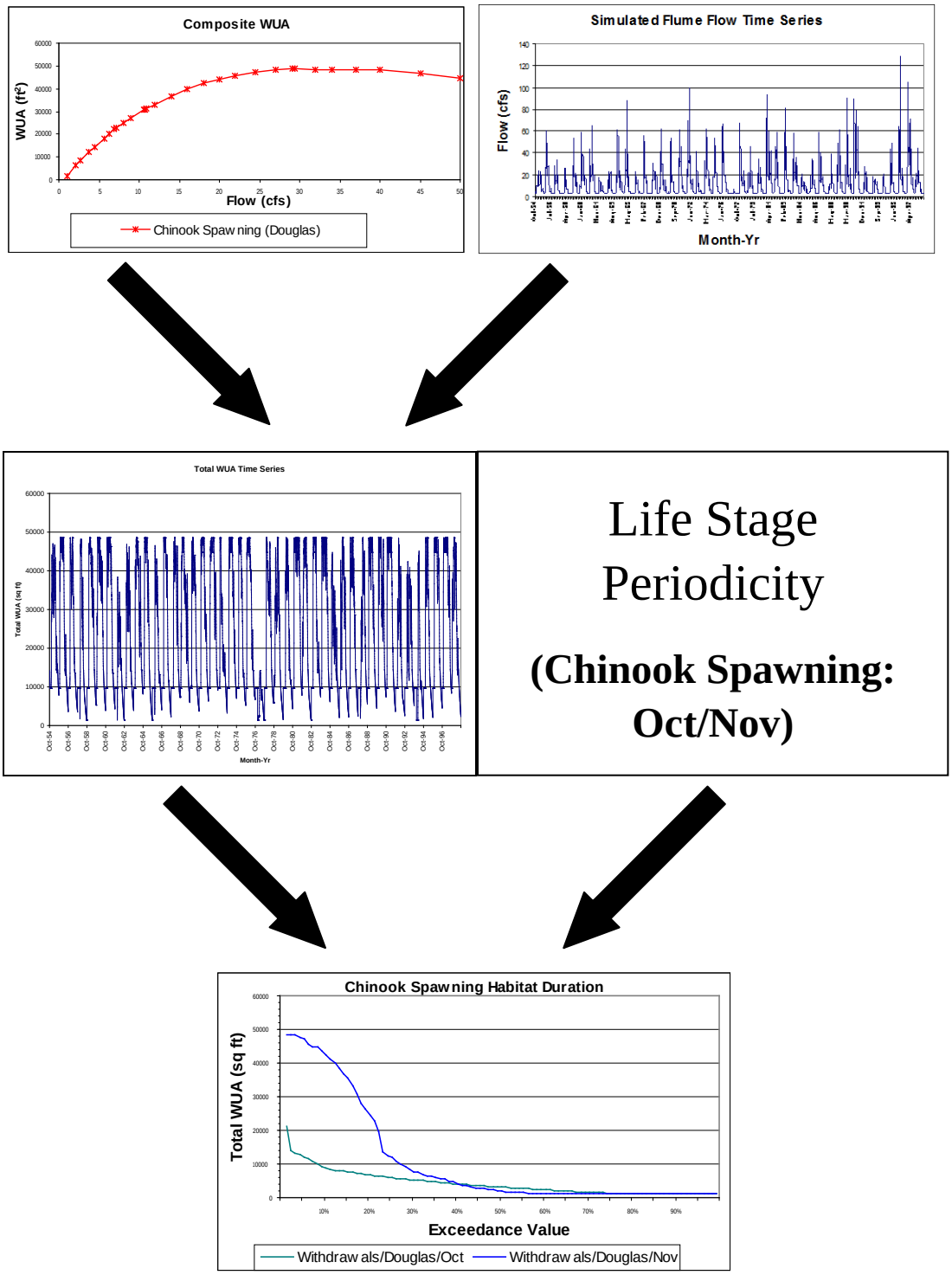



Figure 6-1. Overview of the PHABSIM/HSPF Linked Operations Modeling tool used for assessing effects of the City of Kent's water withdrawals and habitat conservation measures on fish habitat.

Using the total WUA versus flow curves, a daily WUA value can be calculated from the simulated daily flow, which in turn allowed the calculation of habitat duration (exceedance) curves on a monthly basis for each species and life history stage of interest. Knowledge of the periodicity for the different life stages (Figure 3-10) was used to focus the analysis on critical months. For species with life history stages that may be found in Rock Creek throughout the year, four representative months (October, January, April, and July) were chosen for reporting purposes.

The minimum flow targets under drought, dry, and wet precipitation year types differ from the normal precipitation year type by no more than 0.5 cfs. Consequently, differences in the amount of habitat for each species and life-stage under the drought, dry, and wet year types relative to the normal year type were examined by comparing the amount of habitat from the composite WUA versus flow curve at the minimum flow target level for the year type (i.e., 2.5, 2.75, 3.0, and 3.5 cfs).

## 6.1 Effects of Water Withdrawal and Habitat Conservation Measures on Hydrology

As described in Section 3.1.4 (Hydrology), median daily surface flows under baseline conditions range from 1.3 cfs (late September and early October) to 24.6 cfs (late March) as measured at the Parshall Flume near Kent-Kangley Road from water years 1986 through 1998 (Figure 3-6). Surface flows downstream of the Clark Springs System may be affected during the higher aquifer periods throughout the year by withdrawals from the shallow groundwater aquifer, which ranged from a monthly average of 5.8 cfs to 6.7 cfs from 1986 through 1998. There is less of an effect during the low aquifer periods of summer and fall, because the perennial stream flow becomes perched above the aquifer in the area. During the period 1986 to 1998 water was primarily withdrawn via the infiltration gallery. However, use of the three wells at the facility occurred during 1986, 1987, 1998, and 1999.

Section 3.1.4 (Hydrology) also noted that the autumn rise in the annual hydrograph is highly dependent upon precipitation to recharge the shallow groundwater aquifer in the upper Rock Creek catchment that is the perennial source of Rock Creek surface flows. As shown in Figure 3-6 and described in Section 3.1.4, a pinch point is located near the eastern boundary

of the City of Kent Clark Springs property and thus downstream of the upper catchment or basin, and some distance upstream of the Clark Springs System. The pinch point acts like a weir, and prevents impacts to the creek upstream of the pinch point. Consequently, the hydrogeologic control point results in the much smaller localized basin or Clark Springs aquifer (the extents of which are believed to be within the Clark Springs Watershed) having some unique hydrologic characteristics distinct from the upper catchment.

It is possible that one effect of water withdrawals is to increase the amount of precipitation needed to complete the recharge of the local Clark Springs groundwater aquifer, below the pinch point, and delay the natural autumn rise in this hydrograph. Direct evidence of this possible effect is not available because of an insufficient hydrologic record (i.e., the available periods of record for surface flows pre- and post-water withdrawals are too short for analysis). However, some indication for this effect is available from HSPF modeling using the results from Scenarios 2 and 3. Flow exceedance values, which are the probability that a flow could be higher than a particular value, were calculated on a weekly basis from daily flow values simulated under the no withdrawal (Scenario 2) and baseline (Scenario 3) average withdrawal scenarios. A graphic examination of the median, or 50 percent, exceedance values (Figure 6-2) and the difference between the two scenarios suggests there is an approximate three-week delay (mid-November to early-December) in the ascending hydrograph as a result of water withdrawals under typical median conditions.

It is important to note that the preceding analysis should not be construed to mean that a three-week delay in aquifer recharge occurs every year. The timing of the autumn rise in the hydrograph is affected by both the amount of withdrawals in the upper catchment and local Clark Springs aquifer over the late summer and autumn period, and the amount of precipitation during that period. All of these variables vary on an annual basis. Withdrawals from the aquifer above the pinch point in the upper catchment by other wells in the area may also affect the amount of recharge needed, but detailed withdrawal information is not available to quantify these potential affects and the calibrated HSPF model did not vary well withdrawals under the different scenarios. Nevertheless, the analysis suggests that delay in recharge of the local Clark Springs aquifer can be an effect of water withdrawals at the Clark Springs System and that higher levels of withdrawal may increase the amount of delay.

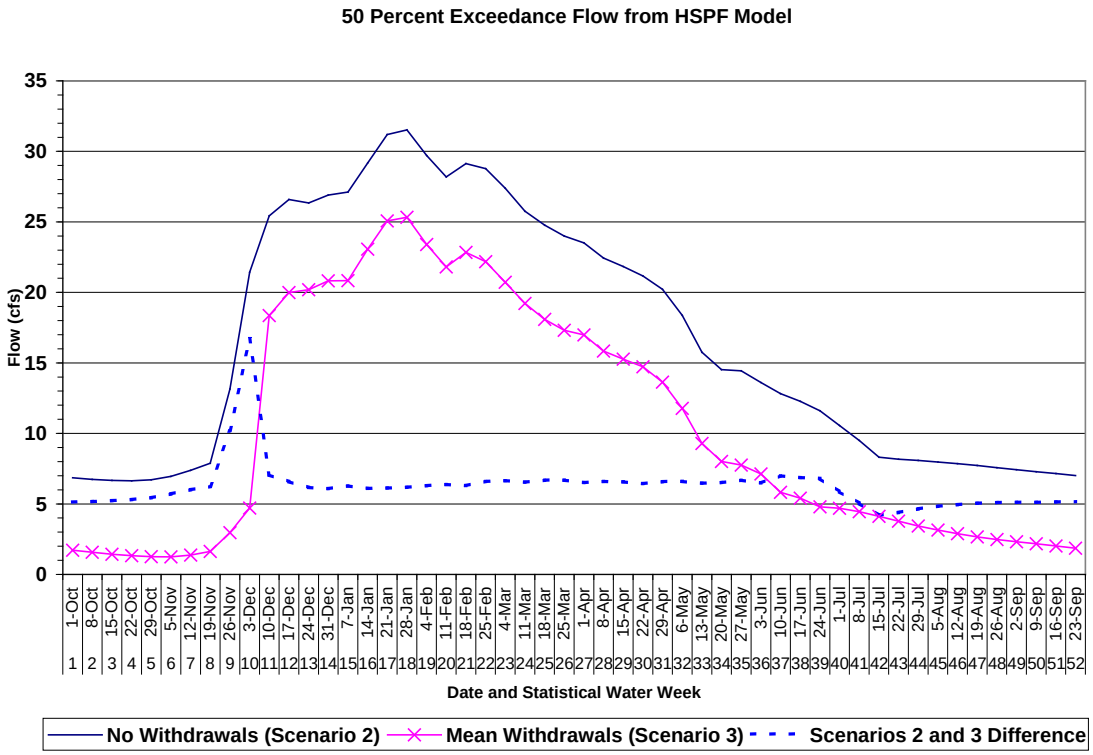



Figure 6-2. Median (50%) flow exceedance values calculated using simulated flows from the HSPF under no withdrawal and mean monthly withdrawal scenarios.

Operations tests, which have involved sequentially turning on and off water withdrawals via the wells or infiltration gallery, have demonstrated that the shallow aquifer at Clark Springs is in hydraulic continuity with surface flows in Rock Creek. However, detailed water quality studies conducted by the City as a requirement of the Department of Health have shown the groundwater is not under the direct influence of surface water. The first operations test occurred during December 9-11, 1997. During this test, withdrawals via the wells went from 0 to 10 cfs, but then declined slightly to 9.5 cfs over the 2-day test. Over this period, the flow in Rock Creek was reduced by approximately 7 cfs (Figure 6-3) with approximately 50 percent of the reduction occurring over the first 4.5 hours of the test.

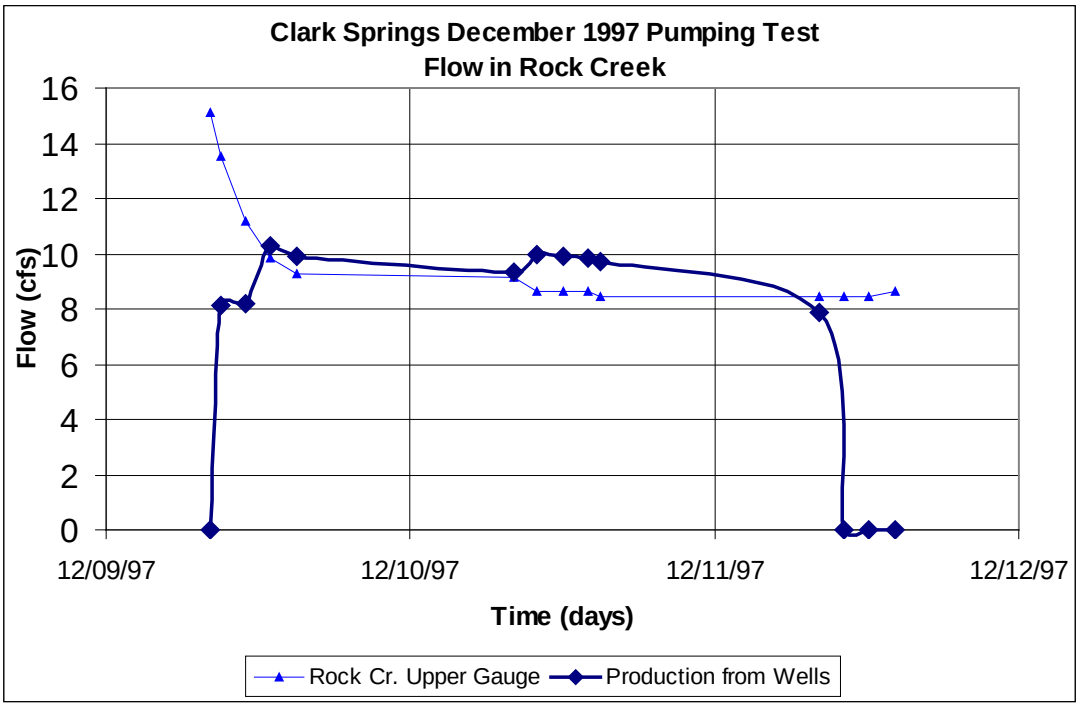



Figure 6-3. Results of the December 1997 operations test. Production via the wells was increased from 0 to 10 cfs for a period of two days.

The operations tests also included two tests of the infiltration gallery. The first occurred in May 7-10, 2001, and included a 12-hour sequence of cycling withdrawals via the infiltration gallery between 0 and 7.5 cfs without any use of the wells. At that time Rock Creek surface flows at the start of the test were approximately 8.5 cfs with withdrawals. After 12-hours of no withdrawals, surfaces flows increased in Rock Creek by approximately 5.9 cfs (Figure 6-4). The second test occurred during a low-flow period in July 30-31, 2004. Under these conditions surface flows in Rock Creek were approximately 2.9 cfs and withdrawals via the infiltration gallery were approximately 5.5 cfs. During the test, withdrawals were curtailed 1.8 cfs for 24.75 hours and surface flows increased by approximately 0.7 cfs.

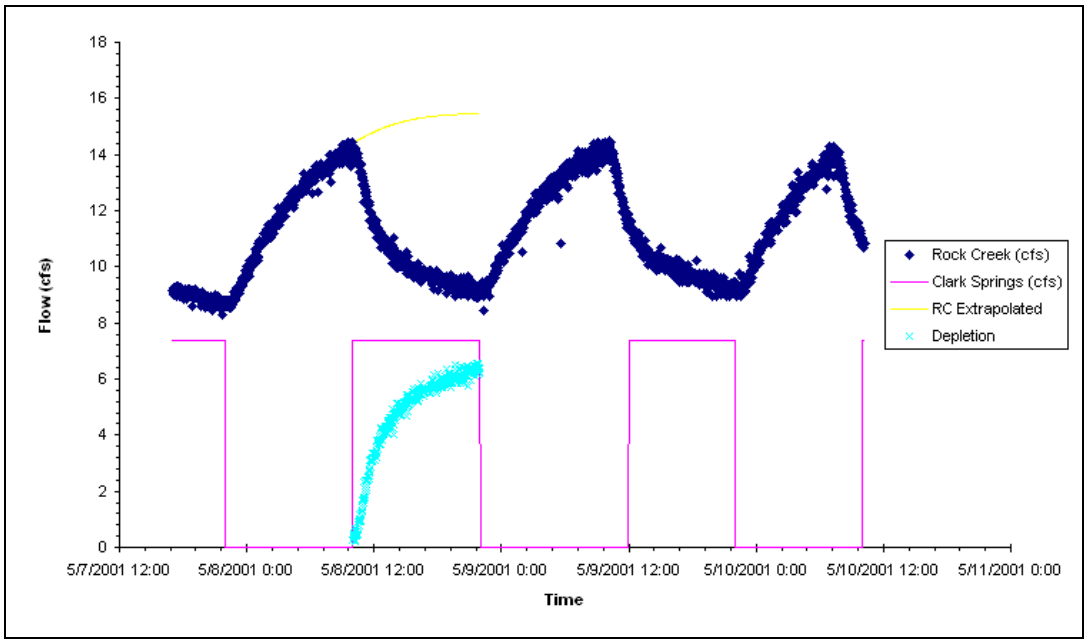



Figure 6-4. Results of the operations test during May 2001. Withdrawals (7.5 cfs) via the infiltration gallery were cycled on a 12-hour sequence.

The two operations tests of the infiltration gallery and the well pump test suggest that changes in withdrawal levels do not result in instantaneous changes in surface flows. Instead, there is a gradual change in surface flows and the rate of change is dependent upon both the height of the groundwater level and the time since the change in withdrawals (Figure 6-5). For example, under high groundwater levels typically present during the winter and spring a 2 cfs reduction in withdrawals would result in a 1 cfs increase of stream flows over approximately 0.1 days or about 2.4 hours. In contrast, a 2 cfs reduction in withdrawals under low groundwater levels typically present during the late summer and fall would result in a 1 cfs increase of stream flows over approximately 3 days and it would require approximately 90 days (i.e., the entire augmentation period) to observe approximately a 1.75 cfs increase, assuming groundwater levels remained static. The source of the withdrawals, whether via the wells or infiltration gallery, also appears to affect the rate of change in surface flows relative to changes in withdrawal level. These tests suggest that simple withdrawal curtailment is an inefficient method for managing stream flows during low flow periods because the stream flow response is too slow and is complicated by the perched stream condition during low flow periods of the stream.

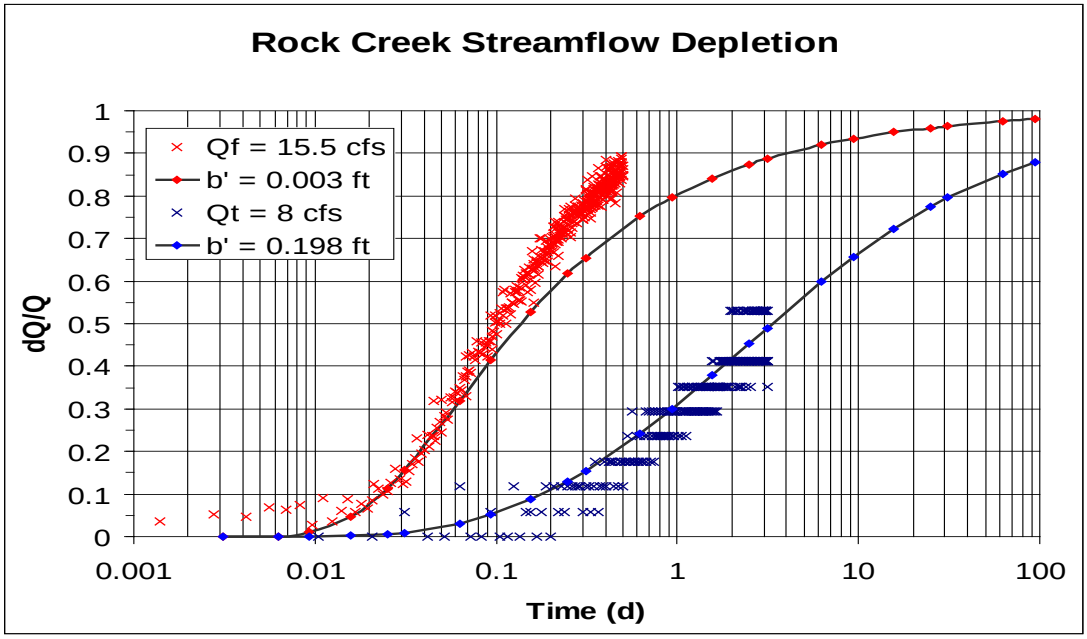



Figure 6-5. Results of the depletion analysis from May 2001 and July 2004. dQ/Q is the ratio of change in surface flow to change withdrawal flow. 0.5 indicates that half of the reduction in withdrawal flow is expressed as an increase in stream flow.

The 2001 operations test of the infiltration gallery also demonstrated that the affect of water withdrawals at Clark Springs declines relatively rapidly in an upstream direction. During the test Rock Creek stream flows were measured approximately 500 ft upstream of the infiltration gallery (site HC-7, Figure 1-2). Flows at this site ranged from 5.2 to 5.4 cfs (Figure 6-6) even though withdrawal rates ranged from zero to approximately 7.5 cfs. These measurements provided direct evidence that the Clark Springs System operations have an insignificant effect on upstream flows in Rock Creek beyond a relatively short distance (i.e., less than 1,000 feet) from the facility. The finding is consistent with the understanding of the hydrogeologic conditions that created Clark Springs, with the analogy of flow occurring over a weir that effectively isolates the upper reaches of Rock Creek from any changes in streamflow that may occur due to operation of the Clark Springs System.

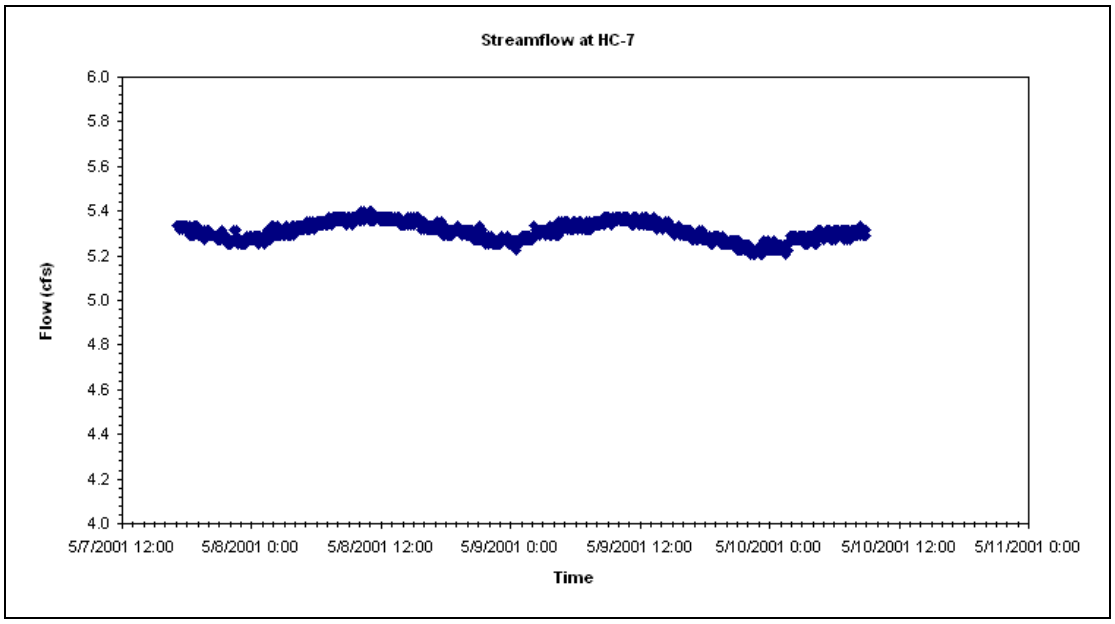



Figure 6-6. Rock Creek stream flow at Site HC-7 during operations test of the infiltration gallery during May 2001.

Under HCM-1 the City of Kent is committed to augmentation flows up to specified levels during October, November, and December. Augmentation levels would be up to 2.5 cfs during wet conditions, 2.0 cfs during normal conditions, 1.75 cfs during dry conditions, and 1.5 cfs during drought conditions. Corresponding target instream flow levels would be 3.5 cfs during wet conditions, 3.0 cfs during normal conditions, 2.75 cfs during dry conditions, and 2.5 during drought conditions. Augmentation would occur by pumping water from the clearwell located at the Clark Springs System into Rock Creek. Augmentation pumping reduces water withdrawals to the water supply transmission pipe by approximately the same amount as the amount pumped for augmentation to the stream. The City of Kent chose this method over withdrawal curtailment because the stream responds much more rapidly to this management method and would result in more certainty for obtaining the desired withdrawal and stream flow levels. The operations test conducted during July 2004 demonstrated the rapid response from augmentation relative to the significant delays and losses of efficiency in withdrawal curtailment (Figure 6-7).

The July 2004 operations test also suggested that augmentation flow losses would occur if augmentation occurred near the clear well. During the test (Figure 6-7) approximately 2.0 cfs was augmented, but the increase in surface flow at the flume was 1.4 cfs, suggesting approximately 30 percent of the augmentation flow was lost to groundwater prior to reaching the flume. An additional test during September 2005 and examination of historical data suggests that the amount of loss is variable. As a result of this finding, the City of Kent is planning to relocate the outlet of the augmentation pipe as part of HCM-1 following acquisition of the Incidental Take Permit from the Services to a location closer to the flume in order to maximize augmentation efficiency.

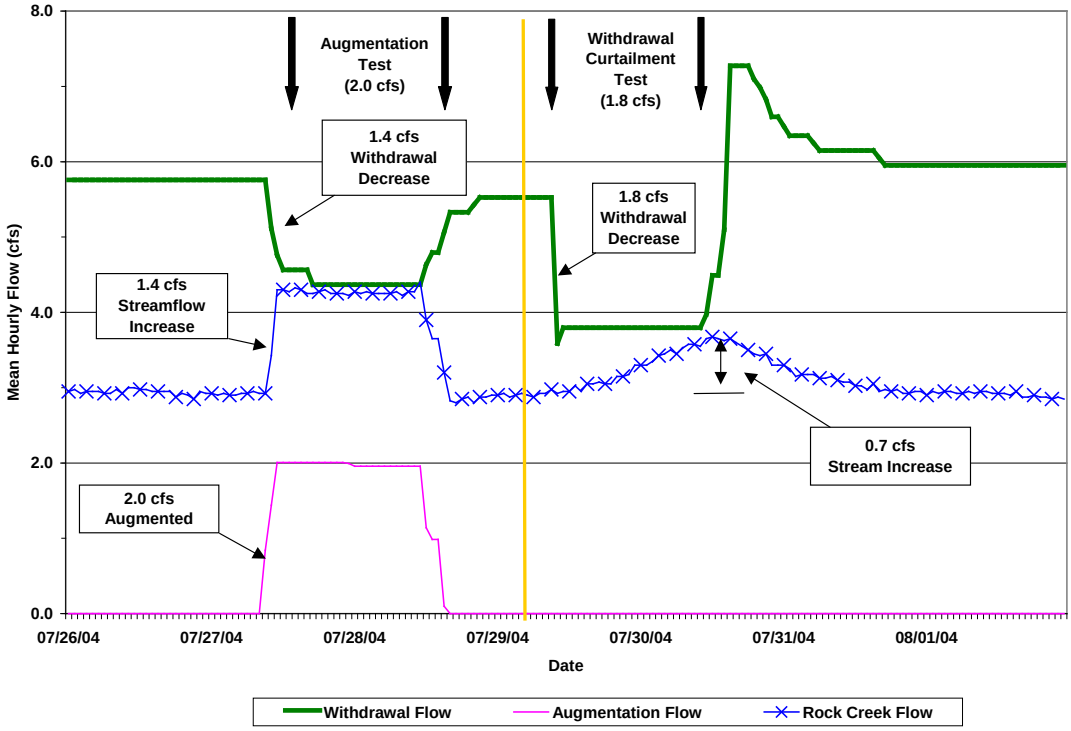



Figure 6-7. Results of the augmentation and withdrawal curtailment test during July 2004.

Precipitation, withdrawal, augmentation, and instream flow data from 1986 through 2009 were analyzed to provide an indication of how HCM-1 might affect withdrawal and instream flow levels under the different precipitation year types that would have occurred during that

period. The analysis utilized the 2-month antecedent precipitation data to assign precipitation year types for the 6 potential augmentation periods during October, November, and December based upon the criteria in HCM-1. When instream flows met or exceeded the target flows at the Parshall Flume during October, November, and December, then no augmentation occurred. When instream flows were below the target flows, water up to the maximum augmentation amount would be allocated to increase instream flows to the target flow.

As indicated previously there is some uncertainty regarding the amount of augmentation loss between the current location of the augmentation pipe outlet and the Parshall Flume. The results of preliminary analysis suggested that a loss factor within the range of 30 and 50 percent would have little effect on estimates of average instream flow (no more than about 0.1 cfs) and a small effect on estimates of average withdrawal flow (no more than 0.2 cfs; all but two augmentation periods no more than 0.1 cfs) and average augmentation flow (no more than 0.2 cfs, all but 5 augmentation periods no more than 0.1 cfs). The preliminary analysis also examined the effect of dropping all years of data that included augmentation. However, the preliminary analysis suggested that dropping years 2000 to 2003 would overestimate average withdrawal flows by as much as 0.3 cfs. The preliminary results suggested that applying an intermediate loss factor assumption of 40 percent to the historical augmentation flow data would best represent the effects of HCM-1 in the analysis.

For example, on October 9, 2001, adjusted augmentation flow, and instream flow were 0.24 cfs (0.39 cfs times 0.6) and 2.00 cfs, respectively. Consequently, instream flows would have been 1.76 cfs if no augmentation had occurred. Precipitation was between 75 percent and 125 percent of normal during the 2 months preceding October 2001; consequently, the precipitation year type was categorized as normal, the maximum augmentation amount would be 2.0 cfs, and the instream flow target would be 3.0 cfs. Under this analysis, if HCM-1 had been in place, 1.24 cfs would have been augmented to reach the 3.0 cfs requirement for a normal 2-month antecedent precipitation period.

Under the analysis, the fall seasons during the period 1986 to 2009 tended to be relatively dry compared to the long-term average. For example, 54 augmentation periods were drier than normal compared to 31 augmentation periods that were wetter than normal (Table 6-2).

Consequently, the analysis may be more representative of what could be expected during normal, dry, and drought years, but less representative of what might happen during wet periods. This is particularly true for October in which only 4 of the 48 2-week augmentation periods occurring in October during the 24 year period were considered wet.

Table 6-2. Frequency that a 2-week augmentation period would have been categorized as wet, normal, dry, or drought between 1986 and 2009.

| | Number of 2-Week Augmentation Periods | | | |
|---|---|---|---|---|
| | **Oct** | **Nov** | **Dec** | **Total** |
| Wet | 4 | 13 | 14 | 31 |
| Normal | 21 | 14 | 24 | 59 |
| Dry | 11 | 11 | 3 | 25 |
| Drought | 12 | 10 | 7 | 29 |
| Total | 48 | 48 | 48 | 144 |

Average instream flows for October, November, and December were analyzed for the 24-year period with and without (i.e., baseline) implementation of HCM-1 under the HCP. For the analysis, changes in flow greater than 0.25 cfs were considered substantive because smaller changes would fall close to or below the measurement error of the USGS gage at the flume (typically 10 to 15 percent). Considered over the entire fall season, HCM-1 provides a substantial increase (>.25 cfs) in average instream flows over those that would otherwise occur without the HCP. During 63 of 144 augmentation periods (43.8%) over the 24 years of data, average instream flows would be more than 0.25 cfs higher under the HCP. The HCP would also provide a higher level of certainty that augmentation would occur relative to a voluntary program without an IA. Based upon the analysis of the available data, the majority of the improvements would occur when they are most needed, i.e., under drought (19 of 29 augmentation periods, 65.5%) or dry conditions (15 of 25 augmentation periods, 60.0%). In contrast, HCM-1 would provide improvements in instream flow less frequently under normal conditions (24 of 59 augmentation periods, 40.7%) and wet conditions (5 of 31 augmentation periods, 16.1%) because instream flows would occur more frequently that meet flow targets without the need for augmentation.

Using the 1986 to 2009 dataset, average annual augmentation levels needed to meet instream flow targets would range from 0.0 cfs (1997) to 1.0 cfs (1992) and average 0.4 cfs per year. However, under the HCP, conditions could occur that require the City to provide instream

flows of as much as 2.5 cfs (i.e., the maximum augmentation level under wet conditions for three months). The need for augmentation to meet instream flow targets generally declines between October and December and from drought to wet conditions. The 1986 to 2009 dataset, under the assumption of implementing HCM-1, suggests average augmentation levels decline from Period 1 (October 1-15) to Period 6 (December 16-31) as follows: October 1-15 (1.0 cfs), October 16-31 (0.8 cfs), November 1-15 (0.5 cfs), November 16-30 (0.2 cfs), December 1-15 (0.1 cfs), and December 16-31 (0.01 cfs). Average augmentation levels range from 0.6 cfs during drought conditions, 0.7 cfs during dry conditions, and 0.4 cfs under normal conditions. In general, little augmentation (about 0.1 cfs) would be needed under wet conditions to meet instream flow targets. Under the analysis, augmentation would have been needed at some time during wet periods of November 1-15, 1995 (average augmentation = 1.3 cfs), November 16-30, 1996 (average augmentation = 0.03 cfs), October 1- 31, 2004 (average augmentation = 0.16 cfs), November 1-15, 2006 (average augmentation = 0.3 cfs), and October 1-November 15, 2008 (average augmentation = 0.6 cfs) to meet wet condition targets.

The analysis suggested that instream flow targets would be achieved during nearly all months and year types, but there are a few exceptions to this pattern. Average instream flows under the HCP may not meet targets because of low water levels. Under most circumstances, the exceptions to meeting the targets during individual augmentation periods and years would be relatively minor (less than 0.25 cfs below target) or of short duration (less than one week). The one somewhat larger exception in the analysis included October 1992 under dry conditions (target flow of 2.75 cfs; average = 2.35 cfs during Period 1 [October 1 to 15]).

## 6.2 Effects of Water Withdrawal and Habitat Conservation Measures on Chinook Salmon (*Oncorhynchus tshawytscha*)

This section describes the effects of water withdrawal and the HCMs on four life history stages of Chinook salmon: upstream migration, spawning and incubation, fry rearing, and downstream migration. Adult Chinook salmon enter the Cedar River in late summer. Upstream migration and spawning in Rock Creek is assumed to occur as early as the last week in September, but more commonly occurs in early- to mid-October and continues through the end of November. Incubation begins at the commencement of spawning and may continue through mid-April. Based upon the time and size of fry trapped in the lower

Cedar River, fry rearing has been documented to range from just a few days to upwards of two months and is concluded by migrating to Lake Washington by the middle of June (Seiler et al. 2005).

### 6.2.1 Chinook Upstream Migration

Water flow and depth during the fall months are important issues for this HCP because low flows have the potential to limit the upstream passage of adult salmon, including Chinook. This section discusses an analysis of water depths under different flow conditions utilizing cross-sectional transects and hydraulic modeling from the PHABSIM methodology.

The main criterion for successful upstream passage at low flows is depth. Many minimum depth criteria can be found in the literature for salmonids, varying with species and investigation. Table 6-3 lists depth criteria from several studies, the majority of which have focused on the design of fish ladders, culverts, spawning channels, and other man-made structures, emphasizing not only the conditions within the structure, but also at the entrance and exit (e.g., Chambers et al. 1955; Thompson 1970; Slatick 1970 1975; Weaver et al. 1976; Evans and Johnston 1980; Bell 1991). Some studies have aimed at evaluating passage conditions in natural channels (e.g., Mosley 1982; Thompson 1972).

As noted in Table 6-3, various investigators have suggested different minimum depth criteria for adult salmon. It is useful to consider two principles when examining minimum depth criteria. First, Powers and Orsborn (1985) emphasized that flow depth should be greater than body depth for the fish to make full use of its propulsive power. Second, Evans and Johnston (1980) emphasized that fish passage structures must be designed for the successful passage of all fish, not just the most fit. Consequently, locations that do not meet a depth criterion under natural conditions do not necessarily result in a complete barrier, but may instead limit passage to only a portion of the spawning population. Based upon the information in Table 6-3, the optimal passage conditions for Chinook salmon were assumed to occur at depths of 1.0 feet or more per the recommendations of Bell (1991). Few studies discuss the minimum width over which a depth criterion should be applied. Thompson (1972) concluded that minimum depth criteria would be needed over a minimum of 10 percent of the channel width. Powers and Orsborn (1984) observed that depths of 0.4 to 0.6 feet were adequate for coho and chum to pass through a chute 1.25 feet in width; however their study was designed to examine depth criteria rather than width. WDFW (2000)

Table 6-3. Depth criteria reported for salmonid upstream passage.

| Author(s) | Depth (ft) | Comments |
|---|---|---|
| Ziemer (cited in Orsborn and Powers 1985) | 0.5-1.0 | Weir design values for salmon and shad |
| Rizzo (cited in Orsborn and Powers 1985) | 1.0 | Weir design, unknown salmonids |
| Thompson (1970) | 1.0-1.25 | Weir design for salmon and steelhead |
| Thompson (1972) | | Minimum for: |
| | 0.8 | Chinook salmon |
| | 0.6 | Coho salmon, steelhead, and large trout |
| | 0.4 | Trout |
| Weaver et al. (1976) | | Minimum for coho and fall run Chinook salmon, and steelhead (weir passage): |
| | 1.0 | 3 foot high sill |
| | 2.0 | 4 foot high sill |
| Dane (1978) (cited in Orsborn and Powers 1985) | 0.75 | Culvert design minimum for Pacific salmon |
| Evans and Johnston (1980) | | Culvert design minimum for: |
| | 0.5 | Trout |
| | 1.0 | Salmon |
| Bell (1991) | | Minimum design values for: |
| | 0.5 | Trout |
| | 1.0 | Salmon |
| Powers and Orsborn (1985) | 0.4 | Minimum chute depth for coho salmon (will not pass all fish) |

recommend a minimum orifice width of 1.5 feet for fish ladders in their draft fishway guidelines, but indicate that widths of 1.0 foot are occasionally used. WDFW (2002) also recommend a minimum bar separation width of 1.5 feet for trash racks to allow adequate fish passage. The depth analysis completed in this HCP applied the WDFW recommendations and assumed that the minimum depth criteria over a contiguous minimum width of 1.0 to 1.5 feet width of channel would allow complete passage.

Within the WRIA 8 Conservation Plan (WRIA 8 Steering Committee 2005), the results of the Ecosystem Diagnosis and Treatment (EDT) model suggested that under current conditions the availability of adult holding habitat in Rock Creek was a limiting factor relative to template conditions. Template conditions are hypothetical sustainable healthy conditions that are based upon knowledge of historic conditions, to the extent they are known (Lestelle et al. 1996). The EDT model utilizes nine different attributes to evaluate adult holding habitat: flow, embeddedness, 3 attributes related to the presence of different pool types, riparian function, instream large woody debris, natural confinement, and hydromodification (MBI 2003b). While it is not possible to use the current analysis to directly evaluate the EDT results regarding adult holding habitat because the attributes to be evaluated are different, it is possible to utilize depth data to evaluate pool depths along the transects relative to depth criterion for holding pool habitat. The Washington Department of Natural Resources Watershed Assessment Manual (WFPB 1995) utilizes a minimum pool depth of 3.3 feet as a criterion for holding habitat.

#### *6.2.1.1 Methods*

The PHABSIM analysis utilized 37 cross-sections (transects) measured at low, medium, and high flows. MCS Environmental collected data for 28 transects and R2 collected the data for the remaining 9. The nine transects collected by R2 were considered representative of the other transects and hence were used for evaluating water depth-adult passage conditions at different flows. Tables 6-4 and 6-5 list the nine cross-sections considered in this analysis.

Table 6-4. PHABSIM Site Information.

| Site | Approximate Site Location (RM) | Number of Transects | Field Collection Dates | | | Mean Measured Flow (cfs) | | |
|---|---|---|---|---|---|---|---|---|
| | | | Low | Medium | High | Low | Medium | High |
| A | 0.2 | 3 | 8/11/2004 | 5/5/2004 | 6/3/2004 | 2.7 | 5.6 | 10.7 |
| B | 0.6 | 3 | 8/11/2004 | 5/5/2004 | 6/3/2004 | 2.6 | 6.3 | 10.6 |
| C | 0.7 | 3 | 8/11/2004 | 5/5/2004 | 6/3/2004 | 2.8 | 6.3 | 10.9 |

Table 6-5. Transects utilized in the flow-depth analysis.

| Site | Transect | Habitat Type |
|---|---|---|
| A | 1 | Pool |
| A | 2 | Pool |
| A | 3 | Riffle |
| B | 1 | Riffle |
| B | 2 | Riffle |
| B | 3 | Pool |
| C | 1 | Pool |
| C | 2 | Pool |
| C | 3 | Riffle |

Water velocity and depth were measured at each station along the cross-section (typically every 0.5 to 1.0 foot). Water surface elevations were measured at the channel edge and several locations across the cross-section. Elevations were measured relative to a local benchmark arbitrarily assigned an elevation of 100 feet. Hydraulic modeling using data collected at the measured flows allowed the development of a water surface elevation versus flow relationship. A graphical example from Site A Transect 1 is provided in Figure 6-8.

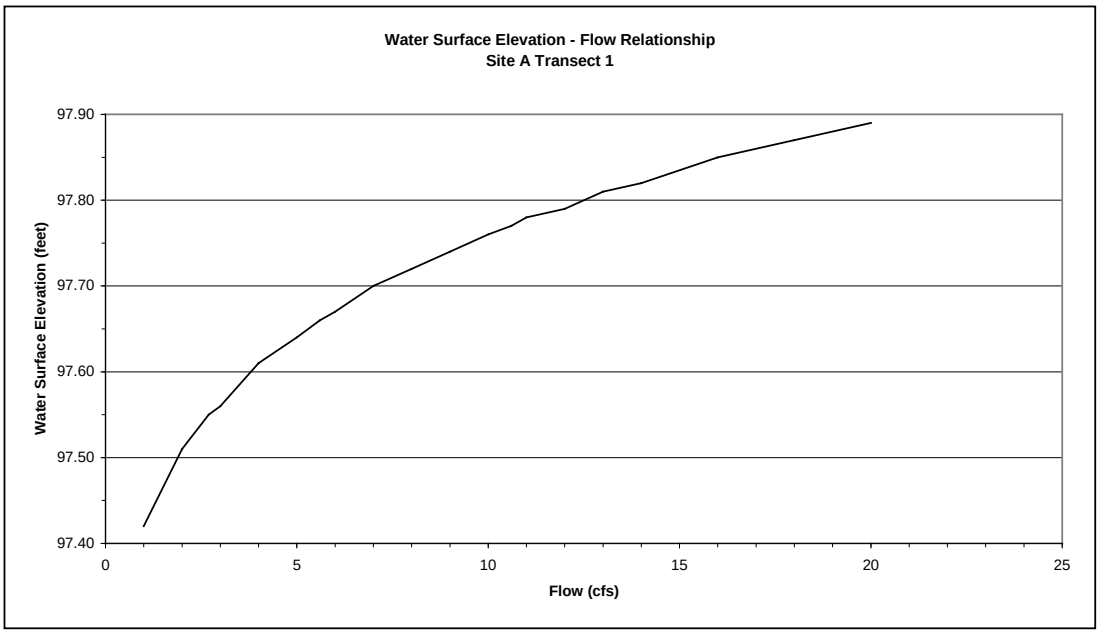



Figure 6-8. Example water surface elevation versus flow relationship.

Water depths at each station were calculated by subtracting the average elevation of the channel bottom from the water surface elevation at four selected flow levels (1.5 cfs, 3 cfs, 4 cfs, and 7 cfs). The baseline condition was considered to be the water surface elevation at 1.5 cfs. In contrast, the median flows at the flume during October and November under a no-withdrawal HSPF model scenario are 6-6 and 7.1 cfs, respectively. Average channel elevations were used because of potential measurement error and small changes in the channels may have occurred between surveys.

#### *6.2.1.2 Results and Discussion*

Table 6-6 summarizes the increase in water surface elevation at 3.0, 4.0, and 7.0 cfs relative to the baseline flow level. The mean increase in water surface elevation over the baseline (1.5 cfs) conditions was 1.1, 1.7, and 2.7 inches at the 3.0, 4.0, and 7.0 cfs flow levels. With the exception of Site B Transect 3 and Site C Transect 3, all transects were relatively close to the mean values.

Table 6-6. Summary of water surface elevation (WSE) changes over baseline at three flows.

| | | | Change (increase) in WSE (inches) over baseline | | |
|---|---|---|---|---|---|
| **Site** | **Transect** | **1.5 cfs WSE (ft)** | **3.0 cfs** | **4.0 cfs** | **7.0 cfs** |
| | 1 | 97.465 | 1.1 | 1.7 | 2.8 |
| A | 2 | 97.465 | 1.3 | 1.7 | 2.6 |
| | 3 | 99.160 | 1.1 | 1.6 | 2.8 |
| | 1 | 94.335 | 1.1 | 1.7 | 2.9 |
| B | 2 | 94.810 | 1.1 | 1.6 | 2.5 |
| | 3 | 94.950 | 1.4 | 2.2 | 3.6 |
| | 1 | 96.490 | 1.3 | 1.8 | 3.0 |
| C | 2 | 96.495 | 1.3 | 1.9 | 2.8 |
| | 3 | 96.735 | 0.4 | 0.8 | 1.3 |
| | Minimum | | 0.4 | 0.8 | 1.3 |
| | Maximum | | 1.4 | 2.2 | 3.6 |
| | Mean | | 1.1 | 1.7 | 2.7 |

Three depth statistics were also calculated for each transect at the four flow levels: maximum depth, mean depth, and mean depth of the primary channel (the portion of the channel with the greatest depth most likely to be utilized by an adult salmon) (Tables 6-7, 6-8, and 6-9). Examination of the maximum water depths (Table 6-7) indicates that 6 of the 9 transects would have less than the 1.0 foot minimum depth criterion at flows of 7.0 cfs. Consequently, Chinook passage would likely be suboptimal at many stream locations in Rock Creek even under a no withdrawal (Scenario 2) flow condition. Of the three transects that meet the 1.0-foot minimum criterion using maximum depth (Site A Transect 2, Site B Transect 3, and Site C transect 2), two would also meet the criterion at the 1.5 cfs flow level. Flows in 7 of the 9 transects would need to be at least 24 cfs, 2 of which would need to be at least 50 cfs to obtain at least a 1.0 foot mean depth in the primary channel (Table 6-9). Flows of this magnitude are rarely seen (one in 10 years) in Rock Creek until after the last week of November. It should be noted that during the previous four years of spawning surveys conducted by the City of Kent (2001-2004) flows during the fall spawning period have been voluntarily maintained at a minimum flow of 3.0 cfs. While few Chinook salmon

have been observed in the stream during these years, substantial numbers of sockeye and coho salmon appear to migrate to the upper reaches without any apparent passage delay.

Table 6-7. Summary of maximum water depth at four flows.

| | | Maximum Depth (inches) | | | |
|---|---|---|---|---|---|
| **Site** | **Transect** | **1.5 cfs (Baseline)** | **3.0 cfs** | **4.0 cfs** | **7.0 cfs** |
| A | 1 | 8.2 | 9.3 | 9.9 | 11.0 |
| | 2 | 16.1 | 17.4 | 17.8 | 18.7 |
| | 3 | 3.5 | 4.6 | 5.1 | 6.3 |
| B | 1 | 6.7 | 7.9 | 8.5 | 9.7 |
| | 2 | 4.4 | 5.5 | 6.0 | 7.0 |
| | 3 | 20.1 | 21.6 | 22.3 | 23.7 |
| C | 1 | 8.5 | 9.8 | 10.3 | 11.5 |
| | 2 | 9.2 | 10.4 | 11.0 | 12.0 |
| | 3 | 5.1 | 5.5 | 5.9 | 6.3 |
| | Minimum | 3.5 | 4.6 | 5.1 | 6.3 |
| | Maximum | 20.1 | 21.6 | 22.3 | 23.7 |
| | Mean | 9.10 | 10.22 | 10.76 | 11.80 |

Table 6-8. Summary of mean water depth at four flows.

| | | Mean Depth (inches) | | | |
|---|---|---|---|---|---|
| **Site** | **Transect** | **1.5 cfs (Baseline)** | **3.0 cfs** | **4.0 cfs** | **7.0 cfs** |
| A | 1 | 5.3 | 6.5 | 7.1 | 8.2 |
| | 2 | 7.2 | 8.4 | 8.9 | 9.7 |
| | 3 | 1.6 | 2.7 | 3.2 | 4.4 |
| B | 1 | 4.0 | 5.1 | 5.7 | 6.9 |
| | 2 | 1.6 | 2.7 | 3.2 | 4.1 |
| | 3 | 11.0 | 12.4 | 13.2 | 14.6 |
| C | 1 | 4.3 | 5.6 | 6.1 | 7.3 |
| | 2 | 5.9 | 7.1 | 7.7 | 8.7 |
| | 3 | 2.5 | 3.0 | 3.3 | 3.8 |
| | Minimum | 1.6 | 2.7 | 3.2 | 3.8 |
| | Maximum | 11.0 | 12.4 | 13.2 | 14.6 |
| | Mean | 4.82 | 5.95 | 6.48 | 7.52 |

Table 6-9. Summary of mean water depth of the primary channel at four flows.

| Site | Transect | Mean Depth (inches) of Primary Channel 1.5 cfs (Baseline) | 3.0 cfs | 4.0 cfs | 7.0 cfs | Flow Needed for 1-foot depth (cfs) |
|---|---|---|---|---|---|---|
| A | 1 | 5.9 | 7.1 | 7.7 | 8.8 | 29 |
| | 2 | 8.4 | 9.7 | 10.1 | 11.0 | 9 |
| | 3 | 2.4 | 3.5 | 3.9 | 5.1 | 51 |
| B | 1 | 3.8 | 5.0 | 5.6 | 6.8 | 44 |
| | 2 | 2.9 | 4.0 | 4.5 | 5.4 | 51 |
| | 3 | 14.3 | 15.8 | 16.5 | 17.9 | 1 |
| C | 1 | 5.3 | 6.6 | 7.1 | 8.3 | 30 |
| | 2 | 5.9 | 7.1 | 7.7 | 8.7 | 24 |
| | 3 | 2.8 | 3.2 | 3.6 | 4.0 | 24 |
| | Minimum | 2.4 | 3.2 | 3.6 | 4.0 | 1 |
| | Maximum | 14.3 | 15.8 | 16.5 | 17.9 | 51 |
| | Mean | 5.74 | 6.87 | 7.40 | 8.44 | 29.2 |

The assessment of adult holding habitat was based on comparing pool depths across transects to the 3.3-foot criterion as specified in WFPB (1995). Results indicated that all of the transects located in pools were considerably shallower than the 3.3 feet criterion under the 7.0 cfs and lower flow scenarios. The deepest pool evaluated, Site B Transect 3, had a maximum depth of 23.7 inches under the 7.0 cfs flow scenario (Table 6-7). Habitat mapping suggested this pool was representative of pools found in Rock Creek; about 31 percent of the pools (ten pools) had a greater residual depth (greater than 1.6 feet) over the 2.75 miles of stream surveyed, and the deepest pool measured during the habitat survey had a residual depth of 2.5 feet (R2 Resource Consultants 2004, unpublished data). Flows of slightly over 50 cfs would be required to form a 3.3-feet deep pool at this location. The analysis confirms the EDT model results that indicated pool habitat in Rock Creek is sub-optimal for Chinook adult holding habitat under current conditions. However, it also suggests that adult holding habitat would be sub-optimal even under natural flow conditions and not substantially better than current (baseline) conditions. Given the size and length of Rock Creek, plus its proximity to the Cedar River where deep pools are available, it seems more likely that adult

Chinook salmon would utilize the Cedar River for holding until ready for spawning in tributaries. Consequently, the lack of adult holding habitat in Rock Creek may not be a limiting factor.

HCM-2 of the HCP provides for the construction of a series of weirs at the mouth of Rock Creek to improve upstream access into the stream. Under current conditions, depths at the mouth of Rock Creek are generally less than 4 inches at 3 cfs. The weirs would be designed to concentrate flows of approximately 3 cfs or less into a slot about 1 foot wide. At a 3 cfs design flow, depths in the slot would be expected to be approximately 1 foot in depth or near the minimum optimal depth for passage. The weirs would also create some pools just upstream that adult salmonids could use as resting/holding areas during their migration.

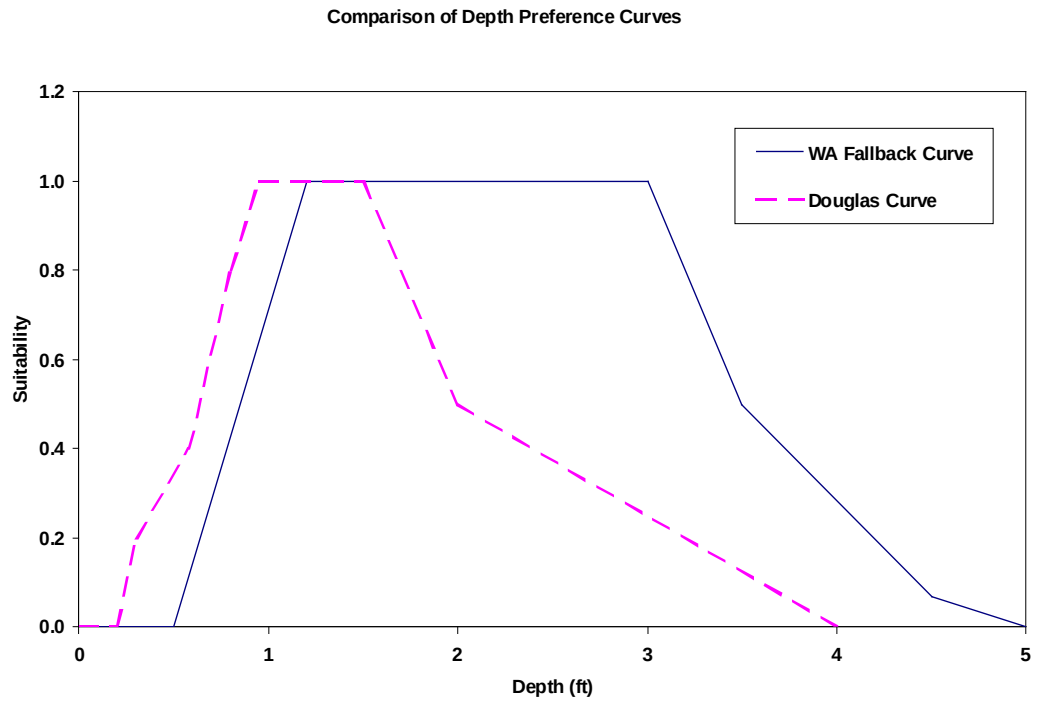
### 6.2.2 Chinook Spawning and Incubation

As described in Section 3.3, the historic distribution of Chinook salmon in Rock Creek is uncertain. Different sources (primarily GIS-based) have placed the upper extent of Chinook spawning at RM 1.3, RM 0.65, RM 0.27, and RM 0.20. Documentation of the rationale for these locations is limited (WDF et al. 1994, WDFW 2005, Streamnet 2005, and WRIA 8 Steering Committee 2005). The latter two locations (RM 0.27 and RM 0.20) are in the approximate locations of the SE 248$^{th}$ Street culvert and the Seattle Pipeline culverts. Both culverts have been cited as partial barriers to anadromous fish (Chinook Engineering 2002; King County et al. 1999), but were replaced and should improve the ability of resident and anadromous fish to move through the lower reaches of Rock Creek. The RM 1.3 location was based upon the upper extent of the WDFW spawning survey index reach (Summit-Landsburg Road; primarily for coho) and not necessarily observations of Chinook salmon at that location. RM 0.65 was the extent examined using the EDT model in the WRIA 8 Conservation Plan. A GIS-based analysis of Chinook spawning habitat in WRIA 8 suggested that potential use of Rock Creek by Chinook salmon was very unlikely because Rock Creek was too small (Davies, NMFS 2005, personal communication).

Habitat duration curves for two Chinook salmon life stages, two alternative spawning Habitat Suitability Curves (HSC), and four alternative distributions were modeled. The two life stages were spawning and fry and the four reaches were Reach 3 (RM 0.28), Reach 5

(RM 0.67), Reach 8 (RM 1.58), and Reach 9b (RM 1.85; i.e., downstream of the augmentation pump) (Figure 1-5). The end of Reach 8 was chosen as the end of one alternative distribution because according to available GIS hydrography, RM 1.3 (one of the reported upper reach limits of Chinook) occurs in the middle of Reach 8. The WDFW index reach ends at Summit-Landsburg Road, which is an access point to Rock Creek; we assumed that river mile discrepancies resulted from different measuring methods (e.g., GIS versus a topographic map and map-wheel).

Two sets of spawning HSC were used in the analysis, a default set of curves based upon the WDFW and Ecology guidelines for conducting instream flow studies, and the second set of curves that were derived from streams comparable in size to Rock Creek. The default set of curves were those recommended by the WDFW and Ecology that are to be used in the absence of curves developed from site specific microhabitat data. Since site specific HSC were not developed for Rock Creek, these curve sets (known as the "fallback" curves) were used for this analysis (WDFW and Ecology 2003). According to Caldwell, et al. (1990), the WDFW and Ecology (2003) "Fallback" curves, were based upon curves from the Yakima River, Washington, and the Sandy River, Oregon, which are much larger than Rock Creek; the curves were further adjusted by WDFW based on professional judgment so that higher suitability was assigned to lower velocities and depths. The other set of HSC curves were those that R2 had derived from a number of smaller streams of similar size to Rock Creek, and that had been applied to streams in Douglas County, Washington, which are termed the "Douglas" curves. A comparison of the curves indicated a higher suitability for lower velocities and shallower depths and lower suitability for higher velocities under the Douglas curves relative to the Fallback curves (Figure 6-9). For completeness, both sets of curves were used in the analysis for Chinook salmon spawning habitat, resulting in development of two alternative WUA-flow relationships.



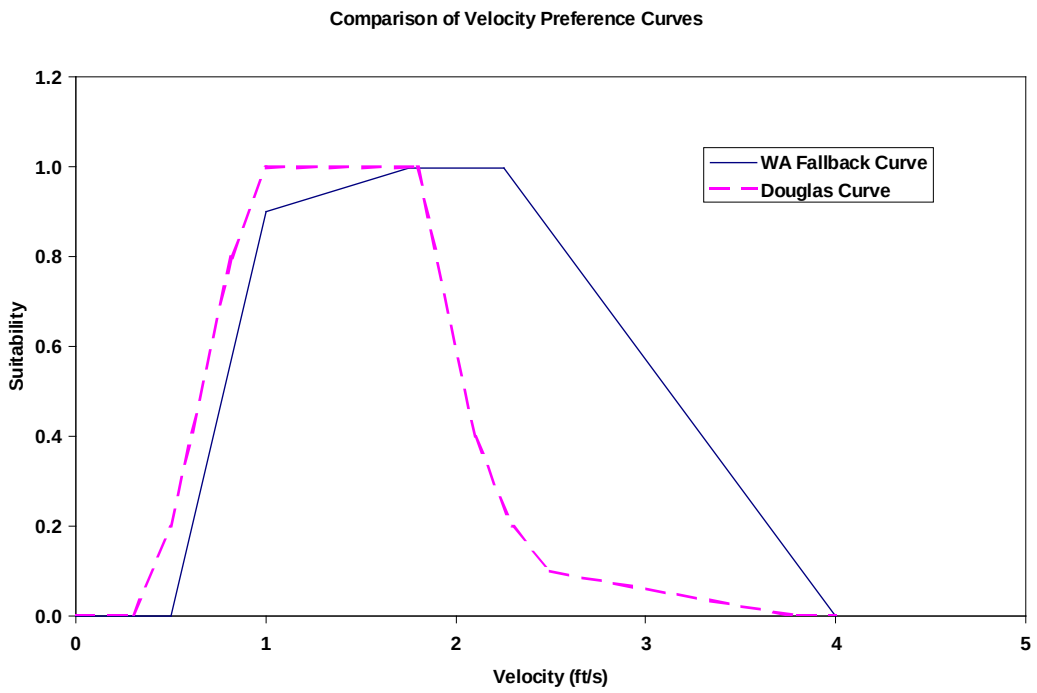




Figure 6-9. Comparison of the Washington Fallback and Douglas County Chinook Habitat Suitability Curves for Depth and Velocity.

The PHLOAT analysis suggested that under current operations the median amount of Chinook salmon spawning habitat downstream of the Parshall Flume is approximately 168 $ft^2$ of WUA during October and 47 $ft^2$ of WUA during November using the ”Fallback” curves (Table 6-10). Under the “Douglas” curves, the median amount of Chinook spawning habitat is approximately 2,977 $ft^2$ of WUA during October and 1,756 $ft^2$ during November. Under HCM-1, Chinook salmon spawning habitat would increase to 1,307 $ft^2$ during October and November based on the “Fallback” curves and 9,139 $ft^2$ using the “Douglas” curves. These represent a 7.8 to 27.7-fold increase over current conditions (baseline) for the “Fallback” curves and 3.1 to 5.2-fold increase based on the “Douglas” curves.

An analogous analysis for the alternative Chinook distributions indicates the shorter alternative reach lengths have less total WUA, but the relationship between WUA and stream length is not directly proportional (Table 6-10). Nevertheless, under HCM-1 the amount of total WUA, compared to the baseline amount would increase on a proportional basis in a similar fashion for each alternative distribution. Compared to current conditions (baseline) under the “Fallback” curve HCM-1 would increase total WUA 7.8 to 8.2-fold during October and 27.7 to 30.8-fold during November depending upon the distribution. Under the “Douglas” curve, the WUA increase would be 2.9 to 3.1-fold during October and 4.7 to 5.2-fold during November.

HCM-1 also includes minimum flow targets and maximum augmentation levels for wet, dry, and drought conditions (3.5, 2.75, and 2.5 cfs minimum flow targets, respectively). The amount of Chinook spawning WUA downstream of the Parshall Flume for these three flow targets and the normal year type flow target were compared to a 1.5 cfs baseline condition (Figure 6-10). Under the “Fallback” curves, Chinook spawning habitat increased approximately 625 to 1,350 percent with HCM-1 compared to the current conditions. In contrast, under the “Douglas” curves, Chinook spawning habitat increased approximately 213 to 307 percent.

Table 6-10. Median total spawning habitat WUA (sq ft) from the HSPF/PHABSIM Operations Analysis Tool during October, November, and December under four alternative Chinook distributions with current operations, the proposed October through December 3 cfs minimum.

| Alternative Distribution Reach | Habitat Suitability Curve Set | Current Operations | | | Proposed Mitigation (HCM-1) | | |
|---|---|---|---|---|---|---|---|
| | | October | November | December | October | November | December |
| RM 0 to RM 1.85 | Fallback Curve | 168 | 47 | NA | 1,307 | 1,307 | NA |
| | Douglas Curve | 2,977 | 1,756 | NA | 9,139 | 9,139 | NA |
| RM 0 to RM 1.58 | Fallback Curve | 116 | 32 | NA | 923 | 923 | NA |
| | Douglas Curve | 2,587 | 1,546 | NA | 7,729 | 7,729 | NA |
| RM 0 to RM 0.67 | Fallback Curve | 36 | 10 | NA | 290 | 290 | NA |
| | Douglas Curve | 1,258 | 767 | NA | 3,587 | 3,587 | NA |
| RM 0 to RM 0.28 | Fallback Curve | 15 | 4 | NA | 123 | 123 | NA |
| | Douglas Curve | 539 | 329 | NA | 1,537 | 1,537 | NA |

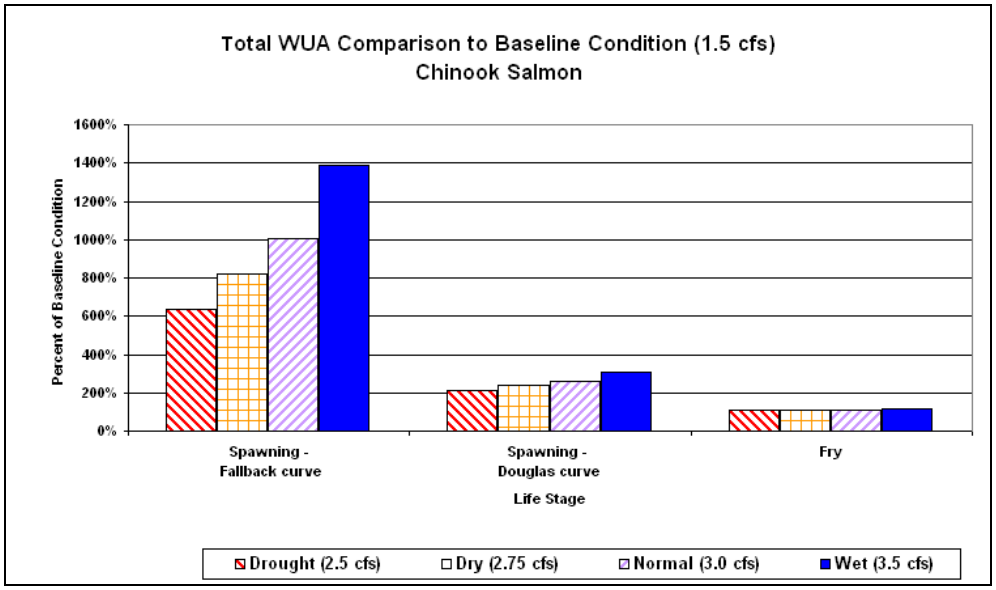



Figure 6-10. Comparison of estimated Chinook spawning habitat total weighted usable area at minimum flow targets for wet, normal, dry, and drought year types relative to baseline conditions (100%).

The proportional increase of amount of habitat under the different minimum flow targets reflects the shape of the WUA versus flow relationship and ultimately the alternative criteria used in the two HSC sets (Figure 6-11). The WUA versus flow relationship that results from using the "Douglas" curves is much steeper than the relationship resulting from the "Fallback" curves over the low flow conditions relevant to the flow mitigation in the HCP.

The alternative Chinook distribution analysis illustrates how differences between the "Fallback" and "Douglas" curves affect the distributional estimates of spawning habitat in different reaches. With the "Douglas" curves, under current conditions over 40 percent of the total WUA downstream of the Parshall Flume is accounted for in Reaches 1 through 5 (to RM 0.67) compared to approximately 21 percent under the "Fallback" curves. In contrast, under the "Fallback" curves, Reaches 9 and 9b (up to the Parshall Flume) account for a relatively high proportion (approximately 31%) of the total WUA downstream of the augmentation pipe compared to approximately 13 percent under the "Douglas" curves. This difference results primarily from the "Fallback" curves having a deeper optimal depth range

than the "Douglas" curves. As a consequence, reaches with a higher proportion of pool habitat are modeled as having more Chinook spawning habitat. These distinctions are important because there is a higher likelihood of Chinook accessing and utilizing the lower reaches in Rock Creek because of its proximity to the Cedar River. During recent years with relatively intensive spawning surveys during October and November, no Chinook salmon have been observed beyond Reach 2 in Rock Creek (R2 2005a; MCS 2003).

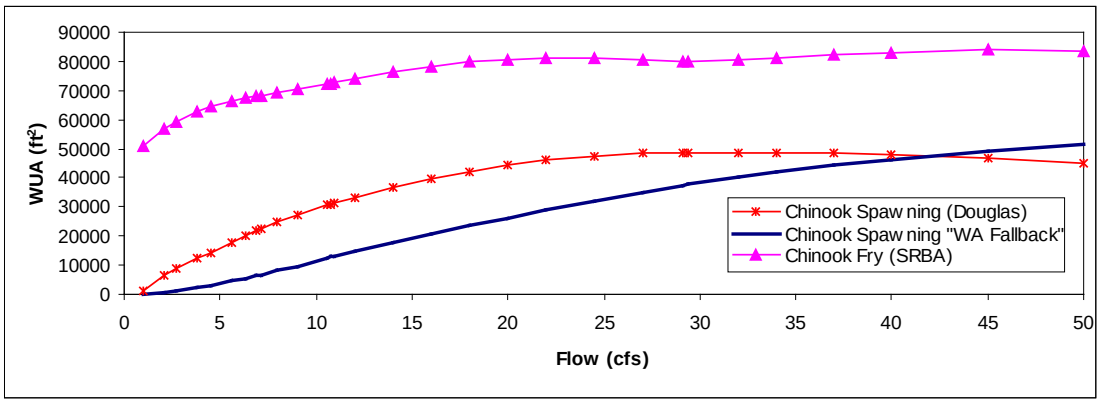



Figure 6-11. Weighted usable area versus flow relationship for Chinook spawning using two different habitat suitability curves sets and Chinook fry habitat.

Changes to instream flows can adversely affect egg incubation primarily in two ways. First, large decreases in flow to the point that redds are dewatered can result in desiccation and death to embryos (Becker et al. 1982). However, the size of Rock Creek and the spawning depth preferences of Chinook salmon are likely to limit spawning to the deeper portions of the stream channel compared to stream margins that would be more likely to dewater if flows decline. Furthermore, even during relatively dry years flows tend to increase or remain stable during the fall in Rock Creek rather than exhibiting a continued decline. HCM-1 is designed to provide a range of flows (depending on water year type) during October, November, and December that should minimize the likelihood of dewatering events occurring during winter months.

The second way changes in flows can adversely affect egg incubation is from scour that can result from peak flow events. Water withdrawals are expected to have a relatively small

moderating effect on peak flow events because the withdrawal levels are much smaller than peak flow events. Two-year and 10-year flood flow events in Rock Creek are 82 and 167 cfs, respectively (Pentec unpublished data). A withdrawal rate of 8 cfs would represent less than 10 percent of a two-year event and less than 5 percent of 10-year event. Consequently, water withdrawals and implementation of HCM-1 are not expected to substantially affect the potential for scour from peak flow events.

### 6.2.3 Chinook Fry Rearing and Downstream Migration

Under current operations, the PHLOAT analysis suggests that under median conditions fry habitat ranges from approximately 67,024 $ft^2$ of WUA during May to about 75,739 $ft^2$ of WUA during February (Figure 10 in Appendix F). These amounts represent 91.3 (May) to 99.6 (February) percent of the available habitat under Scenario 2 (no-withdrawal). This suggests that withdrawals under the current project operations and the proposed HCP have a relatively small effect on fry habitat. The proposed minimum flows during October, November, and December will not affect Chinook fry because fry are not present during that time period.

During the month of March, the median amount of Chinook fry WUA was 9,243 $ft^2$ in Reaches 1 through 3, while Reaches 4 and 5 accounted for 12,192 $ft^2$, Reaches 6 through 8 accounted for 37,118 $ft^2$, and Reaches 9 and 9b up to the Parshall Flume accounted for 16,166 $ft^2$. The trends in WUA over time were similar among the alternative Chinook salmon distributions with February having the highest median WUA and May having the lowest. Similar to spawning habitat under the “Fallback” curve, the distribution of Chinook fry habitat WUA was disproportionate to stream length. Reach 1 through Reach 3 accounted for about 16 percent of the stream length, but about 12 percent of the total fry WUA downstream of the Parshall Flume. Similarly Reaches 4 and 5 accounted for about 22 percent of stream length and 16 percent of fry WUA. Reaches 6 through 8 accounted for about 50 percent of the length and about 50 percent of the WUA. Reach 9 and 9b up to the Parshall Flume accounted for about 14 percent of the stream length, but about 22 percent of

the fry WUA. The analysis suggests there is more suitable Chinook fry habitat in those reaches containing higher levels of pools and other slow moving water velocities.

Fry habitat in the lower reaches of Rock Creek is limited because of the channel size, gradient, and confinement (both natural and man-made), which constrain the development of large pools and off-channel habitat. Two of the mitigation projects to be implemented under the HCP, HCM-3 and HCM-4, are designed to enhance the availability of fry habitat in Reaches 1 and 2, reaches that have the highest likelihood of use by Chinook due to their proximity to the mainstem Cedar River. Under HCM-3, the isolated wetland adjacent to Reach 1 along the left bank would be connected to Rock Creek by the creation of an inlet and outlet channel that would allow Rock Creek water to flow through the wetland during moderate to high flow periods. Depending upon the final design, habitat quality may also be improved through placement of large woody debris. Establishing direct hydrologic connectivity between the wetlands - pond complex and Rock Creek would provide approximately 0.3 acres of off-channel habitat, approximately doubling the amount of this type of habitat associated with lower Rock Creek.

Under HCM-4, the wetland hydraulically connected along the right bank of Rock Creek in Reach 2 would be enhanced by excavating organic deposits, creation of an island that would increase edge habitat, placement of large woody debris, and riparian plantings. Enhancement of the Reach 2 wetland-pond complex would improve approximately 0.25 acres of important winter rearing habitat for juvenile salmonids, and as well, nursery areas and feeding stations for newly emerged Chinook fry. Together, HCM-3 and HCM-4 are expected to provide substantial improvements to the availability of off-channel habit for Chinook fry in Rock Creek.

## 6.3 Effects of Water Withdrawal and Habitat Conservation Measures on Bull Trout (*Salvelinus confluentus*)

This section describes the effects of water withdrawal and the habitat conservation measures on four life history stages of bull trout; upstream migration, spawning and incubation, and fry rearing and downstream migration. Importantly, there have been no reported

observations of bull trout in Rock Creek. However, the USFWS believes conditions exist that "may come close to suitable spawning temperatures and that may provide thermal refuge for rearing or foraging during warm summer periods" (USFWS 2004). Reproducing populations of bull trout have not been confirmed in the lower Cedar River (Kerwin 2001). Bull trout in Chester Morse Lake have adopted an adfluvial life history strategy meaning that the majority of rearing occurs in a lake with annual spawning migrations by mature fish into streams (Connor et al. 2001). There are no upstream passage facilities at Lake Chester Morse or Masonry Dams, and Cedar Falls is considered a natural barrier to bull trout. Consequently, bull trout that actively migrate or are inadvertently washed downstream from the dams are considered lost to the Chester Morse population. Amphidromous bull trout may enter non-natal freshwater systems, such as Lake Washington (designated at foraging, migratory, and overwintering critical habitat by the USFWS), to overwinter and rear. These would likely be the two sources for bull trout were they to colonize or intermittently utilize habitat in Rock Creek. In the upper Cedar River, bull trout spawn during October and November and rearing occurs year-round.

### 6.3.1 Bull Trout Upstream Migration

Adult bull trout have a similar periodicity to Chinook and hence, if they were to utilize Rock Creek for spawning (assuming a fluvial or adfluvial stocks of fish that would use tributaries for spawning) would likely migrate upstream during October and November and encounter the same sub-optimal passage conditions. However, since they are smaller than Chinook, bull trout should be able to migrate through slightly shallower waters than Chinook.

As described in Section 6.2.1 for Chinook salmon, flow mitigation under HCM-1 is expected to increase water depths approximately 1.1 inches over baseline conditions, but upstream passage is likely to remain generally sub-optimal (assuming 1 foot depth is optimal) over most of Rock Creek. In addition, weir construction at the mouth of Rock Creek under HCM-2 is expected to increase water depths at each weir from about 4 inches to approximately 1 foot in depth, or near the minimum optimal depth for passage. The weirs would also provide resting areas for fish ascending the stream.

If bull trout were to utilize reaches of Rock Creek upstream of the Summit-Landsburg Road (RM 1.58), upstream passage would also be improved for bull trout by implementation of HCM-5, which would replace the culvert at this stream crossing with a bridge or box culvert that meets current WDFW criteria. While sockeye salmon, coho salmon, and cutthroat trout are currently known to pass the current culvert at some flow levels, replacement of the culvert is expected to expand the range of flows under which passage is possible.

### 6.3.2 Bull Trout Spawning and Incubation

The PHLOAT analysis was used to estimate the median amount of bull trout spawning WUA from the mouth of Rock Creek to the Parshall Flume under current conditions (baseline) and under the "normal" year type (see Table 4-2) flow mitigation to be implemented under HCM-1. Under current (baseline) conditions, bull trout spawning WUA was estimated to be 27,549 $ft^2$ during October and 24,825 $ft^2$ during November (Figure 17 in Appendix F). Under HCM-1 spawning habitat would increase to 41,117 $ft^2$ of WUA during both October and November, which represents a 49.3 to 65.6 percent increase over current conditions.

The flow management regime proposed under the HCP would not be expected to substantially affect peak flows that could scour the streambed and reduce incubation survival. However, HCM-1 is expected to decrease the likelihood of dewatering events during the late fall. Furthermore, bull trout spawning would occur during a period when the hydrograph is generally rising, and hence the likelihood of redd dewatering is expected to be low.

### 6.3.3 Bull Trout Juvenile and Adult Habitat

Similar to other salmonids that might reside year-round in Rock Creek, the PHLOAT was used to estimate juvenile and adult habitat during each of the 12 months throughout the year and four representative months (October, January, April, and July) are presented under current conditions (baseline) and under the minimum flow targets during the "normal" year

type flow mitigation as described under HCM-1. The WDFW "Fallback" curves for juvenile and adult bull trout rearing habitat are the same. Under current conditions, PHLOAT estimated that the median amount of bull trout juvenile and adult WUA was 1,952 $ft^2$ for October, 18,597 $ft^2$ for January, 13,837 $ft^2$ for April, and 4,207 $ft^2$ for June (Figure 18 in Appendix F). During the proposed flow mitigation period, an additional 1,474 $ft^2$ of median WUA would be provided during October. Some nominal benefits from flow mitigation would also occasionally occur during December.

## 6.4 Effects of Water Withdrawal and Habitat Conservation Measures on Coho Salmon (*Oncorhynchus kisutch*)

This section describes the effects of water withdrawal and the habitat conservation measures on four life history stages of coho salmon: upstream migration, spawning and incubation, and juvenile rearing and downstream migration. Adult coho enter freshwater at the Ballard Locks during late August to mid-November (City of Seattle et al. 1999) and migrate up the Cedar River from early September through late January. River flow and temperature have been found to be important factors in the timing of river entry for coho salmon (Weitkamp et al. 1995). Coho salmon spawning generally occurs in Rock Creek from late November to early March with peak spawning during December and January (WDF et al. 1994, R2 Resource Consultants 2004); however, spawning in the Cedar River has been known to occur in late-October as well. Coho juveniles rear year-round in Rock Creek with the smolt outmigration occurring mid-April through early-July. It is possible that some coho salmon juveniles in Rock Creek gradually move downstream and into the Cedar River prior to smoltification.

### 6.4.1 Coho Upstream Migration

Due to the later migration and spawning periodicity in Rock Creek, the overall adverse effects of water withdrawals on upstream migration, as well as the beneficial effects of flow mitigation under HCM-1 are somewhat less for coho salmon than for Chinook salmon and sockeye salmon. Typically, as a result of fall rains, stream flows have increased in Rock Creek by late November or early December to levels where water depths exceed the minimum depth criterion for optimal passage. However, during some dry and drought years,

the coho salmon upstream migration could benefit from HCM-1 as well as the passage improvements provided by HCM-2. During extended low flow periods, HCM-1 would provide additional flows over current conditions. Similarly, the construction of weirs at the mouth of Rock Creek under HCM-2 would improve upstream access into the stream under low flow conditions. At a 3 cfs design flow, depths in the slot would be expected to be approximately 1 foot or near the minimum optimal depth for coho salmon passage. The weirs would also provide resting areas for fish ascending the stream.

Coho salmon often spawn in Reaches 9A, 9B, 10, 11, and 12 upstream of Summit-Landsburg Road (RM 1.58). Consequently, upstream passage would also be improved for coho salmon by implementation of HCM-5, which would replace the culvert at this stream crossing with a bridge or box culvert that meets current WDFW criteria. While sockeye salmon, coho salmon, and cutthroat trout are currently known to pass the current culvert at some flow levels, replacement of the culvert is expected to expand the range of flows under which both adult and juvenile passage is possible.

### 6.4.2 Coho Spawning and Incubation

The PHLOAT analysis suggests that under current conditions (baseline) the median amount of coho salmon spawning habitat is approximately 1,549 $ft^2$ of WUA during November and approximately 17,917 to 21,628 $ft^2$ of WUA during December to January. Under the normal year type flow mitigation (see Table 4-2), the median amount of coho salmon habitat would increase by 1,868 $ft^2$ of WUA during November, but no changes would occur in the median amount of WUA during December through February (Figure 12 in Appendix F). These represent a 2.2-fold increase over current conditions during November. Only during years when flows are low (e.g., habitat duration value of 80% exceedance or greater), would the proposed minimum flows during December increase the amount of spawning habitat from approximately 1,549 $ft^2$ of WUA to about 3,417 $ft^2$ of WUA which represents about a 2.2-fold increase over baseline conditions.

Similar to Chinook salmon described previously, the flow management regime under the Clark Springs HCP would not be expected to substantially affect peak flows that could scour the streambed and reduce incubation survival. However, HCM-1 is expected to decrease the likelihood of dewatering events during the late fall. Furthermore, coho salmon spawning would occur during a period when the hydrograph is generally rising, and hence the likelihood of redd dewatering is expected to be low.

### 6.4.3 Coho Juvenile Rearing and Downstream Migration

The amount of habitat for juvenile coho salmon is relatively stable throughout the year, regardless of the withdrawal scenario. The PHLOAT analysis indicated that monthly total habitat WUA would range between about 9,151 to 9,988 $ft^2$ under drought conditions (>80% WUA exceedance value) and 10,042 to 10,345 $ft^2$ under wet conditions (<20% WUA exceedance value). During the high flow winter months, water supply withdrawals result in a small increase (e.g., about 281 $ft^2$ during January) in median coho juvenile habitat relative to the no withdrawals scenario (Scenario 2). Overall, HCM-1 would provide a relatively small increase (e.g., about 469 $ft^2$ during October) in rearing habitat compared to the current conditions.

Juvenile coho salmon habitat in the lower reaches of Rock Creek is limited because of the channel size, gradient, and confinement (both natural and man-made), which constrain the development of large pools and off-channel habitat. HCM-3 and HCM-4 are designed to enhance the availability of juvenile rearing and overwintering habitat in Reaches 1 and 2. Under HCM-3, the isolated wetland adjacent to Reach 1 along the left bank would be connected to Rock Creek by the creation of an inlet and outlet channel that would allow Rock Creek water to flow through the wetland during moderate to high flow periods. Depending upon the final design, habitat quality may also be improved through placement of large woody debris. Establishing direct hydrologic connectivity between the wetlands - pond complex and Rock Creek would provide approximately 0.3 acres of off-channel habitat, approximately doubling the amount of this type of habitat associated with lower Rock Creek.

Under HCM-4, the wetland hydraulically connected along the right bank of Rock Creek in Reach 2 would be enhanced by excavating organic deposits, creation of an island that would increase edge habitat, placement of large woody debris. Enhancement of the Reach 2 wetland-pond complex would improve approximately 0.25 acres of important winter rearing habitat for juvenile salmonids, and as well, nursery areas and feeding stations for newly emerged coho fry. Together HCM-3 and HCM-4 are expected to provide a substantial increase in the amount and quality of off-channel habit for coho salmon juveniles in Rock Creek.

The water withdrawals at Clark Springs do not have a large effect on downstream migration of coho salmon smolts during mid-April through mid-July. Reduced flows could potentially reduce the rate of migration by decreasing water velocity. However, the magnitude of this reduction is small (less than 1 foot per second) and the length of stream it might apply relatively short (less than 2.8 miles). Consequently, the likely effect on the overall migration would be minor. Flow mitigation under HCM-1 would not occur during the period of smolt outmigration for coho salmon.

## 6.5 Effects of Water Withdrawal and Habitat Conservation Measures on Sockeye Salmon (*Oncorhynchus nerka*)

This section describes the effects of water withdrawal and the habitat conservation measures on four life history stages of sockeye salmon: upstream migration, spawning and incubation, and fry rearing and downstream migration. Sockeye salmon spawn in Rock Creek from October through December (R2 2004, 2005a). Sockeye salmon have been observed to spawn up through Reach 12 in the Clark Springs Watershed, but the majority of spawning occurs in Reaches 1 through 4. Similar to Chinook salmon fry, emergence begins in late January and continues through May with the peak of the migration to the Cedar River and Lake Washington occurring during late March and early April. The availability of sockeye fry habitat in Rock Creek is assumed to be similar to that of Chinook salmon.

### 6.5.1 Sockeye Upstream Migration

Similar to other large-bodied anadromous, adfluvial, or amphidromous salmon or trout, passage conditions at the mouth of Rock Creek for sockeye salmon are likely to be suboptimal during their spawning migration in October and November. However, upstream passage conditions under pre-project conditions were also likely to have been suboptimal during the early portion (October to mid-November) of the sockeye migration and spawning period. During most years passage conditions for sockeye salmon generally improve over the latter part of their spawning period (mid-November through December) as fall rains naturally increase stream flows

As described in Section 6.2.1 for Chinook salmon, flow mitigation under HCM-1 is expected to increase water depths approximately 1.1 inches over baseline conditions, but upstream passage is likely to remain generally suboptimal over most of Rock Creek until the fall rise in the hydrograph occurs. Weir construction at the mouth of Rock Creek under HCM-2 is expected to substantially increase water depths at each weir from about 4 inches, which is the water depth that would occur at around 3 cfs without the weirs, to approximately 1 foot in depth, when the weirs are in place, or near the minimum optimal depth for passage. The weirs would also provide rest areas for fish ascending the stream.

Similar to coho salmon, sockeye salmon often spawn in Reaches 9A, 9B, 10, 11, and 12 upstream of Summit-Landsburg Road (RM 1.58). Consequently, upstream passage would also be improved for coho salmon by implementation of HCM-5, which would replace the culvert at this stream crossing with a bridge or box culvert that meets current WDFW criteria. While sockeye salmon, coho salmon, and cutthroat trout are currently known to pass the current culvert at some flow levels, replacement of the culvert is expected to expand the range of flows under which passage is possible.

### 6.5.2 Sockeye Spawning and Incubation

The PHLOAT suggests that under Baseline conditions the median amount of sockeye salmon spawning habitat during October is approximately 4,042 $ft^2$ of WUA, while

November has approximately 2,561 $ft^2$, and December has approximately 52,333 $ft^2$ (Figure 14 in Appendix F). Under HCM-1, the median amount of sockeye salmon habitat would increase to about 12,012 $ft^2$ of WUA during October and November, but no changes would occur in the median amount of WUA during December. These represent a 3.0-fold increase over Baseline conditions during October and a 4.7-fold increase during November. Similar to coho, during years with low flow conditions (e.g., habitat duration value of 80% exceedance or greater), the proposed minimum flows during December would increase the amount of sockeye spawning habitat from approximately 2,561 $ft^2$ of WUA to about 12,012 $ft^2$ of WUA or about a 4.7-fold increase over Baseline Conditions.

### 6.5.3 Sockeye Fry Rearing and Downstream Migration

Sockeye salmon fry emerge in the Cedar River from January through early June, with peak emergence occurring from early March to mid-May (Seiler and Kishimoto 1997). Upon emergence from the gravel, sockeye fry almost immediately begin to move downstream into Lake Washington where they will rear until smolting the following spring. As a consequence, sockeye fry are in Rock Creek for only a relatively short period. The analysis tool suggests under baseline operations and the proposed HCP have a relatively small effect on fry habitat. The proposed minimum flows during October, November, and December will not affect sockeye fry because they are not present during that time period. Implementation of HCM-3 and HCM-4 are expected to provide additional high quality fry rearing habitat in Reaches 1 and 2 of lower Rock Creek. However, the extent to which sockeye fry will utilize these areas is unknown, but is presumably low due to their early outmigration tendencies. Large woody debris placement under HCM-6 is also expected to provide some additional areas of slow moving water in Reaches 10 and 12 that could be utilized by as cover habitat by sockeye fry.

## 6.6 Effects of Water Withdrawal and Habitat Conservation Measures on Chum Salmon (*Oncorhynchus keta*)

This section describes the effects of water withdrawal and the habitat conservation measures on four life history stages of chum salmon: upstream migration, spawning and incubation, and fry rearing and downstream migration. There are no established populations of chum

salmon in Rock Creek, the Cedar River, or elsewhere in the Lake Washington watershed. However, chum salmon infrequently stray into Rock Creek. The source of these strays is unknown, but could include the Green River or Snoqualmie River, which are adjacent to WRIA 8. Adult chum salmon typically return to freshwater in October and November and spawn in the lower reaches of rivers from early December to early February (WDF et al. 1994). Juvenile chum salmon, like ocean-type Chinook, have a short freshwater residence and an extended period of estuarine residence, which is the most critical phase of their life history and often determines the size of subsequent adult returns (Johnson et al. 1997; Grette and Salo 1986). In the middle Green River, chum fry have been observed from the middle of March through June.

### 6.6.1 Chum Upstream Migration

The freshwater migration period of chum salmon spans a three-month period from October through December with spawning during late-November and December. Because of the later migration and spawning period (compared to Chinook), the overall adverse effects of water withdrawals on upstream migration, as well as the beneficial effects of flow mitigation under HCM-1 would be less for chum salmon than for Chinook and sockeye salmon. In general, fall rains will increase stream flows in Rock Creek by late November or early December to levels where water depths exceed the minimum depth criterion for optimal passage. However, during some dry and drought years, the chum salmon upstream migration could benefit from HCM-1 and HCM-2. During extended low flow periods, HCM-1 would provide additional flows over current conditions. Similarly, the construction of weirs at the mouth of Rock Creek under HCM-2 would improve upstream access into the stream under low flow conditions. At a 3 cfs design flow depths in the slot would be expected to be approximately 1 foot in depth or near the minimum optimal depth for chum salmon passage. The weirs would also provide some resting areas for fish ascending the stream.

### 6.6.2 Chum Spawning and Incubation

The PHLOAT suggests that under baseline conditions the median amount of chum salmon spawning habitat during November has approximately 4,985 $ft^2$, and December has approximately 41,657 $ft^2$. Under HCM-1, the median amount of chum salmon habitat would increase to 9,985 $ft^2$ of WUA during November, but no changes would occur in the median amount of WUA during December. These represent a 2.0-fold increase during November. During years with low flow conditions (e.g., habitat duration value of 80% exceedance or greater), the proposed minimum flows during December would increase the amount of chum spawning habitat from approximately 4,496 $ft^2$ of WUA to about 9,985 $ft^2$ of WUA or about a 2.2-fold increase over current conditions.

### 6.6.3 Chum Fry Rearing and Downstream Migration

The effects of water withdrawals at Clark Springs and the HCP mitigation measures on chum salmon fry are expected to be similar to those of Chinook salmon fry. Consequently, the PHLOAT analysis suggests that withdrawals under the current project operations would have a relatively small effect on fry habitat. The proposed minimum flows during October, November, and December will not affect chum fry because they are not present during that time period. Similar to Chinook fry, implementation of HCM-3 and HCM-4 are expected to provide additional high quality fry rearing habitat in Reaches 1 and 2 of lower Rock Creek. However, chum fry tend to outmigrate to estuarine areas shortly after emergence from the gravel (Salo 1991), so it is not expected that chum fry would extensively use these areas. Large woody debris placement under HCM-6 is also expected to provide some additional areas of slow moving water in Reaches 10 and 12 that could be utilized by chum salmon fry as refuge habitat.

## 6.7 Effects of Water Withdrawal and Habitat Conservation Measures on Steelhead (*Oncorhynchus mykiss*)

Steelhead trout were historically present in Rock Creek, but the current level of utilization is uncertain. If steelhead trout utilize Rock Creek, the population level is likely to be relatively low. The distribution of steelhead trout in Rock Creek would likely be similar to coho

salmon and adfluvial cutthroat trout; i.e., approximately near the eastern boundary of the Rock Creek Watershed (RM 2.75). Rainbow trout, the resident life history form of *O. mykiss*, is present throughout Rock Creek where suitable habitat is available. Steelhead trout in the Cedar River Watershed spawn from late-January through early-June. Juvenile rearing occurs throughout the year. The availability of steelhead trout fry habitat in Rock Creek is assumed to be similar to that of sockeye salmon. This section describes the effects of water withdrawal and the habitat conservation measures on four life history stages of steelhead trout: upstream migration, spawning and incubation, and juvenile rearing and downstream migration.

### 6.7.1 Steelhead Upstream Migration

The upstream migration of steelhead trout in preparation for spawning occurs during the winter and spring, typically when Rock Creek flows are at their highest. Consequently, upstream passage conditions are expected to be optimal and are not expected to be different from baseline conditions because flow mitigation (under HCM-1) will not occur during the steelhead migratory season. Based upon HSPF modeling, flows are rarely (one in 10 years) below 5 cfs between mid-January to early-May and commonly (one in 2 years) over 10 cfs. Consequently, the weirs at the mouth of Rock Creek designed to improve passage for fall-run fish will likely provide little to no improvements for the passage of steelhead trout.

### 6.7.2 Steelhead Spawning and Incubation

Steelhead trout spawning habitat was modeled during April, May, and June using the PHLOAT. During this period the available amount of spawning habitat declines concurrently with declines in flow. Under baseline conditions, the median amount of WUA was estimated at 6,937 $ft^2$ for April, 3,015 $ft^2$ for May, and 823 $ft^2$ for June. These are approximately 57, 39, and 17 percent, respectively, of the Scenario 2 (no-withdrawals) modeled conditions. HCM-1 is not expected to affect the amount of habitat available to spawning steelhead trout because augmentation is not proposed for the period when steelhead trout would be spawning. Based upon HSPF modeling median monthly flows during the peak spawning months of April and May are 14.8 and 9.5 cfs, respectively, under

Scenario 1 (baseline) conditions. These flows are considerably higher than the October and November low flow periods proposed for augmentation under HCM-1.

Because Rock Creek is moderately confined over most of its length downstream of the Clark Springs facility and too small to develop substantial mid-channel bars, most salmonid spawning, including steelhead, is likely to occur in the stream's thalweg. At flows typical of March through June based upon the HSPF modeling, the average wetted perimeter from IFIM transects (Figure 6-13) would decline about 6 percent (about 33.5 to 31.5 feet) under Scenario 2 (no withdrawals) compared to about 13 percent (about 32.8 to 28.6 feet) under Scenario 1 (baseline conditions). Furthermore, the maximum change in water depth at these transects over these flows would be approximately 2.7 inches under Scenario 2 and approximately 4.0 inches under Scenario 1. Minimum spawning depth for steelhead under Washington Fallback habitat suitability curves is 7.8 inches (WDFW and Ecology 2003), which is nearly twice the maximum change in water depth under Scenario 1. Consequently, the risk of incubating eggs becoming dewatered as a result of water supply withdrawals would be low.

### 6.7.3 Steelhead Juvenile Rearing and Downstream Migration

Steelhead trout juvenile rearing habitat was modeled for each of 12 months throughout the year and the results of four representative months (October, January, April and June) are presented. Under current conditions, the median amount of WUA was estimated to be 715 $ft^2$ for October, 7,325 $ft^2$ for January, 5,375 $ft^2$ for April, and 1,651 $ft^2$ for June. During the proposed flow mitigation period a moderate increase over baseline conditions is expected during October and November (e.g., an additional 613 $ft^2$ of WUA during October).

## 6.8 Effects of Water Withdrawal and Habitat Conservation Measures on Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*)

This section describes the effects of water withdrawal and the habitat conservation measures on four life history stages of coastal cutthroat trout: upstream migration, spawning and incubation, and juvenile rearing. Adfluvial and/or fluvial cutthroat trout are known to utilize Rock Creek based upon observations of relatively large spawning fish (R2 2005a). A

portion of the cutthroat population in Rock Creek may be a resident form that does not migrate to the Cedar River or Lake Washington. However, there is no documented evidence that all three forms (adfluvial, fluvial and resident) are present. Cutthroat trout spawn during January and February. Juvenile and adult cutthroat trout may be present in Rock Creek year-round.

### 6.8.1 Coastal Cutthroat Trout Upstream Migration

Based upon observations during spawning surveys conducted over the past 4 years, the time of entry of adfluvial cutthroat trout into Rock Creek from the Cedar River is early December and could continue through the end of spawning in late February (R2 2005a). Consequently, the flow mitigation under HCM-1 would improve the upstream migration of cutthroat trout during periods when flow augmentation is operating. Similarly, the construction of weirs near the mouth of Rock Creek (HCM-2) would improve upstream passage during low flow periods relative to baseline conditions.

### 6.8.2 Coastal Cutthroat Trout Spawning and Incubation

The PHLOAT analysis estimated the median amount of cutthroat trout spawning WUA was 36,384 $ft^2$ during January and 37,132 $ft^2$ during February under current conditions (Figure 19 in Appendix F). The proposed flow mitigation (HCM-1) is not expected to affect cutthroat trout spawning habitat. During the high flow winter months when cutthroat trout spawning occurs, water supply withdrawals result in a small increase (e.g., about 2,749 $ft^2$ during January and 4,508 $ft^2$ of WUA during February) in median cutthroat trout spawning habitat relative to the no withdrawals scenario (Scenario 2).

### 6.8.3 Coastal Cutthroat Trout Juvenile Rearing

Cutthroat trout juvenile rearing habitat was modeled for each of 12 months throughout the year and the results of four representative months (October, January, April, and June) are presented. Under current conditions, the median amount of cutthroat trout juvenile and adult WUA was estimated at 325 $ft^2$ for October, 3,722 $ft^2$ for January, 2,782 $ft^2$ for April, and 920 $ft^2$ for June (Figure 20 in Appendix F). During the proposed flow mitigation period

(October, November, December) the available habitat is expected to more than double over what would be provided under baseline conditions during October and November (e.g., an additional 403 $ft^2$ of WUA during October).

## 6.9 Effects of Water Withdrawal and Habitat Conservation Measures on Pacific Lamprey (*Lampetra tridentata*)

The degree of utilization of Rock Creek by Pacific lamprey and their specific life history traits are not understood. Consequently, only general life history information is available to help discern the effects of the water withdrawals at the Clark Springs System and the mitigation measures to be implemented under the HCP. In the Pacific northwest, adult Pacific lamprey enter freshwater in July to October, and overwinter to later spawn in May when water temperatures are between 10°C and 15°C (Close et al. 1995, Wydoski and Whitney 2003). Adults die shortly after spawning. Larval Pacific lamprey may remain in freshwater for up to 6 years before migrating to the ocean. During their freshwater residence larval Pacific lamprey live in fine grained sediments located in slow moving waters with high levels of organic material (Wydoski and Whitney 2003, Potter 1980, Moyle 1976).

### 6.9.1 Pacific Lamprey Upstream Migration

Upstream passage requirements for Pacific lamprey are not fully understood. Water depth is not likely to be an important factor because Pacific lamprey have a relatively small dorsal to ventral (top to bottom) length. However, Pacific lamprey are relatively weak swimmers (Close et al. 1995). At hydroelectric dams Moser et al. (2002) observed that lamprey utilize their sucker like mouth to cling to substrate when passing through areas of high velocity, then utilize burst swimming speeds (approximately 6.9 feet per second; Bell 1990) to move forward and cling to the substrate once again. Water velocities of this magnitude are not likely to be experienced by Pacific lamprey during the summer months when upstream migration occurs. Based upon the available information, it is not likely that the upstream migration of Pacific lamprey will be adversely affected by water withdrawals at the Clark Springs System.

### 6.9.2 Pacific Lamprey Spawning and Incubation

Pacific lamprey spawn during May in shallow gravel nests with stream velocities of 1.6 to 3.3 ft/sec (Close et al. 1995). This is a time period characterized by a declining hydrograph and median flows in Rock Creek of around 10 cfs. Although average channel velocities will generally be lower than the range observed by Close et al. (1995), these velocities will be present in some areas and would likely provide sufficient suitable spawning areas for Pacific lamprey.

### 6.9.3 Pacific Lamprey Larval Rearing

Larval Pacific lamprey, called ammocoetes, rear in slow-moving waters with high levels of fine organic materials. The ammocoetes burrow into the substrate and feed on suspended materials, such as diatoms and desmids (Torgersen and Close 2004), and algae (Moyle 1976) filtered from the water. Flow reductions resulting from withdrawals for water supply could have two potentially offsetting effects. First, reduced flows could reduce a stream's wetted perimeter, particularly during low flow periods, which consequently could result in reductions in the area of habitat available to larval lamprey. On the other hand, flow reductions could also reduce water velocities in some areas, which could increase the area where fine organic materials and sediment could settle out. Moore and Mallatt (1980) reported that larval lamprey have specific velocity requirements (0.16 to 0.49 ft/sec) that are suitable for the settling of fine materials.

Analysis of the nine R2 PHABSIM transects indicated that mean channel velocity increased from 0.30 to 0.58 ft/sec over flows ranging from 1.5 cfs (approximately current conditions during the fall) to 7.0 cfs (approximately a no-withdrawal condition; Scenario 2; Table 6-11; Figure 6-12). Notably, flows of 5 cfs or less result in modeled mean channel velocities that are within the optimal range reported by Moore and Mallatt (1980), suggesting that under some circumstances withdrawals may improve larval habitat rearing conditions for lamprey.

Regarding wetted perimeter, the average of 9 R2 transects ranged from 23.3 to 29.5 feet over flows from 1.5 to 7.0 cfs (Table 6-11). The rate of change in wetted perimeter is highest at

lower flows (Figure 6-13). Consequently, water supply withdrawals and augmentation during low flow periods have a relatively large effect on this parameter.

Table 6-11. Mean channel velocity and wetted perimeter from nine PHABSIM transects located in Rock Creek.

| Modeled Flow (cfs) | Mean Channel Velocity (ft/sec) | Mean Wetted Perimeter (ft) | % of Baseline | |
|---|---|---|---|---|
| | | | Velocity | Wetted Perimeter |
| 1.5 | 0.30 | 23.3 | 100.0% | 100.0% |
| 3.0 | 0.39 | 26.5 | 130.0% | 113.7% |
| 4.0 | 0.44 | 27.5 | 146.7% | 118.2% |
| 7.0 | 0.58 | 29.5 | 193.3% | 126.5% |

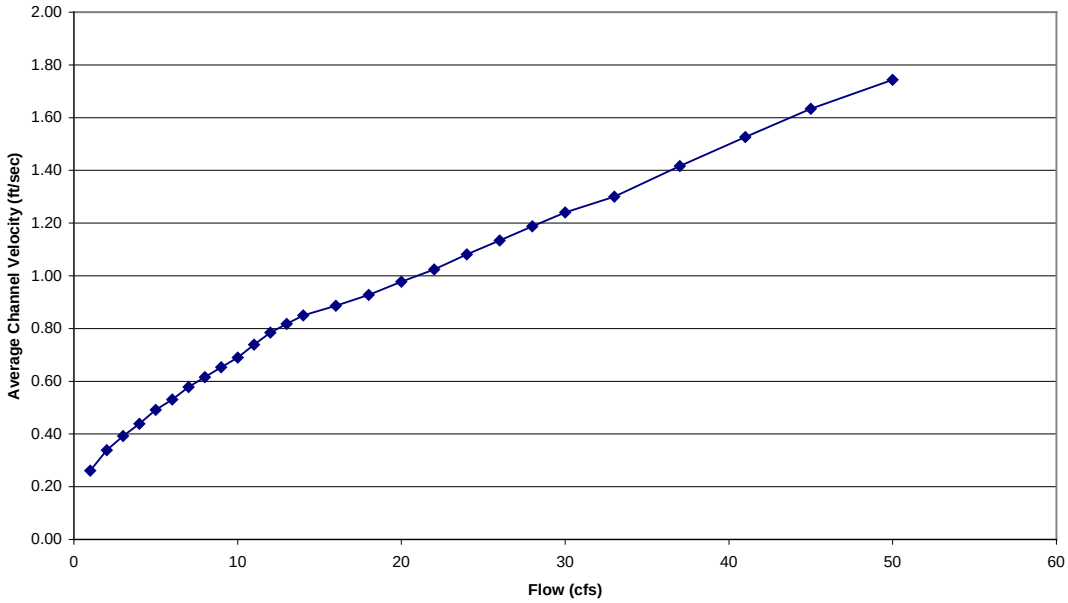



Figure 6-12. Average channel velocity from nine R2 transects modeled in the PHABSIM analysis.

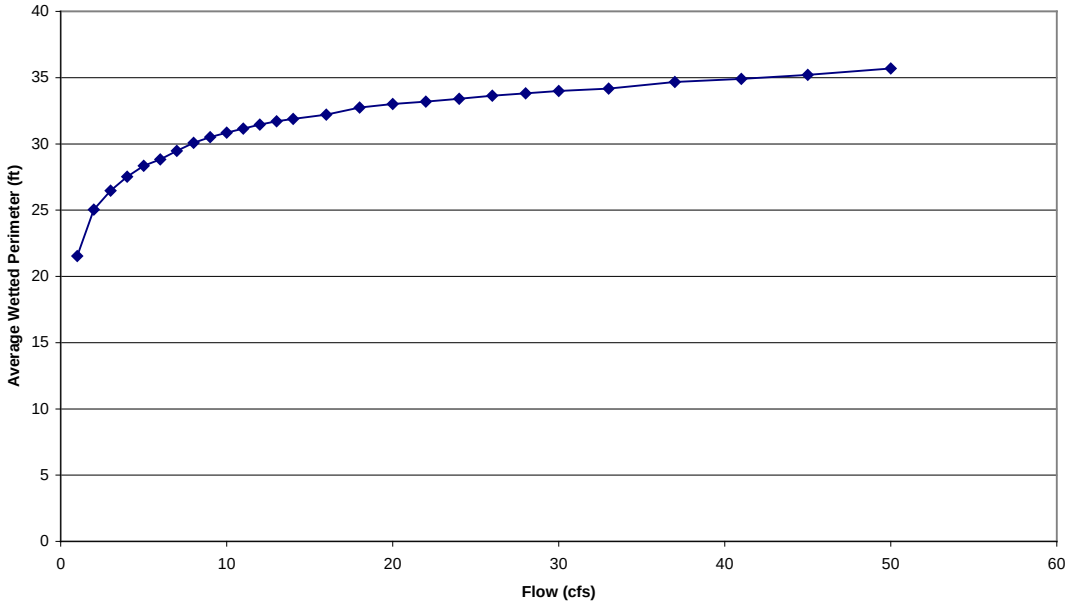



Figure 6-13. Average wetted perimeter from nine R2 transects used in the PHABSIM analysis.

### 6.9.4 Pacific Lamprey Downstream Migration

The downstream migration of juvenile lamprey occurs from March to July with a peak migratory period of April and June (Wydoski and Whitney 2003). The downstream migration is passive and based upon the passage of other lamprey species at dams, occurs primarily at night. Water supply withdrawals at the Clark Springs System are a relatively small proportion of the surface streamflow during the period of outmigration. Operations of the Clark Springs System will not likely impact the outmigration of Pacific lamprey.

## 6.10 Effects of Water Withdrawal and Habitat Conservation Measures on River Lamprey (*Lampetra ayresi*)

Similar to Pacific Lamprey, river lamprey may be present in Rock Creek, but the extent of use in terms of number of fish or their spatial distribution is not understood. The length, life-span, and duration of ocean rearing for river lamprey is shorter than that of Pacific lamprey (Wydoski and Whitney 2003), but little is otherwise known that helps distinguish the life

history characteristics and habitat requirements of these two species. Consequently, the effects of the water withdrawal and the habitat conservation measures on river lamprey are considered similar to that off Pacific lamprey.

### 6.10.1 River Lamprey Upstream Migration

Similar to Pacific lamprey, the upstream passage requirements for river lamprey are not fully understood. Water depth and velocity are not likely to be important factors influencing the upstream migration of river lamprey. Because of their relatively small dorsal to ventral (top to bottom) length, water depths in Rock Creek should provide suitable conditions for upstream migration. Likewise, high water velocities are not expected during the summer months when upstream migration occurs. As a result, neither the operations of the Clark Springs System or the HCMs will appreciably affect the upstream migration of Pacific lamprey.

### 6.10.2 River Lamprey Spawning and Incubation

River lamprey spawn during April to June with most completed during May (Wydoski and Whitney 2003). Similar to Pacific lamprey, spawning occurs in shallow gravel nests. This is a time period characteristically with a declining hydrograph and median flows in Rock Creek of around 10 cfs. Assuming that river lamprey utilize stream velocities similar to that observed for Pacific lamprey, average channel velocities will generally be lower than 1.6 to 3.3 ft/sec observed by Close et al. (1995); however, these velocities may be present in some areas.

### 6.10.3 River Lamprey Juvenile Rearing

Similar to larval Pacific lamprey, river lamprey ammocoetes rear in slow-moving waters with high levels of fine organic materials. The ammocoetes burrow into the substrate and feed on algae and microscopic organisms filtered from the water (Wydoski and Whitney 2003). Flow reductions resulting from withdrawals for water supply could have two potentially offsetting effects. First, reduced flows could reduce a stream's wetted perimeter, particularly during low flow periods, which consequently could result in reductions in the

area of habitat available to larval lamprey. On the other hand, flow reductions could also reduce water velocities in some areas, which could increase the area where fine organic materials and sediment could settle out. Moore and Mallatt (1980) reported that larval lamprey have specific velocity requirements (0.16 to 0.49 ft/sec) that are suitable for the settling of fine materials.

Assuming similar habitat requirements for both Pacific and river lamprey ammocoetes, analysis of the PHABSIM transects described above indicated that flows of 5 cfs or less result in modeled mean channel velocities that are within the optimal range reported by Moore and Mallatt (1980), suggesting that under some circumstances withdrawals may improve velocities for larval habitat rearing conditions. Confounding improved velocities for rearing, the rate of change in wetted perimeter is highest at lower flows, suggesting that water supply withdrawals and augmentation during low flow periods could have a relatively large effect on wetted perimeter.

### 6.10.4 River Lamprey Downstream Migration

The downstream migration of juvenile river lamprey occurs from April to mid-June (Wydoski and Whitney 2003). The downstream migration is passive and based upon the passage of other lamprey species at dams, occurs primarily at night. Water supply withdrawals at the Clark Springs System are a relatively small proportion of the surface streamflow during the period of outmigration. Consequently, operations of the Clark Springs System will not likely impact the outmigration of Pacific lamprey.

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# 7. COSTS AND FUNDING OF THE CONSERVATION AND MONITORING MEASURES

## 7.1 Introduction

Under Section 10(a)(2)(A) of the ESA and regulations promulgated thereunder (50 C.F.R. §§ 17.22{b}{1}, and 222.22) an HCP submitted in support of an Incidental Take Permit must establish "the funding that will be available to implement such steps the applicant will take to monitor, minimize, and mitigate the impacts from the proposed taking." The USFWS and NMFS HCP Handbook states that "whatever the proposed funding mechanism is, failure to demonstrate the requisite level of funding prior to permit approval .... (is) grounds for denying a permit application."

The City of Kent prepared this HCP to conserve and enhance fish and wildlife habitat and to support its application for an Incidental Take Permit. These actions will assist the City in gaining certainty over its ability to meet the current and future water supply demands of its service area. As noted in Chapter 1, the City's Clark Springs System serves as its largest and primary water source that supplies up to 60 percent of the City's total water demand.

The HCMs identified and described in Chapter 4 are intended to avoid take and to minimize or otherwise mitigate to the maximum extent practicable the impacts of take associated with the operations of the City's Clark Springs System. The MEMs described in Chapter 5 were developed to ensure that the HCP conservation measures comply with appropriate design standards and that the measures are effective in meeting their goals.

The City of Kent will provide such funds as may be necessary to carry out its obligations under the HCP and the Implementing Agreements. The City will notify the USFWS and NMFS if and to what extent there are any material changes in its financial status.

## 7.2 Estimated Costs of the Habitat Conservation Measures

The estimated cost of the HCMs, including costs for design, permitting, and construction of the habitat enhancement related measures and the Riparian Acquisition, Easement, and Enhancement Fund developed specifically as part of this HCP will total over $2,500,000 dollars (2005 dollars), not including the costs to provide augmented stream flows during the critical low flow period (HCM-1) or the water conservation program (HCM-7). Final costs will depend on results of the monitoring and need for adaptive management (Table 7-1). The two major costs of the habitat conservation measures relate to the flow augmentation and habitat enhancement measures consisting of HCM-1 through HCM-6, and the Riparian Acquisition, Easement, and Enhancement Fund in Rock Creek Basin identified as HCM-8. The above costs do not include costs associated with the value of the water that the City of Kent will forego as part of its obligation under HCM-1. The total monetary value of that water to the City of Kent is highly variable depending on the quantity and duration of augmentation water provided during the augmentation period. Costs associated with the City's conservation program are likewise not included.

## 7.3 Estimated Costs of the Monitoring Program

As described in Chapter 5, the City of Kent will implement a series of monitoring measures designed to ensure the HCMs are implemented according to specified standards and as agreed to by the Services. In most cases, the monitoring consists of verification that the measures have been implemented as specified (Table 4-1). For example, MEM-1 is focused on the monitoring of stream flow in Rock Creek and is directly linked to the flow augmentation program described in HCM-1. MEM-4 is focused on monitoring the Rock Creek passage improvements that will be constructed as part of HCM-2. As described in Chapter 5, monitoring is also included directly in several of the HCMs including HCM-3, HCM-4, HCM-5, and HCM-6. Project completion reports or periodic summaries of activities conducted specific to each measures will be prepared and submitted as described in Chapter 5. Changes to any of the HCMs may result in changes in monitoring requirements. However, it is difficult at this time to predict the extent of changes that may be necessary.

Overall estimated monitoring costs over the term of the HCP will total approximately $2,509,000. Actual costs may be greater due to inflation.

## 7.4 Proposed Funding to Implement the HCP

The City of Kent will fund its commitments made in the HCP as summarized in Tables 7-1 and 7-2. Funding will be from sources at the City's discretion, including but not limited to, revenues from the sale of water and land, and from outside sources such as grants or contributions. The City will strive to achieve an efficient and effective use of the specified funds to accomplish the goals, objectives and elements of the HCP.

It should be noted that all cost estimates and commitments in the HCP are given in 2005 dollars. Inflationary or deflationary adjustments will not commence until the date an ITP is issued.

Table 7-1. Summary of Costs for HCMs specified in the HCP.

| Habitat Conservation Measure | Title | Summary | Estimated Costs in 2005 dollars |
|---|---|---|---|
| HCM-1 | Flow Augmentation Plan | Augment flows to maintain the flow target in Rock Creek downstream of the Clarks Springs facility from October 1 through December 31, with some variation in the amount of augmentation required based on a wet, normal, dry and drought year basis (see description in text). | Up to $387,504 annually |
| HCM-2 | Passage improvements at mouth of Rock Creek – Reach 1 | Modify Rock Creek channel at the mouth of Rock Creek to provide increased water depth during low flows. | $55,000 |
| HCM-3 | Wetland Improvement and | Connect existing pond adjacent to Reach 1 of Rock Creek to improve off-channel | $40,000 |

Table 7-1. Summary of Costs for HCMs specified in the HCP.

| Habitat Conservation Measure | Title | Summary | Estimated Costs in 2005 dollars |
|---|---|---|---|
| | Juvenile Salmonid Habitat Enhancement – Reach 1 | habitat conditions. | |
| HCM-4 | Wetland Improvement and Juvenile Salmonid Habitat Enhancement – Reach 2 | Improve connectivity and habitat conditions in the existing off channel wetland in Reach 2 of Rock Creek. | $69,000 |
| HCM-5 | Summit-Landsburg Road culvert replacement-Reach 8/9 | Replace the culvert at the Summit-Landsburg Road crossing with a structure that meets existing WDFW fish passage criteria. | $680,000 |
| HCM-6 | LWD Placement – Reach 10 and 12 | Place LWD in Reach 10 and Reach 12 of Rock Creek within the City of Kent watershed property to increase hydraulic complexity. | $62,000 |
| HCM-7 | Water conservation program | Continue and update ongoing City of Kent water conservation program. | $9,300,000 – total estimate over 50 years |
| HCM-8 | Riparian Acquisition, Easement, and Enhancement Fund in Rock Creek Basin | Establish a Habitat Fund to mitigate for impacts associated with operations of the Clark Springs Water Supply System. | $1,600,000 |

Table 7-2. Estimated costs for monitoring and evaluation of habitat conservation measures.

| Monitoring and Evaluation Measure | Title | Summary of Measure | Estimated Costs $ |
|---|---|---|---|
| MEM-1 | Rock Creek Flow Monitoring | Provide funding to maintain USGS gage 12118400 Rock Creek at Highway 516 near Ravensdale. | $1.86 million |
| MEM-2 | Precipitation Monitoring at Landsburg | Provide funding to the USGS to work cooperatively with Seattle Public Utilities to monitor precipitation at Landsburg, to assist in refining classifications of Wet, Normal, Dry, and Drought conditions. | $132,000 |
| MEM-3 | Spawning Surveys in Rock Creek | Conduct spawning surveys at least two years prior to and four years after implementation of HCM –2. Conduct spawning surveys over Index Reaches every fourth year thereafter through the duration of the ITP. | $410,000 |
| MEM-4 | Rock Creek Mouth-Passage Improvements | Document successful project completion and annually check on project functionality. | $104,000 |
| MEM-5 | Wetland Fish Use Monitoring | Document if fish are utilizing the wetlands | $3,000 |

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# 8. ALTERNATIVES TO THE PROPOSED INCIDENTAL TAKE

## 8.1 Introduction

As required under Section 10 of the Endangered Species Act (ESA), the City of Kent has considered multiple alternatives to the incidental take contemplated in this Habitat Conservation Plan (HCP). These alternatives, and the reasons they are not being utilized by the City of Kent, are discussed in this chapter.

The Clark Springs Water Supply HCP and Incidental Take Permit (ITP) cover a variety of activities associated with water supply withdrawals, related facilities, and operations, maintenance and replacement of the infrastructure, within the Clark Springs Watershed. The number of alternatives considered in the course of the HCP's preparation were limited because of the City's intention to meet water demands within the context of the Clark Springs System's existing water rights and installed capacity, and because available in-basin mitigation opportunities are limited.

The City of Kent has identified and reviewed two alternatives to the proposed water withdrawal. These include the No Action Alternative (i.e., continue existing operations, without an HCP and ITP), and the alternative of terminating withdrawals at the Clark Springs water source. These alternatives are discussed in more detail below.

## 8.2 Alternatives to the Proposed Water Withdrawal

### 8.2.1 No Action Alternative

Under the No Action Alternative, the City of Kent would not implement the HCP, would not develop the projects described in Chapter 2, and would not receive incidental take coverage for its water supply operations at Clark Springs. The City would instead seek to avoid the incidental take of listed species while maintaining existing Clark Springs operations and withdrawals consistent with applicable laws and water rights. This means the stream flow mitigation proposal would not be required nor implemented, and augmented flows would not

be guaranteed. Further, the Habitat Mitigation projects identified in Chapter 2 would not be funded nor implemented.

The Habitat Mitigation projections that would not be pursued include fish passage projects and habitat improvements. The habitat fund (see Chapter 2) that would be used to acquire additional property, conservation easements or habitat improvements would not be established. It should be noted that some of the habitat conservation measures in the HCP have been identified by the WRIA 8, Lake Washington / Cedar / Sammamish Watershed Chinook Conservation Plan as needed projects. Under the No Action Alternative, funding sources other than the City of Kent would need to be obtained in order to move ahead with the design and construction of these projects.

The City of Kent's continued withdrawal of water from the aquifer in the Rock Creek basin would have an effect on instream resources, but said effects to date have not been linked to quantifiable levels of take. However, a final ESA Section 4(d) rule for listed fish species has not been issued to identify measures that would be necessary to avoid/reduce take. Consequently, it is possible that continued withdrawal by the City could result in future, undetermined restrictions on water supply operations, pursuant to further rulemaking or project impacts.

In practical terms, the No Action Alternative and related absence of an ITP, would create risks to the City's overall system and fire flow capacity that protect public health and safety in the Kent community, and its ability to meet existing and projected water demands in the event current operations do result in take. In order to avoid such risks, including the take of listed species (Chinook salmon) known to occasionally utilize Rock Creek for brief periods, the City could alter or reduce current water withdrawal patterns from Clark Springs for a portion of the year when listed species are likely to be present in Rock Creek. However, these measures would not provide certainty that: 1) desired habitat enhancement projects and funding for a habitat enhancement and protection fund would occur; and 2) water supply demands could be met in a reliable manner.

Without reliable, sustained production from the Clarks Springs system on an annual basis, there is a significant risk that the City of Kent would not have the water necessary to supply current residential, commercial, and industrial customer demands, and that seasonal deficits could occur on a yearly basis. As described in Chapter 2, the City is currently meeting water supply demands because of its highly efficient water system, aggressive conservation measures, and moderate levels of economic growth. Under the No Action Alternative, the City of Kent would potentially need to move beyond those measures and utilize much more problematic and risky alternative water sources to offset reduced supply from Clark Springs.

For the past 20 or more years, and also more recently as a continued effort, the City of Kent has investigated alternative water supplies and water management to alleviate the projected deficits in future water supply. As described in Appendix G, these investigations have included:

- Acquisition of existing water rights;
- Water right changes;
- Regional supply;
- Aquifer storage and recovery;
- Desalination;
- Water reuse;
- Conservation;
- Wellhead protection; and
- Well replacement.

None of the investigations resulted in the identification of cost-effective, feasible, or reliable alternative water supplies to the Clark Springs Water Supply Facility.

The City of Kent's projections on future water demands suggest that supply deficits will occur during some months (primarily late fall) even after the Tacoma Second Supply

Project, providing Howard Hansen Dam water and is available for summer water use. Seasonal reductions of water withdrawals at Clark Springs would exacerbate the expected deficits even further. Consequently, during those months when use of the Clark Springs Water Supply is constrained, the City would face significant difficulty in meeting demand. It is also possible that the City would be forced to implement more severe summer and fall supply restrictions, which could include a total ban on outdoor water use and water rationing, resulting in economic hardship to industrial, commercial and residential customers. A moratorium on further growth within the service area could also be required. It should be noted that under this scenario, junior water right or exempt well users after 1931 in the Rock Creek Basin may be held to the same or more stringent standards as Kent, that of reduced or no water withdrawals in the basin, in order to avoid "take" of the endangered species.

The City of Kent has chosen not to utilize the No Action Alternative because of the potential adverse water supply consequences to Kent's customers, the risks to Kent's economic future, the loss of fish habitat and flow augmentation benefits associated with the HCP, the absence of reliable and cost-effective source alternatives, and the City's desire to have reliable sources of municipal water supply that advances public health, safety, and economic opportunity in the South King County area.

### 8.2.2 Close the Clark Springs Water Supply Facility

Under this alternative, the City of Kent would cease water supply operations at Clark Springs, and sell or develop the property that it owns in the Rock Creek Basin, and which has been fully annexed into the City of Kent. If this alternative was implemented, it would not be necessary for the City of Kent to seek an ITP because any potential for take as a result of the City's withdrawal activities at Clark Springs would be eliminated. However, this alternative was not considered for adoption because of severe water supply impacts, adverse economic impacts, uncertainty about replacement water supplies, and unknown costs and environmental impacts associated with developing a replacement water supply. In addition,

the protection and mitigation benefits associated with the HCP would not be implemented. If the Clark Springs Watershed is sold and developed, the likely effects would be the loss of forested area and the increase of roads and other impervious surfaces in the Rock Creek Basin, potential traffic and community impacts upon the Maple Valley area, as well as other growth impacts upon the surrounding environment. Increases in impervious surfaces and decreases in forest cover has been correlated in urban and urbanizing watersheds with the presence of flashy stream systems with more frequent and higher peak flows from precipitation events and lower base flows during late summer and early fall seasons (May et al. 1997). With no facilities in the Rock Creek Basin, Kent would no longer have a vested interest in the Rock Creek Basin environment, nor in the oversight of activities that may have an adverse effect upon the environment or water supply of the basin. Impacts created by such activities as the Landsburg Mine site where industrial waste was disposed, mining operations and gravel removal pits, natural gas extraction, logging, additional development and other land uses that further impact the environment and water supply, and many other areas are all activities that Kent would no longer monitor, comment on during permitting procedures nor work with enforcement agencies to ensure adequate management of proposed and existing activities.

Kent recognizes that the Clark Springs watershed is a pristine corner of the heavily impacted Rock Creek basin, and realizes the environmental benefits of Kent remaining in the basin and serving as a steward of the environment with a vested interest in better managing adverse environmental impacts in the basin. These factors, as well as those described above in this chapter, have influenced Kent's decision to pursue the HCP/ITP for its Clark Springs water supply operations in the Rock Creek basin and continue to be an active partner in the management of the resources of the basin for the foreseeable future.

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